Welcome to another issue of UQEI news. In this issue we draw attention to the long term goal of achieving a low-emissions future as quickly and as affordably as possible, and the need for a technology-neutral focus.

In particular we contemplate the role of nuclear, and why it is that we can’t seem to build the necessary knowledge, regulatory frameworks and human capacity that would enable us to confidently evaluate nuclear power as an option, and, if considered viable and acceptable to the community, deployed safely.

Ultimately we need to consider two key questions: (1) are we doing a good job of communicating both the real risks and opportunities for nuclear power in Australia; and (2) what will it take to stop placing limits on our low-carbon power generation options?

We welcome comments and feedback from all and look forward to engaging with you on global energy challenges.

Professor Chris Greig
Director, UQ Energy Initiative

For example, I don’t think the scientific community is doing a good job of communicating either the real risks or the opportunities for nuclear power in Australia. The Academy of Technological Sciences and Engineering (ATSE) is an exception. In one Energy Action Statement, ATSE suggests the way forward for government, industry and universities to progress nuclear as an energy option for Australia:

1. Undertake a comprehensive business/economic analysis.
2. Compare the nuclear option with alternative scenarios to the 2030-2050 timeframe.
3. Review the current policies that preclude its consideration.
4. Build on current education and training activities, including through secondment and increasing and supporting university courses.
5. Examine regulatory requirements and determine the actions needed.
6. Build on current overseas R&D program linkages, for example in fusion or for the Generation IV program.

None of these actions involve actually authorising the construction of a nuclear power plant. They aim to build the necessary knowledge, regulatory frameworks and human capacity to enable nuclear power as an option that can be confidently evaluated, and if considered viable and acceptable to the community, deployed safely. Adopting the ATSE recommendations in their entirety now could potentially see Australia in a position to consider an investment decision on a nuclear plant in ten years, followed by, in the case of a positive investment decision, the realistic start-up of our first nuclear power plant around 2035.

The last Energy White Paper released in 2012 suggested there was… not a compelling energy security argument for nuclear power in Australia but that… if we fail to commercialise new, low-emissions baseload energy technologies… nuclear could potentially be an economically competitive backstop energy option. The 2012 EWP also suggested that if we fail to commercialise new, low-emissions technologies needed.

For example in fusion or for the Generation IV program.

How is it that we are able to preferentially incentivise intermittent, renewable power options and, to a much lesser extent CCS, to meet our long-term emissions reduction objectives, but arbitrarily set aside a proven, large-scale, baseload, low-emissions technology as a backstop option in case our bet on renewables doesn’t deliver? That’s actually poor risk management and in any case, it isn’t a real (backstop) option until the necessary enabling work is done now to establish nuclear power as a real option.

It is time for policy makers, industry leaders and academics to stop advocating for preferences and pushing favoured technologies and adopt a technology-neutral focus on the long term goal of achieving a low-emissions future as quickly and as affordably as possible. A first glance at the just released 2015 Energy White Paper suggests another missed opportunity.
**GLOBAL ENERGY NEWS**

### POSITIVE NEWS FOR GLOBAL EMISSIONS

Preliminary data released by the International Energy Agency (IEA) suggests that efforts to mitigate climate change may be having a more pronounced effect on emissions than previously thought. In the lead up to the IEA’s special report on energy and climate (to be released on 15 June), data indicates that “global emissions of carbon dioxide from the energy sector stalled in 2014, marking the first time in 40 years in which there was a halt or reduction in emissions of the greenhouse gas that was not tied to an economic downturn.”

Global emissions of carbon dioxide remained at 32.3 billion tonnes in 2014, the same as in the previous year. It is thought changing patterns in energy consumption in China (increased generation of electricity from renewables) and OECD countries (efforts centred on energy efficiency and renewable energy) are primarily responsible for the halt in emissions, despite global economic growth of 3% in 2014. IEA Chief Economist Dr Fatih Birol believes this provides a positive incentive in the lead up to COP21 in Paris as it signifies that efforts are producing the desired effect of decoupling economic growth from greenhouse gas emissions.

While it is hoped this indicates the start of a longer term trend, many believe this could prove to be more of an exception to the rule given projections that greenhouse gas emissions will continue to rise as energy systems in developed and developing countries are transformed. When BP releases its 2015 Statistical Review of World Energy later this year it will be interesting to see whether global emissions of carbon dioxide also remain the same as recorded for their 2013 level (which incidentally was just over 35 billion tonnes, with the 32.3 billion tonnes mark passed in 2010).

### INVESTMENT IN CCS IS CRITICAL – SHOULD BE ON SAME SCALE AS INVESTMENT IN RENEWABLES

This was the position taken by Andrew Mackenzie, BHP Billiton’s Chief Executive during a recent speech at the annual Scottish Oil Club dinner in Edinburgh, at which he drew attention to urbanisation and industrialisation as the long-term fundamentals that support global economic growth and the demand for energy.

He illustrated this point with IEA projections, noting that conventional energy sources are projected to provide about three quarters of the world’s energy mix in 2040. Accordingly, “this signals an increase in demand for our products over current levels and also the long-term opportunity before us. If fossil fuels continue to supply most of the world’s energy, [carbon capture storage] could be as large as the oil and gas business,” Mr Mackenzie said.

### POWER PLANTS BEING SHUTDOWN IN BEIJING

As part of efforts to reduce emissions and air pollution Beijing is replacing its coal fired-power plants with gas-fired plants. In less than two years Beijing is decommissioning its remaining four coal-fired power plants. The first of these, owned by China Datang Corporation (600MW) was closed in 2014, with two more plants decommissioned earlier this month – the Guohua Electric Power Corporation owned 400MW plant, as well as a plant owned by the Beijing Energy Investment Holding group. The final closure is set to take place in 2016, with China Huachen Group’s 845MW plant. The new gas-fired power plants will ultimately supply 2.6 times more electricity to the city than the existing plants, while reducing carbon emissions by approximately 30 million tonnes.

Air pollution, which in Beijing averaged more than twice China’s national standard last year, has become a key public health issue over the past few years. In an effort to address both emissions and air pollution policy makers are encouraging a broader use of hydro, solar and wind. The nation is also pushing to increase its nuclear power program. China’s electricity consumption last year grew at its slowest pace in sixteen years, according to data from the China Electricity Council.

### COAL PRICES EXPECTED TO DROP FURTHER

According to the latest commodities research from Bank of American Merrill Lynch coal prices will drop further and stay low throughout 2016. The bank is now forecasting average Newcastle thermal coal prices of US$57 per tonne in 2015 and US$52 per tonne in 2016, down from US$65 per tonne and US$72 per tonne respectively.

In China, lower GDP growth and efficiency gains causing decreased electricity demand are expected to result in power demand growing by just 5% per year in the short term, which could potentially be met by the forecast growth in alternative energy sources rather than coal.

“In 2015 and 2016, the load capacity from clean generation sources is growing by 55GW, comprising a mix of nuclear, hydro and wind. This clean generation is in theory sufficient to meet incremental power demand of 50 – 60GW over the same period,” said the bank.

“Meanwhile, China is adding 20GW of effective coal plant capacity each year to 2018, which could replace older, less efficient plants, thus reducing the overall coal burn.” Furthermore, higher domestic supply and efforts by the government to support domestic coal producers at the expense of imports are also impacting demand.

While demand in India remains relatively strong, Merrill Lynch concludes that “overall the global outlook for thermal coal demand is rather bleak in 2015 and 2016.”

### OFFSHORE WIND IN INDIA

A consortium headed by the Indian Centre for the Study of Science, Technology and Policy is assessing offshore wind resources off the Gujarat and Tamil Nadu coasts. Part of the four-year, €4 million FoWind (Facilitating Offshore Wind in India) project to promote offshore wind power development led by the Global Wind Energy Council, the consortium has now released a tender for the supply, installation, commissioning and maintenance of remote sensing technologies to survey wind profiles. The selected technologies will be deployed in the Arabian Sea and the Bay of Bengal to help measure India’s offshore wind potential and contribute to an offshore wind roadmap for India. In addition to offshore wind potential, port surveys and infrastructure assessments are also being carried out.

In light of these developments and recent announcements India’s Ministry of New and Renewable Energy (MNRE) is working to complete a national offshore wind policy framework. In October 2014 the government announced plans to build India’s first offshore wind farm, a 100MW demonstration project off the Gujarati coast, and Tamil Nadu’s Energy Development Agency aims to build at least 200MW of offshore wind capacity as part of the State’s Vision 2023 Plan.
CARNEGIE WAVE ENERGY COMPLETES INSTALLATION OF UNITS

Carnegie’s Perth Wave Energy Project is up and running with the installation of the third and final CETO 5 wave energy unit last month. Since 1999 Carnegie has been working on CETO wave energy technology and now boasts the only operating wave farm in the world.

CETO technology takes a unique approach to wave power by generating both power and water from ocean swell while remaining fully submerged beneath the ocean surface. Away from breaking waves, this also increases its ability to survive large storms. The technology is capable of generating power onshore or offshore depending upon the specific characteristics of a project site.

According to Carnegie, “the Perth Wave Energy Project (PWEP) is configured to utilise the CETO pumps to pressurise water and deliver it onshore via an underwater pipe. Then, onshore, high-pressure water is used to drive hydroelectric turbines, generating zero-emission electricity. The high-pressure water can also be used to supply a reverse osmosis desalination plant, replacing or reducing reliance on greenhouse gas-emitting, electrically-driven pumps usually required for such plants."

With the installation of the third and final 240kW CETO 5 unit Carnegie will now concentrate on understanding how the 720kW system operates across a range of sea states and settings to inform design and delivery of the CETO 6 project.

EPIA CALLS FOR NEW RACE WAY ENERGY POLICY FRAMEWORK

At the recent Energy State of the Nation (ESON) forum, the Energy Policy Institute of Australia declared the need for a new policy framework for an energy industry beset by uncertainty leading to excessively politicised policymaking. According to director Robert Pritchard, “the industry must have stable, long-term policy to invest. For this, a completely fresh, more-inclusive framework for policy development is required.”

The Institute’s newly announced RACE way policy framework centres on three equally important energy goals: Reliable, Affordable and Clean Energy. The framework is ultimately designed to provide a stable platform for policy implementation and delivery, coupled with a mechanism for stakeholder participation in policy formulation and review.

“The Institute is adamant that technology diversity and neutrality must be the paramount and fundamental principle of modern energy policy. Clean energy means all forms of energy that can play a part in reducing global greenhouse gas emissions and in safeguarding the community from harm. They include not just renewables but cleaner oil and gas, cleaner coal-fired electricity generation, electric vehicles and nuclear power,” said Mr Pritchard, adding that “it would however be pretense to adopt technology neutrality as a policy principle whilst legislative barriers remain in the way.”

The Institute’s RACE framework would allow all energy proponents to compete on a level playing field, with the only operating wave farm in the world.

BREAKTHROUG IN LONG RANGE WIRELESS ENERGY TRANSMISSION

Scientists from Japan’s Aerospace Exploration Agency (JAXA) have succeeded in transmitting energy wirelessly, a key step that could one day make solar power generation in space a possibility. In the breakthrough microwaves delivered 1.8kW through the air to a receiver 55 meters away. “This was the first time anyone has managed to send a high output of nearly 2kW of electric power via microwaves to a small target, using a delicate directivity control device,” said a spokesman for JAXA. The aim is to position microwave-transmitting satellites with sunlight-gathering panels and antennae and use solar energy from space to power activities on Earth, although practical application is still decades away.

Mitsubishi Heavy Industries Ltd (in partnership with JAXA) has also successfully transmitted 10kW through the air to a receiver 500 meters away. Within the next five years it hopes to apply this technology to charge electric vehicles and increase efficiencies associated with transmitting power from offshore wind turbines or sending electricity to isolated rural areas.

By 2018 JAXA is hoping to test the technology in space with a small satellite transmitting several kilowatts from low Earth orbit to a microwave receiver on the ground. Three years later it aims to have a 100kW satellite in orbit, and a 200MW version by 2028. Ultimately by 2031 the goal is to have a commercial 16W pilot plant in operation, and by 2037 start a commercial space-based power industry with one launch every year.

DIVESTMENT MOVEMENT TARGETS WORLD’S TWO LARGEST CHARITABLE FUNDS

A recent campaign initiated by The Guardian has called for the Bill and Melinda Gates Foundation and the Wellcome Trust “to commit now to divesting from the top 200 fossil fuel companies within five years and to immediately freeze any new investments in those companies.” Suggesting that in 2014 fossil fuel investments exceeded US$1.4 billion and US$830 million respectively, the underlying message was that the organisations should offload their holdings in major coal, oil and gas corporations because the investments are undermining the organisation’s values.

In response to the Guardian’s call, the director of the Wellcome Trust — Jeremy Farrer — agreed that while divestment is a “grand gesture” he did not believe it is as effective as engaging with fossil fuel companies. “By maintaining our positions, we meet boards again and again, supporting their best environmental initiatives and challenging their worst,” he said. Adding that selling its shares in such companies could undermine efforts to persuade companies to make their operations more low carbon to fight climate change, he said “were we to sell our holdings, it is unlikely that the buyers would exert the same influence.”

Mr Farrer ultimately summed up the Wellcome Trust’s strategy by drawing attention to low and middle income countries where growth is in their view the best guarantor of better health, and noting that the Trust recognises that fossil fuels are essential to the economy, life and health, and will remain so for decades under any conceivable scenario.

Institute website: www.energypolicyinstitute.com.au
LAUNCH OF THE GATTON SOLAR RESEARCH FACILITY

The largest solar PV systems research facility in the southern hemisphere, and one of the most sophisticated of its kind anywhere in the world, was launched by the Minister for Industry and Science at UQ’s Gatton campus at the end of March.

The Gatton Solar Research Facility is a 3.275MW solar array with more than 37,000 thin-film photovoltaic panels, mounted on the campus’ 10ha former airstrip. The facility is a first-of-its-kind exemplar of integrating renewable energy and rural agricultural activities; both a clear demonstration of Australia’s commitment to the future of clean energy, and UQ’s vision in this space.

Multiple PV mounting technologies are incorporated in the array, including fixed-tilt, single-axis and dual-axis tracker technologies – a first in Australia. Operating side-by-side in the same field, this will serve to inform electrical and economic performance.

UQ Solar director Professor Paul Meredith said the facility would be a game-changer in renewables research. “This research is about improving the way that we integrate solar into our state’s overall energy mix. It also works towards establishing and proving the business model for solar generation in Australia at the megawatt scale.

“Queensland gets about 2,700 hours of sunlight a year. This site turns that into energy, and into knowledge about how to better service local, national and international energy needs through effective solar technologies,” Professor Meredith said.

The Gatton project is part of a research collaboration between UQ, the University of New South Wales, First Solar and AGL PV Solar Holdings Pty Ltd, an affiliate of AGL Ltd.

SOCIO-ECONOMIC IMPACTS OF CSG DEVELOPMENT

Identifying mechanisms to understand, measure and respond to aggregated ‘cumulative’ socio-economic impacts of resource development represents a priority area for the Social Performance group in the Centre for Coal Seam Gas (CCSG). The group has been exploring the impacts of CSG mega projects on the Western Downs of Queensland to understand CSG development across the region and over time, with a view to identifying the changes to community character and wellbeing brought about by the initial phases of development.

Cumulative impacts are the successive, incremental and combined effects (both positive and negative) on communities and their environment from multiple projects in a region. Using indicators to monitor and track changes in core community ‘assets’ including financial capital, infrastructure, skills base, social connections, and the environment, the research has identified impacts over the construction phase that are both positive and negative. As noted by the researchers, “unemployment has dropped, but skills shortages have been felt. Housing prices have spiked, but population has moved steadily upward nonetheless. Reported crimes in some categories have increased, but they have remained steady in other categories.”

Other impacts may influence the changing look and character of some towns, for example the arrival of non-resident workers in fluorescent work gear, and the outward migration of older residents. In the latter example these residents may have seen the change as an opportunity to sell their house for a good price, which could potentially result in towns losing their volunteering resources and their informal childcare providers.

Accordingly, “while many of the impacts of CSG development are obvious and expected, others could be characterised as indirect and unanticipated. However, certain impacts could become problematic if left unmanaged.”

As the article concluded, “with the peak construction phase of CSG development in the Darling Downs now tapering off, residents and business owners are voicing concerns about uncertainty. Gas operators need to address that uncertainty to help local stakeholders make wise decisions and to ensure community, government and the industry avoid the negative consequences that can accompany any resource development.”

Link to Gas Today article based on the research
**ENERGY 101: NUCLEAR**

**Thermal neutron nuclear power concept**

In a nuclear fission reaction, heat is generated primarily by the conversion of atomic mass energy into kinetic energy of the fission fragments, which slow down and produce bulk heating. In a nuclear power plant this heat is captured and used to generate electricity.

- Currently deployed nuclear power technology utilises the uranium fuel cycle.
- In a uranium based thermal neutron fission reaction:
  - Uranium isotope U-235 absorbs a neutron and splits into two lighter elements (fission fragments) and extra neutrons.
  - Reaction converts some of the mass between U-235 and fission reaction products into heat \( (E=\Delta MC^2) \).
  - The released neutrons allow the continuation of a chain reaction.
  - A plutonium isotope Pu-239 is also created by U-238 capturing a neutron, which can itself fission.
  - One gram of uranium fissioning over a day produces approximately 1 MW of heat. This is approximately a million times more heat per unit mass than with fossil fuel combustion and without producing carbon dioxide.

**Control of nuclear fission chain reaction**

The power output of a nuclear reactor is controlled by the number of neutrons able to start more fission reactions.

- The neutrons released in fission are “fast” and not efficient in fissioning U-235.
- Moderators slow down neutrons to increase their participation in the nuclear chain reaction.
- Fast neutron reactors do not need moderators and use fast neutrons.
- Control rods (made of materials with high neutron absorption) are used to absorb some neutrons to eliminate them from chain reactions. Inserting control rods deeper into the reactor core will reduce its power output, extracting the control rods will increase it.

**Power plant components: nuclear vs coal-fired**

The steam cycle and power generation trains are very similar for both fossil fuel and nuclear power plants. The key difference is in the **source of heat** used to produce the steam.

- Thermal power plants use heat to produce steam, which drives the steam turbine and generates electricity.
- Both nuclear and fossil fuel power plants employ a steam Rankine cycle to generate electricity.
ENERGY 101: NUCLEAR

Safety

Only three major accidents have occurred over 15,000 cumulative reactor-years of commercial nuclear power operation in 33 countries:

- One was contained without harm to anyone, the next involved an intense fire without provision for containment, and the third severely tested the containment, allowing some release of radioactivity.
- The nuclear industry has very strict and detailed records of any accidents and near miss events.
- From the outset, there has been a strong awareness of the potential hazard of both nuclear criticality and the release of radioactive materials from generating electricity with nuclear power.
- As in other industries, the design and operation of nuclear power plants aims to minimise the likelihood of accidents, and avoid major human consequences when they occur.
- The evidence over six decades shows that nuclear power is a safe means of generating electricity. The risk of accidents in nuclear power plants is lower than any other source of baseload power generation and declining.
- Naturally occurring background radiation is the main source of exposure for most people.
- The consequences of an accident or terrorist attack are considered minimal compared with other commonly accepted risks.

Lessons learned from major accidents

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<th>Accident</th>
<th>Description</th>
<th>Consequences</th>
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<td>Three Mile Island, USA, 1979</td>
<td>A cooling malfunction caused part of the core to melt in the #2 reactor. The TM-2 reactor was destroyed.</td>
<td>Some radioactive gas was released a couple of days after the accident, but not enough to cause any dose above background levels to local residents. There were no injuries or adverse health effects from the Three Mile Island accident.</td>
<td>Worldwide implementation of adequate preventative maintenance. Worldwide improvements in personnel training and operational procedures.</td>
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<td>Chernobyl, USSR, 1986</td>
<td>The Chernobyl accident in 1986 was the result of a flawed reactor design that was operated with inadequately trained personnel. The resulting steam explosion and fires released at least 5% of the radioactive reactor core into the atmosphere.</td>
<td>Two Chernobyl plant workers died on the night of the accident, and a further 28 people died within a few weeks as a result of acute radiation poisoning. UNSCEAR says that apart from increased thyroid cancers, there is no evidence of a major public health impact attributable to radiation exposure 20 years after the accident.</td>
<td>Changes in the design of &quot;Chernobyl-type&quot; reactors. Strong enforcement of safety culture, particularly in the US. Improvements in enforcing safe operations practice.</td>
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<td>Fukushima, Japan, 2011</td>
<td>Following a major earthquake, 15-metre tsunami disabled the power supply and cooling of three Fukushima Daiichi reactors, causing a nuclear accident on 11 March 2011. All three cores largely melted in the first three days.</td>
<td>High radioactive releases over days 4 to 6. There have been no deaths or cases of radiation sickness from the nuclear accident, but over 150,000 people had to be evacuated from their homes to ensure this. Government nervousness delayed their return. Four reactors were written off due to damage in the accident – 2719 MWe net.</td>
<td>Worldwide changes in the regulations of nuclear plant designs to enhanced safety, preliminary via compulsory passive safety features. Worldwide improvements in the crisis management plans and procedures. Worldwide &quot;stress test&quot; on existing Nuclear Power plants.</td>
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Sources: USNRC, World Nuclear Association

UPCOMING EVENTS

World Geothermal Congress 19–24 April, in Melbourne

Held every five years, the World Geothermal Congress is a unique event that brings together members of the geothermal community from across the globe. This year's theme is "Peace from Down Under – Geothermal in Perspective".

Link to website

Solar 2015 Exhibition & Conference 13–14 May, in Melbourne

The 53rd Annual Australian Solar Council Industry Conference & Exhibition will highlight the people, products and projects that are driving the solar industry to new heights of innovation and excellence.

Link to website

APPEA Oil and Gas Conference and Exhibition 2016

17–20 May, in Melbourne

The largest annual upstream oil and gas event in the southern hemisphere, it attracts delegates from across the country and around the world.

Link to website

The Second Annual United Nations Sustainable Energy for All Forum

17–21 May, in New York, USA

The overarching theme of this year's Forum is "Financing Sustainable Energy for All", including the launch of a new Global Sustainable Energy for All Commitment Platform.

Link to website

Seventh International Conference on Clean Coal Technologies (CCT2015)

17–21 May, in Kraków, POL

CCT2015 is a leading international forum for research into clean coal technologies, including high efficiency, low emissions plants, developments in carbon capture, air pollution control, and low rank coal utilisation.

Link to website

5th World Hydropower Congress

19–21 May, in Beijing, CHN

The 5th World Hydropower Congress will bring together top players and organisations involved in hydropower operation and development around the world, to discuss and debate strategy for the sector over the next 35 years.

Link to website

ATSE NSW Intelligent Grids Symposium

20 May, in Sydney

A one-day symposium on electricity networks, it will explore how grids can adapt and remain relevant, game-changing technologies, regulatory barriers and how services should be priced.

Link to website

VII International Forum ATOMEXPO

1–3 June, in Moscow, RUS

The main topic of the Forum, "Nuclear Power as an Impulse for Socio-Economic Development", is driven by the desire of a growing number of countries to get not only a positive outcome of peaceful atom development in the power industry, but also an impulse for progress in science, education, industry and economy.

Link to website