Dr Moshe C. Kinn
m.c.kinn@edu.salford.ac.uk
14/11/2017
A response to the "Energy Transition and the Future of Energy Research, Innovation and Education: An Action Agenda for Europe's Universities"

The label 'Action Agenda' in this response is the name I give to the whole report.

I am afraid that my comments to your report are complicated and not be fully articulated in this type of forum. To read what I have previously written which is extensive, [1-3] please look at www.dcisthefuture.org/publications. However, with the limited time I have, I have attempted to write something here.

I have spent over ten years carrying out interdisciplinary research at the interface of the electricity system and society. As part of my research I interviewed twenty top academics and policy makers who work in electrical and electronic engineering, and in social science subjects such as; energy policy, disaster risk reduction and management, sustainability, city resilience, and energy economics. These 20 people were willing to give their time and engaged. However there were many more, both from the engineering fraternity and the social sciences who were unwilling to engage. The engineers stated that sustainability was not their subject and the social scientists stated that they knew nothing about the electricity system or electricity. The strange thing is that these social scientist were totally engaged in the above mentioned subjects in which they were policy makers, yet when challenged, they refused to engage with the subject of the electricity system that had direct impacts on their expert subject. Similarly the electrical engineers were professors who controlled both the academic curriculum and the research budget that focused on issues like smart grids and energy efficiency in buildings, yet were unwilling to engage in the subject of the usage of distributed renewable energy systems as a sustainable option for many of today's global sustainable grand challenges.

In trying to solve the dilemma as to how to forge interdisciplinarity within the university system, one is faced with a chicken-and-egg scenario. The conundrum is, we want to promote interdisciplinary thinking within a silo riven environment and we want the internal actors, who are not used to, able, and in my experience are unwilling to open up to cross disciplinary thinking and certainly not interdisciplinary thinking, to think in an interdisciplinary way. In fact the situation is so dire that in 2015 there was a whole special section in the journal Nature dedicated to this problem [4]. The title asked the question 'Why interdisciplinary research matters?' It then stated that '*scientists must work together to save the world*'. The special issue went on to explain that despite its importance, research that transcends conventional academic boundaries is '*harder to fund, do, review and publish*', this conclusion is corroborated within my personal experience over the last 10 years. It is very much a cultural issue. How do you do interdisciplinary research and get through any peer review, for public funds or for journal publications, when the culture is one that is siloed? The gate keepers who are barriers to change are the top academics in these fields who are opposed to the notion of interdisciplinarity. I know this from my personal experiences over the last 10 years.

Therefore, how does one promote interdisciplinary thinking? In a nutshell I think, given the Action Agenda of this report, it is going to be an issue that is going to take at least a generation to actually happen, i.e. at least 30 years. I say this because, if you look at the global warming / climate change debate, it has been 45 years since its inception in 1972, yet all the intergovernmental organisations on the subject state that the world is in crisis and the goals are not being met

A way forward would be to tackle the problem from the bottom up. It may initially take longer to create an environment that breaks down siloed thinking, but in the long run it will be quicker than starting with PhD research. Starting with PhD research and tricking down to Masters subjects is a top down approach fraught with major obstacles. For example, who will supervise and assess interdisciplinary theses when the professors themselves are siloed? In my experience it took me over a year to secure a PhD supervisor, as no one in the electrical engineering fraternity would take me on as a supervisor, since I was trying to understand how society is affected by power cuts. Societal effects caused by power cuts was a social science subject and not a subject for a PhD in the electrical engineering department. Similarly when I mentioned to the social scientists that I would like to research how using distributed electricity systems may help with 21st century societal problems they told me that electricity was not their subject, so I could not do a social science PhD that was looking at the electricity system. When I suggested having two PhD supervisors, one from the electrical engineering department and one from the social science department, neither side thought it a good idea. In the end I did a sociotechnical PhD, within which I developed interdisciplinary skills. The fact is, there are only on average 3 universities in each of the 31 countries in the SET-PLAN database. Therefore, even if there are some academics across Europe who are open minded enough to want to teach and supervise interdisciplinary research, as a percentage of all relevant academics, in my opinion they are miniscule. I therefore question the whole Action Agenda that want to start at the PhD level, which is a top down approach.

The second focus of this Action Agenda is the promotion of education and further research into the following key areas, (1) Energy Efficiency (2) Smart Grids and Energy Systems and (3) Renewables Integration. I see these three areas as a continuation of the centralised smart electricity systems and the internet of things policy. This agenda, like global warming / climate change, is more of the same and not radical rethink or new ideas. Making buildings more energy efficient has to be a good policy, but only thinking about furthering the 'smart' centralised agenda will not lead to the required results. Similarly, focusing on what I call 'social engineering' where the agenda is to try and change people's habits and way of life, has not worked in the past and is not in my opinion a recipe for future success.

NOTE: On one hand, billions of pounds are spent globally on cyber security, yet the 'smart' agenda that seeks to add smart technology everywhere steams ahead. This policy is illogical and self-contradictory. If society is suffering with cyber security issues, doesn't logic state that society should be reigning in on smart technology and looking for reasons not to increase their use, and to remove them wherever possible? There are international conferences, where side by side there are these contradictory themes. One theme promotes the smart use of technology in all aspects of our cities and another grapples with the constant war on cyber security and cyber-crimes.

While the Action Agenda identified the use of distributed energy systems, it only sees them as an extension of the centralised system. However, it is time that they are looked at as self-contained systems that can offer full off grid solutions. Being off grid removes the need for the centralised-grid to require smart technology to integrate them.

The interdisciplinary approach put forward by this report/papers is more cross disciplinary than interdisciplinary. What I mean is the proposed interaction between the academic fraternities has been proposed such that engineers will learn generic information about softer subjects. For example "This *should include public perceptions of energy, energy practices, energy choices and prosumers, energy dialogues, and the differing ways that energy impacts on different constituencies within society".* (Section 3.3.2 subsection 6). It is my opinion that just teaching engineers about for example

energy poverty, will give them the awareness about the problem but will have no impact on the design of new technology.

A definition of interdisciplinarity is ; "*Interdisciplinarity is a synthesis of two or more disciplines, establishing a new level of discourse and integration of knowledge*" [5], it "*analyzes, synthesizes and harmonizes links between disciplines into a coordinated and coherent whole*" [6]. What this report should propose is to teach the direct effects of each type of energy system on each soft subject. The goal should be to synthesis the two subjects until they are one. Engineers will automatically design with the societal problems in mind. By teaching engineers about the need to radically change the technology to reduce the amount of energy it consumes and thus reducing the cost to the consumer is very important. This is because engineers are problem solvers. Give them a problem to solve and they will. Teach them social science subjects, they will see no relevance to their technological innovations and you will have a zero sum gain. Similarly social scientists have to be trained to understand how the technology effects their subject. I have been told by an analysist in a top London centric think-tank that engineers don't speak the language of policy makers, this is a barrier to interdisciplinarity.

I carried out some research to ascertain to what extent scholars in the disaster risk reduction and management fraternity focus on the effects of power cuts during and post disasters. What I found was that their level of focus of the subject of electricity and power cuts, and how the loss of electricity exacerbates a disaster, was under represented in the academic literature [7]. Social scientist have to engage with technology to understand its direct effects and then relay these facts to engineers in the form of 'a problem to be solved' and you will see how technology will change. Just teaching engineers about social science problems will in my opinion, not be catalytic technological innovation.

My way forward

The targeting of PhD research will, if done correctly, produce new and innovative solutions. But this is only the start. Education should start at the bottom and across the board at the same time. Children in primary school are already taught about renewable energy and sustainability. At secondary school subjects that teach about energy systems, like in physics should also include the social aspects of the systems under discussion. When a student enters university they should already be versed in the underlying technology, and societal problems. At undergraduate level, and in taught post graduate classes, as described above, students must be moulded into interdisciplinary thinkers. They must not just learn about a subject that is out of their normal discipline as they will end up becoming cross disciplinary thinkers. The difference between them is the interdisciplinary thinker sees both subjects as one, while the cross disciplinary thinker has a broad knowledge of two separate subjects and perhaps the boundary points between them, but may lose the synthesis needed to deal with the grand challenges we face.

This approach to interdisciplinary teaching must start from the bottom up, at school and as part of undergraduate teaching. It will take a long time, but it will produce a generation of interdisciplinary thinkers.

It has been pointed out to me that when it comes to certain technology disciplines there are systems architects whose job it is to ensure end to end joined up thinking and oversee all the other engineers working on the project, so that no incompatibility exists within the final system. However for the electricity system these is no such systems architect role across the whole system from generation

to consumption. Having people who are systems architects, may have stopped the initiation of intermittent generators feeding into the national grids that couldn't handle intermittent generation, that then needed a whole layer of smart technology, that led to cyber security vulnerabilities with national security implications, that led to a new cyber security industry, which leaves society with a central generation system which at best will always only be one step ahead of those that seek to close it down. The contradiction goes further, as mentioned above, we are promoting the internet of things at the same time a grappling with the never ending cyber security war.

In the UK, the Government recognised, via the Nurse report [8], that there was the need for closer integration of the Research Councils as important interdisciplinary research was finding it difficult to get funding and was therefore not taking place. This created research gaps. Academia will chase research funds. Therefore, there is a need to provide very focused funding criteria for interdisciplinary research. The focus on interdisciplinarity must be such that it encourages academics out of their siloed mentality. For a truly interdisciplinary culture to persist into the long term, carful monitoring will be needed and it will take decades to truly become pervasive.

More emphasis is needed to develop the hydrogen solar economy [9], (especially burning hydrogen in ordinary internal combustion engines [10]), in a ways that it will help solve many of today's grand challenges.

In conclusion the Action Agenda, will in some small way, lead to new innovations and produce a few interdisciplinary researcher. However, like the global warming / climate change debate if there isn't totally joined up thinking across the whole energy system, and if only the top down approach is taken a truly successful outcome will take many decades. The solution is to take a bottom up approach starting at primary school, and using very targeted research funding criteria to breakdown the silo mentality of academic researchers.

[1] Kinn M. Benefits of Direct Current Electricity Supply for Domestic Application [MPhil Thesis]: The University of Manchester; 2011.
[2] Kinn M. Proposed components for the design of a smart nano-grid for a domestic electrical system that operates at below 50V DC. In. 2nd IEEE PES International Conference and Exhibition on Innovative Smart Grid Technologies. Manchester, England UK.2011. p. 1-7.
[3] Kinn M. An Analysis of the Sociotechnical Transition Process from the Existing Centralised Alternating Current Voltage Electrical System in the UK to One Where Distributed Direct Current Voltage is Used to Meet the Energy Needs of the Built Environment: The University of Salford, Manchester; 2016.
[4] Nature. Why interdisciplinary research matters. Nature. 2015;525:305.
[5] Klein JT. Interdisciplinarity: History, theory, and practice: Wayne state university press; 1990.
[6] Schummer J. Multidisciplinarity, interdisciplinarity, and patterns of research collaboration in nanoscience and nanotechnology. Scientometrics. 2004;59:425-65.
[7] Kinn M, Abbot C. To what extent is electricity central to resilience and disaster management of the built environment? Procedia Economics and Finance. 2014;18:238-46.
[8] Nurse P. Ensuring a successful UK research endeavour. Department for Business, Innovation & Skills; 2015.
[9] McAllister R. The Solar Hydrogen Civilization: The Future of Energy Is the Future of Our Global Economy. Mesa, AZ: American Hydrogen Association; 2005.
[10] McAllister R. The philosopher mechanic: Knowledge publications; 2007.