An energy-driven geologist

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A personal view, given at the 2013 NZAS Conference, Wellington, 3 April 2013, on why we do science.

Recently, I attended the 2013 New Zealand Association of Scientist's conference entitled 'What is the value of science in New Zealand?' I gave a brief talk on my own personal view addressing not only this question but also why I do scientific research as a career.

From a rural, farming background in County Down, Northern Ireland, my scientific career has seen me go from a geology undergraduate at Trinity College Dublin to a PhD position at the University of Liverpool to my most recent appointment as an emerging career researcher with the Natural Resources Group at GNS Science here in New Zealand. My scientific research is grounded in the discipline of structural geology. As a structural geologist, I apply scientific fundamentals from physics (and sometimes chemistry and even biology) to the study of how rocks break and deform, allowing me to understand, for example, things like faults and fractures. It was my familiarity with this branch of geology that led me to my current position, where the focus of my research since my arrival has been centred on energy, specifically the geological aspect of energy.

I have been researching the role that faults and fractures play in our national geothermal energy resources and more recently the role they play in New Zealand oil and gas reserves. Faults and fractures often control how hot geothermal waters, oil or gas, are stored and move through rocks, and understanding these important geological features provides insight into the nature of these energy resources and how best to utilise them if we so choose. Through my research, I seek to answer questions such as: how are hot geothermal fluids transported through rock at depth, what physical processes allow this to happen, and how does this relate to New Zealand's geological place in the World? In addition, results from such research can be applied by the energy industry to help with efficient, responsible, and safe development of our national energy resources.

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When posed the question of why I choose to work in this field, or in scientific research at all, there are a number of reasons that spring to mind. The first, and one echoed by many other researchers, is simply that it is what I love to do. I enjoy the process of questioning the world around me, identifying an unknown, and crafting a solution to address it. In addition, my work as a geologist offers me a vast variety of tools and techniques to test my scientific hypotheses. Whether it is applying theoretical equations to my data, collecting information first hand from field mapping, interpreting physical measurements made by tools lowered into drilled wells, performing laboratory experiments to test the mechanical properties of rocks, or using high-powered microscopes that help me understand these structures at the smallest of scales, I am never without options, nor a boring day at work. Indeed the application of many of these techniques to geothermal systems and conditions is novel, and developing them in a new space has been challenging and exciting. The sheer variety of the type of work and data I have at my disposal keeps me engrossed in my science and allows me to tackle my research from a number of angles.

When it comes to research dealing with energy, though, I find there is a more socially responsible reason that drives me to work in this field. This is the unquestionable fact that energy powers our lives. When you consider it, literally everything we do depends on energy. With this idea in mind, I realise my research is only part of a solution to bigger questions such as: where does this energy come from, where will it come from tomorrow, and what exactly is required to get it?

Future global energy security and sustainability is one of the greatest challenges humanity faces today, making it a vitally important research field. How will we keep providing the level of energy needed for the World's population today and, more importantly, given the rapid rate of population growth, how can we provide more? Global energy consumption has risen 67% in only the last 25 years [1]. When considering electricity supply, only one aspect of energy consumption, as of 2011 it is

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estimated that 1.4 billion people on the planet have no access to electricity. The immediacy of this issue is strikingly apparent in countries like India. India currently has an installed electricity capacity of approximately 223 GW, the fifth largest in the world [2]. Despite this, because of insufficient supply, approximately 300–400 million people in the current Indian population do not have access. This begs the question, how can this nation provide a sustainable energy supply to essentially at least 66 New Zealand's worth of people and maintain this as their population grows?

While a global problem, energy is an issue that needs addressing nationally as well. To provide framing for the issue at home, here are some figures from the 2011 energy portfolio from the Ministry of Business, Innovation, and Employment. That year New Zealand produced 17 million barrels of oil. While this may seem like a lot, in context it was only 43% of our domestic demand, implying that we import 57% from other countries. Given that New Zealand has a number of untapped potential hydrocarbon resources, from oil to natural gas, should we be getting half of our needs from abroad? While there are many New Zealanders who wish our country not to exercise these potential resources, for reasons as diverse as conservation, fracking, or fear of further disasters such as the Rena oil spill in 2011, we need to ask ourselves, are we ethically comfortable with other countries taking the environmental risk of extracting and shipping this fuel for us?

Our national energy issues extend beyond supply and sustainability though. In 2009, New Zealand was using more energy per capita than 17 of 30 countries of the OECD (Organisation for Economic Co-operation and Development) [3]. This is mainly due to our heavy reliance on private vehicles, showing that our patterns of use, attitude to consumption, and the technology we employ are major factors in the way we view and utilise energy.

New Zealand is gifted with ideal geological settings that provide us with a wealth of renewable energy options. In 2011, renewable energy in New Zealand (hydro, geothermal, wind, bioenergy, and solar) provided 39% of the total amount of energy supplied for use, an increase of 1% from the previous year [4]. Looking at only the electricity aspect of energy in New Zealand, 77% is supplied from renewables. These values may not fit too well with our '100% Pure' brand, but looking back, a value of 39% is an increase from where New Zealand was 25 years ago, when renewables supplied approximately 27% of the total amount of energy used. In fact this figure of 39% places New Zealand as the second-ranked OECD country for renewable contribution (behind Iceland and ahead of Norway).

Given the options and national resources available to use, we as New Zealanders have the enviable position of choosing where our energy future lies. The unique geological setting we find ourselves in offers us options not available to most other countries. Can we, and do we want to be, 100% renewable in terms of energy consumption, and what are the obstacles to getting there? If we do, how long will it take us, and how 'clean' can we be until we get there?

In addition to the issues mentioned, energy research goes hand in hand with other important scientific and social issues such as climate change and environmental conservation. Working in a field as vitally important as energy is gratifying and knowing the issues we face nationally and globally is one of the driving forces behind why I chose scientific research as a career. I believe, as a geologist and researcher, that New Zealand, given its unique circumstances, is the place to do this. New Zealand stands to act as an example to other countries on how to successfully and responsibly utilise and manage a diverse range of energy resources as well as lead the way in renewable, sustainable and clean energy research. To me this global calling is one of the greatest values of science in New Zealand.

References

1. British Petroleum. 2012. BP Statistical Review of World Energy. http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2012.pdf
2. Central Electricity Authority, Ministry of Power, India. 2013. All India Regionwise Generating Installed Capacity (MW) of Power Utilities Including Allocated Shares in Joint and Central Sector Utilities. http://www.cea.nic.in/reports/monthly/executive_rep/mar13/8.pdf
3. Ministry for the Environment, New Zealand. 2009. Energy Supply and Demand, Environmental Report Card. http://www.mfe.govt.nz/environmental-reporting/report-cards/energy-supply-and-demand/2009/energy-supply-and-demand.pdf
4. Ministry of Economic Development, New Zealand. 2012. New Zealand Energy Data File. http://www.med.govt.nz/sectors-industries/energy/pdf-docs-library/energy-data-and-modelling/publications/energy-data-file/energydatafile-2011.pdf