Welcome to a new edition of the Energy Group Newsletter. Back in December we had the privilege of hearing from a set of excellent speakers about the state of the art in low carbon transport fuels, engine developments and manufacturing processes at our low carbon cars event, and you can read a summary of the talks here. We also learn in this edition about living with a wood pellet boiler, about balancing future ‘smart’ gas grids, and about newly-released books on peak oil and renewable energy resources.

Many thanks to all the contributors, whose wide range of expertise enables us to keep up with developments across the field of energy.

Finally, we look forward to seeing many of our members at our one-day event on 13 July, “Renewables at scale: realising Gigawatt generation”. Registration is open, and you can sign up at: https://www.iopconferences.org/iop/737/home

Jenny Love
Low carbon cars: fact, fiction or folly?
Roger Welch reports on the Energy Group meeting held on 8th Dec 2014

The Energy Group organised a one day meeting to explore the technical, economic, and environmental challenges to transport by gathering together a diverse mix of technologists, academics, and policy advisers to give a wide ranging view on the subject.

Welcome and Introduction

The retiring chair of the Group, Colin Axon, set the scene by presenting some key figures showing the immediate requirement for creating a low carbon transport infrastructure. First, that air pollution in the UK gives rise to approximately 28,000 deaths per year, of which 6,000 can be associated with transport pollution. Secondly and quite shockingly, 50% of all the oil extracted to date has taken place since 1989 (and 90% since 1961), showing a huge and increasing dependence on liquid fossil fuels.

Currently 4 gigatonnes/year of oil are extracted with 85% converted to liquid fuels – mostly for transport. This raises an important yet often neglected challenge: that alternative solutions proposed to displace or compete with liquid fossil fuel transport systems require the characteristic of scalability.

One challenge with alternatives to liquid fossil fuels is that, technically, they are the ‘next best solution’. For example they require more processing steps to convert their stored energy into kinetic energy. With this, Colin set out the goal for the day: to investigate these process efficiencies and how best to increase them.

Limits to the Internal Combustion Engine
Professor Andrew Atkins, Ricardo

Professor Atkins framed his talk in terms of the key challenges faced by the automotive industry when developing new technologies: safety, environment, emissions and sustainable manufacturing. ‘Environment’ and ‘emissions’ may sound like the same thing but low carbon dioxide and clean air are different, and sometimes competing, challenges, and clean air often beats CO₂ in terms of priorities.
It is also important to balance the ‘CO$_2$’ and ‘sustainable manufacturing’ priorities. Cars have been consistently getting more fuel efficient in terms of gCO$_2$/km. However, the whole life CO$_2$ footprint of a car involves the emissions associated with production. Typically, for a car with an internal combustion engine, 23% of its CO$_2$ emissions are associated with production. In a typical Electric Vehicle, 46% of CO$_2$ emissions are associated with production, due to the additional processing required to manufacture the batteries.

The presentation focussed mostly on how to increase efficiency of and therefore reduce the in-use CO$_2$ emissions associated with internal combustion engines. For context, the maximum efficiency of the heat engine is reasonably estimated at 66%. Typically diesel engines are currently 40% efficient and petrol engines are around 33% efficient with lean gasoline engines starting to become as efficient as many diesel engines. It is expected that with heat recovery technology 60% efficiency will soon be a reality.

The efficiency of the ICE can be improved by increasing the pressure of the cycle and adjusting the stoichiometry of the combustion. With increased efficiency the engine size can be reduced, leading to further gains. Hence the industry and technology pushes are towards turbo/supercharged engines. Professor Atkins mentioned Ricardo’s work on using the waste heat from the engine to drive a turbine, which charges a battery, which can then be used to turbo/supercharge the engine, which leads to better improvements in efficiency than using the recovered energy to directly drive the transmission. Professor Atkins also outlined some other projects which used liquid nitrogen to provide isothermal compression to improve efficiency.

Of course, another priority along with environmental and safety goals is also cost. New technologies have to compete in an aggressive market where engine blocks for a typical 1.6L engine can cost as little as $400.

In summary, Professor Atkins presented a wide range of technologies that have the potential to make a significant difference to the efficiency of the internal combustion engine, which if deployed will not eliminate the demand for liquid hydrocarbon, but will potentially significantly reduce it.
Life Cycle Assessment on Conventional and Electric Vehicles

Professor Anders Hammer Strømman, Norwegian University of Science and Technology

Professor Strømman presented NUST’s work on assessing the whole life CO₂ emissions from conventional and electric vehicles. The need to understand this is in part driven by the taxation system in Norway, which heavily taxes conventional vehicles and has significantly lower taxes for electric vehicles. This has led to significant uptake of electric vehicles in Norway (electric vehicles now make up 12% of new car sales).

Much of the data used in this study has been provided by car manufacturers who publish their own data on life cycle analysis. The size of a vehicle has a large impact on its lifetime emissions, with large vehicles responsible for as much as three times more CO₂ than smaller vehicles (ranging from 25-75 tonnes of CO₂ over a 200,000km vehicle life). Hence, when comparing between heat engine and electric vehicles it is important to compare equivalents.

Typically 5-10 tonnes of CO₂ emissions are associated with the manufacture of a conventional vehicle; this doubles for an electric vehicle due to the manufacture of the batteries (see the previous talk). However, electric vehicles have the potential to emit less CO₂ over the lifetime of the vehicle if the electricity generation is carbon efficient. This depends on the generating mix for the individual countries. If the electricity is generated from coal then electric vehicles emit more CO₂ than their conventional equivalents. For a typical energy mix (such as in the UK) smaller electric vehicles perform worse than their conventional equivalents, but larger electric vehicles can perform better than their conventional equivalents, depending on the size of the battery pack. In Norway, where there is a significant amount of low carbon hydroelectricity, electric vehicles significantly out-perform conventional vehicles in terms of CO₂ emissions.

This analysis contained two uncertainties around batteries. Firstly, it had been assumed that one battery pack was used (and unrecoverable) over the 200,000km lifetime of a car. This, as discussed during the presentation, is not yet proven and would be highly dependent on the territory where the vehicle is being used. It is envisaged that battery packs in cooler climates, such as Scandinavia, would have longer life than those used in hotter climates.
Following on from this, the presenter acknowledged that there has been little research on the environmental impact of battery manufacture and, again, the impact is likely to depend on where the batteries are made. This is because the production process requires a dry atmosphere, hence the additional air conditioning required in the tropics/Asia would adversely impact on the CO₂ emitted in production.

The study also investigated the impact of biofuels on the CO₂ emissions of conventional vehicles, and how changing land use affects the carbon cycle and the albedo of the Earth’s surface. As these effects indicate, the impact of replacing fossil fuels with biofuels is not trivial to assess. However, the modelling done by NUST shows that vehicles powered by biofuels can have significantly lower CO₂ emissions than conventional or electric vehicles.

**Prospects for Biofuels**

*Dr Chris Malins, International Council on Clean Transport*

Dr Malins gave a balanced overview of the potential for biofuels and the policy frameworks required to ensure that they are part of the energy mix.

By 2050, according to worst and best case scenarios, biofuels could reduce emissions by between 500 and 1,500MtCO₂/year respectively. However, since biofuels can rarely compete with conventional fuels on price alone, these emission reduction impacts can only be realised with international policies promoting their production and use. To date there have been some regulatory drives, for example to support rural development, promote energy security, and address concerns relating to climate change.

It is important to consider what is meant by a ‘green’ fuel. Typically this will include reduction in NOx/SOx/CO₂ emissions, reduce environmental footprint, and/or be renewable/sustainable. Current fuel crops do not necessarily fulfil these criteria. Firstly, they compete with food crops, creating concerns about food poverty (one tank of fuel is equivalent to the calorific intake of one person for one year). Secondly, converting land from its previous use to grow fuel crops can release as much CO₂ into the atmosphere as will be saved over a 20 year period. So any policy moves need to consider a range of competing and complex issues.

So-called ‘second generation’ biofuels, made from cellulosic material, have the advantage of not competing directly with food crops. The starchy
biomass can be converted to liquid and gaseous fuels by a range of
technologies including gasification, pyrolysis and fermentation. The UK
currently produces 25 million tonnes/year of sustainable cellulosic material
in the form of agricultural and domestic waste, which can be converted to
energy and fuel. However, there is little policy direction on this subject and
combined with some outstanding technical issues it is unclear how this
market will develop over the next few years.

Finally, there are so-called ‘third generation’ technologies which include
algal biofuels, solar fuel synthesis, and liquids from waste fuel gases.
However, there remain significant technical hurdles to overcome before
these make a significant contribution to the energy mix.

**Transformative Change in Manufacture for the Automotive Sector**

*Adam Chase, E4Tech*

Adam Chase began his talk by looking back to the origins of automotive
transport where electric vehicles were the first cars to compete with the
horse drawn carriage; in 1900 EVs had a 28% market share. Indeed,
Porsche’s first model was electric. However, by the 1930’s the internal
combustion engine had become the dominant design.

Today most of the growth in the automotive sector comes from developing
economies. However, concerns relating to CO$_2$, air quality, and energy
security are driving legislation leading to innovation and technology
development of alternative powertrains.

Which fuels will dominate? The point was made that although the UK has a
large and growing investment program in new technologies, which
technologies will win may depend on the interests of the stakeholders who
will benefit differently from different technologies (e.g. power utilities will not
benefit from better ICE vehicles but would see benefit in plug-in EVs
becoming dominant). Hence, strong policy frameworks are required to
prevent any one industry segment dominating innovation.
Given the dominance of liquid fuels in the transport infrastructure it is likely that they will continue to dominate especially as biofuel alternatives become more available, but is difficult to predict what the mix will be after 20-30 years. It could in fact be diverse, with electric vehicles, hybrid EVs, natural gas and hydrogen fuel cell vehicles coexisting. Adam concluded his presentation with the thought that, “policy sets the direction of travel, innovation takes us on the journey”.

**Pace of Innovation and Change**
Dr Sjœrd Bakker, TU Delft

Dr Bakker concluded the day with a thought provoking presentation. It was firstly reiterated that innovation in alternative powertrains is as old as the automotive industry with electric vehicles, with mechanical energy storage systems (coiled springs) being early innovations.

It is likely that the ICE will continue its dominance through further innovation to improve efficiency but this cannot continue forever. Dr Bakker presented a graph showing the number of commercially available vehicles with alternative powertrains, showing electric vehicles and electric/ICE hybrids dominating the emerging markets. These innovations come from a mix of large automotive companies and start-up companies, showing the potential for new entrants in the market.
Interestingly, the hydrogen fuel cell, which has found some significant niche applications and provides a powertrain with good lifetime performance, has not yet gained market traction. This has been due to the challenges associated with the production and storage of fuel.

Given that innovation does not follow a linear path, how do innovators influence policy makers and ensure that public money is spent in the wisest possible way? Clearly this is not an easy question to answer, but expectation management, providing stimulus to enable markets to move from dominant designs, providing networks to emerging marketplaces, and creating a critical mass so that an industry can survive without intervention are good guiding principles.

Roger Welch
Towards renewable heating: our experience of a domestic wood-pellet boiler

John Twidell FInstP and Committee member of the IOP Energy Group

Background
My wife and I are committed to using renewable energy to reduce our household and other use of fossil fuels. As part of this, we are aiming towards zero fossil fuel heating in our home.

Our home is located in a Conservation Village with no mains gas supply (we would not want to use gas anyway), and is a conversion from solidly built hundred-year-old stabling, with central heating. The external walls and attics are now well insulated (e.g. 200 mm external insulation on solid walls) as well as some of the floors. Windows are now double-glazed, either using additional internal secondary glazing or new units of argon filled double-glazing.

In this situation, there are several strategies to achieving zero fossil fuel heating, with common methods being via heat pumps (using renewable electricity), biomass combustion (logs, chips or pellets), or even anaerobic digestion. Previously, we had used a farm-scale wood boiler. This was cheap to run, with significant local waste wood and timber dried in a large wood store. We used only about 30% of the oil that would otherwise be needed, with total heating and electricity costing us about £800 per year in 2013/14. However obtaining, storing and cutting wood – which was once fun – in older life has become laborious and time-consuming. So we opted for a wood pellet boiler - as opposed to a wood chip system, which would be more suited to larger scale applications and those utilising the site’s own wood.

THE BOILER AND BUFFER
The pellet-boiler is an Austrian Herz ‘Pelletstar (10-60) 45 kW system. Fig 1 shows the layout of the combustion chamber. Air blown onto the pellets allows primary combustion to CO and H₂, and air entering above this allows secondary combustion to CO₂ and H₂O. Flue-gas ventilation takes place with a suction fan, which is speed-controlled according to flue-gas temperature and oxygen concentration. There are several safety devices to prevent the possibility of combustion back into the pellet store and, if
necessary, to cool the combustion area with water. The manufacturer’s technical brochure claims 93% boiler efficiency, which is probably the gross (higher) value with water vapour condensation. However this value is much too large for the non-condensing boiler and the rest of the system, including its associate pipework, buffer, fuel feeder, pumps etc. (more detail later on).

Figure 1. Combustion chamber and heat exchanger. Wood-pellets enter via the Archimedes screw from the pellet store and through a firebreak. Ash from the chamber falls into a tray, and soot deposits within the heat exchanger are loosened by occasional automatic brushing into a second tray. We empty these trays monthly.

The control of forced air and fuel into the combustion chamber is sophisticated, for example incorporating measurement of exhaust gases with a ‘lambda probe’ to enable optimised combustion – see Figure 2.

Figure 2. Lambda probe set in the flue gases measures oxygen concentration and is the sensor for optimising combustion and fuel feed rate.

The control panel leads to information about key parameters through the whole system, including about 15 temperatures through the boiler, flue and buffer tank. With an additional interface, these parameters can be seen, logged and changed logged remotely – shown in Figure 3.

Figure 3. Control panel leading to about 10 screens with parameters and settings
At the house-end of the district-heating pipe there is a heat exchanger for passing heat to the established central heating and hot water supply.

**THE BOILER-HOUSE**

We decided to house the boiler and fuel store in a purpose-built boiler house, connected to the household central heating via a buried mini district-heating loop.

In practice a wood-pellet boiler system with its necessary buffer tank and fuel store requires about 10 times the volume of an equivalent oil system. For example, the pellet store must be large enough to take at least 4 tonnes of pellets for ‘economic’ delivery (ours takes nearly 10 tonnes, equating to least a year’s supply).

A schematic of a similar system, showing the amount of space required, is shown in Figure 4.

![Fig 4. Schematic of a wood-pellet-boiler system. Not shown is the considerable amount of insulated water piping, the water-pressure stabilisation pump, and the connection to the mini-district-heating pipes.](image)

We estimate that only about 65% of the combustion and buffer-stored heat is pumped into the household central heating and hot water (more accurate measurement of requires longer time fuel usage, together with additional instrumentation of one or two heat meters and of electrical power meters, which we intend to install).
So what happens to the other 35%? Despite having excellent pipe and tank insulation, most of the rest of the heat of the pellet system appears as heated air in the well-insulated, but ventilated, boiler room, so it is important to make use of this otherwise waste heat. Our strategy was to have the new boiler-house and its attic space insulated and large enough for other uses, such as drying washing (unlike burning oil, there is no ‘smell’ with pellet burners), growing mushrooms and making wine. We find that the ventilated boiler house maintains an internal temperature about 10°C more than the three-day average external temperature. Of course, if the boiler system could have been integrated within the house, as in a cellar, the waste heat could in principle help to heat the house more directly, however fire and ventilation regulations would complicate this being carried out.

CONSTRUCTION, INSTALLATION AND SUPPLY

Designing and then obtaining Planning Permission for a new boiler house in our Conservation Village took us about a year. Once obtained, installation commenced. Figures 5 and 6 show the ‘district heating’ pipe being installed, with the end rising into the boiler-house floor.

Figure 5. Trench for the district heating pipe

Figure 6. Insulated twin pipes for the circulated water from the buffer tank in the boiler room to the heat exchanger into the household central heating and hot water supply
We are fortunate in living near the hub of local initiatives for wood fuel and boiler supply. The delivery of wood-pellets uses the same vehicles routinely used to deliver animal feed-pellets to farms; no special vehicles are needed. Thanks to the Renewable Heat Incentive (RHI), there are now multiple outlets for the competitive sale of wood-pellets. In our area the initial bulk pellet supply tends to be from the Midlands National Forest or from Scotland. The bulk supply is delivered to local suppliers already having suitable vehicles with blowers and officially registered load weight measurement.

**COSTS AND THE UK RENEWABLE HEAT INCENTIVE**

Our system was not cheap, with the boiler costing £11,200. Purchase, fitting and commissioning of pipework, pumps, buffer tank, back-flow pipes, controls etc. added considerably more. In addition we chose to build the separate boiler house.

However, the UK ‘Renewable Heat Incentive’\(^1\) offers significant support for the hardware of boiler, fittings and pellet store. There are two categories: Commercial (requiring heat meter readings of heat delivered into a building for pro-rata payments, as with electricity Feed In Tariff claims) and Domestic (flat rate, not requiring a heat meter). Once we had obtained a Green Deal Energy Certificate for the house above grade E, the online Domestic RHI grant application was relatively straightforward. Once the system was commissioned and registered by the qualified installer, the grant period started. In our case we receive a domestic grant quarterly to our Bank account, indexed linked for 7 years; eventually we will have been supported for most of the capital cost of the hardware.

In terms of operating cost, pellets cost about £210/t, which totals considerably more than the foraged wood for the old farm-scale boiler, but our own intense labour is no longer needed.

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CONCLUSION

With the wood pellet boiler, a major aim of having a net ‘fossil-carbon free’ home has been met. The path for this was long, not straightforward and not cheap, but it is in retrospect satisfying. We installed technologies when they were not common, but now see these commonly accepted and provided by a significant number of local businesses. The world is changing!

John Twidell graduated BSc and DPhil in physics from Oxford University. His first post was Khartoum University where he says, ‘I found the Sun’. He then moved to the Universities of Essex (2 years), Strathclyde (20 y), South Pacific (Fiji-2y) and De Montfort (5y). He lectures and researches in renewable energy dominated topics. His university text book with Tony Weir (Renewable Energy Resources – Routledge) is now in its 3rd edition and is used internationally.
Energy News

Highlighting developments in a variety of energy technologies over recent months

2014: 100GW renewable generation capacity added globally…

According to a recent report, *Global Trends in Renewable Energy Investment*, 103GW of new renewable capacity was estimated to have been built around the world during 2014 (excluding large hydroelectricity schemes). Lead editor Eric Usher talked of the "[continued] concentration of investment in two sectors, solar and wind".

Wind power made up nearly 50% of the total, though solar was not far behind, with a big leap in solar installations in China and Japan. Utility-scale projects constituted three quarters of solar investment in China. In contrast, projects of under 1MW accounted for more than 80% of solar investment in Japan.

Although investment was only slightly up on the year in Europe, offshore wind investments here dominated the global picture.

Globally, renewables were estimated to have produced 9.1% of the world's electricity generation in 2014. The report suggests that this contributed to saving of 1.3 Gigatonnes of carbon dioxide emissions.

… and nearly 20% of UK electricity came from renewables

Official statistics show that renewable energy generation contributed 19% of the UK’s electricity demand of 352.6TWh last year. The provisional figure for total renewable power generation was 64.4 TWh in 2014, an increase of 20% over 2013. The installed renewable generation capacity grew by nearly a quarter over the year, to 24.2GW.

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2 http://fs-unep-centre.org/sites/default/files/attachments/key_findings.pdf
UK hosts Europe's largest battery storage project

A two year trial of a 6MW/10MWh battery bank, known as the Smarter Network Storage facility, has commenced in Leighton Buzzard, Bedfordshire. Consisting of 3,000 individual lithium-ion batteries, the battery complex is able to power over 27,000 homes for an hour or 1,100 homes for a whole day during periods of low electricity demand. The installation is about the size of three tennis courts and is divided into two rooms: one hosting the battery racks; one housing the transformers and inverter units that convert electricity between DC and AC. The system can carry out frequency regulation and load shifting, therefore contributing towards several useful functions: helping solve the problem of intermittency of renewables, protecting the grid from Stress Events such as power outages, and decreasing the need and cost of traditional reinforcement, such as transformers and cabling.

Plant powered bus shelter

Researchers at Cambridge University and green technology companies are experimenting with a means of powering a small shelter using a combination of solar photovoltaics and plants. During the day, as the sun shines on the shelter the two systems each make use of different wavelengths of the incident radiation.

Thin-film solar panels (commonly known as BIPV, or building-integrated photovoltaics) turn light into electricity by using mainly the blue and green part of the solar spectrum. Plants, growing behind the solar glass, use the red spectrum radiation needed for photosynthesis. Electrons naturally produced as a by-product of photosynthesis and metabolic activity generate currents, the latter mechanism enabling power to be generated during the night.

The long-term aim of the research project is to develop a range of self-powered sustainable buildings for multi-purpose use all over the world, from bus stops to refugee shelters.
Battery powered trains trialled by Network Rail

A successful prototyping exercise last year led to the entering of battery powered trains into passenger service for five weeks from January.

Last summer a test train was created by retrofitting lithium iron magnesium battery cells into an Abellio Greater Anglia Class 379 unit which normally operates using electricity drawn from overhead power lines. This led to further trials on real timetabled routes on electrified parts of the rail network, where the trains can recharge their batteries at terminal stations using existing line converter equipment. Although battery powered trains are not a new concept, having been used for specialist applications where there is no power supply, this is the first time they have been used as passenger trains.

The purpose of these trials is to investigate the potential for battery-powered trains to bridge gaps between electrified parts of the network and run on branch lines where it would be too expensive to install overhead electrification. Network Rail hopes that the trial could ultimately result in a fleet of battery-powered trains to replace diesel-powered equivalents.

(Image: Bombardier)

Natural gas vehicles and smart gas grids
Juliana Montoya Cardona, Hanze Groningen University of Applied Sciences

This article explores the applicability of smart grid concepts to the Dutch gas network, by reflecting on the experience of the electricity sector.

Why natural gas vehicles?
Natural gas vehicles (NGVs), like electric vehicles (EVs), are an alternative to oil-fuelled vehicles: combusting conventional methane generates about
25% less CO2 than oil derivatives. There are close to 15 million natural gas vehicles on global roads today, with the three greatest users being Iran, Pakistan and Argentina. NGVs may in some circumstances have advantages over EVs, such as range. The Dutch automobile industry expects an increase in NGV sales.

NGVs are usually charged at dedicated stations, but domestic charging facilities are now available. The pressure of the gas grid is much lower than that required for a compressed natural gas (CNG) vehicle, so electricity is required to compress mains gas before it is used in cars.

**Why smart gas grids?**

So called ‘smart’ electricity grids have been a familiar concept for a number of years. As more renewables come on to the grid, the flow of information and power is no longer in one direction, but becomes bi-directional.

![Figure 1: location of Groningen](image)

A similar phenomenon can occur in the gas network. Groningen is an interesting example of this. Located in the north of the Netherlands in a gas-rich region, high quality and well controlled natural gas is injected into the network from a small number of points. The gas then transports itself through pressure differences to where it is drawn off the network.

However, this system looks set to change with the introduction of new gases such as biogas. Small producers of biogas, such as farmers, will be able to inject gas of variable quality at multiple decentralised points. As such, regional gas distribution companies will have to move from passive transit systems to active systems that dynamically control the quality and pressure of gas in bidirectional flows. Pressures have to be carefully
maintained, and the volume of gas extracted from the network should not exceed the volume injected into the network.

**Effect of integrating natural gas vehicles in smart gas grids**

A modelling study was carried out to investigate the effect of NGVs on gas grid balancing in Groningen. This was compared to a similar study using EVs and the electricity network.

**How do NGVs change seasonal demand profiles?**

For context we consider householders’ various energy demands in Groningen. Gas demand (for heating, as is the case in the UK) is highly seasonal, whereas electricity and energy use for mobility are relatively constant throughout the year. This is illustrated in Figure 2:

![Current Groningen energy demand in winter (left) and summer (right)](image)

*Figure 2: Current Groningen energy demand in winter (left) and summer (right)*

The consequence of this difference is important when EVs and NGVs are added. If the Groningen vehicles fleet were 100% EVs, the impact on the electric grid would be an increase of 50% in electricity demand in a constant way throughout the year. However, for NGVs in the winter the impact is negligible, but in summertime NGVs would be almost the main end use of natural gas.
How do NGVs change hourly demand profiles?

One concept in electrical smart grids is the use of the batteries in EVs to discharge back to the grid if required and with the EV owners' consent. Can this concept transfer to NGVs in the gas network? This is modelled in Figure 3, in which vehicles are plugged in to charge during the night and discharge back to the grid during certain points during the day, to flatten the total city gas demand profile during winter… but not during summer!

For electric vehicles, in general the power levels during the charging process depends on the battery chemistry. In the future, there may be prospects for fast charging (having higher maximum power) which would enable charging of a battery pack in a few minutes. Similar to EVs, it is assumed that NGVs would recharge at night; however, current home refuelling technology is slow. This has the interesting consequence that there is little dispersion in users' recharging timings and therefore the load on the gas network.

![Figure 3: light-coloured line is the total gas demand over a winter day (left) and summer day (right) including the effect of NGVs. Note their flattening effect in winter but peak-creating effect in summer.](image)

Using NGVs with EVs
In the long term, managed charging of NGV and EVs, coordinated among megawatts of charging load, could help provide additional services or emergency reliability services. In the Netherlands using the NGV and EV capability to charge and discharge the gas and electricity grids could be an important support for the integration of renewable power generation.

Juliana is a PhD Student at Eindhoven University of Technology (TUE) and a research analyst at the energy centre (EKC) of Hanze Groningen University. She graduated in 2014 from the European Masters in Renewable Energy (EUREC) with a specialisation in Hybrid systems. Juliana is engaged in energy issues such as global climate change and sustainable development. Email juliana.montoya.cardona@pl.hanze.nl
Introducing the new Energy Group Chair

Robin Morris took over the position of Energy Group Chair in November 2014. We asked him to describe his past and present interests in the field of energy…

How did you get interested in energy?

I spent one summer working at the Central Electricity Research Labs in Leatherhead. As I recall, the staff newspaper included such items as: tasteful watercolour images of "Dawn over Didcot [A]”, why AGRs were technically superior, and a child on a tricycle photographed with an electricity transmission tower at the end of her garden. Lord Marshall of Goring was then Chairman of the Central Electricity Generating Board. It was reassuring to see a physicist in this role.

What do you do in your day-job?

I primarily work as an advisor to a number of technology companies. My main focus centres on energy efficiency and localised use of energy. The mix of activities can vary greatly. One week, I might be modelling the local air pollution contribution from refrigerated vehicles. The next, providing analysis for a report on the role of energy storage. My commercial skills and network are also brought into use, addressing barriers to entry and helping to build understanding. I help by enabling input to codes of practice, commenting on draft standards and submitting consultation responses. Most recently, I have been investigating underlying correlation of factors such as energy efficiency of housing stock with incidence of fuel poverty, for Oxford City Council.

What physics do you find most interesting in the study of energy?

At Johnson Matthey's corporate technology centre, I was privileged to work on a wide range of projects, including hydrogen storage materials, compound semiconductor materials and high-temperature superconductors (a brand-new field, back then!). The environment was fantastic, working in multi-disciplinary teams, with access to a wide range of analytic equipment and excellent connections with university departments. This gave me a great opportunity to provide a physics perspective, including characterisation and modelling of some interesting materials. It was also
instructive to work on enhancing the efficiency of systems, through development of appropriate sensor technology, such as high-temperature optical fibre thermometry for furnace control.

*What are your hopes and plans as EG chair?*

We will continue to arrange engaging meetings, including with other groups. I hope group members will continue to share their reports from interesting meetings, in the newsletter.

*Robin can be contacted at: robin.morris@physics.org*

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**Notice: MyEnergy Mates**

The Energy Group Committee realises that many members strive to save energy in their own homes and lifestyles, perhaps in association with self-generation. John Twidell is one of these, and has suggested we have an email link between each other. The general aims could be: share experience, seek advice, notify results, discuss options, compare equipment, etc.

Those interested should email John at `<amset@onetel.com>` and give their comments and suggestions. Eventually this may grow to a more formal Club using the IOP section MyIOP, but initially it would be small. John promises not to 'reply all' to emails, so not swamping inboxes. Occasional summaries could be sent to everyone in the Club, so sharing experience.
Book Reviews

The Energy World is Flat – Opportunities from the End of Peak Oil
Daniel Lacalle and Diego Parrilla

Review by Anthony Webster

I originally offered to review this book because I was interested in finding out more about the financial modelling of energy markets – however, this book is not about financial modelling. The book provides qualitative explanations for the behaviour of energy markets during the past, present, and future. Although different to my initial expectations, this qualitative presentation is fine for a physicist who is able to pick up modelling methods elsewhere, and probably better for many other (non-mathematical) readers.

I think it is a good book, and worth reading. The book primarily considers energy supply and demand, and the likely cost of energy that is expected as a result. The book predicts a fall in the price of energy, and was completed just as the oil price was starting to fall around December 2014. Interestingly, as discussed in a short appendix to the book, the authors suggest that increased production by OPEC is in effect a price war that is about curbing the shale oil revolution, slowing the growth of renewables, slowing the growth in electric and natural gas vehicles, as well as possibly a deliberate attempt to destabilise Russia’s economy.

The authors argue through a series of ten points, each explained in a chapter and referred to as “Flatteners”, why they expect that energy prices will fall and energy will become increasingly widely available at increasingly similar prices. The basic market mechanism, outlined by the authors in detail, is that undersupply or insufficient refining capability has in the past produced sufficiently large spikes in price to drive (successful) innovation for new energy supplies or conservation improvements. The peak prices combine with governments’ recognition of the necessity of energy supply to
bias towards subsequent overproduction, with a subsequent fall in price. During periods of oversupply crude oil refineries tend to be highly profitable and in charge, but during periods of undersupply the primary oil producers are in charge and the refineries struggle to remain profitable. Perhaps surprisingly, both subsidies to keep energy prices affordable and high energy taxes act to keep the consumer’s price of energy fairly insensitive to changes in oil prices. This contributes to keep oil demand insensitive to all but very large changes in oil supply prices, again biasing towards necessarily large variations in oil price.

The authors’ view is that this disconnect between consumer prices and oil prices prevents markets from operating as effectively as they ought to. A concern about government intervention inhibiting the effective operation of markets is raised on a number of occasions, perhaps most strikingly in the penultimate chapter. For more detail on the book’s detailed content I refer you to the web, or better still, to the book itself.

The authors are clearly and openly against the concept of peak oil, and instead provide a series of reasonable and logical arguments for why energy supply should remain affordable and become increasingly similar in cost world-wide. Personally, I often find suggestions that peak oil will not occur to be supported primarily by faith-like beliefs in economics and market forces, which presume that alternative sources of energy can and always will be found. The discovery of shale gas and oil is a recent example that some people quote to support this belief. However the discovery and extraction of increasingly small and inaccessible reserves does not assure me that there is plenty more oil and gas - it confirms that known and existing supplies are increasingly struggling to meet demand. However, throughout the book the authors provide a very comforting picture, in which energy will remain affordable and become increasingly evenly available world-wide.

Surprisingly, I found the arguments about peak oil (rightly or wrongly), very reassuring. In contrast, the penultimate chapter briefly discusses the credit crunch, and is highly critical of the present situation, suggesting that we are in a “phase of complacency that ignores the accumulation of debt and the creation of fake money as uncomfortable anomalies, until it explodes“, going on to immediately add, “And it does, make no mistake.” (page 228). This statement was surprising and seemed out of character for the authors, appearing to suggest that the authors’ economic arguments are based on rational principles and not wishful thinking. The discussion provided a
refreshing and worrying perspective that I’ve not really heard much
discussion of, and as I said, was completely out of character with the
otherwise reassuring nature of the rest of the book.

To summarise, for me this is an informative book that provides a range of
different perspectives on the supply and demand for energy that I had not
previously been aware of. It was definitely worth reading, and I would
encourage others to do so.

Anthony Webster is a theoretical physicist presently working at Culham Centre for
Fusion Energy, with interests in Bayesian probability theory, statistics, and their
applications.
Renewable Energy Resources (3rd Edition)
John Twidell and Tony Weir
Routledge

Review by Sophie Lyons

Now in its third edition, this book acts as a comprehensive guide to renewable energy technologies across the spectrum. From wind to wave power, the technical principles behind the collection and use of renewable energy resources are clearly laid out and set in an up-to-date real world context, providing a valuable reference for students and professionals working across the renewable energy field. In particular, non-specialists with a physical science background working in the energy sector are likely to benefit from this clear and wide-ranging book.

Topics covered include all major renewable electricity and heat generation technologies, and considerable attention is also paid to other key aspects of energy systems. Chapters on electricity distribution, storage technologies, and energy efficiency provide useful references for professionals working on system-based projects, as well as enabling a thorough understanding of the requirements placed by renewable technologies on energy networks. Given the strong role envisaged for electricity and energy storage in future renewable energy scenarios, it would be interesting to see more specific examples of storage technologies currently in use, and those at demonstration stage. For example, one area which is not covered is the potential for large scale use of hydrogen for storage, e.g. in power-to-gas systems.

Policy tools and metrics for assessing the suitability of different technologies (such as Life cycle analysis, and economic parameters) are considered in detail in their own chapter. Thorough guides to fundamental principles such as electrical power, fluid dynamics, and heat transfer are also provided, in dedicated “Review” chapters.
Each chapter of the book provides a concise description of the relevant physical principles, including the appropriate equations, and up-to-date examples of existing installations are used to illustrate explanations of the most relevant applications. Alongside technical details, economic, environmental and social factors are discussed in terms of their impact on criteria for developers, governments, and policymakers. Chapter summaries capture the present global state of technologies, as well as some of the key technical aspects, providing a quick overview for the hasty reader.

The authors are concise and clear in their descriptions, and equations use consistent symbols throughout, using recognised conventions where appropriate. Combined with the helpfully labelled structure, this makes the book an enjoyable read as well as an indispensable reference.

While the emphasis placed on the underlying physics of renewable energy resources means that this book is most likely to be useful for those with a good grounding in physical sciences, it also provides a thorough overview of the renewable energy field, relevant to specialists and generalists working across the renewables sector. The updates capture much of the technological and commercial progress of the last decade, providing an accurate picture of the outlook for the global renewable energy industry – one that looks increasingly cohesive and secure.

Sophie Lyons is a Consultant at Element Energy, specialising in low carbon transport and energy storage. She studied Physics at the University of Bristol and Environmental Technology at Imperial College.
Forthcoming Energy Group Event

Renewables at Scale: Realising Gigawatt Generation

*Day meeting*

*Institute of Physics, London W1B 1NT*

Monday 13 July 2015

10:30 - 17:00

Renewables supplied nearly 20% of UK electricity in 2014, with over 100 GWh of new generation capacity added worldwide. This one-day meeting looks at the scaling-up of deployment in the UK and asks what advances will underpin this growth. Our expert speakers will highlight recent progress and look at key opportunities for reducing cost and improving the efficiency of renewable power.

Talks include:

- Electricity system in transition - Geoff Hammond – Bath University
- Solar photovoltaics - think big, or small? - Nicola Pearsall – Northumbria University
- Modelling and turbine selection for efficient tidal energy - Mike Case - Tidal Lagoon Power
- Balancing for high renewable penetration - Malte Jansen - Fraunhofer IWES

More details and registration at

[https://www.iopconferences.org/iop/737/home](https://www.iopconferences.org/iop/737/home)
A number of events are taking place in the UK as part of EU Sustainable Energy Week 2015. These include:

- REECH (Renewables and Energy Efficiency in Community Housing), 18 June, Liverpool

- The Smart Electricity Consumer: Realising the electricity demand side resource, 17 June, London

- Harnessing Community Energies, 4 June, Forres

- Distributed Energy Generation: Opportunities and Challenges, 17 June, Nottingham

For more information, see http://www.eusew.eu/energy-days/about-energy-days-events
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We welcome comments and suggestions for events and items for the Newsletter.

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