


# ZED LIFE

HOW TO BUILD A LOW-  
CARBON SOCIETY TODAY

Bill DUNSTER

RIBA  Publishing



# ZEDlife

In his seminal new book, Bill Dunster demonstrates that zero-carbon, zero-waste design doesn't have to come with a hefty price tag, and is achievable today. This book presents a range of tools that form key ingredients in a low carbon society. Focusing on technologies that are already in use, *ZEDlife* explores both small-scale ideas (such as shelters and lighting) and large-scale solutions in buildings and across cities. An essential resource for both students and practitioners, *ZEDlife* offers an interdisciplinary approach to sustainability, making connections to a web of technologies through full-colour case studies of new build and retrofit projects from across the globe.

The argument for low-cost, zero-energy, zero-waste architecture has never been timelier. This book offers a forceful challenge to the status quo and provides workable, sustainable solutions for zero-carbon, zero-waste design.

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Bill Dunster OBE is an architect and founder of ZEDfactory. In 2010 he received an OBE for Services to Sustainable Housing Design. He has taught at the Architectural Association, UCL, Kingston University, Harvard, EPFL in Lausanne, and is currently a Visiting Professor of Zero Carbon Urbanism at UCL and at Cardiff University.

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At long last, there's a lot of excitement about prospects for an ultra-low-carbon economy. But what does that actually mean in practice? Building on a lifetime's experience as one of the world's leading low-carbon architects, Bill Dunster spells it out for us, balancing technical detail with inspiring visions of solar trees, ZEDpods, the Zero Bills Home, pedal-assisted bikes and trikes – and a lot more besides! This is exactly the right time to get granular about practicalities, but always holding our gaze on the incredible benefits that the *ZEDlife* will bring for people all around the world.

**Jonathon Porritt**  
Founder Director, *Forum for the Future*

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**ZEDlife**

**How to build a low-carbon society today**

**Bill DUNSTER**



**BILL DUNSTER**

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# **ZED**LIFE

*How to Build a Low-Carbon Society Today*

RIBA  **Publishing**





## *Acknowledgements*

The ZEDlife concept has evolved with the input of everyone that has either worked at ZEDfactory or collaborated with us to design, build and commission climate neutral development projects. We need your enthusiasm and your help to keep going and make progress every year. Special thanks are therefore given to: Alan Powers for patiently helping to craft the narrative, and asking me to keep trying harder; Sue Dunster for keeping ZEDfactory going and making sure this book got written; Fiona Qian for designing and project managing the ZEDlife book within the ZEDfactory, and working with the RIBA Enterprises so carefully. Above all, the ZEDfactory directors that carry these projects forward with their own skill and hard work: Rehan Khodabuccus for spending four years writing a PhD on the Zero Bills Homes concept and then helping set up the Zero Bills Home Co with David Burdett Brown; and Gilles Alvarenga, Yan Guo, and Lalit Chauhan for inspired input to the ZEDfactory live projects. The next generation is going to be an improvement in all respects. Credit too must be given to Jon Double for his visualisations, and the architects that have made these projects work: Taus Larsen, Asif Din, Steve Harris, Tianran Dong, Roberto Rocco, Shaoru Wang, Miguel Suarez, Yuan Ning, Leigh Bowen and Susan Venner. Finally, thank you to the BRE Innovation Park and Martin Milner (structural engineering) for working with us on both the Zero Bills Home and the ZEDpod prototypes, and to our most recent clients that have set the all-important challenge to deliver viable development solutions: Mr Li – President of the Yourun International Company – Jingdezhen ceramic quarter regeneration; Marcos Byington Egydio Martins and José Augusto Byington Leite de Castro of the Itayhe estate; Paul Heistein – One Planet Amersfoort; Matt Bulba – Shoreham Cement Works; David Burdett Brown – The Zero Bills Home Co.; Belinda and Colin Challenger of the Sir Arthur Ellis Trust – Newport Eco-village; Carl Grover – EcoGrove Eco-village – Barking and Dagenham; Tom Northway – ZEDpods; and of course, to Peter Bonfield and Jonathon Porritt for reading the book and commending it to others.

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# Preface

## Generation ZED

When there is little or no environmental leadership from central government, if people want to protect the water, the air and the food that sustains them then they must take direct action themselves. This requires some thought but is now increasingly possible, affordable and desirable. The escalating financial costs of the healthcare required to offset unhealthy food, unhealthy lifestyles and toxic pollution, plus the rising costs of electricity, heat, fossil fuels and climate change adaptation make it possible to find alternative low environmental-impact strategies that are now viable.

The continuous development of new decentralised technology, coupled to our deeper understanding of building physics, climatic conditions and climate change, enable us to reassess achieving climate-neutral targets at much smaller scales than previously thought possible. The aspirational 'net zero-carbon' agenda that should form the basis for every national construction industry and housing programme can now be demanded by everyone who is asked to invest in a building or infrastructure. Instead of waiting for politicians to introduce mandatory legislation setting minimum standards, it is now time for the customer to demand construction that does not pollute the

air, has no energy bills and offers a higher quality of life. Anything less means that all of us have been short-changed. Generation X was a protest over a dysfunctional and environmentally bankrupt society powered by fossil fuels. Generation ZED is going to try and find a future that works.

**The Paris Agreement** of 2016 was almost the first clear consensus from the majority of the human race about planetary-scale governance.

It is no longer clear that the existing industrial base and its funding capital will embrace the need to reduce its environmental impact fast enough to respond to the challenges set by international accord and defined in the Paris Agreement.

It is also no longer clear that national politicians are prepared to communicate the seriousness of the 'tipping point' as they are rarely rewarded for bearing bad news. A perceived conflict has emerged between compliance with the Paris greenhouse gas emissions targets and the short-term financial gain achieved by nations that reject this more onerous environmental-impact legislation.

The longer-term health benefits of planning in industrial production and the construction industry to reduce energy and materials consumption, at the same time as improving air pollution and



cleaning rivers and coastlines, is often forgotten by nationalists seeking to preserve the existing financial status quo.

However, synchronising environmental performance standards around the Paris Agreement creates an international 'common market' based on the highest standards. Any country delaying investment in clean technologies and industrial production that meets this 'common market' will quickly lose access to production economies of scale and will lose its export market. At the same time the quality of life in these countries will be increasingly degraded by air and water pollution, shorter life expectancies and increased expenditure on sourcing fossil fuels, either from fracking or aggressive procurement outside its national boundaries.

As Buckminster Fuller has said, 'The best way to predict the future is to design it.' If there cannot be leadership and responsible environmental legislation from politicians or governments the onus is for individuals, companies, towns, cities and even countries to set voluntary environmental standards and to participate in the behavioural and cultural change required to deliver the Paris Agreement. This becomes a 'grass roots' environmental movement led from the bottom-up not the top-down.

It appears we can no longer rely on the centralised supply of affordable services such as electricity, water and local public transport or even food production, education and healthcare. In many countries none of these essentials are taken for granted.

This failure of leadership due to vested interests means all of us must participate and collaborate to achieve the highest quality of life that can be available to the maximum number of people. This requires a set of low-carbon technologies and urban systems thinking that can transform the existing dystopia into an equitable, clean, green way of life. A mixture of voluntary birth control, interactive technology and systems planning can still stop our species becoming the plague that tipped climatic change into an irreversible process that could sterilise the planet.

The following questions could inform both the regeneration of our existing communities as

well as change some the key factors informing contemporary architecture and urbanism:

- How does our electric grid change urban and architectural morphologies?
- How could energy storage change both urban and rural lifestyles?
- How could planning a circular economy change urban design?
- How can cities reduce air pollution while increasing the convenience of personal transportation?
- How can energy demand be reduced to the amount of renewable energy available locally, or even within the plot boundaries?
- How can the early adopters of this thinking be rewarded with no net annual energy bills and possibly no local transportation costs?
- How can existing buildings and urban quarters adapt and be transformed to meet the new standards required by the Paris Agreement?
- What could these new buildings and urban transformations look like, and can a new vernacular evolve from the Paris Agreement?

ZEDlife looks at a set of complementary tools that fit together to deliver low environmental-impact architecture and urban design at various densities and scales of deployment. It sets up clear supply chain and manufacturing opportunities for a clean tech industrial transformation and provides a roadmap for practical solutions that will enable almost any community to plan for meeting the environmental performance targets agreed by the global community in Paris 2016. The solutions are flexible and can be upgraded with technological progress. Those that embrace this thinking first will have a strategic advantage in future markets and will gain both experience and international trade in manufacture, design and planning.

They may also enjoy sleeping at night.



# Foreword

Dr Peter Bonfield OBE FREng

*Chief Executive, BRE*

**Bill Dunster** is a rare visionary; an entrepreneurial and courageous individual whose belief and commitment to a more sustainable built environment is outstanding. His quest for positive impact has delivered a number of pioneering exemplar projects and developments that demonstrate and prove his thinking. However, the built environment at large has not yet managed to encapsulate and embrace the types of thinking and approaches Bill has promoted and developed on a large scale. As a consequence Bill continues to pursue his relentless quest for greater sustainability in the built environment by finding kindred spirits and organisations to work with him so that his ideas obtain wider impact, and with that more financial sustainability.

We have been very pleased to host two of Bill's buildings at our BRE Innovation Park on our Garston Site just south of St Albans. One, the Zero Bills Home, takes the concept of sustainability to a place beyond where most people think. The goal of this house is not to minimise negative impacts of the environment, but instead to use the house to be a net generator of positive impacts by combining energy efficiency and renewable technologies, for example. The house is also able to be built by major developers or individual house-building enthusiasts in a cost effective way.

The second building he has built is called the ZEDpod, which is an innovative design aimed at providing low cost and sustainable housing on 'grey field' sites – car parks and similar – which have the potential for providing dwellings as well as places for parking.

These two projects, the ZeroBills Home and ZEDpod are typical of Bill's approach; pushing boundaries and driving innovation ahead of the norm and showing others how the future can be delivered, today.

This book gives insights into Bill's sometimes uncompromising perspectives on how things and organisations are and how they should be. He shares his ideas, often in significant detail, to show how he thinks housing and developments should be delivered in pioneering and practical ways that meet the sustainable outcomes so needed by our society and our planet.

You may not agree with all he says or proposes, but if you have a passion for a more sustainable future and if you are willing to open your mind to new ways to design and build then, like me, you will enjoy reading Bill's book. You will be stimulated to try new ways and methods so that a much more sustainable approach becomes the norm. And in doing so better protects our society and environment in a way that creates and enables better economic prosperity through innovation.



# PART I

# INTRODUCTION

## The ZED Challenge



I.1 How to achieve a step change reduction in carbon footprint at the same time as achieving an overall increase in quality of life.



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**We use the word ZEDlife** to describe how everyone could live in a way that will make things better if they knew how. The primary aim is to make fossil fuels, incineration and nuclear power things of the past. This is so much easier than people realise.

We have taken care to ensure that what we are suggesting here can be adopted without making drastic changes to current buildings and infrastructure. By keeping it simple, the transition to a resource-efficient society powered by renewable energy systems can move forwards gradually over the next three decades.

No doubt the solutions of today will be pushed aside by better ones in the future, but this book offers the best we can do for now – technology that sadly doesn't get discussed in the media. Once it is known about, the public can demand it and put pressure on politicians to play their part.

Whoever can do this first – companies or whole countries – will have the commercial advantage as they attract international investment and achieve economies of scale fastest, while reducing the money spent competing and cleaning up after fossil fuels. Think of Silicon Valley in the 1990s, but triggered in this case by national governments setting environmental performance standards that in turn set the rules for global industrial supply chains.

A painful failure in this regard occurred in March 2015 when the UK government, under pressure from volume housebuilders, decided to scrap the implementation of Code 6 of the Code for Sustainable Homes. Seven years of preparation by the house-building industry, under the expert guidance of the highly respected Building Research Establishment (BRE), was meant to lead up to compulsory adoption in 2016. This wasn't just the imposition of 'green crap' as the prime minister of the time chose to call it,<sup>1</sup> but a major opportunity for British manufacturing and services to compete internationally. Instead, the cancellation virtually handed the advantage to the European 'Passivhaus' supply chain. When (we hope, rather than 'if') this political decision is eventually reversed by a future administration, the UK will find its industry only fit for delivering the minimum legal standards required by the building regulations. We shall have lost the

business advantage together with the benefits of lower energy bills for consumers and the stock of higher-value homes that could have accrued in the meantime.

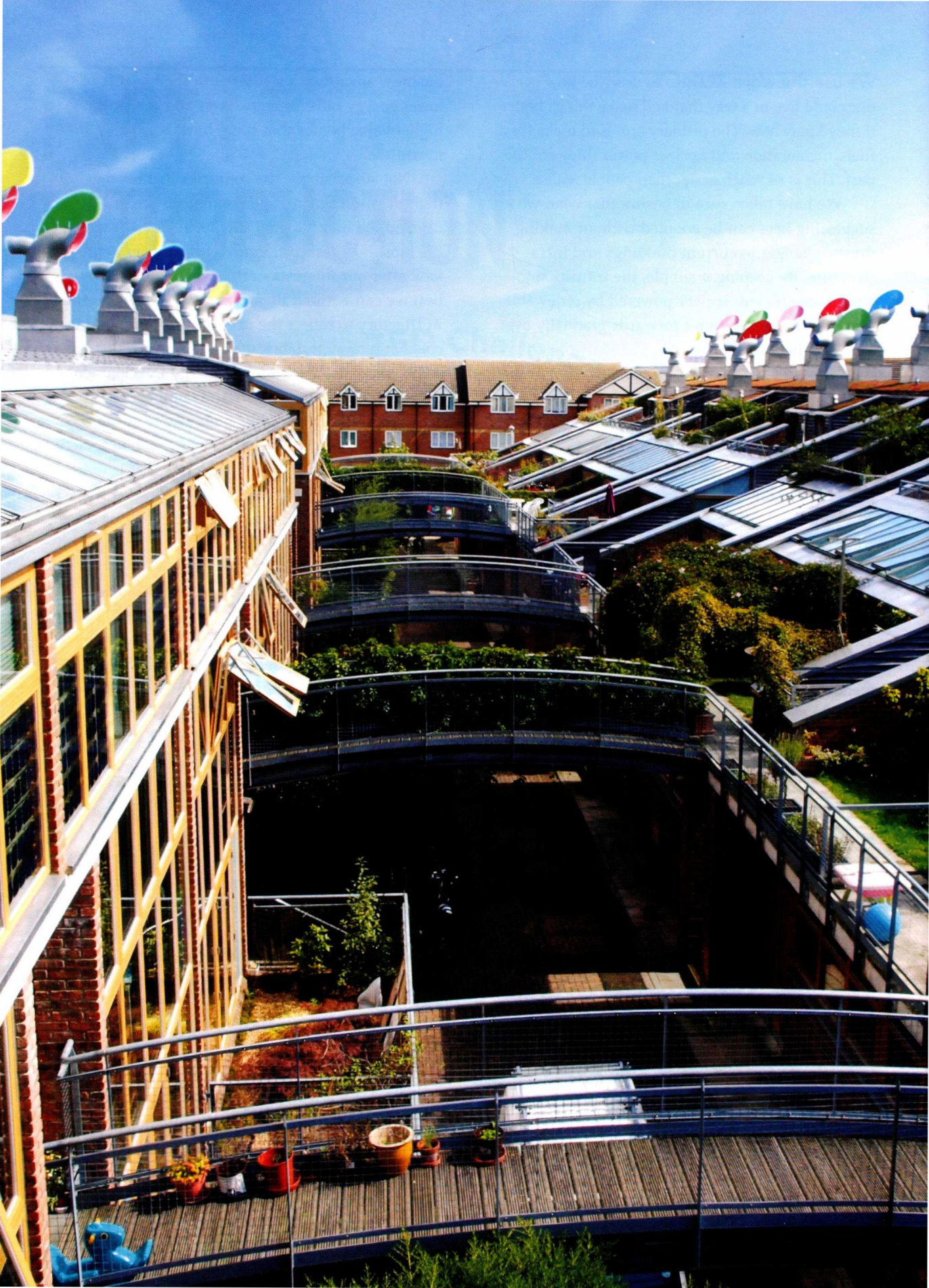
Not surprisingly, the countries that set the highest environmental performance standards develop the international supply chains that win the most business. If our governments neglect to look after our interests in this way, we must do the best we can without their help. We called our office ZEDfactory to reflect the need for planning and collaboration with fabricators and industrialists. The 'ZED' stands for Zero [Fossil] Energy Development. Bringing together architects and engineers with industrial production is the only way to create the tools that will realise a workable low-carbon society. This way, architecture can play a role that is more valuable to society than its normally limited scope of giving cosmetic treatment to buildings whose design is really determined by market forces working with minimum environmental standards.

Humans are the only species that has tried to self-consciously plan its survival on earth. This attempt defines civilisation, so let's not lose sight of it now. The ability to observe what is happening to the environment, to understand the reasons for change and then to anticipate future change is unique to our species. Right now, the risks are higher than they have ever been. Fuel costs will rise over the long term, accelerating climate change and conflict over dwindling resources. The actions of governments, slowed by their own internal conflicts, cannot be expected to rise to the challenges of change (**fig. 1.1**).

The good news is that we have reached the point where we can understand building physics and associated technology well enough to empower individuals to solve their own infrastructure requirements without asking for permission or assistance from a central authority.

The decentralisation of information technology, local transport, energy and infrastructure is similar to the displacement of landlines by mobile phones – all that was required was a piece of kit we didn't have before. This DIY future is well underway and it is time to assemble the tools and make them available to as many people as possible.







# A Beginner's Guide to ZEDlife

## The ZEDlife – a philosophy for the construction industry?

Humans are the first species that have tried to self-consciously plan their survival, but our ability to do so has fluctuated throughout time. Recently it has become clear that not enough people understand the problem, let alone the solution. We have formulated ZEDlife as a relatively simple plan for creating stability in society by ceasing to deplete the natural capital of the earth on which we live.

The need for such a scheme ought to be beyond question. Survival is far from assured, and in the face of such dangers there is no place for schemes that are too complex, or liable to fail. We need a plan robust enough to survive a wide variety of unexpected events. Solutions to the impending crisis have been held back by disagreement over details and the conflicts of political groups and their supporters. This is why attempts to achieve solutions by political means are too slow to keep pace with rising fuel costs, accelerating climate change and conflict over dwindling resources.

What is natural capital? It means resources such as fresh water, fertile soil and predictable climate events. As climate change accelerates, these resources are depleted and 'business as usual' becomes

untenable, so our ingenuity will be tested. The ZEDlife strategy will undoubtedly change in response to new threats and our ever greater understanding of how best to adapt to them. The following 12 priorities are fundamental to our collective survival:

### 1: STOP RUNAWAY CLIMATE CHANGE

Climate change is not desirable and there is an international consensus for reducing human generated atmospheric greenhouse gases. The targets defined by COP21, the conference held in Paris in 2015, must be delivered well before the planned deadlines to maximise our chances of staying within relatively benign levels of global temperature rise.

### 2: LEAVE ALL FOSSIL FUELS IN THE GROUND

All fossil fuels should be left in the ground. Extracting them from the ground means they will be burnt by someone somewhere on the planet, no matter what international treaties have been signed. If the developed world increases energy efficiency, paradoxically this makes the problem worse, as the oil producers are likely to cut their prices and entice developing countries to abandon their drives for efficiency and consume more oil and gas instead. The outcome is at best neutral, and this in itself is a further step towards disaster (**fig. 1.2, overleaf**).





1.2

- 1.2 Fossil fuels equals conflict.
- 1.3 It is important not to forget Chernobyl and Fukushima.
- 1.4 The capital cost of nuclear power could make it poor value for money and the high embodied CO<sub>2</sub> of construction and legacy suggest that a whole-life carbon footprint analysis may reveal that the electricity produced is far from carbon neutral.
- 1.5 The decommissioning and radioactive legacy containment costs of the UK's existing nuclear power programme are similar to the reported costs of the UK's two Gulf wars. Redeploying the same funds into energy efficiency and renewable energy could have avoided both.
- 1.6 Can carbon be the new currency in our social evolution?

## Japan's nuclear warning to the UK: be prepared for the worst

Fukushima chief sounds alarm over hazards as Britain plans new reactor

Simon Tisdall Tokyo

The catastrophic triple meltdown at the Fukushima Daiichi nuclear plant was "a warning to the world" about the hazards of nuclear power and contained lessons for the British government as it plans a new generation of nuclear power stations, the man with overall responsibility for the operation in Japan has told the Guardian. Speaking at his Tokyo corporate headquarters yesterday, Naomichi Hirose, president of the Tokyo Electric Power Company (TEPCO), which runs the stricken Fukushima plant, said Britain's nuclear managers "should be prepared for the worst".

"We tried to persuade people that nuclear power is 100% safe. That was easy for both sides. Our side explains how safe nuclear power is. The other side is the people who listen and from them it is easy to hear OK, it's safe, sure, why not?"

"But we have to explain, no matter how small a possibility, what if this [safety] barrier is broken? We have to prepare a plan if something happens... It is easy to say this is almost perfect so we don't have to worry about it. But we have to keep thinking: what if...?"

British ministers recently agreed a commercial deal with the French state-owned energy company EDF Energy to build the UK's first new nuclear reactor in a generation at Hinkley Point in Somerset. The agreement included the UK government providing accident insurance.

TEPCO's Fukushima Daiichi facility, on the coast about 124 miles north-east of Tokyo, was hit by a giant tsunami with waves peaking at 17 metres high caused by the Great East Japan earthquake on 11 March 2011. In what quickly became one of the world's worst nuclear disasters, operators lost control of the plant when the power supply, including emergency back-up, failed amid massive flooding. As cooling systems malfunctioned, reactors 1, 2 and 3 suffered meltdowns. Reactor 4 was closed for routine maintenance at the time. But one of several

hydrogen explosions blew the walls and roof off the reactor building. This week a delicate and lengthy operation to remove fuel rods from that reactor began.

Radiation leakage forced the evacuation of tens of thousands of people from the area. An exclusion zone 11 miles by 19 miles remains in force two and half years later. The facility is being decommissioned, but TEPCO's clean-up, which has been criticised by environmentalists, is expected to take up to 40 years.

Hirose said that although the situation facing Fukushima Daiichi on 11 March was exceptional, measures could have been

Continued on page 20 >

1.3

## 'Colossal' cost alert on Hinkley Point

● French minister says EDF was 'carried away' ● Fears over impact on utility of £18bn outlay

MICHAEL STOTHARD AND ANNE-SYLVAINE CHASSANY – PARIS

France's energy minister has warned of the "colossal" cost of the £18bn flagship Hinkley Point nuclear project to EDF, saying the state-owned utility may have been "carried away" by its British investment.

The comments by Ségolène Royal are likely to fuel already fraught talks over a final investment decision for the plant that is critical to the UK's energy future. The Somerset power station is expected to provide 7 per cent of the nation's electricity within a decade.

Ms Royal told the Financial Times she was worried by the impact the project

would have on EDF's already stretched balance sheet if it were to proceed. "I am wondering if we should go ahead with the project. The sums involved are colossal," the minister said.

The French government has an 85 per cent stake in EDF, which said this week that it had put aside a further £2.7bn for "extreme scenarios" relating to the project, meaning the total bill could surpass £20bn.

As majority shareholder, France has the most clout on the decision to build the project, which has already suffered repeated delays – the latest at the behest of Ms Royal. A final decision for Hinkley Point, which is being built with

Chinese partner CGN, is now not expected until September.

Other members of the French government, including Emmanuel Macron, the economy minister, have said the project must go ahead, as it has already been informally agreed with the UK government and it is crucial to the future of France's struggling nuclear industry.

Ms Royal is the only minister publicly to express doubts but, as President François Hollande's former partner and mother of his four children, she is an influential force in the administration. Ms Royal dismissed Mr Macron's argument about the impact on France's nuclear sector if EDF were to back out.



I am wondering if we should go ahead. Sums involved are colossal

Ségolène Royal

"I think that if Hinkley Point did not happen it would not put the French nuclear sector in danger," she said.

But she conceded that withdrawing would damage the French state's reputation. "It would send a bad signal [and] competitors would say, 'look at France, the state does not keep its word,'" she said, adding, "That kind of thinking tends to weigh very heavily on decisions over whether we can reverse things when we get a bit carried away."

Trade unions at EDF are trying to halt the project while the chief financial officer quit this year, citing fears that the investment could bring EDF down.

Call for plan B page 2

### 3: REPLACE FOSSIL FUELS WITH PROGRESSIVELY VIABLE ALTERNATIVES

We must replace fossil fuels with renewable energy alternatives, and nuclear fuels are not among them. Nuclear materials can poison food and water supplies, and no one can confidently predict the indefinite continuation of high levels of monitoring and the absence of natural or man-made disasters at nuclear sites. Thirty years after the nuclear pollution from Chernobyl spread to the British Isles, Welsh lamb can still show high levels of radiation, while the only nuclear storage we have at Sellafield still discharges into local air, sea and land even though it is not supposed to. There is no independent evidence that nuclear is a valid low-carbon energy source – or that it can be responsibly managed for millennia. There are renewable alternatives that carry virtually no risks, so we should not be considering further dangers from this outdated fossil fuel technology (figs 1.3–1.5).

## Investigation into bungle over nuclear plant deal

£6bn clean-up contract to finish early after minister admits tenders for Magnox reactors were 'flawed'

By Alan Tovey

AN INQUIRY has been launched into the contract to decommission Britain's Magnox nuclear power stations after the scale and cost of cleaning up the ageing reactors spun out of control, forcing the deal to be scrapped.

The Nuclear Decommissioning Authority (NDA) yesterday pulled the deal with Cavendish Fluor Partnership (CFP) to decommission a dozen reactors, as it was discovered far more work was needed than specified in the original contract.

Two years ago the deal was awarded to CFP – in which blue-chip Babcock has a 65pc stake – with it expected to run for 14 years.

However, with complications mounting and costs soaring, the NDA has decided to end the £6bn agreement after just five years in 2019, admitting the way the tendering process was botched.

In 2005 the NDA put the future costs of decommissioning Britain's entire nuclear estate at about £50bn though this has now soared to about £10bn, with the giant Sellafield plant – which is not part of the Magnox clean-up – accounting for about £87bn of the total, according to experts.

Dr Paul Dorfman, from University College London's Energy Institute, said: "They were set up to fail and have failed because the understanding of the costs and complexity to nuclear decommissioning is changing all the time."

Magnox reactors were thrown up in a rush to give electricity too cheap to meter and create plutonium and there

was no thought of how they would be decommissioned.

"Each Magnox reactor is bespoke so decommissioning each one is different with its own complexities and challenges. The more we learn about dealing with the 'back end' of nuclear power, the more we see how complex and costly it is."

Energy Secretary Greg Clark said an independent inquiry led by former National Grid boss Steve Holliday will investigate what went wrong with the contract, raising the spectre of disciplinary proceedings for those responsible. "Taxpayers must be confident that public bodies are operating effectively and securing value for money," Mr Clark said.

However, the botched contract has already left the taxpayer facing a £100m bill to settle the legal claims of two companies whose bids were unsuccessful, with Mr Clark admitting "it was clear the tender process was flawed".

Mr Clark said that the decision to end the deal early was "no reflection" on CFP's work. However, the news sent shares in Babcock down 4.3pc, to 877p, with the company's order book being reduced by £800m as a result.

Although the contract decision was one for the NDA, Mr Clark said it was so significant that it required his sign-off, along with that of the Treasury.

"We have a responsibility to ensure that the NDA's decisions reflect its legal obligations, including under procurement law, that further risks to taxpayers' money are contained, and that robust arrangements are put in place to deliver this essential decommissioning programme."

The NDA will now start preparing a new contract for when the CFP deal ends in 2019.

However, analysts expect the company to be well placed on future decommissioning work.

1.5



#### 4: MAKE ANY HUMAN ACTIVITY CLIMATE NEUTRAL

Carbon footprinting is a key concept to apply to every operation that we undertake – housing, offices or industrial uses, among many others. It is based on an equation between a certain site area and a target of carbon reduction. The aim is to generate a slight surplus of renewable energy from within the site to ‘repay’ the carbon produced during its creation and maintenance on an annual basis, while also matching its annual energy demand. The target is reached if the carbon footprint represented by the set-up of the project (‘the embodied carbon’) can be repaid within the estimated lifespan of that project. If this can be achieved, the project can be deemed climate neutral.

This is the goal, and if every construction project were to adopt this overall target quickly enough, human induced climate change could gradually reduce. This strategy might be a turning point in the evolution of human civilization because the threat of runaway global warming could be averted and the situation stabilised.

This simple shared priority must form the basis of any future government or legislation that claims to be acting on behalf of the best interests of the

majority of its citizens. Since the first work on this book, the political situation has deteriorated in this respect in the US and the contagion may spread. This is why the COP21 agreement represents both a practical and symbolic line that now divides hope from despair.

#### 5: USE CARBON AS THE NEW CURRENCY

Carbon dioxide (CO<sub>2</sub>) can act as a currency for measuring the impact of any proposed human intervention, because carbon footprint and overall environmental impact are closely correlated, similarly the cost of conventional goods and activities and their overall environmental impact (fig. 1.6). In general, allowing for some exceptions, a common metric capable of simplifying even the most complex footprint audits is better in practical terms than aiming at 100% accuracy. If the footprint analysis is too complex, or takes too long, it becomes expensive and nobody wants to do it. Even if construction of any kind represents production of CO<sub>2</sub> that remains a form of embodied carbon, this can be offset by renewable energy generated by the project.

ZEDfactory

**CARBON  
NEUTRAL  
LIFESTYLE.**

Using CO<sub>2</sub> as a common metric for uniting the environmental footprint of construction with its in use performance, at the same time as leaving fossil fuels in the ground.

2



## 6: DO NOT EXPORT YOUR PROBLEMS OFF-SITE

Developers of new construction projects have often paid to 'export' their CO<sub>2</sub> footprint by arranging that it should be matched by gains in a foreign country. Doing this takes away scarce opportunities for renewable generation, opportunities that will shortly be needed by more local communities. Therefore, this undesirable practice should be invalidated. All carbon offsets through renewables should be achieved on the same site as the project.

Because renewable energy is harder to store and transport, it tends to favour more local patterns of production and consumption. If the COP21 targets are achieved globally by 2050, almost every community will have to be running on renewable energy. No matter how much is invested in renewables we would not be able to meet the energy needs purely from renewable energy, even if demand were to be reduced by as much as a third.

At what point, then, do the carbon footprint accounts have to balance to ensure that the collective human civilization avoids causing runaway climate change? The ZEDlife solution favours simplicity because there is no right answer. As Mahatma Gandhi told us, 'Be the change you wish to see in the world.' From today onwards there is no excuse for all new human infrastructure not to be climate neutral, cancelling out its CO<sub>2</sub> footprint over its lifetime.

Making this resolve would mean that the construction industry moves into a 'transition' operation in which economies of scale start as soon as possible. This would still be only the first step, however, because the total carbon footprint of human civilization has to be not just zero but negative. We have to compensate for a hundred years in which excessive amounts of CO<sub>2</sub> were released into the atmosphere. This extra rectification can be achieved by taking the CO<sub>2</sub> that is already in the atmosphere out of the carbon cycle and sequestering it back into the ground, year by year. The scale of the problem is so large, and the urgency so real, that any investment in infrastructure or buildings must not contribute to accelerating climate change, but work in the opposite direction.

This is not an option that can be rejected just because the message is unpopular or worrying.

There is no workable alternative, and even the most ardent climate change deniers ought to have been silenced after a majority verdict from 155 nations to sign COP21 in Paris in 2015 – their future is the same as everyone else's and we are already on the brink of disaster.

The best plan is immediate positive action, demonstrating that we can still have a better future. Admittedly the problem of changing so much on which contemporary civilization has been built, above all the ability to extract fossil fuels, seems daunting. Humans have now become planetary curators and the question is whether the human race can change its culture fast enough to be qualified to do the job.

## 7: MAXIMISE ENERGY EFFICIENCY

Renewable energy is going to see us through and beyond the crisis, but while by definition it will not run out, it is still precious. We must use less of it than we have been used to using with fossil fuels. There are techniques now well established that help to reduce consumption of energy in buildings, chiefly insulation that really works, active thermal mass to absorb temperature change, high standards of draught proofing to hold heat in, and heat recovery ventilation in temperate climates that captures energy that might otherwise simply escape upwards. These form an essential set of safeguards that could save approximately one third of the current energy consumption.

However hard you try, it is unavoidable that in making buildings, energy-intensive materials have to be used – materials that add to the CO<sub>2</sub> footprint. Durability then becomes a key criterion, as if these materials have a short service life, little has been gained and the CO<sub>2</sub> payback becomes impossible. One largely neglected way of maximising energy efficiency is to configure the shape and orientation of the building to achieve further gains. Sunlight can provide both passive solar gain and electricity, but we as people want sunlight in our homes for well-being as much as we need it to feed our solar devices. If access to sunlight were to be enshrined in all future investments in buildings and infrastructure, we would choose better solutions to the complex process of juggling different demands and would end up with high-quality urbanism.