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Beyond Electricity: Using Renewables Effectively

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(Photo: Vera Kratochvil)

Mention 'renewable energy' in general discussion, particularly in Europe, and people tend to think of the familiar poster children: wind and solar power. This reflects the main thrust of efforts to cut carbon, which is directed at cleaning up the electricity supply. Discussions around wind farms, nuclear power and the alternatives are so productive of dispute that it might be disconcerting for some proponents to realise that even if the electricity supply were completely decarbonised tomorrow, it would be substantially less than half the battle won – closer to a fifth, as it happens.

I was put in mind of this fact at the Scottish Hydrogen and Fuel Cell Association (SHFCA) members' meeting held last week, which Fuel Cell Today was invited to attend. The theme of the meeting was 'Energy Conversion and Storage' and it featured several excellent speakers and much discussion (our full report on the event will be published soon). Things were kicked off by Professor Ian Arbon of the UK's Institute of Mechanical Engineers (IMechE), who commented on the fact that when targets are set 'electricity' is often conflated with 'energy' and that legislative efforts ostensibly directed at renewable energy often seem limited to electricity. To put this limitation into context, IMechE quotes the following figures for the UK energy consumption split: 23% electricity; 35% transportation fuel; and 42% heat (based on TWh/year; 2008 data).

Is this split typical? It's actually a pretty good approximation: in 2011 the IEA reported that global energy consumption breaks down as 19% electricity, 30% transportation, and 51% heat. For the OECD countries the figures it quotes are 23% electricity, 36% transportation, and 41% heat (the IEA figures have been corrected here to exclude non-energy use). For Europe, the European Renewable Energy Council estimated the split in 2006 at 20% electricity, 32% transportation, and 48% heat.

So should policy focus shift to decarbonising heating first, then transportation, and lastly electricity? That isn't the suggestion. Despite the attendant difficulties, and there are many, a large-scale introduction of renewable sources into the electricity supply is still easier to accomplish in the near term than a large-scale (sector-wide) conversion to renewable heat or climate-neutral transportation fuel – part of the reason it is being tackled first. Once this is achieved, the argument goes, it should then be possible to achieve further emissions cuts by electrifying heat and transportation.

It is certainly true, as was underlined at the SHFCA meeting, that renewable electricity offers an excellent way to 'inject' renewables into heating and transportation. To accomplish this requires a common energy carrier or vector, a form of energy that can be used for power, heat and mobility. Although electricity can be a common energy carrier it is not ideal because it is so difficult to store in large quantities. Hydrogen is a storable and more flexible alternative.

Much has been written about the use of electrolysers to store renewable energy by generating hydrogen, and how this can facilitate the introduction of variable renewable energy sources into the electricity supply by offering a way to balance the grid. Variable renewables are generally seen as posing a problem that needs to be solved, but perhaps they should be viewed instead as offering a significant opportunity for heating and transportation.

In his presentation, Prof. Arbon also emphasised the distinction between 'power' and 'energy' – an obvious point, one might think, but central to this discussion. To use a trivial illustration: in order to introduce 6 MWh of wind energy to the grid you can't simply install 6 MW of wind power and expect the turbines to produce at rated capacity for an hour. The variability and unpredictability of wind, coupled with variation in demand, mean that your 6 MW wind turbines may only be relied upon to produce 2 MWh of *usable* electricity in any given hour. To get 6 MWh over an hour you would thus actually need to install something like 18 MW of wind turbine capacity. But your 18 MW wind farm will likely produce significantly more energy every hour than the 2 MWh that the grid can accept. While in theory some of this excess electricity may be exported, in reality it is likely to go to waste because there is no immediate demand for it, particularly as the proportion of variable renewables in the grid and in all neighbouring grids increases (which can be expected in Europe).

Extend the hour to a year and the implication is clear: in order to meet targets there is likely to be significant overinvestment in renewable capacity in the grid. This is capacity that can be used elsewhere, if you implement a conversion to hydrogen and then use this hydrogen to fuel combined heat and power generation or transportation, for example. In this view, it isn't the variability in supply that is the problem, but the mismatch with instantaneous demand. But demand exists for renewable heat and transportation fuel – far greater demand than for electricity – and some of this could be met if hydrogen is used for time and space shifting. (Hydrogen can also be used to serve non-energy demand as a chemical feedstock.)

This requires a change in thinking. A wind farm, for instance, should not be seen as a source of electricity, but as a valuable source of energy. To this end, planning for future installations of variable renewable capacity should as a matter of course include planning for energy conversion and storage. Yes, there is an energy loss involved but we aren't likely to run out of wind and, while wind turbines, electrolysers and hydrogen storage have high upfront costs, marginal costs would be very low.

There are of course many other issues to take into account and there isn't space here to discuss them all. But we'll be exploring these concepts and others in more detail in our upcoming report on Electrolysers and Renewable Energy, to be published later this year.

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