

THE TEST

**SOLAR LIGHT FOR ALL:
A DEFINING CHALLENGE FOR HUMANITY**



JEREMY LEGGETT

More than a billion of the world's poorest people, having no electricity, are forced to waste \$27 billion a year on kerosene and other unsustainable forms of lighting. If every one of their households could buy a single solar light, they would save at least \$78 billion over three years, and spend it on basic necessities, not least food in a time of famine. They would also avoid kerosene's dire health assaults and high carbon emissions, while significantly lifting their education prospects via more than a trillion extra homework hours.

If we cannot collectively banish this particularly crazy dysfunction from our world, Jeremy Leggett argues, what chance do we have with all the many other global problems we face?

From the front lines, he chronicles society's efforts to pass this test, in serialised chapters as the story unfolds.

“Leggett brings us another vibrant, first-hand account of the continuing struggle for energy revolution, showing how the tipping point away from fossil fuels has clearly been reached, but that much effort is still required for even simple tasks like ridding Africa of the kerosene lamp.”

Ashley Seager,
former Economics Correspondent, The Guardian

“...an enthralling, vivid, narrative ...if you start reading you won’t be able to stop, I guarantee”

Walt Patterson,
Senior Associate, Chatham House

“This book is better than “Game of Thrones” in the tension it creates for me in wanting to know what happens next. Leggett writes about the most important issues of our times - poverty alleviation and climate change solutions - in the mode of a can’t-put-it-down adventure story. Certainly in the wonky world of energy and climate politics you won’t get anything as readable and real. Sign up for free downloads now to find out if we, humanity, will pass The Test and how you can help make it so.”

Danny Kennedy
Managing Director, California Clean Energy Fund

“...gets to the heart of a great global issue, in unputdownable prose.”

John Hassard
Imperial College Institute of Security, Science and Technology

“...very moving and provocative.”

Dan Shugar
CEO, NEXTracker

“...more brilliant insights from Leggett - he is so right about the role of corruption”

Charmian Gooch, Co-founder,
Global Witness

“We’re only into chapter 2 of ‘The Test’, and the betrayal of some of East Africa’s poorest people already shouts out for urgent action. This has to be the simplest message in our sustainability world: kill kerosene for lighting now, in the process eliminating billions of dollars of government subsidies. Cut out the poor quality counterfeit lights, and allow today’s quality-verified solar lights to deliver the biggest possible economic benefit to households, communities and national economies alike – in terms of the massive uplift in net purchasing power that would result.”

Jonathon Porritt,
Founder, Forum for The Future

Royal Albert Hall, London, 4th July 2017

The great auditorium is decked out as though for the Oscars. Closely packed circular tables are laden with linenware, glassware, silverware. There are tables even in the boxes where elites sit for concerts. Behind the stage where the orchestras and bands normally play, velvet drapes soar to the domed ceiling, dripping with glitter. Spotlights throw shafts of mauve through air more accustomed to arias, finales, Land of Hope and Glory.

The awards are not for the movie industry tonight. Nor the music industry. They are for the business world. The Prince of Wales's Business In The Community organisation is staging its 2017 Responsible Business Awards.

More than a thousand company executives from more than a hundred companies sit with their companions listening to the chatter of two celebrity BBC presenters, one from television, one from radio, whose job it is to announce the winners. These happy folk come and go, to blasts of brassy music and loud cheers from the tables where their corporate entourages sit.

I try not to grind my teeth. Most of the seats here cost £450. I can't help a few uncharitable thoughts in consequence. I'm like that. I while away awards dinners calculating how many Malawians can be fed or educated, or both, for the half a million pounds a concert-hall full of rich people spends on a single evening of fine food and champagne.

I know I shouldn't. I don't hesitate to spend £100 on an occasional round of golf. A grown man whacking a piece of plastic around manicured lawns, burning money while one in nine fellow humans go malnourished.

But here is the thing. The thing, I tell myself on a regular basis, is to do *something*. And most of the people in the Albert Hall tonight *are* doing something.

In any case, there is more than sniffiness about opulence behind my teeth grinding. I am concerned that an organisation I founded might actually win one of the awards.

There are nine trophies to be handed out tonight, in different categories of responsible business. The penultimate one, sponsored by global retail giant Unilever, is the Global Development Award. SolarAid's wholly-owned retail

operation, SunnyMoney, is on the short list for this award. The problem I have is that I do not view either SunnyMoney, non-profit seller of solar lights in Africa, or SolarAid, charitable fundraiser for such selling, as success stories. There is a part of me that is almost appalled that we might win. If we are indeed as good as it gets in the corporate world's contribution to global development in 2017, I tell myself, then God help the poor in Africa.

The tables are for ten people, and I have ten companions this evening. I have volunteered to be the odd man out, and am sitting at a table across the hall from them. They are from SolarAid, SunnyMoney, and Yingli Green Energy Europe, the Chinese solar manufacturer with whom we are partnered in developing new solar lights. I refused to permit a single penny of SolarAid money to be spent on even a single SolarAid or SunnyMoney attendee. Yingli then offered to pay for the whole table.

They are probably having a better time without me around. For most of the ten year history of SolarAid, I have been chair of the board, and the organisation has been run by chief executives. But since January, and the tragic retirement through ill-health of the latest incumbent, a brilliant man called Nick Sireau, I have been a reluctant acting chief executive. This is not how I expected to be spending most of 2017. I have told the youthful team that there will be two GOGLAs in their lives until the next chief executive takes over, in September. One is the Global Off Grid Lighting Association, the trade body of the solar lighting industry. The other is their temporary boss: Grumpy Old Git Lacking Appreciation.

Here is why I tend to grumpiness. The number of people without access to grid electricity in our world is 1.2 billion, 16% of the global population. Many of these billion-plus are forced to use expensive oil-for-lighting in the form of filthy and dangerous kerosene lamps. This costs them around \$50 a year, in the countries where SolarAid operates. A solar light, in utter contrast, costs the end-user a one-off payment of \$5, in the case of the product Yingli and SolarAid have developed together, the SM100: one of the most affordable solar lights available in the world today. That light will last a minimum of three years and more likely five.

Let us do the math, as Americans like to say.

SolarAid's SunnyMoney, or indeed any other of the hundred-plus solar lighting companies operating in East Africa, can sell solar lights that free up cash for the buyer - just from cancelled kerosene costs - approaching \$150 over the lifetime of the product (assuming a conservative 3 years for that lifetime). Many of the buyers are people trying to live on little more than a dollar

a day. \$150 is a huge sum for them: a sum that can be spent on food and other necessities, in a time where famine is stalking the continent. In Malawi, the average annual income is \$225.

The term “no brainer” is often used to describe attractive economic propositions. This is well beyond a no brainer. Each solar light is effectively a licence to print money for the poorest of the poor, and in fistfuls of dollars every year.

So how many solar lights has the global solar lighting industry sold to the global community of a billion-plus souls languishing without grid electricity? The Global Off Grid Lighting Association and the World Bank's Lighting Africa project together recently published cumulative figures through to the end of 2016, for branded lights with verified quality standards. The answer is shocking: less than 30 million.

What's more, not all of these went to people without electricity. Many of those across the world who are connected to the grid also have inadequate or unreliable access to electricity, given the amount of time grids malfunction.

It gets worse. The GOGLA / Lighting Africa figures also show - at a time of soaring global sales of larger-scale solar systems - that sales of solar lights have actually been falling in 2016.

Then there is the replacement rate to consider. Many solar lights only last 2 to 3 years before needing to be replaced. Factoring that in, Bloomberg New Energy Finance concludes that that the global solar lighting industry is not reaching any more new customers than it did three years ago.

How can that be? What is going on? Why are we letting all that free money go to waste, never mind all the other social benefits of solar lights?

SolarAid's sales via SunnyMoney have fallen too. In part that is by design. Our model is different to the for-profit model of most solar lighting operations. We exist to kick start solar markets for others. We use philanthropic funding raised by SolarAid to fund retail operations by SunnyMoney that sell solar lights to African people without making a net profit, so that they can resell the lights for profit. In this way we create jobs, get solar lights into the hands of end users, trigger cash savings some of which gets spent on more solar lights, and so prime a market. The more we pump frontier markets this way, the more likely they are to take off, so that conventional commercial companies can take over from us.

Unlike many potentially big ideas, we know this one can work. We catalysed the first two African solar lighting markets between 2012 and 2015, in Kenya and Tanzania. We define a catalysed market as one where more than 10% of kerosene lamps have been displaced. Key peers in the solar lighting industry,

not least the Global Off Grid Lighting Association itself, agree that SolarAid was primarily responsible for the takeoff of these markets. They want us to repeat the act as many times as we can in Africa's 50 as-yet uncatalysed markets.

But this is to gloss over our weaknesses and failings. We were too slow to exit the markets we had kick started in 2015. As fully commercial companies piled in behind us, backed by more than 200 million dollars in venture capital, we found our sales plummeting, and almost overnight – or so it felt to me – faced an existential cash-flow crisis. In 2015 and 2016 we fought to stabilise our sinking ship. After an ocean of pain, we just about managed to do so. Now we are trying to catalyse frontier markets in Malawi, Zambia and Uganda. But we are resource limited and struggling, as things stand.

Hence my embarrassment at our being short-listed for the BITC Unilever Global Development Award. It is compounded by my sense of personal responsibility for the cash-flow crisis. As chair of the board and founder, I could have pre-empted the crisis by leading development of an exit strategy appropriate for the catalysed markets. I didn't even have one drafted. I made the elementary mistake of thinking that because sales had gone exponential so quickly, they could continue to grow almost by default.

OK, other colleagues signed off on this too. But the mistake is so obvious, with the benefit of hindsight. I could and should have seen it coming.

Back to the Albert Hall. On the SolarAid-SunnyMoney-Yingli table of ten, I am sure excitement is growing. We are on the short list for the award thanks to the passionate pitching of a trio of three to a very senior panel of judges from companies including Unilever, Bank of America and Coca-Cola. Jamie McCloskey of SolarAid covered the SolarAid/SunnyMoney model, our history and prospects. Lorraine Hammond of SolarAid talked numbers. Carolin Staehler of Yingli recounted our joint product-development story.

I was in Mexico at the time, on wider solar industry duty. Probably just as well.

The time for the Global Development Award arrives. Unilever's Chief Sustainability Officer, Jeff Seabright, comes onto the stage to present it. The drums roll, and there is the usual fumbling with the envelope. Or did I just imagine that. At this point I am not concentrating.

A shared top prize. And the winners are, in the small business categorySunnyMoney.

Smile on fixed, Leggett, I tell myself.

The dramatic music blasts and dining companions reach to shake my hand as I stand up.

Across the Albert Hall I see four of my ten rise ecstatically from their seats. The others are clapping quite as loudly as the Barclays table did when their award was announced.

Astana, Kazakhstan, 10th - 11th July, 2017

The Expo of 2017 has the topical theme of 'Future Energy'. Astana, the city in the steppe, is adorned with banners the length of the road in from the airport, and many of them suggest that solar and wind energy are the centrepiece of this future. This is somewhat remarkable, considering that Kazakhstan is plentifully endowed with oil, coal and gas.

But these days even major oil producing nations appreciate that a great global energy transition is looming before them. The Crown Prince of Abu Dhabi has told his people they will be exporting no more oil by 2050, and will not be unhappy about it, given all the clean energy they will have invested their oil money in in the interim. The ruler of Dubai has signed his nation up to fully 75% of national energy from clean sources by 2050, and a solar roof on every building by 2030 en route. Even Saudi Arabia is getting in on the game of late, with a \$50bn push into solar and wind. Kazakhstan is in good company.

Five years ago, I helped Astana win the Expo, in competition with other short-listed cities around the world. The Kazakh government invited me and a renewable energy expert from the International Energy Agency to make the opening pitch to the judges: commissioners from the Bureau International des Expositions. Our brief was simple: paint a picture of the clean energy revolution in as wonderful a light as you can. Now I have been invited back, to do essentially the same thing, updated, at a conference in the Expo itself.

Much has changed in those five years. The Expo site looks as though it has been descended on by every eminent architect in the world, armed with a simple brief to avoid straight lines and very few other instructions. The brand new mini town they have collectively designed is a polymict eruption of curved walls, domes, and spheres. The conference centre I am speaking in is a marbled marvel of bends. Kazakh families and foreign visitors wander the boulevards and pavilions where the nations of the world are staging exhibitions of their versions of what Future Energy looks like. Again, images of solar and wind abound.

Since the night in the Albert Hall, I have been thinking hard. The idea has grown on me that fixing the conundrum of expensive and high-carbon kerosene vastly outselling inexpensive and zero-carbon solar is a defining test

for humankind. If we cannot quickly replace oil-for-lighting with solar lighting, given all the blindingly obvious economic and social imperatives for so doing, what chance do we have with all the many other global problems we face? In an age of climate treaties and UN Sustainable Development Goals, where we are making progress on many fronts, how can we be taking so long to kick this open goal? How can we be failing this test?

One of the 17 United Nations Sustainable Development Goals sets a target for when we should pass it by. Goal 7 entails ensuring “universal access to affordable, reliable and modern energy services” by 2030. 190 world leaders signed off on that, in 2015. At the rate of progress since, with a grand total of less than 30 million lights in the hands of the 1.2 billion, there is precisely zero chance of achieving it. We must greatly accelerate the deployment.

I ponder the message to deliver in Astana. I could easily portray the global energy transition today in even more upbeat terms than were possible five years ago, both in terms of accelerating progress with clean energy - other than solar lights - and snowballing setbacks for fossil-fuels. But I dare not leave out the story of kerosene versus solar. It is simply too much of a thorn in the side of optimism.

I have been asked to give two presentations on two consecutive days. I elect to make the first a bullish celebration of how fast the solar element of the clean-energy revolution is unfolding, and the second a tale in two parts: initially an optimistic exploration of how battery storage, electric vehicles and energy efficiency can accelerate the clean-energy revolution, followed and much tempered by *The Test*.

The first morning. My first presentation, the second of two opening key-notes. I suggest that the global energy transition is unfolding much faster than most people realise. New global renewable power generation capacity exceeded new fossil fuel capacity in 2015 & 2016. Onshore wind and solar will become the cheapest two options in many nations by 2020, analysts profess. Solar seems set to become the cheapest power on Earth, Bloomberg reports: it is already less than half the price of coal in recent auctions. Many nations, states, cities, and corporations are eagerly leaping aboard the revolution. In California, the Senate passed a mandate for 100% renewable power by 2045. More than 1000 cities and 100 major companies target 100% renewable power. Canberra plans to hit 100% by 2020, Google by 2017. Employment reflects all this. There are now many more US workers in solar and wind than in coal and gas: 475,000 compared to 55,000 in coal mining.

Meanwhile, fossil fuel investments are nosediving. It is easy to see why. Coal looks to be in terminal decline. China's new coal plants make "no economic sense", the International Energy Agency has concluded. Despite huge cuts in expenditure, most oil majors couldn't even cover their costs in 2016, even at an average \$50 oil price. The industry is piling up a mountain of debt just to keep operating. Its business model is broken at a systemic level. France now intends to ban all oil and gas exploration. The oil company with the highest share price in North America, Suncor, is favoured by investors because it has said it will stop looking for oil, and give the expenditure saved back to investors as dividends. Meanwhile long-term oil investors have begun giving up on the industry, and switching to renewables.

Bullish as clean energy industry practitioners like me are about all this, Silicon Valley gurus are more so. By 2030, Tony Seba professes, all new energy will be solar and wind, all new cars will be electric vehicles. Oil and gas demand will be in steep decline.

This is total system change, and it has happened before, in little more than a decade, when the the horse-drawn carriage was displaced by the horseless carriage, otherwise known as the motor car.

You don't have to believe enthusiasts like me on this, I tell the audience. As the popular BBC tech programme Click concluded recently, "The solar revolution is coming... fossil fuels could be facing extinction."

Kazakhstan has chosen the theme of its Expo well.

On the afternoon of the first day I take some time to explore the Expo site. The first pavilion I come to, walking clockwise from the main gate, is not a national exhibition, but a company one. Shell's logo adorns a tent with the theme "Make The Future". The exhibition inside subtly advances Shell's view that oil and gas have to be the backbone of making the future, when it comes to energy. The only putative future vehicles on display are all designs by students. They look like amateur night at the whacky races. There is not a hint of what is going on at Tesla, Daimler, and all the carmakers whose innovation permits nations and cities realistically to contemplate and in some cases already begin setting targets for completely banning internal combustion engines, diesel and otherwise. Similarly with the treatments of solar and wind: no sense at all that these technologies are the cheapest available in some countries, and set to be the cheapest in most countries in just a few years. As for oil, not a hint of the debt mountain being built up by the oil industry as it doggedly pursues its flawed

business model. A big picture of the Kashagan oilfield in Kazakhstan, in which Shell has a major stake, is prominent in the exhibit. There is no mention of how many years that project was delayed by, in the face of costly and unforeseen technical problems, and how many billions of Euros it was over budget. Shell employees came to dub the Kashagan project CashAllGone. I know because they told me.

Shell might just as well have been honest and put up a statement of their basic message: “Grown ups get their energy mostly from fossil fuels, and their motive power mostly from the internal combustion engine, and so they will for decades to come.”

Here, then, is one aspect of *The Test*. Can a company like Shell switch from being a barrier to future clean energy, to being part of the solution? In the case of the kerosene-solar conundrum, can it play a material leadership role in getting rid of an entire, indefensible, category of oil use?

Other oil companies are doing better than Shell are, as things stand, when it comes to renewable energy. Norway’s Statoil has set up a renewable energy division, and is playing to its offshore engineering strengths by pioneering the development of floating wind farms. This work holds the potential for dramatic reductions in the cost of offshore wind. Total, the French oil and gas major, has invested hundreds of millions in solar, batteries and other elements of the clean energy revolution. It also sells solar lights of its own design and production. The company recently sold its 2 millionth light, outstripping SolarAid’s 1.9 million. It sells most of its lights from petrol forecourts across Africa. Total targets 5 million lights by 2020: not enough, in my view, but miles better than any other oil company. I sent a note of congratulations to the Senior Vice President for Sustainable Development & Environment, Jerome Schmitt, when they passed 2 million. I received a charming reply. “We definitely share a comparable journey”, he said.

Could I ever imagine such an interaction with Shell? Not today. But history is not destiny. And the global energy-transition drama is playing out so very fast.

The next day, in my second presentation, I continue the theme of the first. This isn’t just about renewable supply, I say, its about battery storage and electric vehicles. Things are moving rapidly in every leg of this trio. Take the events of the recent week. On 5th July the first major carmaker called time on internal-combustion-engine-only cars. Volvo will use electric motors in all cars from 2019. The next day, Bloomberg’s annual prediction of electric vehicle growth significantly exceeded last year’s estimate: EVs will be cheaper than conventional

cars in most countries by 2020-2025, and by 2040, 54% of new vehicles and 33% of all light vehicles on roads will be EVs. The same day France announced a plan to ban sales of petrol and diesel cars by 2040. That would have sounded radical a year ago. Now, Tony Seba suggests that it is actually irrelevant: there won't be any petrol and diesel cars left to ban by 2040!

Meanwhile, in breathtaking contrast, the oil majors are arguing that the vast majority of global primary energy will still be coming from fossil-fuels at that time. Good luck with that, in the face of the daily news about renewable energy and electric vehicles.

Where does the developing world sit in my tide of bullishness about a clean energy future, I ask?

And so to *The Test*.

I make the basic case, and repeat the question that frustrates me so much. How can it be that, collectively, we are missing such an open goal?

I am sure that the reasons are multi-faceted. But there is one simple over-arching answer. None of us are trying hard enough. Not governments, not companies, not international organisations, not non-governmental organisations.

In this respect, I observe, the Expo has a plan for real-life projects to follow up the theme of the event. I have one for the organisers to consider, I say. Help SolarAid in our quest. Let's together figure out a way to play a lead role in eradication of the kerosene lamp. What a great way to cement the legacy of the Expo.

An ambitious notion is beginning to take shape in my mind, triggered in part by my experience in the Albert Hall a week ago. Sitting in that hall, that night, were executives from companies and organisations that could eradicate the kerosene lamp from the world within a matter of years, if they chose to work together with seriousness of intent. There were plenty not present who could add considerable fuel to such a campaign. It seems clear to me now what SolarAid should do in the next few years. We should try to work with enough of those companies and organisations, in clever enough ways, that we play a useful role in ensuring that civilisation passes *The Test*.

Johannesburg, South Africa, 18th July 2017

Mandela Day. South Africans are celebrating the life of the father of their unified nation, four years after his death. Foreigners too. In Capetown, Richard Branson leads a parade with The Elders, a group of former world leaders and other senior luminaries that Nelson Mandela created to promote peace and human rights.

The theme of Mandela Day this year is action against poverty. South Africa's National Development Plan aims to eliminate poverty and reduce inequality by 2030, consistent with UN Sustainable Development Goal number one. They have a long way to go. More than 63% of South African children live in poverty as things stand. Sustainable electrification will be vital if African nations are to hit their poverty alleviation targets, and that is why UN Sustainable Development Goal 7 has the goal of clean energy for all by 2030. I am at the Power Gen Africa conference and trade show, a gathering of 3,000 electricity-industry professionals from all over Sub-Saharan Africa, checking out progress.

The conference is making a Mandela Day donation to SolarAid to kick the proceedings off. I shake hands with the conference organiser as he hands me a fake cheque the size of a desk. A short speech is required, and I recount my memories of reading *The Long Walk To Freedom*, Nelson Mandela's autobiography published in 1994. I recall a passage about the arrival of electric lighting in his village, and the impact it had on his life: his delight at being able to read long into the night, fuelling the education and wisdom that teed up the transformative things he would be able to do later in his life. But how many young South Africans are able to do that today without wasting their money on kerosene, I ask? I recount the arithmetic of *The Test*, and invite the companies attending the conference to play a part in getting a solar light into every African home.

We wait for the next speaker, Minister of Public Enterprises, Lynne Brown, who is stuck in traffic. All is not well in the nation Nelson Mandela played such a heroic role in steering clear of implosion and civil war. The current national leader, Jacob Zuma, is mired in corruption scandals. Commentators openly accuse the President of running the country through personal networks of

favouritism and cronyism, a process they refer to as Zumafication. I am fascinated to hear what Brown has to say. I know that the corruption issue will be a huge factor in The Test, and not just in South Africa.

She has an impressive poise in speaking, as you might expect of a woman sitting at the top table in the African National Congress. She talks of a famous satellite photo of Africa, a collage of cloud-free images of the continent at night. It shows what the colonialists used to refer to as the Dark Continent, she says: in this case dark quite literally, because few lights are on in Sub Saharan Africa. Let us agree that when our grandchildren look at their equivalent of those satellite photos, they see light, meaning electricity driving prosperity.

This is where the national utility, Eskom, comes in, she makes clear.

And where corruption rears its ugly head, I think.

She does not avoid the issue. She launched a probe into Eskom in May, and has since replaced the entire board with interim directors.

I am constrained in what I am able to say today because of the ongoing legal case, Lynne Brown says, but I can say this. When apartheid fell, Nelson Mandela and his generation of leaders laid a table with enough seats for all to be able to eat. They had an agenda of redistribution but not retribution. Instead, 23 years on, the rich have become richer. If we can't redistribute the wealth better than we have, then we are doomed to an unsustainable future.

So what does a sustainable future look like?

Here the pragmatism of the politician kicks in. We cannot contemplate a future with growing carbon emissions, she says. We are already seeing climate change in South Africa, most notably in extreme drought in the Western Cape. But we can't let the long term imperative of the planet's breathability be more important in the short term need to maintain jobs. She spells it out. We must carry on mining our coal, and burning it for the foreseeable future.

Elsewhere in news today, analysts at Morgan Stanley are professing that solar and wind will be the cheapest form of power in most countries by 2020, just two and a half years from now. My colleagues at Carbon Tracker, the London-based financial think tank that I chair, tweet that on average they already are, if you do the accounting the correct way.

In Johannesburg today you would never guess. After the opening speeches, I tour the Power Gen Africa trade show. Hardly any of the stands feature renewables, notwithstanding the collective donation to SolarAid. Almost all are about building and servicing fossil-fuelled central power plants. I talk to delegates. There is a long way to go, they agree.

A long way rendered even longer in the face of corruption like modern South Africa's. Resolving this will be a key element of *The Test*. I do not speak just of South Africa. The catalogue of corruption is long, worldwide, when it comes to the defence of fossil fuels.

One of the problems that must be solved, doubtless linked at least in part to corruption, is the question of subsidies. Enormous sums flow to fossil fuels, and far less to clean-energy alternatives. The International Energy Agency tallies in excess of four times more in subsidies for fossil fuels than for renewables: \$490 billion compared to \$112 billion in 2014. This is true even in the G20 of richer nations, where \$71 billion per year went to fossil-fuel subsidies between 2013 and 2015, and \$18 billion to renewables.

Kerosene is among the wasteful beneficiaries. One authoritative study, by Evan Mills at the Lawrence Berkeley Lab in California, analyses subsidies for kerosene in the 173 countries where it is used for lighting, cooking, and heating. Kerosene for these purposes cost consumers \$43 billion a year in 2013. That sum does not include \$18 billion in direct subsidies by governments. \$7 billion of that subsidises kerosene for lighting.

Another study, by Bloomberg New Energy Finance and Lighting Global, tallies \$27 billion a year spent by the 1.2 billion people without grid electricity on lighting and phone charging using kerosene, candles, battery torches and other fossil-fuel powered stop-gap means.

To put these sums into perspective, let us calculate the cost of getting solar lighting to every one of the 1.2 billion people currently lacking access to electricity. SolarAid's cost of operations to deliver a solar light for sale in Africa are a good starting point, for illustrative purposes. Averaged across the four most recent years for which we currently have audited accounts, 2012 – 2015, they amount to \$5.5 (£4.2). In our best year, 2013, when we sold more than 600,000 lights, they were \$3.6 (£2.8). Let us use that figure for the calculation, since there would be substantial economies of scale in selling millions, not hundreds of thousands. \$3.6 is a very conservative assumption for sales at the volumes inherent in passing The Test.

An average of 5.25 people live in each household in Sub-Saharan Africa, and 5.14 in Asia, so let us take 5.2 as the average for the whole developing world. That means the 1.2 billion live in 231 million households, rounding to the nearest whole figure.

The total cost to an organisation like SolarAid of delivering a solar light for sale to each household can then be calculated: 231 million multiplied by \$3.6, equals \$0.8 billion.

But that's just the cost of getting the products to where they are needed and we still need to cover the selling of the lights themselves, assuming we are not giving them away, but trying to create micro-enterprises by selling them, SolarAid-style. Assuming that the households buy the solar lights at the lowest available retail price today (\$5), the total global cost to consumers would then be 231 million multiplied by \$5, which equals \$1.2 billion.

That is a hopelessly conservative figure, because high sales volumes would surely drive price down, as we have seen so spectacularly with solar panels. It would certainly be much less than £1 billion in reality. If so, the 1.2 billion people without grid electricity are being forced to spend more than \$26 billion a year by not using solar lights.

Adding the cost of delivery to the sales total gives a maximum cost for providing clean light to each and every one of the 1.2 billion people without grid electricity: \$2 billion.

This is 28% of just the *subsidies* going to kerosene for lighting. The *annual* subsidies. The vast majority of the solar lights would last at least 3 years.

It is a mere 7% of the \$27 billion actual global spent each year on non-solar lighting.

In fact these numbers are conservative to the point of being almost indefensible, other than for illustrative purposes, because the volume economies of scale - both in operational costs and product costs - would be huge, the more that solar lights made their way to the 1.2 billion people. Yingli and other solar light manufacturers fully expect their product costs to fall when volume lifts to millions of solar light sales a year. Long before every home would have at least one solar light, SolarAid would have rendered itself redundant, mission accomplished. Fully commercial companies would long since have taken over the charge.

But these numbers are surely one of the most spectacular examples of how dysfunctional our world can be.

Passing *The Test* does not require re-engineering the world according to some theoretically perfect model. It merely involves making it a little less dysfunctional.

Lilongwe, Malawi, 20th – 22nd July 2017

In a tattered office in a battered office block off a street of red-dust potholes, SunnyMoney's Malawi Operations Director Phil Walton and Sales Director Brave Mhonie are running me through the basics of their business.

We are selling around 80% of the quality-verified solar lights sold in Malawi, Phil says, and we have hardly any competition in the rural environment. But we are struggling, and so are all the other companies in Malawi.

I look at the figures. Team Malawi has sold 9,000 solar lights in the first three months of the financial year. Projecting that to the entire year would be 36,000 lights. That wouldn't be much more than a single shipping container full. In each of SunnyMoney's two most successful years, 2013-14 and 2014-15, we sold more than 600,000 lights, mostly in Kenya and Tanzania. Of course, those countries aren't as poor as Malawi. Average income here is well under a dollar a day.

61.7% of Malawians don't have mobile phones, Phil says. We had hoped to be selling our SM100 light into that group in boatloads, but we aren't yet, I'm afraid. Tomorrow, when you meet the sales team, we'll explore why, and what we intend to do to try and get sales to takeoff. But one of the key takeaways is that our biggest competition is poor quality and counterfeit unbranded solar lights, otherwise known as generics, that are on sale for less than quality lights.

How many of these generic lights are there out there? It is difficult to say, in any one country. But the Global Off Grid Lighting Association estimates that the global split of quality-verified lights and non-quality-verified lights is roughly 50:50.

As for the 38.3% of Malawians who do have mobile phones, Phil continues, Pay-As-You-Go - where buyers pay in instalments - should be a good option for us. We are the only solar company offering this service in Malawi. But here too we are well short of takeoff.

A member of the Malawi team demonstrates how Pay-As-You-Go works with a real light and mobile phone. The product we use, made by the Hong Kong company Omnivoltaic, is called PilotX. It has a bright light, and unlike SM-100 it can charge mobile phones. A customer pays a SunnyMoney agent for this solar light in four instalments. The light is programmed to turn off if an instalment is not paid.

I am shown the app on the mobile phone that is used to register a payment and reactivate the light until the next instalment needs to be paid. It is remarkable. Silicon Valley high tech in one of the poorest countries in the world.

The vast majority of customers pay their instalments on time. The problem is persuading enough people to trust the process, and the light, in the first place. And at least in part, that is because of rubbish generic lights undermining consumer confidence.

Evening. Beer and supper in a bar. A power cut. No lights, in a whole district, in the centre of a capital city. Among the candles, laughter. I do not hear complaints.

This mission isn't just about the off-grid population, I remind myself. In many developing countries the grid is shockingly unreliable. Even in the developed world, grids are far from 100% reliable.

Our supper is being cooked on a charcoal fire on a terrace outside the bar. The lady doing the cooking is struggling. I hand her an SM100 with a headband attached. She smiles, thanks me, and wears it for the rest of the evening, the beam of light from her forehead slicing through the carbonaceous billows from her cook fire.

Now there is another thing that will have to change if we are to hit UN Sustainable Development Goal number seven. Cooking with wood and charcoal. In the 21st century.

An all day sales meeting, in a conference centre behind a wall topped by coils of razor wire. Donnex, Ivy, Joseph, Kingsley, Martin, Saidi, and Sam span 27 of Malawi's 28 districts. They give presentations one by one, in their individual versions of the modest Malawian way. Brave, their boss, interjects regularly but unobtrusively, adding colour and detail. His is a more forceful style, radiating a confidence born of transparent passion for the mission. He has been with SolarAid for ten years, working his way up the ranks. As a reward we are paying for him to attend a block-release executive diploma course run by the University of St Gallen in Switzerland. What he makes of the city of St Gallen, after Lilongwe, I can barely imagine.

Phil Walton, a thoughtful expatriate Brit who spent years in software development in Silicon Valley, now on a one year contract as a volunteer with SunnyMoney, is a born leader. He shepherds the team through the day, building an upward trajectory in the mood.

As I listen and watch, it becomes clear that kerosene is only one of our problems in Malawi. We can retail our SM100 at 5,500 Kwachas, after

government taxes. (1,000 Kwachas = around £1). Generic products cost 3,000-4,000 Kwachas. The Chinese manufacturers have cynically designed these to be brighter than quality-verified products: an effect that lasts only for a short time, but with the price difference is enough to give low-quality lights a strong edge over high quality lights at the market stall. The generic products also tend to be bigger, another factor that plays to peoples' prejudices of what value means.

The sales team spends a lot of time pondering how to overcome all this. Marketing and PR would clearly solve a lot of this problem. But where would the resources to do this come from?

Here I can't help, at the moment. SolarAid fundraising is struggling as much as the field sales teams, as things stand.

Phil sums up. We are only serving 2.4% of the accessible market in Malawi each year at the moment, he says. We need to find the key to unlocking this, and reaching the 40% that ought to be easily available to us. Certain directions are clear in seizing this opportunity.

When it comes to the SM100, we have a Memorandum of Understanding with the Ministry of Education that allows us access to all schools. Nobody else has that. We should focus our SM100 sales on that channel. This is how we achieved takeoff in Kenya and Tanzania, and we must try our best to repeat that in Malawi.

As for Pay-As-You-Go, instead of recruiting a large number of agents with minimal ability to sell in volume, we should favour a smaller number of "Super Agents", who do have the ability, and give them rights to match our expectations of them. Crucially, they must manage the payments from customers, not our sales staff. Then the latter can concentrate of lifting sales, unencumbered by back-office logistics.

The next day I meet one of these Super Agents. Charles Lumanga, based in Salima, is a neat and articulate man, an economist by training. He describes the magnet that drew him to solar, and to finding SunnyMoney: education. He describes how his parents bent over backwards to give him the schooling he needed to break out of the poverty trap, and how determined he is to bring that to fellow Malawians, not least those closest to him.

First, he contacted another solar light company. They sold him a light that gave spectacular light the first night, but much dimmer light the next, and none on the third. He persevered, and at SunnyMoney was given the full passionate

Brave Mhonia treatment, plus exposure to lights that really worked. Now he is confident in the products SunnyMoney sells, and has big plans.

Phil asks him how we could help with those.

Could we use Airtel mobile money for payments, Charles responds. (Airtel is the biggest Malawian telecoms company). People can pay for electricity, water, and transfer money just with their mobiles. Why not Pay-As-You-Go increments? Then customers could save on travel costs to pay instalments to agents, plus avoid the inconvenience to those trips.

We would need remote activation of the light for that to be possible, Phil responds. Solar home systems can be activated remotely, but not yet the small entry-level lights like the SM100 and Pilot-X. It will come but we don't know when yet.

Charles has another question. When your staff were demonstrating Pay-As-You-Go to me I saw that each sale comes up on your office computer. Could I get that kind of sales data on my own computer?

Yes, says Phil. The software is constantly being evolved and this we can now do. More, we can now send SMS messages to all our customers via the app we use, and so will you be able to do the same, offering your customers promotions and so on.

Christmas has come, Charles says slowly.

His dream, he tells us, is to create a shop for SunnyMoney products that would set a national example in Malawi, and indeed beyond in Africa. He describes what it would look and feel like, right down to the huge billboard next to the main road where the shop would be strategically located.

I try to encourage him further, not that he seems to need much of that. I talk about the international mission of UN Sustainable Development Goal 7, and the army of people like him that will be needed around the world to deliver it. If he succeeds with his dream, he could be a poster child not just for Africa, but the wider developing world. SolarAid, and all our peers, will be trying to help in both the delivery of that army and the funding of it.

So will there be a chance of working capital, Charles asks.

Yes, says Phil, we can introduce you to the Malawian financial co-operative Fincoop. They have green loans for SuperAgents like yourself: at 10% interest, not the normal commercial rate of 45%.

And SolarAid will be working on the availability of capital at a higher level, I add, some of which we hope will flow to Malawi.

And at lower rates than 10%. In ancient Rome people used to be thrown in jail if they charged interest at rates that high.

Phil and I visit a Total filling station. In the forecourt, solar lights are on prominent display. But you can write with your finger in the thick layer of dust on their lids. They cannot be selling well. We ask the petrol pump attendant about the lights. She can't tell us much about them.

On to a supermarket. Under a roof looking like it is made of aluminium foil, hundreds of Malawians with baskets and trolleys walk aisles of products of a variety that would be familiar to many UK mini-mart shoppers. I stand next to one display, a floor to shoulder display of one Unilever brand, Sunlight soap power. I hold an SM100, turned on. Phil takes a picture.

Sunlight washing powder, and sunlight captured in the batteries of a solar light. A play on brand and functionality. But we are making a serious business point here.

More on that when I am in Zambia.

Kampala, Uganda, 25th – 26th July 2017

The Ugandan capital could be a splendid city in which to live, rolling as it does across a handful of tree-decked hills. Instead it is just another urban hell hole, its roads clogged and often motionless while half Asia's cast-off diesel cars, lorries and buses pump black carbon into the lungs of its crammed residents. In a tatty villa within a walled compound I sit with the SunnyMoney Uganda senior management team, taking a deep dive into their problems.

Operations Director Ramulat Andiru kicks off. A lady with wavy hair and a dazzling smile, she speaks quietly but has steel in her character. She blew the whistle on a major fraud by the previous operations director, a man who had bullied half the office into supporting the theft of \$60,000 worth of solar light stock. In essence, she shopped a criminal gang.

We have sold 62,000 solar lights since we were set up in 2014, she explains. In 2015, when we sold more than 33,000, we virtually had a national monopoly on sales of the smallest, entry level, lights. In the last 3 months, however, we have sold just 3,700.

True, I think. But the Ugandan market is nowhere close to takeoff yet. The solar lighting industry sold only 185,000 quality-verified lights here last year. For a population of 41 million, with an average of 5 in each household, that's a 2.2% annual reach. There is opportunity here, if you can overcome your problems, and together we do smart things with the right partners.

I don't leap straight into this. First I want to hear the team's take on their problems. There is no substitute for this. It can't be done on skype from London.

There are now 60 solar lighting companies active in the country, Ramulat explains. But most are selling the bigger systems, and our main competition for entry level lights are Greenlight Planet and [d.light](#), two international manufacturers of solar lights founded by Americans. We were the first serious player in the market when we started in 2015, using Greenlight Planet and [d.light](#) products before the SM100 was ready for us to use. Then those companies came to Uganda, copied our model of finding agents via schools, and took lots of our agents away from us, offering them lower prices for direct supply.

It had been the same in Kenya and Tanzania, I reflect. You can catalyse markets, or in Uganda's case maybe begin catalysing a market. But you can't expect the companies you help to be collegiate or collaborative, it seems.

That's capitalism, I guess. The same cut-throat principles apply in the markets of the developing world as on Wall Street.

We sell our SM100 for \$7, not the \$5 we would like, Ramulat continues. That's because the government has ill-advisedly decided to tax solar. So we have to charge 18,000 shillings at wholesale, 25,000 at retail. And here is where the second problem comes in. Generic lights are selling for 10,000 shillings.

She tells me the same sad story I heard in Malawi: of a far-reaching network of rubbish generic light sales. They seem to sell on the same scale as the quality-verified branded products.

The third problem takes me a little by surprise. The first downpayment on a pay-as-you-go light, bigger than our SM100, is 17,000 shillings. Rural customers long for higher-end solar lights to power AC appliances, even if they are very poor. They tend to tell SunnyMoney agents that they would rather pay 17,000 shillings for a first payment on a bigger system, knowing that several more payments of the same general size are to come, than a one-off payment of 25,000 shillings for an SM100.

Rebecca Asilo, head of agents and much besides, chips in. Another problem is that Non-Government Organisations have been buying solar lights and giving them away for free. You can well imagine how difficult it is for my agents to sell solar lights in regions where people know that solar lights can be obtained for free.

Indeed.

At this point I elect to table my upbeat thought about how much potential we have, in a market reaching only 2.2% of Ugandan households a year, if we can be clever.

And lucky, I add.

They laugh dutifully.

Let's come back to how we do that after you have walked me through the agents programme and the schools work.

Rebecca takes over the narrative. As she speaks she becomes visibly enthusiastic about her role. SunnyMoney hasn't a hope of reaching each door step of every remote home, she says, but agents can. Communities have unquestionable trust in the people that they have lived around and have interacted with, and this makes it easy for the right agent, carefully chosen, to reach out with a product to his or her neighbors. If SunnyMoney staff from Kampala go in to try and do the same, the community will react differently. We have one superagent, Suzan, a deputy head teacher, who makes this case for us. She is well known in 4 districts, and she sells lots of lights, all over that large area. If only we had more like her. SunnyMoney Uganda has about 300 Agents, but only 124 are active, and most order only a few products as things stand. For this reason, we are trying to establish SunnyMoney agent groups: 6-10 area agents working together, sharing training and any other support SunnyMoney in Kampala can extend to them.

Rebecca shows a Powerpoint cartoon graphic to illustrate her point. It shows a super agent and three agent networks. The superagent is a white man, and half the agent networks are white people. I can't help commenting.

She looks at me with a level gaze. You have no idea how hard it is to find business graphics on the internet with only black people in them, she says.

Ahem, right. Point taken.

On to the inevitable issue. Credit. So how much do you think a good superagent would need for a revolving working capital fund, I ask, in order to have a good chance of making sales take off.

They don't need to confer. 5 million shillings says Rebecca. The others nod. \$1,300 dollars, or thereabouts, per agent.

We move on to schools. Samuel Oyaku heads up this project: one of the few men in an office of women.

We have managed to roll out this campaign in 75 out of 136 districts, he recounts, with total sales of 47,000 solar lights since we started in Uganda. We have worked closely with the Ministry of Education and Sports to create confidence among our customers about the quality of the products we sell. In this respect, the District Education Officers are vital to our effort. By gaining the confidence of these important figures in the regions, we have managed to remain a leader in small-scale solar lighting sales to schools, at least staying

abreast of solar companies like Green Light Planet and [d.light](#) who have far more marketing clout than us.

But, he adds, we have lost grip of some of the districts in central and Eastern Uganda where we made impressive sales in 2014 and 2015.

We move on to talk about the problems of delivering relatively small consignments of solar lights to far flung places. The team is using motorcycles. Outside, rain is falling with monsoonal intensity. Thunder rumbles. Lightening flickers. It is the rainy season, and the Ugandans are immensely grateful for its return to form, after long-running drought.

But I am thinking of all those red mud roads, how quickly they turn to ruddy sludge when it rains, and the nightmare it must be to negotiate them on a motorcycle.

Another problem.

The next morning. I meet with Ramulat and Rebecca. I want to hear their tales of corruption first hand. But first Ramulat tells me that one of the call centre staff, a young woman, was delivering solar lights on a motorcycle yesterday. She skidded in the mud, fell off, and broke her arm.

I feel like holding my head in my hands, but manage not to.

Can't you tell everyone to get off their bikes and wait out the rain, I ask? Unless they are in some particularly dangerous area. Satisfying customers must come second to the health and safety of the staff.

But when the rain stops the roads are even worse, Ramulat says. It takes a couple of days for them to dry out.

We discuss what to do. Me being more successful in fundraising, so we can buy a small fleet of four by fours, would be a good start. Failing that, risk can be cut by setting up superagents or agent networks in each district - people we can trust - and keeping them reasonably stocked with products delivered by truck.

I ask Ramulat to tell me her whistleblowing story in her own words. As it comes tumbling out, I realise this brave lady must have been under enormous stress in the days when the enormity of the thieving became clear to her. She was head of finance, at the time, and the ringleader, a former acting operations director named Ronald, had fraudulently ordered and stolen stock for later sale, while paying off his gang in the office to cover the paperwork. Most of these people were relatives that he himself had appointed.

One day Ronald asked Ramulat to sign a big cheque for an urgent order, for an up-front payment to a customer with whom we had payment terms. She

refused. Ronald tried to strong arm her. So did his relatives. She left the office and went home, from where she phoned the supplier in question. There was no up front order but there was a large order that had already been made - the stolen stock.

During that period the then SunnyMoney CEO in Kenya was in the country but Ronald blocked him from meeting Ramulat and drove him away to the airport. Ramulat asked Lorraine for the CEO's telephone number, but it was too late: he had already boarded his flight back to Kenya.

Ramulat informed Lorraine about the fraud, and Lorraine got in touch with the CEO. He travelled back to Uganda immediately. He and Ramulat then notified the police.

Ronald went on the run.

Rebecca's story, of an episode while she was working for another non-government organisation, was little different. Here the ringleader was a woman. Her scheme was more sophisticated than Ronald's, but just as brazen.

These brave young women tell their stories with steady voices.

I ask if at any time they have feared for their personal safety.

No, they say.

I wonder if they are just being stoical. Rebecca, I know from an earlier conversation, keeps an enormous black dog. I am a dog person. I'd like to meet that dog, I said to her, he looks cool. No you wouldn't, she replied. He hates white men.

I try to cheer Ramulat and Rebecca up by observing that corruption is a problem that is far from limited to the developing world. I ask them whether they have heard about the recent scandals at Volkswagen and Shell, for example.

They haven't.

Volkswagen executives colluded to cheat on emissions tests in diesel cars, I say. They fitted electronic devices that would give low emissions readings while tests were being run, and then turn off when the tests were finished, so the cars could pollute away. They fitted them to millions of cars – grown men who presumably love their children, knowingly behaving as a criminal gang, for very little reward as far as we know, other than a bit more profit for their company. e-mails obtained by investigators show that they tried to cover up their crime as the net closed on them.

As for Shell, they paid a billion dollars to the Nigerian government knowing it would be passed on to a known criminal for access to a single oilfield in Nigeria. e-mails obtained as evidence show the CEO at the time

knew about the bribe. The current CEO tried to play down its significance, dismissing incriminating comments in the e-mails as inconvenient “pub talk”.

I will be amazed if executives from these companies can stay out of jail, I say, once all the investigations and trials are done.

Ramulat and Rebecca look at each other. That’s the difference then, Rebecca says. The police here are corrupt. All a criminal has to do is pay off the investigating officer, and he or she is free.

I expect that is what Ronald did, Ramulat adds. That is why we have heard nothing more from the police.

I head off into town with Samuel to do a bit of spying on our competition, kerosene and generic solar lights both.

Kerosene provides the dominant lighting fuel for rural and off-grid peri-urban consumers, he tells me. Onsellors come to fill jerry cans, then split the contents into small plastic bottles, which they sell in the villages. All the petrol stations up country sell kerosene from pumps. Here in Kampala not all do.

Nonetheless we see stations advertising kerosene in just the same way they do petrol and diesel.

Most of the filling stations are run by Total and Shell. Obscure brands make up a minority. As soon as any of those build a good volume of sales, Shell or Total buy them up.

An idea comes to me. Some cities are now naming end dates for diesel – in the case of Paris, Mexico City, Madrid and Athens [by 2025](#). Why not ask the oil companies to do the same for kerosene sales? Once they have done that, they can then phase sales down, at the same time as they ramp solar light sales up.

Kerosene sales cannot be material to the holistic business models of these huge global companies, I reason, and the harm it does is so very transparent. What would they really have to lose? They could opt for 2030 as a target date, consistent with UN Sustainable Development Goals.

I resolve to write the CEOs of Total and Shell open letters making the request. And other oil and gas companies while I am about it.

Samuel takes me to the market in what he calls the downtown area. There is chronic poverty all over the streets here. The mud sidewalks are crammed with traders hawking all manner of goods from tiny makeshift stalls. These head off on either side of the road into covered pedestrian market alleys, which you have to pick your way through stepping over people reclining on the ground among the goods they are selling.

We come to one of the bus stations, where minibuses wait by the dozen to carry their tightly wedged passengers upcountry. Here the stalls are more than usually makeshift. Transparently inferior solar lights are on offer to travellers.

Samuel pretends to be a shopper. How much, he asks a trader, picking up a solar light that looks like a kid's toy.

The stall keeper quotes a ridiculously low price. It is nonetheless probably a week's salary for anyone within a mile of us.

Do you give a warranty?

The trader looks shifty. He is not used to being asked that question.

No, he says eventually. Works well. Look.

The light comes on, brightly.

Samuel explains that any traveller unfortunate enough to buy this light would never find this trader if he were to return to complain about his few nights of use before it breaks. The vendor would be long gone, to his next con spot, in another market.

But the market pollution caused by his sales of generic products would linger in the filthy air. Samuel and I might easily be able to spot the difference between a bespoke light and an SM100. But ordinary Ugandans can't.

Lusaka, Zambia, 28th – 29th July 2017

Landing in Lusaka, I see Total advertises the length of the airport's baggage carousels. "Total: Committed to Better Energy", the mantra on the main ad reads. Smaller ads are for Awango, their solar lantern.

Time to live up to your advertising, guys, I think, composing the letter to the CEO in my mind.

Lusaka beats Kampala by a long way, for a timid traveller fearing lung cancer from diesel fume inhalation, or teeming populations, or both. In large areas of the city, the boulevards are wide and far fewer people are around.

Of course, the latter may in part have something to do with the recent state of emergency. The current president has imprisoned his main opponent and charged him with treason. The opponent made the mistake of not stopping his motorcade to allow the president's to pass.

The SunnyMoney Zambia office, another villa in a walled compound, sits in a pleasant leafy suburb. Alex Burrough, an enthusiastic expatriate English lady who came to SunnyMoney from Voluntary Services Overseas, is the

Operations Director. She has plotted a tight schedule for me. It begins with a meeting with agents.

It would be good for Jeremy to hear what works for you, Alex tells them, and what could be improved.

The SM100 is durable, one says, and the one year warranty is a big draw for us and our customers. With the savings they make on kerosene, people come back and buy more products, and bigger products. It is a good business. People know the lights work because they see me using them myself.

I ask if generic products hamper his business.

People don't buy the cheap lights because I warn them and they know me.

I note that one down. Encouraging.

The prospect of avoiding kerosene is good for our selling, another agent adds. We have all seen so many times houses burning as a result of kerosene spills, so many people dying.

Agriculture accounts for nearly 85% of employment in Zambia. It is heavily seasonal at the best of times, and dependent on absence of drought. The agents use the profits they make to feed their own families. In choosing solar as a job, they have made something of an existential bet. Once the maize income is spent, the solar business drops steeply. But the agents know when people have money and are likely to buy. They plan their sales campaigns accordingly.

I ask about Pay-As-You-Go. Would it help for people to pay less and spread payments, even for smaller products?

Yes, it would help us sell more, says one agent. I love the idea that the light cuts out if payments aren't made, so we wouldn't have to chase for payments. But an issue is that the mobile network is often not so good in Zambia. You have to walk up a hill to get reception.

OK, I say, so agents would have to be in a certain location, with network coverage, on a certain day so that consumers could come to make their payments.

Mobile ownership is high, they concede. But the trust in using mobile money is not yet there.

What else would help?

They make a list. Product information in the main languages in Zambia. Advertising: posters and banners for us to use. And credit of course. Even just \$200 – 250 would help them sell a lot more lights, they say.

Alex and I are joined by Joshua Makungo, head of finance, for a deep dive into the Zambian business. SunnyMoney has sold just over 200,000 lights since it was set up in 2009. The peak sales year was 2014-15: just under 53,000. Last year, with a fierce drought, sales were terrible: 17,000. The first quarter this year is 7,000. Zambia is struggling just as badly as the other two countries.

But the story is the same as for Malawi and Uganda when it comes to opportunity. Zambia's population is 17 million. That means 3.4 million households. The solar industry sold 55,000 lights last year. That is just 1.5% annual reach.

SunnyMoney has built a platform, after all the years of effort, from which it is possible to see sales becoming exponential. Our sales comprise around 80% of the rural market, where only 3% of the population have electricity. We are active in all 10 provinces, and more than 80% of the 72 districts. Because of Zambia's central location in Africa, we also serve neighbouring countries, including the Democratic Republic of the Congo, one of Africa's big three population centres. Sales so far are small, but they hint at potential for future growth.

Of course, [d.light](#) and others may try to take that network from us, just as they did in Kenya and Tanzania in 2015 and 2016, and are doing today in Uganda, without any effort to craft a phased transition from a market catalysed by our philanthropic money to a fully commercial one.

That gives me another idea.

Passing *The Test* will require much greater collaboration than has been contemplated to date, between all the main players, and some new ones besides.

In a dusty industrial suburb of Lusaka, Alex and I visit Unilever's East Africa office. I repeat a case I made earlier this year, at the Unilever headquarters in London, together with Yingli Green Energy Europe boss Darren Thompson.

Unilever has arguably the best base-of-pyramid distribution network the world has ever seen. It comprises shops of all sizes from urban supermarkets to the tiniest rural store, and an army of door-to-door salespeople. As a result, some 2 billion people a day use its many food, refreshments, personal care and home care products, in 190 countries. Of its \$50 billion-plus a year turnover, more than half comes from emerging markets. It has no less than 13 brands that each turn over a billion dollars-plus per year. It tells the markets that its future growth will be primarily focused on the emerging markets.

Yet it has sold very few solar lighting products to date.

Were it to sell solar lights in its network – lights made by Yingli/SunnyMoney or anyone else – each product sale would save the buyer more than \$70 a year on kerosene purchases no longer needed, based on SolarAid’s research in the field in east Africa. Unilever could free up that that money for use by its own consumers while making a profit on the light sales themselves.

Let us imagine the corporation tried an experiment with a million solar lights. Unilever’s cost of buying them would be well under \$4 million, procuring from a manufacturer like Yingli - or more likely a group of manufacturers, given that the entire solar lighting industry sells less than 8 million lights a year as things stand. The lights would sell for around \$5 at retail, in shops and in the product baskets of the countless Unilever door-to-door sellers, assuming the corporation could talk governments out of taxing solar lights.

But here is the big oversight on Unilever’s part, I argue. Those million lights would save more than \$150 million for the consumers who buy them, just in kerosene purchases no longer needed, assuming a conservative average three year lifetime for the products.

Where would that \$150 million be spent? Very likely in the same places the solar lights were purchased. Very likely, much of it, on Unilever products.

If even half of what I have just said is correct, Unilever is overlooking a “free money tree” for its consumers in emerging markets, as things stand, one worth hundreds of millions of dollars *each year*, assuming they sell more than a million solar lights to the 2 billion people using their products.

Of course, they would have plenty of scope to sell more. There are 230 million households in the developing world with no access to electricity. And very many millions more in regions where electricity grids are reliable in their unreliability.

And none of the above includes what will be obvious to anybody who knows a little about the world of corporate responsibility and corporate sustainable development. Unilever is one of the top ten performers, in multiple categories of sustainability practice. It is arguably in the top handful, alongside companies like IKEA and DSM. I am personally convinced of that.

So for this great company, *The Test* is very much unfinished business.

3

Cambridge, UK, 31st July 2017

I land at Heathrow, take a train into London and then another to Cambridge. I have occasional sessional teaching duties at the University, with the Cambridge Institute for Sustainability Leadership (CISL). CISL is widely known for running HRH The Prince of Wales's Business & Sustainability Programme for business executives, and other advanced courses in sustainability leadership for business groups, tailored to individual company needs. CISL also runs part-time graduate programmes for business professionals, including the Master's in Sustainability Leadership.

My job today is to give the Master's students a one-hour overview of the state of play in the global energy transition. I run through my slide show, updated overnight on the flight from Johannesburg, trying not to let my tiredness show. The class is 30 mid-career to senior people doing an intense residential week towards their degrees in Sustainability Leadership. They are from the USA, Europe, Australasia, the Middle East and Africa. They represent companies including Accenture, BT, Deloitte, Ernst & Young, HSBC, IKEA, KPMG, PepsiCo, Proctor & Gamble, and Unilever.

The first three questioners all thank me for lifting their spirits with the positivity of my analysis. I wonder if I have overcooked it. I resisted the temptation to talk about *The Test* in my hour. I do so now, in synopsis. My optimism is qualified, with a small Q, I say. We have to fix this little aberration of solar lights versus kerosene lamps first.

After the session the first in line to talk to me is a lady from an oil company. She is from Nigeria. She doesn't want to talk oil, she says, but solar. Why is there so little solar in her homeland, she asks, when there is evidently so much in the rest of the world?

At lunch, chance places me next to the lady from a transnational consumer goods company. She is in marketing: a senior brand manager. I give her the last solar light I have left in my bag, and a headband to go with it.

It's possible to brand the lights with anything you want, I say. The headbands too.

After lunch, I repair to a leafy suburb of Cambridge, and a garden shed owned by my friend Tony Juniper. Tony has converted his shed into an office, and here we will conduct the monthly combined board call of SolarAid and SunnyMoney, joined on skype by soon-to-start CEO John Keane and Finance Director Lorraine Hammond. Tony and I are the directors of SolarAid and SunnyMoney ...the only two directors.

How did *that* come about, many readers will be asking themselves. What a recipe for disaster, others will be thinking - perhaps especially those who know the two directors concerned.

Though it is legal for a charity to have only two directors, it is certainly undesirable, especially when the two are ageing white men of - how shall I put it - a certain adventurous inclination. Tony is a very well known environmental campaigner and writer, a former chief executive of Friends of The Earth, and an advisor to the Prince of Wales. Both he and I are excited and motivated by big-picture thinking, and acting, and less excited by attention to detail.

This is how our isolation in Tony's garden shed happened. SolarAid's history involves three phases. The first, from 2006 to 2011, we can think of as the reconnaissance phase. In seeking where to shoot for exponential impact, the early team experimented with a number of projects, notably manufacturing of solar lights in Africa. None of them worked. We had a board of up to six directors then.

In what can be thought of as the takeoff phase, from 2012 to 2015 we were successful for a while. We focused on selling small solar lights at the base of the energy ladder, and hit an updraft via sales through head teachers. We sold more than a million lights in Kenya and Tanzania, quickly became the biggest retailer of solar lighting in all Africa, and catalysed the first two proper African solar lighting markets. We had a board of three directors for much of that phase: myself, Solarcentury's former CEO Derry Newman, and a former banker, Philip Angier. This board worked well. Derry was Managing Director of Sony UK before leaving to run Solarcentury between 2007 and 2012. Sony were distraught when he left. Their head of human resources told me - in jest, I like to think - that everyone in the company hated me. At Solarcentury, Derry was equally successful. He spanned everything a retail brand like SunnyMoney needed, plus he was passionately protective of the Solarcentury/ SolarAid purpose-driven culture. Philip was a rigorous numbers person, a man of huge experience in the charity world, and a perfect mentor for Lorraine. Derry and Philip together made for an ideal brake on my entrepreneurial instincts, while their expertise plugged all the considerable gaps in my own.

It was just as well that this board was functional, because SolarAid's third phase we can think of as the stall phase, and it has lasted from 2015 to the present day. As I recounted earlier, we were too slow to exit the markets we had catalysed in Kenya and Tanzania. What I didn't recount was that I couldn't have pulled SolarAid through the existential cash-flow crisis of 2015 and 2016 without Derry and Philip. The three of us worked together as a close-knit team through the crisis.

But I knew all through 2016 that they would be moving on at the end of that year. Philip had put in a full decade helping me and SolarAid out by then. He gave me a full year's notice that he couldn't do any more. Derry too gave me plenty of notice, in his case because of serious health problems in his immediate family.

In contemplating responsibility for both governance and leadership of SolarAid in 2017, as a result of my enforced role of stand-in chief executive, I knew I needed at least one suitably-qualified fellow trustee who was willing to take a risk in joining me, and who I could be confident of working functionally with. Tony Juniper fitted that bill, and I was very lucky that he accepted the role. Directors hold legal responsibility for everything that transpires in a charity. Taking that on is no small thing. It even encourages entrepreneurs to work hard on their attention to detail.

But I also knew we would need a third director badly. This person must be able to cover the numbers better than I and Tony could, and be a continuing mentor to Lorraine in her vital role as finance director. And a third ageing man, or indeed any man, should be avoided if at all possible.

I went to all the women in my network in the financial sector asking them to help me shake the trees in their own networks. A seemingly perfect candidate duly fell out. She sounded passionately keen about our mission. Her colleagues thought the world of her. Interviews went well. The team liked her.

Then she did her own due diligence on our budget and balance sheet. In detail.

She told me she couldn't do the job because it involved too much risk. She feared we would run out of cash in 2017.

The books were better than they had been for some time when she looked at them. I was more than disappointed. Complete absence of risk is not something you want of a charity. Part of the mission has to involve pushing the envelope. Tickover mode does not lend itself to triggering the big changes that are needed in society.

And so to those risky accounts, in Tony's garden shed, with his three dogs running around in panting circles outside as we go through them with Lorraine and John.

The key details are these. SolarAid has to raise just over £700,000 this financial year, April 2017 to March 2018. These incomings have to balance outgoings for the entire organisation: losses by the SunnyMoney national offices, plus running costs for SolarAid in London. If we can do that, we will exit the year with roughly the same cash in our bank accounts that we had when we entered it: just over £200,000. That is nowhere near the kind of working capital we would need to be as effective as we were in Kenya in Tanzania in 2013-15. In 2013-14 we raised £2.2 million and in 2014-15 £2.5 million, our best performance ever. But £200,000 at year end amounts to a solvent organisation. If cash falls below £100,000, then that is a different matter. That would be when the painful decisions about cost cutting would have to be made, for a second time.

The £700,000 budget was one I spent weeks thrashing out with the teams in London and Africa at the beginning of the year. As any business leader knows, every key actor in a budget has to believe that the numbers they are responsible for are realistically achievable. They also need to appreciate the implications of collective failure to hit the total budget. In our case, the sensitivities are huge. Any significant overshoot of losses by an African country can be a potentially existential problem. So too can a shortfall in fundraising in London. If both happen, the speed of the resultant cash crisis is breathtaking, when you model it.

This is what put our putative financial-specialist director off.

Tony, Lorraine, John and I peruse the first quarter's results for the financial year. Two African offices are a little behind target, one is ahead. It's Uganda – kudos to brave Ramulat. The net loss for all three countries is down on target. London overheads are also a little behind on budget as well. But fundraising in London is ahead of target. The net of the total outgoings plus incomings is that the combined SolarAid / SunnyMoney organisation is ahead of budget by £60,000.

We look at the forward cash flow projections, and conclude that we remain cautiously optimistic of hitting the whole-year budget target, and have certainly escaped any painful decisions for another three months, even on a worse-case analysis. The name of the game now is to work on exceeding that budget by a lot more than £60,000. Never mind our understandable desire to avoid painful decisions, if we are to play a serious role in the passing of *The Test*, substantial overperformance on budget will be imperative.

Evening descends on the garden. It is warm enough to eat dinner on the patio. Tony's wife Sue joins us, and we open a bottle of our favourite wine. I tell him that when I was CEO of Solarcentury, between 1999 and 2007, I can't remember many quarters when I was ahead of budget. I can remember plenty when I was miles behind.

The last swifts of summer weave through the air above us, feasting on invisible bugs to build up energy for their long migration to winter quarters. Tony tells me that these birds will fly all the way to the rainforests of the Congo, without touching land once.

Solarcentury headquarters, London, 3rd August 2017

A post-Africa catch up with my two closest colleagues at Solarcentury. It is a good day on which to do this. IKEA has announced a new partnership with us, on battery storage. Solarcentury is already the furniture giant's delivery-partner of choice, to date, in pursuing its ambition to become the number one global retailer of residential solar roofing. Now IKEA customers can add storage of their solar electricity, and save up to 70% on their electricity bills in the process. This development comes the day after Centrica, one of the Big Six utilities operating in the UK, announced a 12.5% increase in its electricity bills.

Press coverage is copious, and all positive, redolent with suggestion of an energy future very different to the past. Even the conservative tabloids the Mail and the Express carry the story.

Frans van den Heuvel, chief executive, gives me a tour of operations in his current mission: to transform the company from being mostly a developer and contractor of solar, UK-focussed, to a global fully-integrated developer, builder and operator of utility-scale, commercial, and residential solar projects. A cheerful and charming Dutchman, multiply talented in all the right areas you would need to lead an ambitious solar company operating on four continents, he radiates positivity as he describes how he is progressing.

Frans has led Solarcentury for five years now, in what I think of as the third and fourth phases of the company's history. The first two were cycles of investment and deliberate losses en route to profitability. The first of these, from 1999 to 2007, I led. In those early years of the solar revolution we struggled our way across "the valley of death" between investment and first profits, taking too long in the process, operating only in the UK. We raised four rounds of

venture capital, totalling £29 million, to tide us through and finance the second phase, wherein we would go international.

That phase, from 2007 into 2012, was led by Derry Newman, the ex Sony boss who would go on to play such a mission-critical role in SolarAid's boardroom between 2012 and 2016. I had taken the first version of the company to £13 million in turnover, but few entrepreneurs make good CEOs for the growth phase of companies, and I was no exception to that. Neither did I want to, with people like Derry prepared to step into the story. Derry took Solarcentury to around £60 million.

After Derry's enforced retirement because of the health problems in his family, Frans then grew the company, in its third phase, to more than £220 million revenue. That was a time of extraordinary exponential growth. Between 2013 and 2015, we had the fastest growing profits of any energy company in the UK, and the fifth fastest growing profits of any British company of any kind.

The fourth phase, triggered by a fundamental reversal in UK government support for solar in 2015 - a fiasco of broken promises that has since caused many thousands of redundancies in the UK solar industry - forced us to expand our international work fast. Progress so far has been what a founder would want. As a newspaper headline read in May, "UK's biggest solar company takes shine to global projects with deals worth £3bn." A spectacular drone tour on YouTube of a recently completed 40 megawatt solar farm in Chile gives a feel for what those projects will look like.

Financing them will require a whole new level of capital raising. Neil Perry, Chief Financial Officer, gives me a progress report on that. Neil joined the company right at the start of the first phase, 17 years ago, direct from an investment bank. Bored with that world, he wanted an adventure in something edgy and entrepreneurial, and he certainly found it. A man who mixes razor-sharp seriousness-of-intent with playful camaraderie, he has become one of the most respected finance directors in the global solar industry. He has been an invaluable deputy to each of the three Solarcentury CEOs. Without him, Solarcentury could not have survived to be what it is today.

After Neil and Frans finish their tours of Solarcentury's state of play, it is my turn to brief them on SolarAid. I run them through the first-quarter budget numbers and lessons learned on my Africa trip. Both men are staunch defenders of the charity's role in the cultural glue of the company that created it. Frans even tapped attendees at his 50th birthday party for donations. But as I describe the precarious state of SolarAid, with its budget of less than a million

pounds, I can't help but feel insecure about how it must all sound to them. Their preoccupations are measured in the hundreds of millions these days.

SolarAid headquarters, London, 8th August 2017

A morning closeted with the SolarAid team, in a horribly lit meeting room in the windowless basement of an old office building off the City Road. We are brainstorming strategy in the light of my trip to Africa, and other lessons from the first quarter of the financial year. John Keane, the next CEO, won't be joining us for another month. He is recharging his batteries in Canada, ready to hit the ground running, so I very much hope. I am determined to leave him a ship capable not just of floating but fast sailing, and so there can be no easing off in my final month. Finance Director Lorraine Hammond and head of fundraising Jamie McCloskey are with me, joined by Oli Sylvester-Bradley, head of marketing, a Solarcentury alumnus. Emily Bellis and Eva Nordheim from fundraising and Alison Williams from finance make up the entirety of the team.

In truth I suppose that I might have settled on the hand of cards I have at the moment, had I been offered the choice nine months ago when I took over as stand-in CEO. But I cannot help feel an edge of disappointment that things have not gone better, in terms of my performance.

My problem is that I can smell a route to exponential growth in both sales of solar lights, and fundraising. The sales aspect I have written about already. The fundraising I haven't yet.

We have raised more than £8 million in the five full financial years since 2012. Our donors have been diverse. Individuals have committed most: £2.8 million (34%). Of these, high-net-worth individuals contributed £1.5 million, and individual supporters £1.3 million. Corporations came a close second: £2.5 million (31%). Governments and aid agencies came third, with £1.6 million, (19%). Foundations and trusts came last, with £1.2 million (14%). A tiny further amount consists of sales of solar lights from our website.

How to view this record? A common view is that we should be proud of our achievements: that most charities with the relatively low overheads we have would be envious. Others point to the transformative nature of our mission: to rid the world of kerosene for lighting, or at least to play a lead role in that system change. For these people - and I count myself among them - our fundraising record comes nowhere close to matching the scale of our ambition.

I have been agonising over how we can turn that around: how we can make the fundraising go exponential, the way our sales of solar lights did for a while, in Kenya and Tanzania, from 2013 into 2015. I worry that while donations from governments/aid agencies and foundations/trusts have been and continue to be vital, the sums we are might raise won't be likely to move the dial going forward, even if we can repeat the historic track record.

But how likely are we even to do that? We are living in a world where government and aid budgets are coming under ever-increasing pressure. Foundation funding is also likely to head the same way, facing as it does calls for increased domestic grant giving in the face of rising social hardship.

I have come to the view that we need to maximise new funding streams, ones that hold the potential to grow exponentially but also to deliver us greater independence, and better predictability of income and hence cash flow. With greater predictability comes increased space for strategic and tactical manoeuvre.

I think there are four such potential new funding streams.

The first involves royalties on sales of SM100 lights, or any other lights we might co-develop with Yingli Green Energy Europe in the times ahead. In a world of 1.2 billion people without electricity, passing *The Test* of bringing all them solar lighting will involve the selling of many more than the pitiful 8 million or so quality-verified solar lights that is all the global solar lighting industry can manage each year as things stand. That market has to be pushed into growing fast, and since SM100 is one of the most affordable solar lights, as things stand, Yingli would reasonably aspire to a significant market share if that happens. The royalty income to SolarAid on annual sales of Yingli products, if measured in millions, would be significant. It would amount to a whole new category of philanthropic fundraising.

So too could the second potential funding stream. It involves a major effort to persuade companies to join Solarcentury in donating a tiny percentage of their profits, or sales, to SolarAid. We think of such a community of companies as "the percent club". If we signed up a hundred companies that all grew in the next six years to contribute at the level Solarcentury has in the last six years, we would have raised £70 million.

The third potential funding stream is more conventional. It involves an effort to generate regular payments from individuals via standing orders, rather than one-off donations. Other non-governmental organisations have found a route to exponential growth in their regular-donations supporter base. With the right outreach effort, SolarAid might be able to do the same, so I hope.

The fourth potential funding stream involves carbon offsetting. We know that each solar light we sell saves around a tonne of carbon dioxide over its lifetime. We know how much it costs SolarAid to deliver a light for sale in Africa by SunnyMoney: £4.20, currently, based on audited accounts, as described earlier. Therefore individuals and companies have the means to calculate how much they need to pay to offset carbon from flights, other travel, or indeed general operations, should they wish. If we present a convincing enough case to them, this potential income stream could perhaps prove exponential too.

We wouldn't necessarily need all four of these routes to work. If just one works well, certainly two, then the results could be transformative.

So how are we doing?

On royalty income, Yingli and we have barely begun the systematic pitching of SM100 to the kinds of corporate players that could be procuring solar lights by the million. That is work very much in progress. Unilever is top of our target list. But there are others not far behind. Again, we only need one to jump and we have a potentially game-changing scenario.

On the percent club, we have elected to build a small nucleus of supportive companies first, and expand outreach rapidly thereafter. Half a dozen companies have signed up so far, some for a share of profits, some for a share of sales. We have enough momentum for a launch event in October, and will begin systematic outreach once John Keane is in post in early September.

On regular individual payments, we have been campaigning hard since April. Standing-order payments have risen slightly, but the overall results are disappointing.

On carbon offsets, a handful of companies and individuals have stepped forward, some without our asking. We have enough of a nucleus to begin systematic outreach. That avenue is also work in progress.

So, in conclusion, much work remains to be done. When John starts, I am hardly going to be able to play more golf. My plan, while he runs SolarAid and SunnyMoney, is to focus in on the big-league projects in sales and fundraising: the potential game changers.

Royal Albert Hall, London, 13th August 2017

How different the hall looks tonight, compared with the night of the Responsible Business awards little more than a month ago. The Proms are on, and tonight's is a Rachmaninov double: Piano Concerto number 3 and Symphony number

2. I am much in need of a reminder that beauty exists in our world, as well as beast. Across the Atlantic, the small Virginian city of Charlottesville has been invaded by hordes of neo-Nazis, protesting a plan to take down a statue of a pro-slavery general. A counter demonstrator has been murdered. Incredibly, the American President has refused to condemn the neo-Nazis. They openly carry Nazi flags, they wear helmets reminiscent of the Wehrmacht's, they do not even feel the need to wear hoods, as their Ku Klux Klansman forebears felt compelled to do. Their hate-filled faces are all over the internet. And President Trump defends them, these defenders of those who wrought carnage on the United States in the name of permanent enslavement of human beings.

I can scarcely believe what I read in the news. Once again life is showing me a reality stranger than fiction. This time on the downside.

I visited Charlottesville in October last year, a few weeks before Trump was elected. America's biggest privately-held wind developer, Apex Clean Energy, had invited me give a talk at their company retreat, tasking me to inspire their troops. They also organised a public lecture in their beautiful local theatre, the Paramount. It was packed with Virginians, listening to my optimistic account of the global energy transition, behaving with the utmost civility.

Little did I imagine what could transpire in their city less than a year later. How I feel for those Virginians today.

And tomorrow, by unworldly coincidence, I meet with a group of church-people from Liverpool, the port from which much of British involvement in the slave trade coursed. They tell me that the city and its past shipping bears responsibility for the souls of 1.5 million slaves. They want to erect a memorial for those souls, the first of its kind in Britain, lit up at night with 1.5 million solar-power lights. They are considering raising money for SolarAid in parallel with the raising of funds for their project, so that the memorial can connect to Africa by freeing today's Africans from the modern form of enslavement that is enforced dependency on kerosene.

4

Paramount Pictures, West London, 16th August 2017

Fifty people sit in a small cinema in a modern office block on an architect's dream of a corporate campus. Most are from the business world. Many are heads of sustainability from big companies.

We are at a private screening of Al Gore's film, *An Inconvenient Sequel*. Ten years on from the release of his original blockbuster, *An Inconvenient Truth*, the new film tells the story of that decade, and the race against time that it represents, for those with eyes to see.

I have not been looking forward to this screening. I know how good a job the great man does of explaining the horrors of climate change, but I can do without dwelling too much on how bad the bad news is these days. As an ex researcher of earth history, I figure I have a passable appreciation of how fast the meltdown of our climate is progressing, and for some years now I have preferred to focus more on the solutions. When you are in a race in which the stakes include a liveable planet, so I figure, it can be bad for your concentration to watch too closely how fast the opposition is running.

Necessarily fortified with a large glass of wine, I watch the Arctic melting before my eyes, the streets of Miami waist deep in water, Indian pedestrians quagmired on roads that are literally melting, Filipinos frantically smashing a ceiling to escape onto their roof as flood waters rise, and much else in the same vein. And I ask myself, as I do so often, how the climate denialists can have been so very blind for so very long. I know what the neuroscientists tell us about how human brains work, and how deep in metaphorical concrete we tend to encase our belief systems. Yet still, as the science of climate disruption moves from predictions made to predictions exceeded, the extent of the denial never ceases to amazes me.

Al Gore spends much more time on the politics of climate change, and the readily available solutions, than he did in *An Inconvenient Truth*. He explains how pro-fossil-fuel climate-blind billionaires of Alt-Right persuasion like the infamous Koch Brothers have spent somewhere between 1 and 2 billion dollars spreading doubt about climate change, and machinating to get climate deniers

elected, not least the coal-loving Donald Trump. “Our democracy has been hijacked”, he laments.

He is a master of moving graphics. The lines in his graphs soar upwards, whether he is talking about global temperatures or deployment of solar power. One in particular I enjoy: a depiction of the solar energy rollout in Chile. The graph plot rears almost vertically, and as the camera pulls back, keeps going and going.

I note that the head of sustainability at IKEA UK is in the audience. I resolve to talk to her at the after party about how we might get a few more of those solar soarers going in powerpoint land.

City of London, 22nd August 2017

Anything Solarcentury and SolarAid can do to get solar soarers going must involve partnerships. One of my roles, for company and charity alike, is to scout for potential partners. At the same time I do this, I look for opportunities to put my money where my mouth is: smart clean-energy companies to invest my small savings in, consistent with my (no doubt concrete-encased) belief system. Today’s potential victim is a team of thirty or so software architects, embedded engineers, data scientists and machine learning experts called Green Running. They have a smart box that they will soon start selling, which they call Verv.

The Verv box is the size of one of those now-redundant computer disc boxes, and sits attached to the electricity meter in a building by a single simple clip. It takes only minutes to instal, even by a non-technical person. Once the device is attached, it samples the building’s electricity use a million times per second. This level of sampling is 5 to 10 times faster than smart meters in use today. Such speed allows the user, via a simple app, to pinpoint every individual appliance turning on and off in the building and present the disaggregated electricity use on a computer screen. Once this sampling is underway, a legion of useful possibilities opens up, including saving money, saving emissions, checking individual device operability, and auto-checking safety remotely: for example, that aging relatives have not left the grill on.

Green Running CEO Peter Davies demonstrates all this to me using real electrical goods. As he turns them on and off I can see a simple display on his tablet screen changing to reflect the comings and going of electricity load, and the most important financial and emissions facts arising from them. I can

instantly see why Google has supported the company, and why British Gas is an early shareholder.

Behind Peter, team members sit at their large computer screens in an open plan office with views over a muddy River Thames. Many of them are machine-learning specialists. Machines have to learn fast when processing a million bits of data a second, and many of them are hooked up in harness, learning from others' experience as they go. This is artificial intelligence in action, right at the cutting edge of the global energy transition.

The possibilities for state-of-the-art technology like this to do social good are many and varied, in the developed and developing worlds alike. In energy, for example, Google is using AI to save hundreds of millions of dollars, and their equivalent in carbon emissions, by trimming electricity consumption by its energy-ravenous servers. Machines learn from many different servers where tiny adjustments of electricity use can amount to a collective mountain of efficiency gains. In medicine, for example, AI is being used to diagnose rare cancers that human medics have little chance of identifying. Any one time-pressed human doctor has only his or her own brain to tap for knowledge. Computers can be rapidly trawling every available medical database in the world.

But AI can be mis-used in many ways too. As a Microsoft executive, Kate Crawford, recently explained, the technology is "ripe for abuse by authoritarian regimes ...a fascist's dream – power without accountability." This at a time when nationalist authoritarianism is on the rise in politics around the world. The white supremacists who gathered in Charlottesville, and the incomprehensible support they have been receiving from the man in the White House, are just one example of this. And as the forensics of the November 2016 election result emerge it seems increasingly clear that the appliance of AI helped Trump win the Presidency, whether deployed by the Alt-Right or the Russians.

In January, hundreds of AI and robotics researchers convened to urge policymakers to regulate use of their technologies. They collaborated on a road map for doing this, spelling out 21 principles for the sustainable and ethical use of the fruits of their labours: the Asilomar Principles. Principle 23 concerns the common good. "Superintelligence should only be developed in the service of widely shared ethical ideals, and for the benefit of all humanity rather than one state or organization", it reads.

The concerns are palpable, and they are particularly acute when it comes to AI use in robots. Elon Musk said as long ago as 2014 that he considers AI to be humankind's biggest existential threat. As for AI hooked up with robotics, two days ago Musk, Mustafa Suleyman at Google, and 114 AI specialists wrote

an open letter to the United Nations calling for a ban on the development on autonomous weapons, otherwise known as killer robots. “These can be weapons of terror”, they wrote, “weapons that despots and terrorists use against innocent populations, and weapons hacked to behave in undesirable ways. We do not have long to act. Once this Pandora’s box is opened, it will be hard to close.”

This all reads like science fiction, but it is rapidly emerging fact, today. I am following all this closely, becoming ever more concerned about it. The experience feels much like the learning about nuclear weapons deployments that I underwent in the early 1980s. I am finding that it takes a few hours a day just to keep abreast at summary level, so fast are things moving.

Its saddens me enormously that human beings can push the boundaries of applied science this fast, and yet still can’t get electricity to more than a billion fellow citizens. This feeling is a severe dampener now on the cautious optimism I feel every time I consider the global energy transition in isolation.

SolarAid HQ, London, 6th September 2017

John Keane took over as CEO at SolarAid two days ago, and today we are doing our first CEO – chair catchup. As I listen to him run through the opportunities and challenges, as he has seen them in his first few days, I feel a mix of relief and excitement.

John was SolarAid’s second employee, when we started in 2006. By then he had already been working for several years on bringing solar lighting to remote Tanzania, alone. He was the most knowledgeable player then, in those days of early pioneers, and remains so today, widely respected by the industry that has emerged in the interim decade. Over most of that time, he was the chief of operations at SolarAid. He has spent the last year as head of technology with the Global Off Grid Lighting Association, in order to be with his wife working with the UN in Rome. A cheerful and handsome man, he radiates an energy and positivity that I know is cheering up his youthful colleagues after a year with a stand-in boss.

I love what he has posted in a blog about his return to the SolarAid fold, and the way it reveals his core passion for the mission.

“While much has been achieved over the past decade, with great leaps in technology and innovative business models bringing solar lighting to more and more people, I believe that business as usual

means that hundreds of millions of people will still be forced to burn kerosene and candles in 2030. That will be truly unacceptable. The issue of 'access to reliable, modern energy' is not something we don't know how to solve, we simply lack the funding and resources to do so. If the sector, and the wider global community, can not find a way to deploy the requisite resources to solve the issue by 2030, as the Sustainable Development Goals demand, we will have failed a very embarrassing test.

Our job is to do everything we can do to avoid that future reality. Our job is to reach people others are not able to reach. Our job is to do whatever it takes to bring access to those who will otherwise be left behind.

It is my sincere hope that by 2030, SolarAid will have been consigned to the history books because everyone will have access to clean, reliable light and power.

We are going to need help to achieve our objectives, from the public, governments, industry groups and finance experts, but there's no reason why we can't solve this problem if we work on it together. Please join the movement – together we can eradicate the kerosene lamp from Africa and create a world where everyone has access to clean, renewable energy.

I ask you to remember this challenge when you flick the switch at home tonight ...and every night, until we get this done."

My relief flows from the improved prospects SolarAid has with such a person of passion, but also proven ability to execute, at the helm. My excitement comes from the fact that John is a man not just of operational action experience, but ideas. It was he who had the idea that triggered SolarAid's phase of exponential growth in 2012 – 2015: that we should forego solar home systems and concentrate on sales of solar lights, right at the bottom of the energy ladder, because they would be more affordable for the target users, and would get far more lumens of light per square metre of living space per dollar spent than the bigger systems. It was thinking that transformed the organisation from a pedestrian do-good charity to an agent of transformative social change, at least for a few years.

And here is the thing. He has another transformative idea now. He is more excited about this one than the one he had in 2012.

I am too.

UK Parliament, London, 12th September 2017

Since my trip to Africa it has become clear to me that we need to be doing more to try and cut the supply of kerosene off at the source. The three most obvious ways to do this would be to persuade governments to ban the sale of fraudulent generic solar lights and to stop subsidies for kerosene, meanwhile persuading oil companies to name an end-date for the sale of kerosene for lighting, and commit to a progressive replacement of kerosene with solar lights in the interim.

As ever, powerful collaborators will be essential if any of that is to be pulled off. This evening I am dinner with one such. Sir Ed Davey was Secretary of State for Energy and Climate Change between 2012 – 2015 in the Conservative - Liberal Democrat Coalition government of 2010-2015. He lost his seat in the 2016 election, but was re-elected in 2017, and is now the Liberal Democrats' spokesman on Home Affairs. We first met at a climate summit, in Peru in 2014, and have run into each other several times since, in different guises. We see eye to eye on many more issues than we disagree on, and I find him to be a man of charm and integrity.

Our dinner will be hurried, for voting is afoot in the Houses of Parliament, and Ed will have to leave whenever the Division Bell summons him to the Chamber. Our discussion will be focussed, for Ed has volunteered to champion some work on African solar lighting in the current Parliament.

I bring him up to speed with the latest at SolarAid, and in the global solar lighting market. We discuss the options for policy actions. There is a lot that can be done, he thinks. This is work that lends itself to an all-party approach. It should not be an issue for party-political point scoring. He thinks it will be perfectly feasible to approach former Conservative colleagues in the Department For International Development, for example.

Excellent, I say. DFID has been a serious funder of SolarAid for some years now.

The Division Bell rings, and Ed stands to leave. MPs are paired for these votes, and his pairing is Amber Rudd, Secretary of State for Home Affairs in the Conservative government, and former Secretary of State for Energy and Climate Change – until the Conservatives closed down that ministry. She stands in the doorway of the dining room waiting for Ed.

I wave to her, and she waves back.

I wonder if she recognises me.

My relations have not been as cordial with the Conservatives, over the years, as they have with the other parties, to say the least. Favouring nuclear

energy and shale gas as they do, they tend not to find the enthusiasms of solar industry leaders agreeable – especially those that have taken them to court and won.

I sip my Parliamentary Chablis and wait for Ed to return.

Terschelling, Netherlands, 21st – 23rd September 2017

A half hour boat ride from the Dutch coast, an idyllic island sits draped with sand dunes and pine woods in the Wadden Sea. On this island, Terschelling, 500 Dutch people interested in sustainability are gathering for a festival held every year, *Springtij*. There, in conditions of maximum informality, they dive deep into discussions of sustainability. Discussion groups convene seated inside giant buoys on the harbour arm, standing out on the mud flats, perched in the sand dunes among the ruins of German bunkers from WW2, and a variety of other interesting places. The discussions span all aspects of the Sustainable Development Goals, and the participants span the full breadth of government, politics, and the corporate and NGO worlds. Such a gathering would be impossible, I fear, in the tribalised unpleasantness of contemporary Britain. Civil servants wouldn't get permission to go even if they wanted to. Captains of industry would never turn up to eat raw oysters with those who confront them in the NGO world. And as for the politicians.

I am one of only a handful of non-Dutch people to be invited. The socialising and networking is a wonder. Over buffet lunches and suppers, invariably involving the finest fresh seafood, I wander from one group to another, joining conversations with people I know or am meeting anew. Whenever I appear, delegates switch effortlessly from Dutch to perfect English. The whole experience is both magical and humbling.

At a sit-down dinner I find myself opposite an old friend, Pier Vellinga. Pier was a Dutch diplomat in the 1990s, and we spent many an hour in each others' company at sessions of the climate negotiations and meetings of the Intergovernmental Panel on Climate Change. Sitting next to me is Rein Willems, a retired CEO of Shell Netherlands. Rein is a staunch defender of the oil and gas giant, and it soon becomes clear, as conversation progresses, that he and Pier are well used to disagreeing about climate change.

Their difference of views is not over the threat itself, but the pragmatism or otherwise of policy responses, and particularly the feasibility of a total withdrawal from fossil fuels, or even deep cuts any time soon. I contribute less than

I listen, and I listen to arguments I have heard so many times over the years. The discourse is passionate on both sides, but calmy so. Rien's arguments are a carbon copy of Shell's corporate position. Men like him formulated it, after all. But he is a deeply civilised family man, a committed Christian so I learn, and impossible not to like.

He and Pier reach a point of disagreement where Rein defends coal burning in the Netherlands in certain circumstances. Here Pier becomes slightly agitated, and knowing how much of his life he has devoted to a successful outcome at the climate negotiations, I can see why. This is the point in the conversation where many other people I know would be picking up their wine glass and heading off to another seat. But these two men are far too civilised for that.

As Pier composes himself to deploy a new set of arguments, I chip in.

Well if we can't persuade you that renewables could run economies as a whole, Rien, how about important segments of them? What about at the very bottom of the energy ladder, for a starter. There, your company sells kerosene from petrol forecourts right across the developing world. Surely we could replace all that with solar lighting? And we would be saving people enormous sums of money if we did so, never mind the carbon emissions we would be saving.

I run through the economics of *The Test*, and come to the bottom line: how is it possible to make a moral argument for not naming an end year for kerosene sales, and progressive replacement of kerosene with solar in the interim?

The difficulty he has with his answer encourages me that we might have a good tool with SolarAid's letter to oil company CEOs seeking an end date for selling kerosene for lighting.

Solarcentury HQ, London, 4th October 2017

I have convened a small seminar for our fast moving times. One of Carbon Tracker's young analysts, Matt Gray, has won a place on the Global Solutions Program at the Singularity University in Silicon Valley, an institution built around the search for exponential organisations, home to a good few of the high priests of the tech industry. Matt has attended his first session there, and found it to be a life changing experience. I am keen for the CEOs of Solarcentury and SolarAid, who are both in search of exponential growth for the organisations they captain, to hear his top takeaways. It is the first time Frans and John have met. We have a fun hour, with an abundance of soaring curves, and discussion of how they came about.

I leave my question about the potential downsides of the fast-emerging new technologies until a few minutes before the end. There has been a lot of discussion of late of how uncontrolled the development of AI and robotics are, and the enormous potential social problems that parallel the potential advantages we are focussing on - not least by the hundreds of signatories to the Asilomar Principles. This very day, indeed, Google's AI acquisition, DeepMind, is announcing the creation of an ethics committee to advise the organisation. Was there much discussion of all this on the course?

Honestly no, Matt says. The atmosphere was pretty much one of default positivity.

Tadworth, Surrey, 23rd October

A SolarAid board call from my study at home. We review the results from the first half of the year. We are still very close to the overall target for incomings versus outgoings, with fundraising slightly ahead of budget, and losses behind budget as the difficulties I witnessed in all three African countries continue to take their toll. Fundraising stands at £346,000 against a target of £305,000, losses are £362,000 against a target of £317,000. African sales total 33,000 products for revenue of £250,000: only 45% of target. But Jamie's hard work has begun paying dividends, with success in one large grant application and very probably another, so we are told. This means we should be well ahead of budget by year end, and better resourced next year in the field in Africa. That will hopefully lift sales.

John professes himself pleased, and optimistic. He will do his first tour of the African offices in a few weeks. I know the teams in Lilongwe, Kampala and Lusaka are much looking forward to that.

Meanwhile, a report published today shows that we are not the only ones struggling to sell solar lighting in the developing world. The Global Off Grid Lighting Association's half-yearly compilation of sales by leading off-grid solar lighting companies spans the first six months of 2017. These data capture both pico solar products (<10.999 watts) and solar-home-systems (>11 watts). Whereas overall global sales of solar have been growing exponentially since 2006, sales of these smallest products - spanning of course those affordable by the billion-plus without electricity today - have been falling for the last 12 months, and 18 months in the case of Sub-Saharan Africa. Sales in the last 6 months were 3.52 million, down 7% on the previous half year. That is less than

a thousand small solar products selling per hour, worldwide. By contrast, the 74 gigawatts of “big solar” installed in 2016 involved the installation of more than 30,000 solar panels per hour.

This conjures up quite an image of the deepening conundrum of small solar sales deployment declining while big solar is soaring. In the time it takes one distributor to sell a single small, inexpensive, solar light or solar home system, installers of large and much higher priced solar panels have deployed fully thirty of them. If small solar could be sold at the same rate as big solar is installed, and if one product was sold to every household without electricity in the world, it would take less than a year to sell the 220 million required.

Less than a year to pass *The Test*.