Can Industry 4.0 save the planet?

The use of technologies, techniques and business models linked to industry 4.0 will be essential to achieve a low carbon transition, and the public sector will play a key role, argue Tomas Wyns and Martin Porter

Following the 2015 Paris Agreement on climate change all countries around the world will have to implement long-term strategies and policies to achieve net zero greenhouse gas emissions around 2050. Energy and resource intensive industries will hence also be faced with the same challenge. The emissions from these sectors are known to be 'difficult' to mitigate and will require a combination of process, product and business model transformations. The use of technologies, techniques and business models linked to industry 4.0 will be an essential part of this low carbon transition. Furthermore, the public sector will have to play a catalysing role to enable this low carbon industrial revolution to take place.

Net zero greenhouse gas emissions by 2050 and challenges for industry

Reducing greenhouse gas emissions to almost zero by 2050 will be one of the biggest socio-economical challenges for the EU since its inception in 1957. Over a period of 30 years all sectors in the economy will have to see a coordinated transition to a net zero emissions society. In certain sectors notable progress has been made. We are currently witnessing a revolution in the energy sector with renewable energy production such as wind and solar outcompeting or soon outcompeting all fossil fuel based power production. In the transport sector the electric age is finally dawning as is the end of the internal combustion engine with its phaseout being announced by a growing list of major economies.

When it comes to energy and resource intensive industries such as steel, cement and chemicals production in the EU the good news is that emissions have come down significantly since 1990. With cement and steel production 40% lower (in 2014) and chemicals even 60%. This is due to reduction in production capacities in some of these sectors but also major investments in energy efficiency. The bad news is that from hereon further reductions will become more difficult and costly. It is also clear that existing technologies will not bring about net zero emissions ever.

Pathways to industrial decarbonisation

The pathways towards deep emission reductions in these industries will need a sophisticated combination of actions. First of all, there is an urgent need for the development and deployment of breakthrough technologies. This can include electrification of processes, the capturing and storage of CO_2 emissions, the utilisation (with long-term) fixation of CO_2 emissions and the use of alternative feedstocks. With investment cycles in these industrial sectors taking around 30 years, there is an urgent need to bring these technologies to the market. But also the invention of new products with same performance but (much) lower CO_2 emissions during the production process will be important.

Thirdly, and most important, radically changing existing business models and value propositions will be essential in combination with the above to achieve the Paris Agreement long term target. These new business models can

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include a move to higher levels of circularity along the supply and value chain of the basic materials industry. One example would be the introduction of product as a service value propositions. This concept has been implemented already by Philips Lighting with the move to lighting a service as opposed to lamps as a product. In such framework the efficient or even circular use of products becomes of high interest to the producer of these goods.

However, the example of lighting has not found its way into the business models of energy and material intensive industries. One of the issues is lack of reliable information of product use downstream for materials such as steel, chemicals and cement, in particular at the end of life of these products.

It is in this area in particular that the application of elements that are part of an Industry 4.0 framework can play an enabling role.

Industry 4.0 and the low-carbon economy

While most energy and materials intensive processes have become highly automated and depend upon sometimes very sophisticated IT tools, the application of these techniques is often limited to the process site. Once products have left the plant, in most cases, the producer doesn't track their eventual processing and use. One of the consequences is that the sometimes high quality material present in products at the end of their lifetime cannot be traced or extracted or only at high transaction costs (eg. by being labour intensive). Advanced digital technologies can make a big difference here.

For instance the use of digital ledger technologies (eg. blockchain) can help trace the use of basic materials (eg. steel and concrete) from their production until the end of life when embedded in products down the value chain. Furthermore, advanced machine learning in combination with thermal or other spectroscopic techniques at an industrial scale can advance the automation of recycling by allowing the highly efficient selection between low and high-quality steel or aluminium scrap and different types of plastic waste.

With these and other technologies at their disposal, new business models linked to circularity might finally become cost-effective and hence attractive. In practice some energy and materials intensive industries can be offering this product use tracking and specialised recycling as part of a service. It might therefore even become possible that basic materials such as steel are leased or rented out instead of sold in the future. As a result the need for virgin primary steel, plastics and even cement might go down significantly due to the application of circular economy technologies and business models and this will therefore advance greenhouse gas reductions even further.

There are also other elements that are part from accelerated digitisation that can become important in the low carbon transformation of industrial sectors. Important here is again the need to speed up technological changes as part of this transformation. In the area of material sciences there is a need for discovery acceleration in the quest to find large cost-effective power storage and electrification of transport but also the push for new chemicals catalysts that can help with development of low carbon processes, the use of CO_2 as a feedstock and the production of hydrogen. The development of advanced discovery laboratories in the EU and globally will be essential for this R&I process. These labs will heavily depend on emerging key enabling technologies that can be part of industry 4.0. This includes the use of AI and machine learning to speed up the identification of promising molecules and materials. This area can also be the first killer app for the use of quantum computers.

Another example can be the industrialisation of 3D printing. It has the potential to reduce the use of basic materials such as steel and concrete by limiting waste in the construction process and by enabling the design of products that require less material in the first place.

While it is still not certain what role advanced digitisation will play in the future of energy and resource intensive industries, there is the opportunity to develop a roadmap that uses new digital technologies. It can lead to reduced need for basic materials but also finally enable the development of new business models along the value and supply chains of these industries.

The public sector as a catalyst for mission oriented low carbon innovation

We know that the road towards a competitive low carbon industry will consist of combined pathways of process, product and business model innovations along the respective supply and value chains. Advanced digitisation can play a critical enabling role in these scenarios, in particular through providing options for different value propositions through eg. the circular economy. It is however no given that any of these scenarios will materialise and that hence a low carbon industry will become a reality in 30 years.

A transformation of this size in such a relative short timeframe will require a list of catalysing activities by the public sector. Other historical transformations can serve as an example. The internet, for instance, was the result of intense public R&I activities by the US Defence Advanced Research Projects Agency (DARPA) and an incredible spin-off of the European Organisation for Nuclear Research (CERN). Other game changing technologies such as the Global Positioning System (GPS) and the touchscreen had a similar origins story.

To achieve net zero greenhouse gas emissions by 2050 will need focused and hence mission oriented public R&D programmes. These can be build around grand challenges such as zero emission steel making by 2030. This type of R&I will also have to look beyond the development of innovative processes and include challenges for new business models. An example would the use of value discovery programmes which support industries to explore new business models and value propositions, eg. as part of a circular economy.

The public sector is also ideally placed to provide (long-term) catalytic financing for the industrial transformation. There will be a high level of technology risk involved in moving to a low carbon economy. Public grants but also instruments such as investment risk guarantees that lower the cost of capital will be important. The public sector, eg. as opposed to venture capital, can be present for a longer time and hence increase the chances that fledging technologies and initiatives mature sufficiently to reach market readiness.

The government also has a pivotal role in so called market formation. It can be the first purchaser of low carbon products and hence create a market for these products. The public sector can do this directly through public procurement, for instance by requiring the use of low carbon materials in large infrastructure projects. It can also enable these markets indirectly through regulatory initiatives.

This includes the introduction of low CO_2 or energy-efficiency standards eg. for construction products, buildings or appliances but also the introduction of instruments that seek to include external costs of production processes in final products through putting a price on CO_2 emissions. In this context it is also important that regulation does not lock-in incumbent high CO_2 technologies. The EU's CO_2 and cars legislation seemed to be designed to promote efficient diesel engines and therefore impeding the shift to revolutionary electric vehicles in Europe.

The smart, efficient and mission oriented combination of the above-mentioned instruments the public sector can enable can be called a modern industrial strategy. It will have to be an essential element of Europe's low carbon transformation.

Conclusion

In 2050 a net zero emissions Europe and in particular its industry will look very different compared to today. The good news is that there will still be a high level of industrial activity. The combination of innovations along the value chains of different industries and business model changes as part of circular economy will even create the possibility of more value being created in the absence of CO_2 emissions. Existing and emerging technologies part of Industry 4.0 likely will be critical in making this happen.

A smart public sector, however, will the unique catalyst to make it a reality. If they are smart, EU policy-makers will agree a confirmation of such a mission by the end of 2019, through a new 2050 Roadmap and 'mid-century strategy'

– and combined with a renewed agenda and effort in the next Commission on a modern European industry strategy for a world-leading smart, clean industrial economy. ■

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