How we can deliver radical "cool' innovation in time to make a difference?

As the new Midlands Thermal Energy Research Accelerator is formally launched with £20 million of Government backing, Professor Toby Peters, Visiting Professor in Power and the Cold Economy and Founder of clean tech start-up Dearman, explains *how* a new research centre can accelerate the development and deployment of novel cooling technologies.

Internet entrepreneurs have made innovation look deceptively easy. Paypal, Google, Amazon and eBay all seemed to transform the way we do things almost overnight. Uber was founded in 2009 and today is valued at more than $60 billion. Facebook was a twinkle in Mark Zuckerberg's eye in 2004 and now it's worth $330 billion.

But engineering innovation is different: developing, validating, demonstrating and manufacturing physical products takes longer, and costs tens, if not hundreds of millions. Tesla, the electric car maker, started trading in 2003 and will have spent several billion dollars in equity and debt financing, but will only deliver its first 'mass market' model – priced at $35,000 – next year.[1] This could be seen as the inevitable difference between developing a new real-world product rather than an online business model, but it's a lag we can no longer afford. Our climate deadlines are now so tight that we must find ways to dramatically reduce the time taken to bring new energy-efficient products to market – in other words to speed up the innovation process in energy engineering. The launch of the new Midlands Thermal Energy Research Accelerator (T-ERA) should help achieve exactly that.

Britain is legally bound to reduce its CO2 emissions 80% by 2050, and at the Paris conference 195 countries adopted the first ever legally binding global climate deal. Yet demand for energy services keeps growing – particularly in the fast growing economies of the developing world. The scale of the challenge is highlighted in the latest *BP Energy Outlook*[2], which shows just how far short we are of achieving sustainable trajectory in global carbon emissions (see previous article). So the pace of energy innovation must accelerate greatly if we are to have any chance of delivering the Paris targets.

That means there is an urgent need to develop and deploy technologies that reduce energy and resource consumption, not simply by a few percentage points but by a substantial fraction. The harsh reality is that our traditional innovation strategies and funding systems are not structured to support the complex, cash intensive, slower-growing but radical new products that could end up being hugely significant — the disruptive, step change solutions that might address the global challenges in sustainable energy, water, food and health.

Innovation goes on all the time, of course, but most of it is *incremental* – the process by which big manufacturers continually work to improve the efficiency or reduce the cost of existing products. Radical innovation is quite different: instead of attempting to marginally improve the status quo, the developer – typically a start-up or SME or University research team - must *replace* the status quo altogether. The stakes are high, and so is the failure rate. Innovation in energy is harder still because of:

- the capital investment in existing assets;
- the strategic role of energy – products must work;
- the understanding of system infrastructure that is required;
- the often radical nature of technical change against the incumbent;
- the range of stakeholders necessary to be involved from new supply chains to customers willing to buy the new product;
- the validation process before customers will buy a new technology;
- the size of the investment, and the exponential growth required to make a meaningful difference.

Historically, radical innovation has also been slow. It can often take 5-7 years to move a radical innovation from a basic concept to commercial prototype, just as long again to move from this stage through validation to full production, and the same again to make it to the mass market. Look at wind turbines, solar, EVs – or worse still the hydrogen economy.

Unlike an incremental efficiency improvement to a traditional technology, the process to move a radical innovation from prototype to commercial production require the developer to solve engineering design challenges, often develop new materials, create an efficient manufacturing process at scale and build a supply chain which can deliver performance and durability at an acceptable price - and then scale up production while evolving the product for changing market conditions.

More often than not, a radical innovation in energy is likely to require significant investment in new infrastructure such as electric vehicle charging points, or even the deployment of a new energy vector like hydrogen. And of course this is all before the marketing programme, creating the policy and regulatory environment needed to drive adoption, building customer confidence, sales channels and after-sales support.

One of the key reasons the innovation process has proved so lengthy in the past is that the various stages of development have typically been pursued sequentially, whereas they

should be tackled in parallel - and crucially should inform each other. There is not much point spending years developing a brilliant device, only to find out it is impossible to manufacture with current materials. Nor is there much point scaling up manufacturing if you haven't already made sure the market understands the importance of the problem your product will solve, and that you can sell it competitively to the incumbent technology. This need to pursue engineering, manufacturing and marketing in parallel makes it essential for small developers to collaborate with established organizations, to leverage their expertise and shorten the development timeline.

So if we are going to deliver radical innovation more quickly and more broadly, there are clear challenges:

- create a coalition of partners from the technology innovators, academic, public, for-profit and not-for-profit sectors to work together to accelerate new science through demonstration, validation and manufacture to deliver workable products into the global market.

- Work together to find ways to shorten the time span from idea to impact through new prototyping, testing, manufacturing processes – not least speed the process by more efficiently enable the best practices of design for manufacture concurrent with development and not wait to finish their scientific thinking before focusing on manufacturing.

- Think about how to deliver robust and adequate size test beds for validation and to secure customer confidence

- Along with building competitive manufacturing upstream, also develop great marketing, sales, service and after sales channels downstream.

- Train the people a radical new innovation needs from manufacture to assembly to after-sales service ahead of, not after, the sales and deployment curve

If we can crack these, using collaboration to build confidence and accelerate the timeline to market, then the incentive to invest in the key new technologies we need becomes stronger.

T-ERA is designed to be this hub to establish partnerships between technology innovators, universities, specialist suppliers, and with industry experts. And equally important with the companies who can provide manufacturing capability, invest in the new processes, develop infrastructure and international distribution channels. It will engage with the market for structured test-beds for validation and demonstration. It will invest in skills development.

Through these links and alliances, T-ERA can create a world class environment and facilities to enable young companies pursuing radical innovation to learn from people who have been there and done it. But it will also create a structured environment for forward-looking, established companies to benefit from the value relationships with start-ups can bring. These are afterall the fast-moving, creative companies re-imagining the answers who can enable far bigger companies to access genuine innovation, without having to divert their attention from their core activity. It's a truly symbiotic relationship that can ensure invention moves more quickly to adoption. By embedding these collaborations in a new institution with a clear vision of accelerating technology to market, T-ERA will indeed help accelerate the pace of energy innovation in the UK.

Professor Toby Peters
Visiting Professor in Power and Cold Economy, University of Birmingham
Chief Executive, Dearman
t.peters@bham.ac.uk

[1] http://qz.com/494051/elon-musk-tweeted-the-date-he-will-deliver-the-first-mass-market-tesla-model-3/
[2] BP energy outlook, 2016 edition, https://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2016/bp-energy-outlook-2016.pdf