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Editorial

We have another good line-up of articles and authors. My thanks go to Robin Morris and Donna Palmer. Robin has written about some recent analysis of total energy cost of photovoltaics with some surprising results, and Donna about a novel event to get postgraduate students working on energy-related problems to think more entrepreneurially. Robin Morris and I attended the launch of the Liquid Air Energy Network and I’m grateful to Robin for proof-reading my report.

If you’ve been to an event that you enjoyed, please let us know, so that other group members share in that knowledge.

Colin Axon

This newsletter is also available on the web and in larger print sizes.

The Energy Group website is http://eg.iop.org

The contents of this newsletter do not necessarily represent the views or policies of the Institute of Physics, except where explicitly stated.

The Institute of Physics, 76 Portland Place, W1B 1NT, UK.
Tel: 020 7470 4800   Fax: 020 7470 4848
Next Energy Group One-day Event

Realising Fusion Power: Recent Advances and Future Research Paths

Monday 25th November, 2013
Institute of Physics
Combined with the Group AGM

Recent advances have opened up new directions for the UK research programme in the last three years. In this unique one day meeting, we bring together key experts to discuss the outstanding physics and technology challenges in both magnetic and inertial confinement fusion research. The programme is designed to enable plenty of time for discussion with the speakers and within the audience. Charges apply (with the usual concessions), lunch and refreshments are included.

Coffee will be available from 10:00, the main event starts at 11:00. The Energy Group AGM will take place between 10:15 – 10:45.

Date: Monday 25th November, 2013
Time: 10:15 – 17:15
Venue: IOP, 76 Portland Place, London W1B 1NT.
Registration: www.iop.org/events/scientific/group/index.html#/?i=3
Organiser: Dr. Anthony Webster, anthony.webster@ccfe.ac.uk
Enquiries: amy.fitzgerald@iop.org

Lorne Horton (JET): Progress and challenges for MCF
Roland Smith (Imperial) Plasma challenges for ICF
John Collier (CLF): Technology challenges and roadmap
Elizabeth Surrey (CCFE): Systems integration
Steve Roberts (Oxford): Development of materials for Fusion
Steve Cowley (CCFE): Panel and open discussion

Charges apply (with the usual concessions), lunch and refreshments are included. Earlybird registration date: 25th October.

Co-sponsored with support from the Culham Centre for Fusion Energy, IOP Plasma Physics Group, and the Central Laser Facility.
New Insights to PV Lifetime Energy Costs
By Robin Morris

In their paper ‘New criteria for success in PV?’ Dale and Benson analyse the global energy balance for the solar photovoltaic (PV) industry. They present results from a new model which considers the energy inputs required for the manufacture and installation of complete PV generation systems. The authors suggest that the global PV industry has been a net user of electricity until relatively recently, but go on to say that there is a better than 50% chance that PV will start to make a net positive energy return between 2012 and 2015.

PV is promoted as a low carbon source of electricity generation, but the embodied energy calculations usually relate only to the manufacture of the solar cells. Within this tight definition, a PV cell repays the energy invested in its manufacture. However, the broader energy expenditure should be taken into account when considering the net energy contribution of the complete system, taken from cradle to grave. Dale and Benson consider mining, processing, fabrication of panels and balance of plant through installation, operational and maintenance periods to eventual disposal and recycling. Their approach did not consider gradual decline in quantum efficiency over time as this could be considered a second-order effect.

The paper covers six materials systems: the dominant single-crystal and poly-crystalline silicon cells, amorphous silicon (a-Si), ribbon silicon, cadmium telluride (CdTe), and copper indium gallium diselenide (CIGS). Mandatory requirements for proportion of renewable generation and a raft of incentives have been used to promote the adoption of solar PV. These stimuli have resulted in the installation of solar PV generation approaching 100GW worldwide. Reduced prices and growing markets have been grabbed as political payback.

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Dale and Benson made use of the energy return on investment comparisons by Raugei and applied learning curve techniques to the production of PV modules to predict future reduction of energy used for manufacture. The production of CdTe is cited as least energy intensive, though the drive for alternative materials systems – such as organic or dye-sensitised cells – will be driven in part by the attraction of lower energy costs. The paper does not exclude approaches which would offer opportunities to surpass the theoretical limits for single-junction cells.

The Stanford University authors present an analysis which initially seems attractive. They suggest that new measures for success are needed if the PV industry is to take a more significant role in energy supply. They would add energy flow analysis to the materials and economic constraints. The monitoring of balance between electrical input and generation could be used as a criterion for success in reducing emissions of carbon dioxide. The analysis does not extend to local air pollution, nor does it make ecotoxicity lifecycle comparisons.

The authors do not appear to have considered the energy costs associated with managing the variability of generation and reduced correlation between peak supply by PV and times of peak demand in the cooler northern countries. But energy costs of storage or back-up generating plant could perhaps be included in the analysis. Dale and Benson suggest that the contribution from PV is almost negligible on a global scale. However, over-production of solar power in Germany has recently (June 2013) resulted in negative electricity prices and is setting real challenges for both the market and electricity system engineers.

While application of PV in regions with high insolation gives a more attractive energy return, this does not address the question of mismatch between the location of demand and supply. Future work might also explore the opportunities for improved energy payback that can be realised from distributed generation, through reductions in transmission and distribution losses in comparison with the centralised production model.

Robin Morris is an independent consultant on sustainable technologies. He is currently working with the senior management of SMEs. Robin has particular interests in distributed generation, LED lighting, energy storage and energy efficiency in the built environment. He is a graduate of Imperial College, is Honorary Secretary of the Energy Group, and Chair of the community action group ‘Low Carbon East Oxford’.

Research Student Conference Fund

Providing financial support to research student members to attend international conferences and major national meetings.

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For further information, see www.iop.org or email supportandgrants@iop.org.
Saying YES to Energy
By Donna Palmer

At the end of May, 50 postgraduate students from across the UK took part in the first Energy Young Entrepreneurs Scheme (Energy YES). Over four days, ten teams of researchers had to develop a business plan for their own energy-related idea. To support them complete the task the teams received one-to-one mentoring and attended workshops given by leading companies in areas such as IP and patenting, finance, commercialisation and marketing strategies. The teams also heard from individuals that have taken research ideas to commercialisation. On the final day each team presented their idea ‘Dragons Den-style’ to a panel of would-be investors and industry experts. On the judging panel was Douglas Drysdale from Harrison Goddard Foote complimented the participants:

“I was very impressed by the high standard of the presentations. The pitches showed a remarkable level of applied innovation and, more importantly, demonstrated that the teams had come to grips with many of the drivers for creating a successful company and securing investment.”

After the first round of judging ten teams were whittled down to two: the York-led Fusion Doctorial Training Network team with their idea based on liquid earth alkaline batteries, and the team from the Midlands Energy Graduate School (MEGS) with their idea of eco-friendly refrigerator cooling units. In the final, both teams had to make another presentation and answer further questions from the judges, with MEGS winning the £1,000 prize. The MEGS team were five postgraduate researchers drawn from the universities of Birmingham, Loughborough, and Nottingham. Mei Chew, a 3rd year PhD student working on Nuclear Waste Management at Loughborough said:

“Energy YES has been so worthwhile. Winning aside, we’ve learnt a lot about commercialisation of science and it has been really useful to talk to mentors such as patent attorneys that we wouldn’t usually have access to. The speakers were excellent and it’s especially
encouraging to hear from people who have been in our shoes as researchers and gone on to successfully commercialise their idea.”

The competition is the first of its kind specifically designed to enhance business skills of postgraduates in the energy community. It was developed by the Network of Energy Centres for Doctoral Training and Haydn Green Institute for Enterprise and Innovation. If you are a student and interested in taking part in Energy YES 2014 or work in industry and want to find out how you can support please get in touch with Donna Palmer.

Dr. Donna Palmer manages the EPSRC-funded Network of Energy Centres for Doctoral Training and is based at Nottingham University. She is a Member of both the Royal Society of Chemistry and Institute of Physics, holding CChem and CSci professional qualifications. Previously Donna worked as a project manager for Pera. Donna obtained her M.Chem. and Ph.D. from the University of Leicester. She can be contacted at Donna.Palmer@nottingham.ac.uk
The Role of Liquid Air in Energy and Transport Systems

Colin Axon reports on this one day meeting held on 9th May 2013 at the Royal Academy of Engineering, London.

In part this event was about launching a report by the Centre for Low Carbon Futures consortium\(^1\). This was also the first gathering of the whole UK community of expertise in this area. The event also launched the Liquid Air Energy Network\(^2\). The potential of liquefying air as a grid-scale energy storage device has been discussed for some time; Highview gave a talk to the Energy Group Start-ups event in 2011\(^3\), however, they are not the only player. There are very interesting prospects of using liquid air (or nitrogen) as a supplement in an internal combustion engine, either as part of a combined thermodynamic cycle with refrigeration units on trucks or ships, or even as the ‘fuel’ itself. Any physicist would feel at home with the basic thermodynamics and properties of gases, but the engineering poses interesting and non-trivial challenges, particularly in respect of scale-up.

Richard Williams (Birmingham) chaired the event. His opening remarks were interesting in that his comments were all about supply-side. The technical journalist, David Strahan (footnote to the report of his talk), had been engaged as the report’s editor. He made a number of personal observations including that when he started on editing the report, he had not been convinced about the use of liquid air for transport purposes, but had changed his mind. The morning was dedicated to energy storage, with the afternoon for transport.

\(^{1}\) Members are the universities of Birmingham, Hull, Leeds, Sheffield, and York www.lowcarbonfutures.org
\(^{2}\) www.liquidair.org.uk
The first speaker was Nigel Brandon (Imperial). He thought that the benefits of using liquid air were strong. However, Brandon did support demand-side response (DSR). He thought that increasing gas capacity was important, but he saw this as competing with DSR.

Then Rob Morgan (Brighton U. and Highview) set out the case for liquid air grid-scale storage in a very clear talk. He said that there were 5GW liquid air plants already operating (as production facilities) and that a standard storage tank on LNG had about 16GW of capability. He claimed that the Highview pilot plant in Slough could potentially achieve 50-60% round-trip efficiency when co-located with a source of ‘waste heat’. Morgan suggested that although this could be improved, it was sufficient because it was not operating all the time and was adding value to the grid system. Morgan walked through a simplified version of the thermodynamics cycle Highview uses. It interesting that nearly all of the components used are off-the-shelf which is a key point in making the technology reliable and reducing the need for development time and money. The clever part being the engineering systems integration to get the efficiency up. Morgan’s estimates of the full cost for the first-of-kind 20 MW / 800 MWh plant is £1744 / MWh, with the costs for the 20th unit dropping to £995 / MWh. The open question Morgan raised was whether it was better to build smaller more distributed units, or fewer larger ones. The smaller units potentially can be more responsive to localised grid issues, though parasitic losses may be proportionately higher.

The regulatory question was taken up by Anthony Price (Swanbarton). This appeared to be the most significant barrier to deployment and was not specific to liquid air energy storage systems. Widespread energy storage was not conceived as part of the electricity market at privatisation. As a result, Price said that there was not an obvious business model and that the segmentation of the power industry actively discourages investment in storage. Price pointed out that the current arrangements encourage the take-up of small diesel gensets and small gas turbines. With no clear regulatory or licensing policy and currently no Government policy for widespread deployment or adoption of storage, the uncertainty increases the risk in financing projects. Price suggested that policy is required to clarify the position of storage in the regulatory framework and to set a target of 2GW of new storage capacity by 2020. He called to give storage parity with support for other new / green technologies to provide certainty of income. This support mechanism should be based on capability. As storage is neither generation, nor demand, Price said that existing licensing provisions are inconsistent and are not necessarily relevant. He called for a new classification which would clarify the position of...
network operators who own storage. However, Price ended on a pessimistic note saying that he thought that it will be hard to implement in the current electricity market arrangements. He considered that 'the market' will not deliver storage capacity because the risks are too high, and that the Government will not send the strong signals that are required to the market. So far so cool. The next session was dedicated to transport. The technology and business case is less convincing, but it is not without promise. The discussion was split by whether liquid air was the 'fuel' or an ancillary service to the thermodynamic systems of a vehicle. These ancillary services may be modification of the fuel combustion characteristics, regenerative energy recovery and storage, or for refrigeration services. There are some interesting parallels with hydrogen. Like the interest in hydrogen before it, the use of liquid air as the energy vector requires significantly different infrastructure and motive power devices. Like hydrogen, the liquid air generation technology is well-known and could be delivered at scale by the specialist gases companies in short order. Like hydrogen, on-board storage may be similar. However, that’s where the similarities end. Turning the stored energy into mechanical motion will require a different engine. Indeed, not an internal combustion engine, but an internal steam engine. The possibilities for system integration look the most promising.

The reasons why having a tank of liquid nitrogen in a vehicle is potentially interesting were set out by Colin Garner (Loughborough). He said that on a mass per vehicle basis, LN$_2$ is better than compressed air, and that the energy density is comparable with batteries. An advantage LN$_2$ offers over batteries is faster filling. Garner thought that LN$_2$ use might be most appropriate for down-sizing or perhaps new engine architectures. The nitrogen expands by a factor of 700 when changing phase from liquid to gas. Using a constant volume process (isochoric) to warm the LN$_2$, the high pressure generates work by letting the highly pressurised liquid expand (in a reciprocating engine or turbine). Adding a heat source in the expansion part of the cycle enables the LN$_2$ to expand isothermally (maximising energy output).

The details of a suitable engine were developed by Andy Atkins (Ricardo). They have been working on a two stroke (Dearman) engine with experiments showing that expansion of LN$_2$ is comparable with a naturally aspirated petrol engine. Liquid water is added with the LN$_2$ – acting as a heat exchange medium – and the water is extracted on the exhaust stroke and recirculated. Atkins suggested that there were lots of opportunities for integrated energy recovery systems, particularly for light goods vehicles and refrigeration.
Nick Owen (E4Tech) drew some interesting comparisons. For example, he estimated that costs might be £25 kWh\(^{-1}\) which might be one tenth that of Lithium ion batteries (even if optimistic about the prospects for Lithium). A LN\(_2\) engine could, in effect, use off-peak energy [though this would compete with energy storage – CA]. However, Owen recognised that LN\(_2\) was not a long-haul ‘fuel’. His view was that LN\(_2\) engines could compete with fuel cells and batteries in niche areas such as forklifts and airport trucks.

Building the LN\(_2\) highway was the topic of Steve Cooper (Spiritus Consulting). Cooper had an up-beat message about how well the gases industry functioned and was organised. Gases are an established industry and form 3-4% of the turnover in the chemical process sector. Safety procedures were well-established, understood, and already governed by international (globally accepted) standards. This includes dealing with the fractionation problem in tanks of liquid air. The processing equipment is mature technology, regularly reaching 99.5% availability and has automated operation. Cooper pointed out that the industry already has nation-wide coverage with significant distribution infrastructure in place – including pipelines and tanker-trucks, and storage.

Just before lunch, Roger Harabin (BBC) interviewed Peter Dearman, the inventor of the eponymous reciprocating engine. Dearman is not a trained engineer, but a self-confessed ‘shed inventor. This was a gentle stroll through Dearman’s progress from initial idea, through prototype, to starting a company\(^4\) and getting funding. That first device was just a modified ICE, but it successfully moved a car 100m. His passion for making stuff came across strongly. Like Trevor Bayliss and Mike Burrows before him, Dearman developed that important feel through practice, rather formal education, for how mechanical things worked before hitting upon an idea that would have a life of its own.

\(^4\) www.dearmanengine.com
The afternoon session concentrated on markets. William Holt (Strathclyde) spoke on the opportunities in Scotland for liquid air technologies in the light of targets and the aspirations of the devolved Government. Holt suggested that the combination of proven technology and the need for geographically distributed systems was a strong point in favour of liquid air technologies for Scotland.

Phil Carter (National Grid) spoke about a 6 MW storage demonstration plant in the planning stage for integration into NG’s Isle of Grain LNG facility. It would have five hours operating time and be largest such UK demonstration. Grain is already an energy hub with two CCGTs, an aviation fuel facility, and the landing site for the BritNed 1 GW electricity interconnector. Carter explained that there were several integrated cycles using waste heat from the CCGTs and the coolth of the CNG terminal.

For the case in Germany, Tim Evison (Messer Group) showed how liquid air energy storage could help mitigate the phasing out of nuclear plants by stopping the need to dump wind energy into neighbouring countries. Evison thought that conducting trials in Germany would be a useful step forward.

The investors viewpoint was made succinctly by John Leggate (Quintal Partners). An interesting point he made was about the expansion of energy use in Africa being driven by the need for refrigeration of food and medicines. Leggate made one of the most perceptive comments during the day in noting that the past is littered with failed 'big new ideas', for example fusion and the hydrogen economy. Now perhaps, he suggested, we may add CCS and the nitrogen economy to the list in the future. However, he did say that he thought that both the energy storage option and the Dearman engine had significant potential. Leggate added that data centres and other big cold users might find use for integrated systems based on liquid air.

In summing up, Richard Williams said that this was a landmark meeting – it was the first time that the whole academic and business community had got together in one place. There is a lot of interesting and clever physics and engineering to be done. Whether both of the principal applications are successful remains to be seen, but this was a fascinating start to the journey.

Colin Axon is Lecturer in the School of Engineering and Design at Brunel University, London. He works on smart grids, energy and resource use in the built environment, metrics and indicators for energy security, and sustainable mobility. Previously he worked in the Department of Engineering Science at the University of Oxford. He is Founder and Associate Director of the James Martin Institute for Carbon and Energy Reduction in Transport, at the University of Oxford. Colin is the Chair of the Institute of Physics Energy Group.
Network of Energy Centres for Doctoral Training Conference
Donna Palmer reports on the second annual conference held at Imperial College, London.

The first day was a workshop to learn all about the art of networking. The postgrads were soon able to put their new skills into practice at the poster and networking reception that followed the expert panel discussion on ‘The Cost of Electricity in 2050’. The panel were Steve Hargreaves (Corporate Strategy Director, EDF Energy), David Kennedy (Chief Executive, Committee on Climate Change), Jim Skea (Imperial College), Malcolm Grimston (Chatham House), and Paul Fennel (Imperial College).

The second day started with a keynote address by Paul Ekins (UCL). The rest of the day was handed over to students from energy CDTs and the MSc in Sustainable Energy Futures at Imperial. Prior to the conference students had been selected to give oral presentations on their research. The talks, which were arranged into themes, were captured by graphic facilitator Eleanor Beer¹. All were amazed at her ability to represent the sometimes very complex ideas that the students were presenting (Figure 1).

The network², which is funded by the Engineering and Physical Sciences Research Council (EPSRC), brings together the 13 Energy CDTs to exchange ideas, stimulate collaboration and develop future energy leaders. Looking ahead, we will soon be expanding our network as the results of 2013 EPSRC call for CDTs will be announced in the coming month.

¹ www.eleanorbeer.com
² Website: www.ukerc.ac.uk/support/CDT+overview
LinkedIn group: Energy CDT Network. Twitter: @energycdtnetwork
Dr. Donna Palmer manages the ESPRC-funded Network of Energy Centres for Doctoral Training and is based at Nottingham University. She is a Member of both the Royal Society of Chemistry and Institute of Physics, holding CChem and CSci professional qualifications. Previously Donna worked as a project manager for Pera. Donna obtained her M.Chem. and Ph.D. from the University of Leicester. She can be contacted at Donna.Palmer@nottingham.ac.uk
Chair’s Notes

Energy Group AGM

Monday 25th November, 2013
10:15 – 10:45
Institute of Physics, 76 Portland Place, London W1B 1NT.

We urge you to attend as this will help ensure the vitality of the Group, the committee, and the activities we undertake.

This year nominations are needed for new Committee Members. Three places are available.

Informal enquiries can be made to either Colin Axon (colin.axon@brunel.ac.uk) or Robin Morris (robin.morris@physics.org)

Completed nomination forms are available from, and should be returned to the Honorary Secretary, Robin Morris (robin.morris@physics.org) before Monday 18th November.

If you unable attend the AGM and have issues you would like to be raised at the meeting, please notify the Honorary Secretary before Monday 18th November.

Attendance at the AGM is free and precedes our event

“Realising Fusion Power: Recent Advances and Future Research Paths”

Please see p.3 for details.

Colin Axon,
Colin.axon@brunel.ac.uk
Energy News
Westmill Solar Co-op wins European Award

At the European Sustainable Energy Week Award in June the Westmill Solar Co-operative won the award for reducing energy consumption. The judges praised Westmill Solar Co-op’s imaginative approach and scale of vision and the successful delivery of a project under challenging conditions. There were 224 entries from all over Europe for the six categories.

Westmill Solar Co-operative owns and operates the first community owned solar farm in the UK which is probably the largest community owned solar project in the world. The solar farm is rated at 5MW, located on the Oxfordshire / Wiltshire border, spread across 30 acres. They have over 1600 members who share a say in how the cooperative is run and benefit from a share of the project revenues.

Web: www.westmillsolar.coop/
Book Reviews

Low Carbon Technology Transfer – From Rhetoric to Reality
by David Ockwell and Alexandra Mallett (Eds)
Published June 2012, 390 pages ISBN 978-1-84971-269-9, £65.00 (hardback), Earthscan from Routledge, www.earthscan.co.uk

Having worked in a university technology transfer office and spent a number of years working with numerous low-carbon technology companies, I was particularly interested to review this book. In summary the practicing physicist, or the scientist expecting to read extensive examples of how innovative technologies where lifted out of the university labs and exploited on the world stage to bring both financial and moral satisfaction to technologists, business people, and policymakers alike, is likely to be disappointed. The book is aimed at policymakers and economists rather than the scientist, and the examples described are written from the perspective of the analysis of the policy framework surrounding the programmes, rather than the analysis of the technologies transferred. However, a reader who has an interest in energy technologies and is actively working in exploiting technologies and battling against a regime of ‘market-failure’ would do well to at least read the comprehensive introduction and refer to the chapters of most relevance to their environment or interest. This book provides a global perspective on what the editors present as “the most pressing issues facing society today”.

The book seeks to differentiate low-carbon technology transfer from other types of technology transfer by identifying the unique aspects of the sector such as the urgent need to find low carbon technology solutions (presented from a global warming perspective). Secondly, the aim of ‘facilitating the transfer of low carbon technologies’ to speed up the adoption of technologies that would be adopted and delivered by the market in the
long term (addressing market failure), and finally the multifaceted nature of the challenges in (i) developing pre-commercial technologies, and (ii) enabling the adoption of developed technologies across geographic and economic regions.

Building from this I found the book informative, by a taking step back from the debates and statements we hear from politicians and interest groups, and defining the term ‘low-carbon technology transfer’ (which I thought I understood) and describing what is meant by technology transfer in different parts of the world. For example, in the developed world, the investment in technologically risky programmes by the state to address ‘market-failure’ with the view to seed the market, back-winners, and create high value jobs in a wealth economy. Compare this to the developed world where demand for energy is increasing, where say, the distribution of readily available solar PV and LED lighting to remote locations would reduce pollution from dirty or inefficient generation.

The book is well researched, well presented, and the list of contributors is extensive. Predominately the contributors are experienced policy advisors (either civil service, or university-based), climate change and economic development academics, economists, scientific and technology strategy advisors, and a minority of engineers. The contributors bring to the book their wide experience in working with exploitation of low carbon technologies in many areas of the world including China, India and South Asia, and the UK. They also address the role of intellectual property, the impact of the United Nations Framework Convention on Climate Change, poverty reduction, trade and investment, the Clean Development Mechanism as drivers for, or inhibitors of, low carbon technology transfer.

The book is usefully summarised with a quote from David Vincent one of the contributors, and one of the founding fathers of the Carbon Trust:

“Technology is important, but it is only one aspect of building a low-carbon developing economy. Having a supportive and stable policy and market framework... [is] also important”.

This is predominately a comprehensive reference book rather than a cover to cover read.

Roger Welch
Published February 2013, 312 pages ISBN 978-0-415-52902-0, £35.00 (paperback), Earthscan from Routledge, www.earthscan.co.uk

This publication of this book is timely. According to the UN, more than half the world’s population now lives in cities. In the first chapter, the editors remind us that this part of the world’s population fits into 1.5% of the land area and that the IEA estimates that cities are responsible for more than 70% of greenhouse gas emissions. The book is split into four sections. The preface recognises the need to change the way in which energy is used in and supplied to cities if efficiency gains are to be realised. Integration is the main theme that links the chapters but I am left with the nagging doubt that modelling of urban energy systems appears to be based on assumptions which are too limited. There seems to be a failure through the book to recognise the effects of different asset ownership models. It’s not clear whether this represents an appeal for more control and power for cities or an indication of market failure. Despite the attempt to encompass a variety of urban systems, there is a strong bias to the British context. There are comparisons with other western systems where urbanisation in India might provide useful examples of modern integration.

The volume provides useful context for energy use and both fascinating and sobering historical examples of pollution and fuel supply. It’s great to see mention of the effects of transport on urban air quality, though the impact on air quality of the use of electricity from coal-fired power stations is not mentioned (widespread media coverage of excess/early deaths in northern China). It would have been pleasing to see more about embodied carbon emissions and other environmental impacts. For cities with rapid growth, concrete use is responsible for a significant proportion of their carbon dioxide emissions. As energy is used more efficiently or is
delivered from low-carbon sources, a lifecycle approach to understanding embodied energy and pollution footprint becomes relatively more important.

There is an arguable case for proper consideration of the role of ubiquitous regulation and incentives. Additional analysis might have explored the effect of ownership model on urban energy systems. I would like to have seen more on the boundaries of maximum extraction of work and limitations to building fabric, lighting, heating and transport sectors.

The options for megacities may well be quite distinct from those for the half of the urban population who live in small cities. The urban energy systems of today are indeed cultural artifacts and it is not clear what is accessible to improvement activities. One author picks up on the enhanced revenue raising possibilities for public works as improvements to properties lifted their rateable values. Perhaps in a further lesson for modern policymakers, the history reveals development of the energy systems often characterised by frantic entrepreneurial advances, followed by punitive legislative control. The concept of the diffusion of a new technology or product would usefully be balanced with a review of the role of regulation and subsidy (for example: compact fluorescent lamps, condensing boilers).

The publisher claims that the book is intended for a wide range of readers: “students, researchers, planners, engineers, policymakers and all those looking to make a contribution to sustainability”. It is unfair to expect one book to pick up on every case study or aspect which is of personal interest to the reader. Within the confines of each specific topic, there is reasonable coverage and the authors’ efforts may have been done better justice by amending the chapter titles to reflect the actual content. Perhaps the editors could have provided an introduction to each chapter in order to address some of the apparent gaps in the coverage and so adjust readers’ expectations. My main concern for researchers is that the references are sometimes a little old and perhaps the range is not as global as I had expected to see. The structure of the book left me wondering whether specific subjects – such as the effect of policy interventions, energy payback or lifecycle assessment – were going to be covered in another chapter. I don’t find it satisfying to see models using data which I believe to be somewhat dated or where significant constraints or externalities do not seem to be incorporated. The outputs from applying such tools are particularly open to misuse by policymakers – one of the claimed audiences.

The book is a series of cameos which provide useful insights into certain aspects of energy use in urban areas. The writing style is not particularly consistent and the flow is interrupted by the topic divisions. The treatment felt too detailed for a non-scientific audience and took a narrow view of sustainability in most chapters. Whilst the book will serve as a useful
starting point for people new to the subject, I am not convinced that it succeeds in offering a consistent picture of the challenges and opportunities associated with urban energy systems. The publisher’s expectations of meeting the needs of a wide audience may have been unrealistic. By making space for the detailed descriptions and understanding within the authors’ specialist fields, the book may have missed the opportunity of providing an authoritative, high-level overview. Using different authors for each chapter seems to have resulted in patchy coverage. I feel that the chapter titles generally seem to promise more than they delivered.

Robin Morris

Renewable Energy – a First Course by Robert Ehrlich

Four years ago, Robert Ehrlich, in his own words, was a “newbie in the field of renewable energy”, so he learnt on the job by teaching a first year physics course in renewable energy at George Mason University. This book results from that experience. There is no quicker way to learn a subject than to teach it, so here we see how an experienced teacher stimulated his students with the new knowledge. Each chapter has about 20 problems to solve, which mostly require basic physics and often stimulate lateral thinking. The book is well presented and of a generous size, with clear pictures and diagrams.

Ehrlich starts by explaining joules and calories, the conservation of energy and the second law of thermodynamics in just four chirpy pages. It is immediately obvious that the author is a good lecturer who communicates well with his first-year students.
The opening chapters set energy in the context of society’s needs and outline all energy supplies, including nuclear and fossil fuels. We learn that conventional energy supplies are not satisfying an increasing world population and that renewables are needed. The key countries promoting renewables are described, together with their economic needs; Germany and China feature strongly. There is an early chapter on fossil fuels, their chemistry, resource statistics and environmental impacts. Similarly for nuclear power which starts with the discoveries of Marie and Pierre Curie and progresses to nuclear structure, fission and fusion, health physics, and nuclear power stations and safety.

We meet the first renewable 133 pages in – biofuels. Photosynthesis is briefly explained, leading to biomass production. But there is virtually no detail and only hints of the complex range of established processes and products derived from that biomass. However we are told of plans to grow crops up the sides of skyscrapers! Geothermal energy follows, mostly for thermal power stations. We consider geological thermal gradients, heat extraction, the potential of ‘hot rocks’ and environmental impact, including the risk of triggering earthquakes. As with other chapters, opportunity is taken for ball-park physics analysis e.g. the increasing cost of drilling with depth. Such an approach is praiseworthy for a first year physics course; it is the way that a problems is solved that matters – perhaps of more importance than the problem itself.

Now nearly half way through the book, we meet wind power. Wind resources are outlined worldwide, the power in wind is calculated, wind speed distributions introduced (Weibul and Raleigh) and the Betz ‘maximum power extraction’ criteria calculated. Lift and drag forces, and tip-speed ratio are taught in one page; aerodynamics and engineering surely deserve more. These fundamentals are applied to practical turbines in a few more pages, but key commercial developments are missed, for instance the importance of multipole generators and rectifier/inverter interfaces for variable speed grid-connected turbines. Environmental considerations of bird and bat impacts, of acoustic noise and of visual impact are briefly, but critically, examined.

Then comes a chapter on hydropower, within which Ehrlich surprisingly and rapidly includes wave, tidal and ocean thermal power. Perhaps this was half term for the lecture course. Following this, there are 66 pages on solar radiation, including the greenhouse effect, and solar thermal applications. As usual, the treatment teases out opportunities to use basic physics illustrations and to set problems. Chapter 11 is on photovoltaics – that most physics-dependent renewables technology of them all. We move from solid-state physics basics of valence and
conduction bands, to manufactured cells for power generation. Ehrlich even includes some quantum mechanics in his explanations. Surely, of all the renewables subjects considered, this provides most motivation for later more advanced physics courses.

Quite rightly, there is a full chapter on energy conservation and efficiency (of use). This includes the physics of LED lighting (yes, vital) and thermoelectrics (not so vital). Vehicles and their component losses are considered; the thermoelectric generation from the exhaust is used to charge the starter and lighting battery (this is for physicists after all!). But electric vehicles only receive 10 lines. Then follows a chapter on energy storage and transmission, including power networks, batteries and flywheels.

To conclude, we have a chapter on climate-change politics and on carbon emissions. China is a main driver of emissions, but also a main driver for solar energy application. The USA is criticised for being reactionary and for being generally unbelieving of climate change impacts. Ehrlich’s concluding exhortation to his students, as a soon-retiring professor, is for them to think critically and strategically. He clearly believes that studying renewable energy should help this.

John Twidell,
AMSET Centre

Write for the IOP Energy Group Newsletter

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Been to an event recently?
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If you’re new to writing, the Energy Group Newsletter is a great way to get started. The Editor will help you polish and shape your article to make the most of the ideas that you want to put across.

For an informal discussion, email Colin Axon, colin.axon@brunel.ac.uk
Forthcoming Events

Realising Fusion Power: Recent Advances and Future Research Paths

UK and European fusion research is refocusing on the technology and materials for a demonstration-scale power plant. Recent advances have opened up new directions for the UK research programme in the last three years. In this unique one day meeting, we bring together key experts to discuss the outstanding physics and technology challenges in both magnetic and inertial confinement fusion research. The programme is designed to enable plenty of time for discussion with the speakers and within the audience. Charges apply (with the usual concessions), lunch and refreshments are included.

Coffee will be available from 10:00, the main event starts at 11:00. The Energy Group AGM will take place between 10:15 – 10:45.

Date: Monday 25th November, 2013
Time: 10:15 – 17:15
Venue: IOP, 76 Portland Place, London W1B 1NT.
Registration: www.iop.org/events/scientific/group/index.html#/?i=3
Organiser: Dr. Anthony Webster, anthony.webster@ccfe.ac.uk
Enquiries: amy.fitzgerald@iop.org

Lorne Horton (JET): Progress and challenges for MCF
Roland Smith (Imperial) Plasma challenges for ICF
Steve Roberts (Oxford): Development of materials for Fusion
Elizabeth Surrey (CCFE): Systems integration
John Collier (CLF): Technology challenges and roadmap
Steve Cowley (CCFE): Panel and open discussion

Co-sponsored with support from the Culham Centre for Fusion Energy, IOP Plasma Physics Group, and the Central Laser Facility.
A Tour of LED Lighting: How it Works, What's Next, and What to Buy
Dr James McKenzie, C.Phys, M.Inst.P.
Co-founder and Chief Executive Officer of PhotonStar LED Group.

James will explain how LED lighting works – from the device physics to complete lighting system. He will examine how we can reduce the amount of electricity that is needed to illuminate our lives. James draws inspiration from evolution and will illustrate the talk with practical demonstrations. He will take a look at how changes in light quality can affect us during the day. Along the way, the audience will be gain insights into the key characteristics to look for in the best of today's light sources – and have a preview of developments that are in the pipeline.

Date: Wednesday 18th December, 2013.
Time: 18:30.
Venue: Institute of Physics, 76 Portland Place, London W1B 1NT.
Organisers: IOP Energy Group and London and South East Branch.
Enquiries: Robin Morris, robin.morris@physics.org
Register at: https://www.iopconferences.org/iop/442/home

Lean, Green and Mean – Meeting Energy Efficiency Targets

Energy efficiency is increasingly recognised as a vital part of the energy future and now is the time to seize the opportunity and accelerate deployment - but how is this to be achieved? This conference examines the opportunities available as well as the barriers that need to be addressed if we are to meet the UK Government’s ambitious targets.
Date: Thursday 16th January, 2014.
Time: 09:00 – 17:15.
Venue: Energy Institute, 61 New Cavendish Street, London W1G 7AR.
Organisers: Energy Institute.
Registration: www.energyinst.org/energy-efficiency
Enquiries: Gemma Wilkinson, gwilkinson@energyinst.org 020 7647 7174

We are very grateful to the Energy Institute for their generous offer to Energy Group members:

IOP Energy Group members are entitled to attend at the reduced EI member rate when quoting IOP.

Fees:
EI Individual member: £ 60.00 (£ 72.00 inc. VAT)
Non member: £ 220.00 (£ 264.00 inc. VAT)

Confirmed speakers:
Peter Atherton, Liberium Capital
Malcolm Ball, Green Investment Bank
Dr Steven Fawkes CEng FEI, BGlobal
Professor Martin Fry FEI, Martin Fry Associates
Nick Katz, Honest Buildings
John Mulholland, Mulholland Energy Solutions
David Purdy FEI, Energy Efficiency Deployment Office

Topics:
Update on UK policy on energy efficiency. Building demand and the impact of mandatory energy audits. How can behavioural psychology reduce energy consumption? Strategic campaigns and motivational techniques. Innovations in technology, products and practice. How can we increase the flow of investment? The impact of the Green Investment Bank. Utilising innovative finance models
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We welcome comments and suggestions for events and items for the Newsletter.

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