

TRUSTWORTHY AUTONOMOUS SYSTEMS

Acting independently

H3	ACT	PLAN	TRACK	PARK	OPP	THR	NEU
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Swarming is a collective behaviour exhibited by insects and birds when they aggregate together to accomplish tasks such as migration. [One field of robotics that is maturing fast is dedicated to building swarm intelligence](#) - multi-robot systems that can interact with each other for problem-solving. Swarm robots can investigate and analyse complex systems and determine appropriate courses of action. Research at Bristol University is aimed at [using artificial evolution to develop robots with the capacity to learn swarm behaviours](#). Robotics could replace humans in work too dangerous to do such as toxic waste clean up. A swarm could, for example, investigate a toxic waste site autonomously and instruct and execute clean up efficiently and without any human intervention.

The potential is enormous. Researchers in Germany have developed micro and nano-sized robots that can autonomously move in the opposite direction to the way a fluid flows. This makes them particularly promising for intervening inside the human body. Among other things, these robots could be used to carry drugs, genes or other substances to specific sites inside the body, opening up new possibilities for treating different medical conditions.

[Future robotics may allow machines to learn from problems they confront](#), write their own instructions and then respond to sudden external changes. This means that autonomous systems can change their behaviour from what was initially programmed, thus becoming independent from human controllers. They would not be limited to what is written in their system; they would become smarter, artificially intelligent and perhaps even more 'aware'.

This raises important issues around ethics and the design of trustworthy machine systems. UK Research and Innovation's (UKRI) [Trustworthy Autonomous System's \(TAS\) program](#) has granted each of six university research nodes £3 million in funding, in order to look at the processes used to design fully autonomous systems and the associated legal, ethical and social contexts for the possible applications of independently acting machines.

THE HYDROGEN ECONOMY

The gas is greener

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One of the key commitments in the [Energy White Paper](#) is that government will work in partnership with industry to evaluate hydrogen as an option for heating homes and workplaces and will develop plans for a possible pilot hydrogen town before the end of the 2020s.

The UK is not alone. Hydrogen is among President Biden's new energy plans for the US - a clean energy revolution that aims to create 10 million new jobs - and EU member states have agreed to rapidly upscale the market for hydrogen at the EU level. [Canada](#) and [Australia](#) are amongst other nations also developing a hydrogen strategy.

China - already the world's largest producer of hydrogen (but 'grey' hydrogen made from coal and gas rather than 'green' hydrogen from renewable sources) - is [joint venturing with Shell](#) to build hydrogen refuelling stations in Zhangjiakou City, which will host part of the 2022 Beijing Winter Olympics. In [a report](#) published in the Green Belt and Road Initiative Center, authors Mengdi Yue and Christoph Nedopil Wang noted that between 2017 and 2020, China had established 61 hydrogen refuelling stations, developed the first fuel cell-powered tram, and successfully tested a manned aircraft powered by hydrogen. The indications are that [China could become the global leader](#) in renewable hydrogen.

Figures from the [International Energy Agency](#) reveal that global low-carbon hydrogen production is expected to reach 1.45 million tonnes in 2023 (up from just 0.04 million tonnes in 2010) based on new hydrogen plants opening around the world. The cost of producing hydrogen power is falling at a dramatic rate, with figures from the US Department of Energy predicting a fall from \$6-1kg in 2015 to \$2-1kg by 2025.

This significant decline falls neatly within the timeframe of environmental benchmarks such as the Paris Climate Targets, and there is hope within the hydrogen industry that the energy source will be integral to meeting these goals

FURTHER READING

