Horizon Scan 3 Fact Sheet

High impact innovations transforming Australian agriculture

Agriculture is being transformed by technologies that have the capacity to make the entire agricultural supply chain more precise, more profitable and more sustainable.

With a strong track record of technology integration, the speed of technology innovation means that industries need to proactively seek out alternative sources of technology and sift out those with the potential to be game changers.

This is the third report in a series of scans looking for high impact technologies overseas and in other sectors of the Australian economy that will likely disrupt the agricultural supply chain.

The six technologies identified through the research will support industries to be better positioned to maintain a strong competitive advantage and ensure the sector is well placed into the future.

How can you harness the technology of tomorrow for the benefit of agriculture today?

This research takes a look at the five technology innovations with the potential to shape Australia's rural industries:

- Ambient Intelligence
- Augmented Reality
- Grid Edge Technologies
- Plant Genome Sequencing and Editing
- Smart Dust
- Graphene

Report contributors

Dr Grant Hamilton, Dr Levi Swann, Dr Sangeetha Kutty, Prof Roger Hellens, Prof Greg Hearn, Assoc Prof Richi Nayak, Dr Jared Donovan, Dr Debra Polson and Dr Markus Rittenbruch.

Full report

Horizon Scan 3: October 2017. Report by Queensland University of Technology for AgriFutures Australia: agrifutures.com.au/product/horizon-scan-3/

AgriFutures Australia Project No. PRJ-010512
AgriFutures Australia Publication No. 17/050
ISBN: 978-1-74254-973-6

Learn more
agrifutures.com.au/
national-rural-issues

AgriFutures™ National Rural Issues

QUT

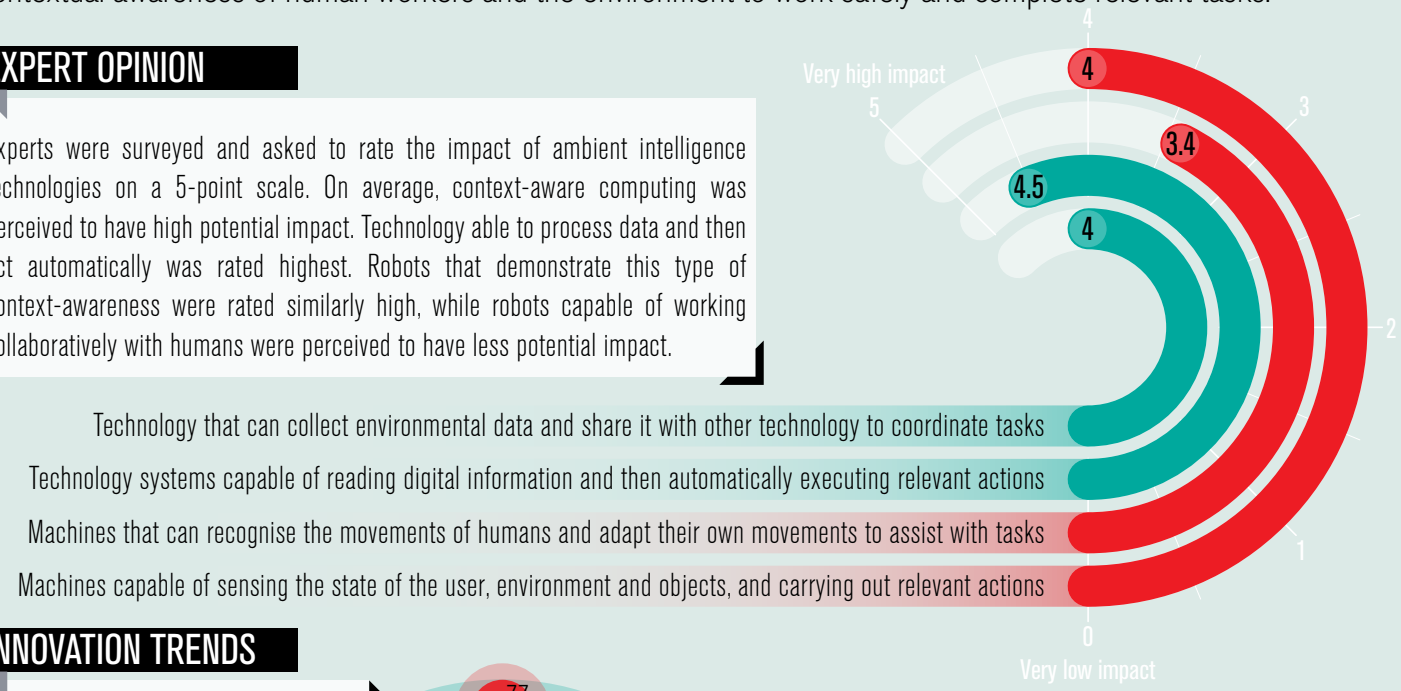
AMBIENT INTELLIGENCE

CONTEXT-AWARE COMPUTING • COLLABORATIVE ROBOTS

Ambient intelligence relies on computing devices that are ubiquitous in the environment to gather data about human behaviour and external events. The data are utilised by smart devices and machines to react in ways that seamlessly integrate with human activity and the surrounding environment. Context-aware computing devices are aware of contextual information, such as that of a user, the environment or surrounding object. This awareness is used to deliver situationally adaptive information and actions relevant to the task of the device or the task of the user. Collaborative robots are autonomous robots that work alongside and collaboratively with humans. They use contextual awareness of human workers and the environment to work safely and complete relevant tasks.

EXPERT OPINION

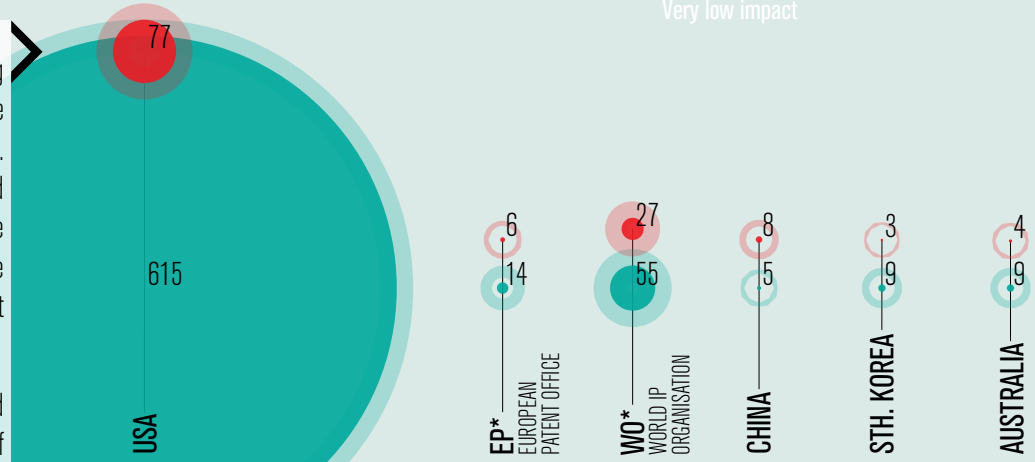
Experts were surveyed and asked to rate the impact of ambient intelligence technologies on a 5-point scale. On average, context-aware computing was perceived to have high potential impact. Technology able to process data and then act automatically was rated highest. Robots that demonstrate this type of context-awareness were rated similarly high, while robots capable of working collaboratively with humans were perceived to have less potential impact.

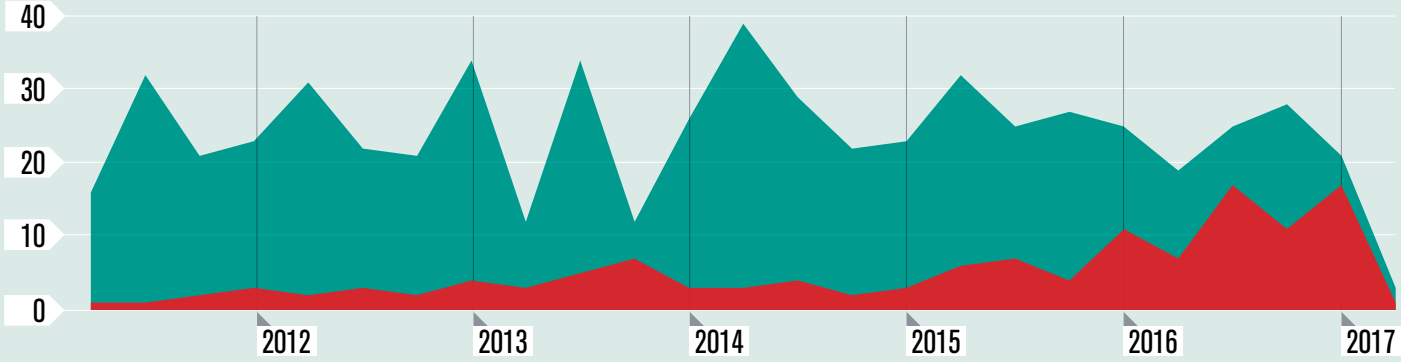


INNOVATION TRENDS

Innovation of context-aware computing technology has been more extensive than collaborative robot technology. Analysis of number of patents published by country identifies the USA as the primary location of context-aware computing and collaborative robot technology innovation.

Analysis of number of patents published per year shows persistent innovation of context-aware computing over several years. Innovation of collaborative robot technology has been less extensive, however, has experienced an upward trend since 2015.





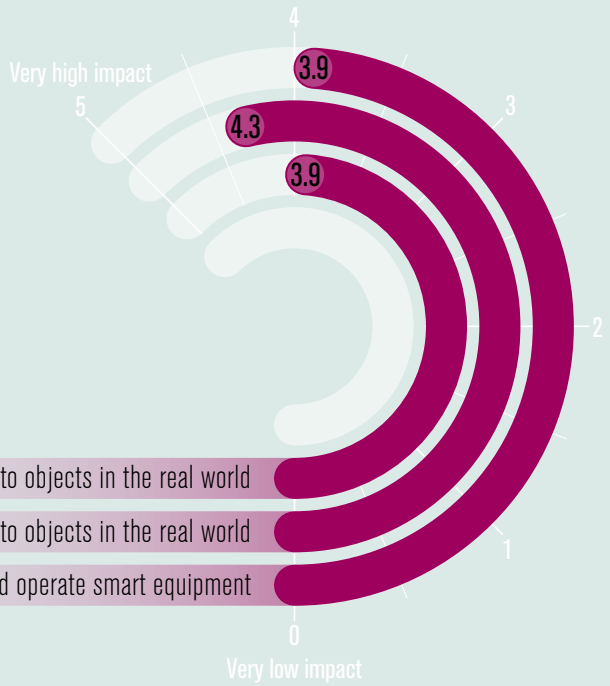
QUT ife Institute for Future Environments

AUGMENTED REALITY

Augmented reality technology enhances a user's surrounding environment by integrating digital images and information with their view of the real world. This is achieved by using head mounted displays or smart phones, with which the devices camera captures a view of the real world and then information is overlaid onto this view. It will be possible for users of augmented reality technology to move through the physical world while receiving contextual information that they can interact with and manipulate in various ways.

EXPERT OPINION

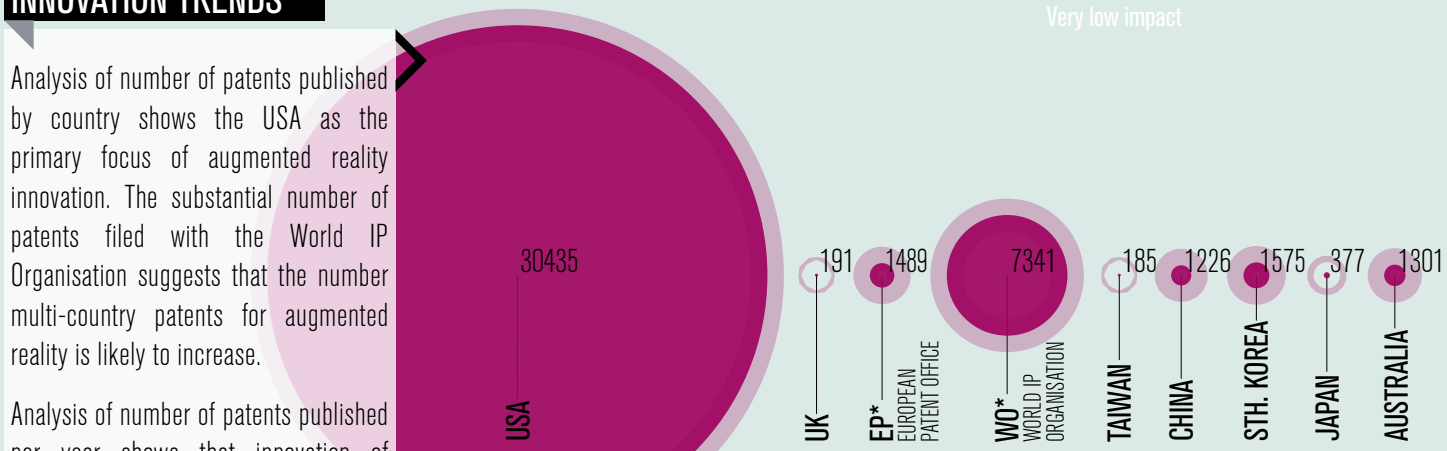
Experts were surveyed and asked to rate the impact of augmented reality technology on a 5-point scale. On average, responses show that augmented reality is perceived to have high potential impact for Australian rural industries. The use of phones and tablet computers were perceived to be of greater impact than immersive head mounted displays. Participants perceived augmented reality to be potentially useful for communicating with and operating smart equipment.

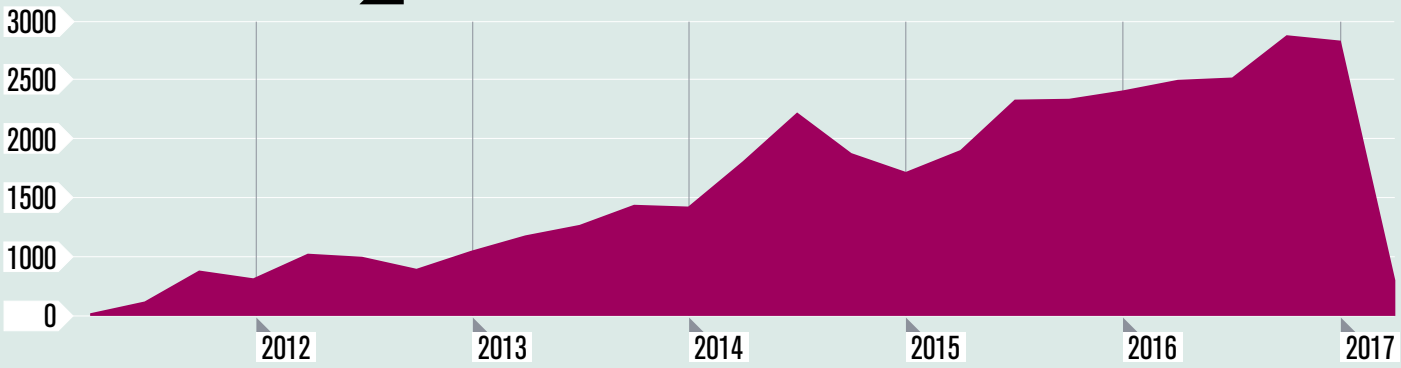


INNOVATION TRENDS

Analysis of number of patents published by country shows the USA as the primary focus of augmented reality innovation. The substantial number of patents filed with the World IP Organisation suggests that the number multi-country patents for augmented reality is likely to increase.

Analysis of number of patents published per year shows that innovation of augmented reality has increased steadily since 2011. Over 10,000 patents related to augmented reality technology were published in 2016.





QUT ife
Institute for Future Environments

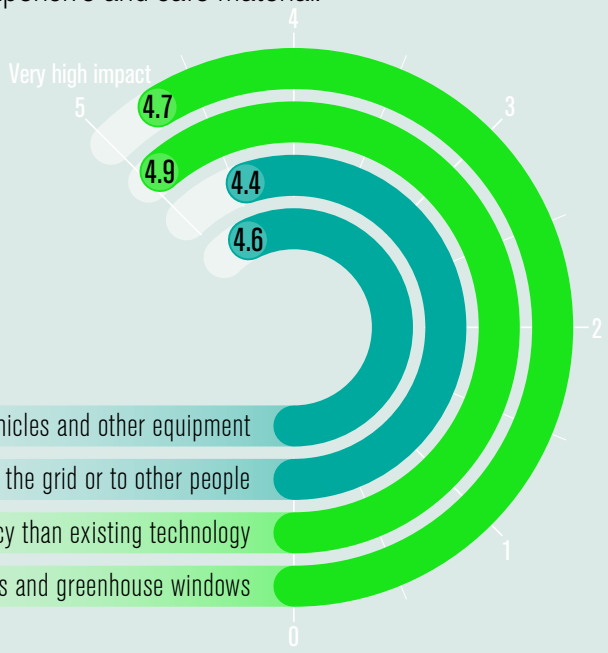
GRID EDGE TECHNOLOGIES

SODIUM-ION BATTERIES • PEROVSKITE SOLAR CELLS

Grid edge technologies are situated at the edge of the power grid and include solar panels, smart meters, smart thermostats, and smart appliances. They are accessible to consumers and are integral to new models of energy generation and consumption. Perovskite solar cells are an emerging solar technology with the potential to be less expensive, more efficient and offer more innovative use cases compared to silicon solar cells. Consequently, they could make solar cells accessible to more people. Sodium-ion batteries offer energy storage for large- and small-scale renewable energy generation. While identical in function to existing battery technology, sodium-ion battery technology is advantageous as sodium is an abundant, inexpensive and safe material.

EXPERT OPINION

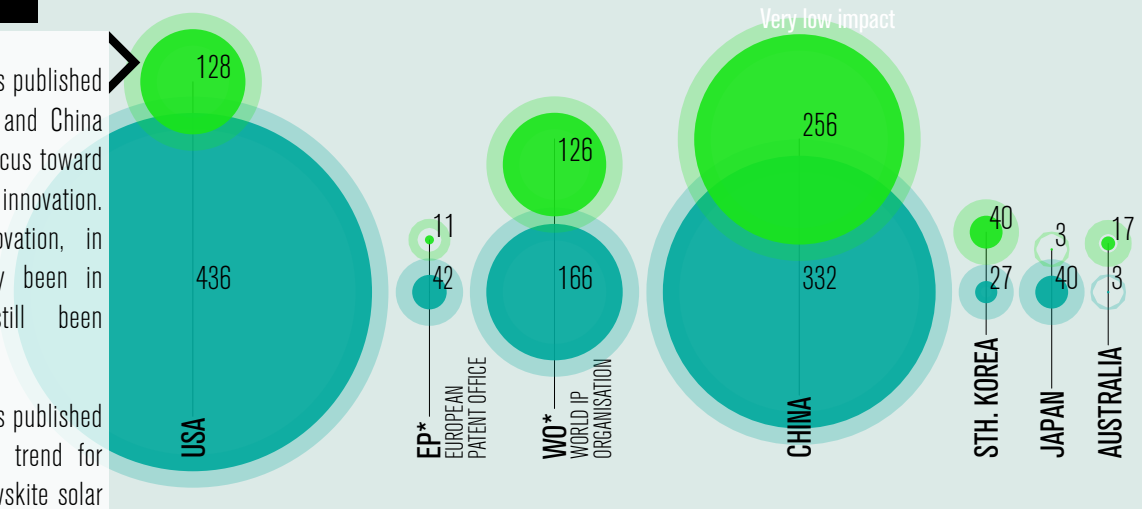
Experts were surveyed and asked to rate the impact of grid edge technologies on a 5-point scale. On average, responses show that efficient, inexpensive and simple to manufacture solar cells and energy storage technologies were perceived to have very high impact for Australian rural industries. Emerging perovskite solar cell and sodium-ion battery technology was perceived to have high potential impact by all survey respondents.

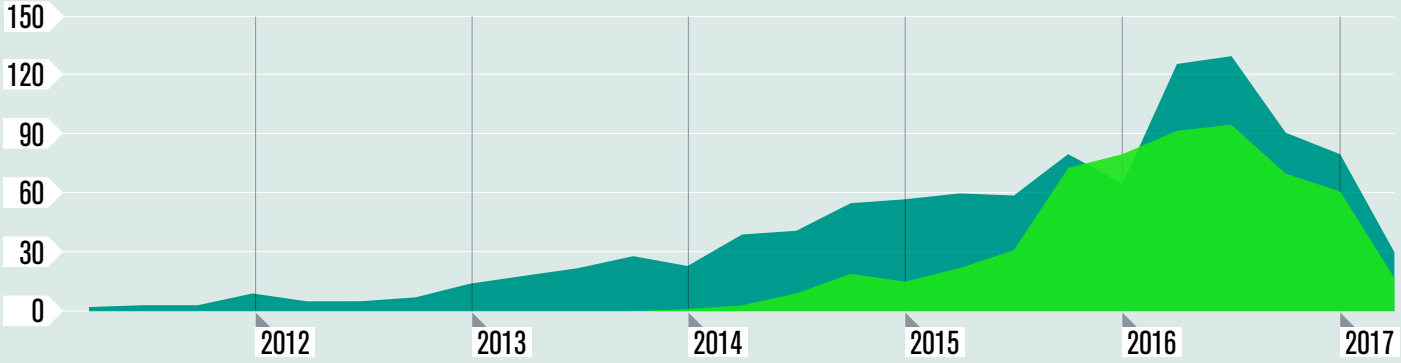


INNOVATION TRENDS

Analysis of number of patents published by country shows the USA and China have demonstrated similar focus toward sodium-ion battery innovation. Perovskite solar cell innovation, in contrast, has predominantly been in China, although has still been considerable in the USA.

Analysis of number of patents published per year shows an upward trend for sodium-ion battery and perovskite solar cell innovation. This upward trend is particularly evident for perovskite solar cell technology, which is only a new technology.





QUT ife Institute for Future Environments

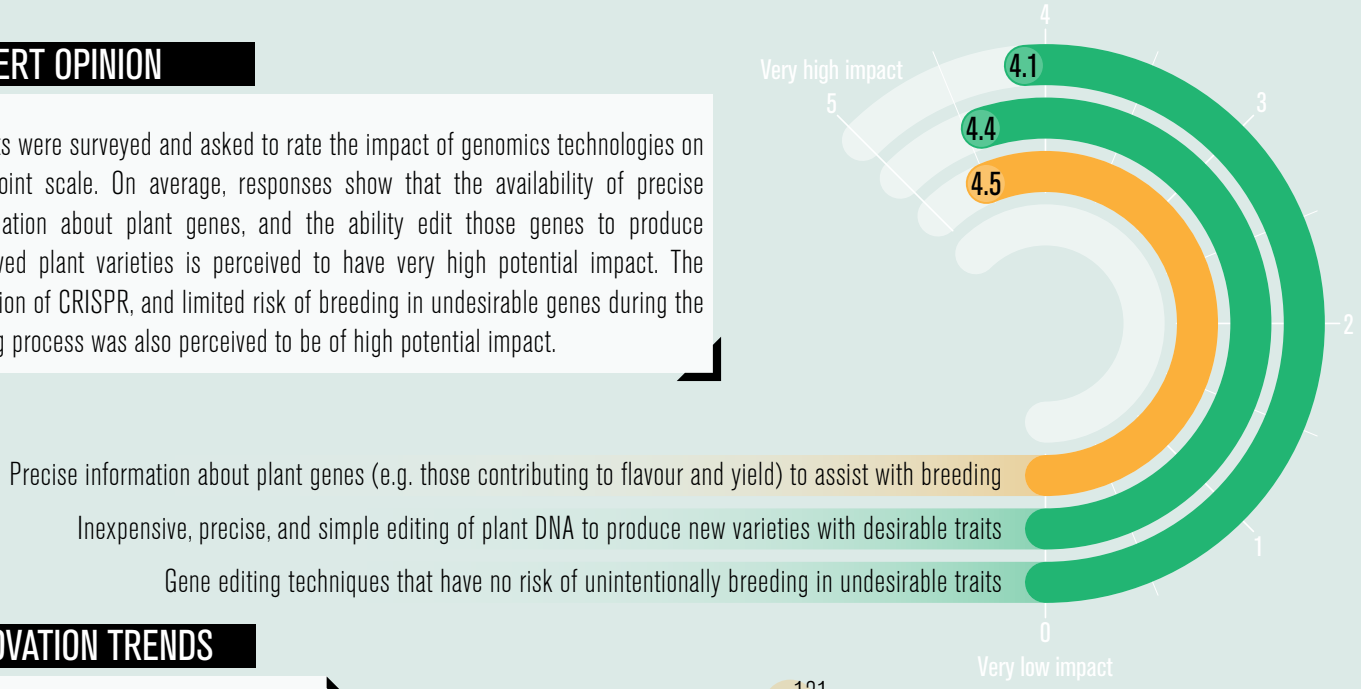
PLANT GENOME SEQUENCING AND EDITING

PLANT GENOME SEQUENCING • CRISPR

The study of genomes facilitates understanding of genetic variation of organisms, and combined with the ability to edit genomes, is poised to have significant impact in a number of domains. Plant genome sequencing has resulted in advanced understanding of plant gene function and biological processes. In practice, this information helps to better understand and improve important crop traits, including disease resistance, yield, and flavour. CRISPR is a gene editing tool that is capable of precisely targeting and removing undesired sequences of DNA, and replacing them with desired sequences. CRISPR is less expensive, more precise, and simpler than other gene editing tools.

EXPERT OPINION

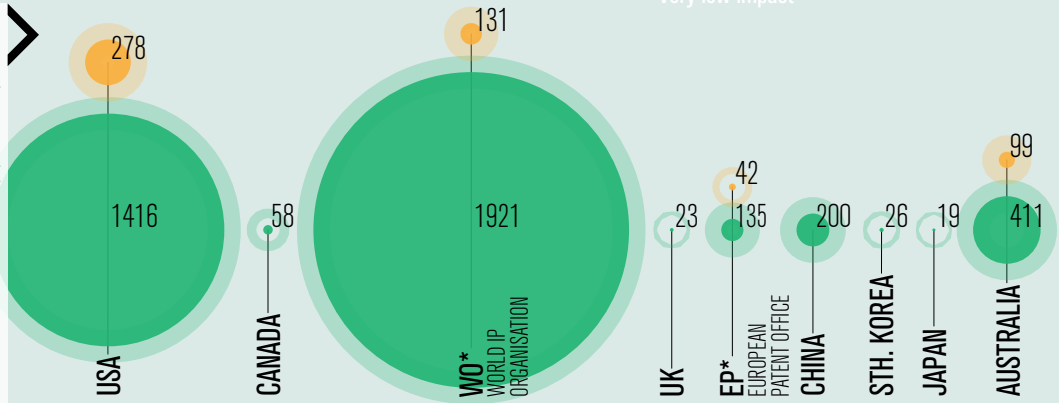
Experts were surveyed and asked to rate the impact of genomics technologies on a 5-point scale. On average, responses show that the availability of precise information about plant genes, and the ability edit those genes to produce improved plant varieties is perceived to have very high potential impact. The precision of CRISPR, and limited risk of breeding in undesirable genes during the editing process was also perceived to be of high potential impact.

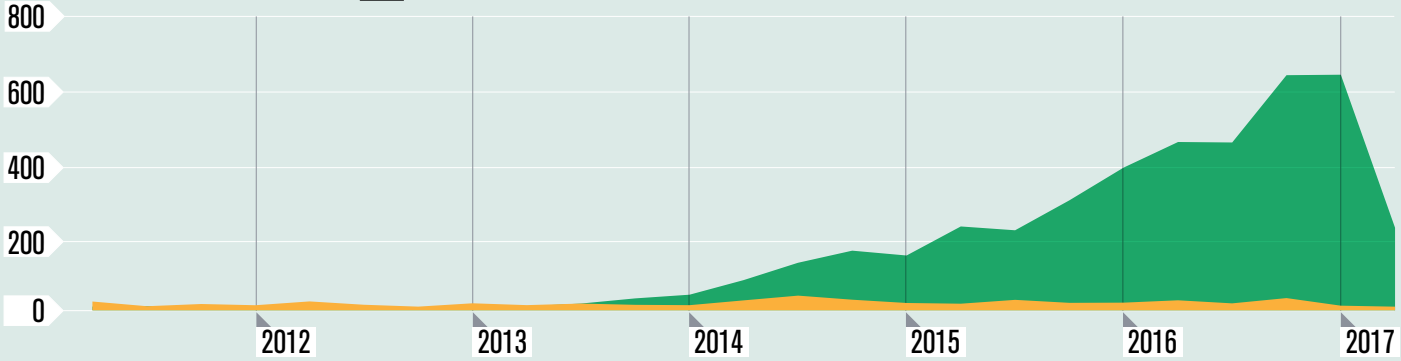


INNOVATION TRENDS

Analysis of number of patents published by country shows a substantial number of patents filed with the World IP Organisation. This suggests that a vast number of CRISPR patents will be granted for member countries in the near future. At present, the USA is the primary focus of CRISPR and genome sequencing innovation.

Analysis of number of patents published per year shows a flat trend of genome sequencing innovation. CRISPR innovation, in comparison, has experienced a sharp upward trend since 2014.





QUT ife Institute for Future Environments

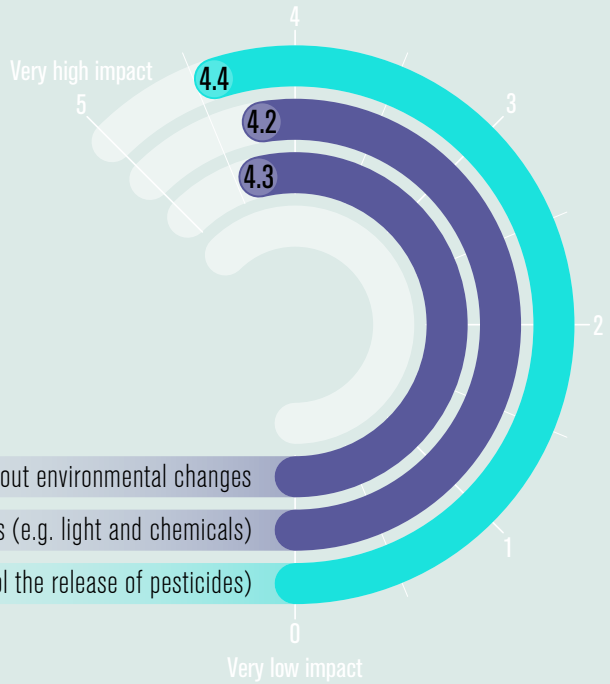
SMART DUST

NANOSENSORS • NANOMACHINES

Smart dust is a network of nanotechnology that permeates all types of environments to collect and communicate information, and then act on it in useful ways. Key components driving smart dust are nanoscale sensors and robots, nanoscale power generation and storage devices, and molecular machines. Applications could include environmental monitoring to optimise the use of inputs. For example, nanopesticide and fertiliser delivery systems that can control the release of pesticides and fertilisers based on the conditions under which they are needed.

EXPERT OPINION

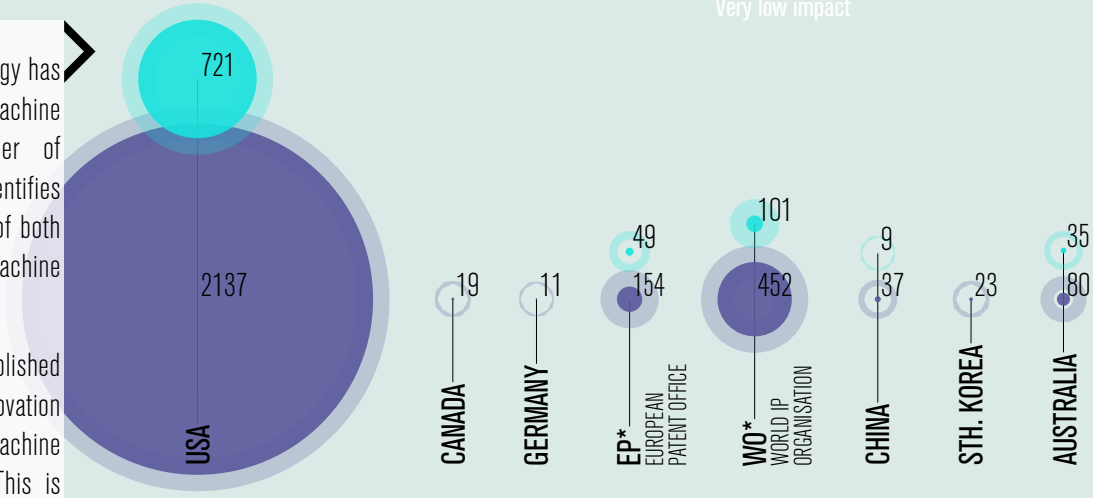
Experts were surveyed and asked to rate the impact of smart dust technologies on a 5-point scale. On average, responses show that the potential impact of ubiquitous sensor devices embedded in the environment and on equipment was perceived to be very high. Rated particularly highly was nanoscale devices and nanopesticides capable of detecting environmental conditions and responding with controlled release of pesticides and other chemicals.

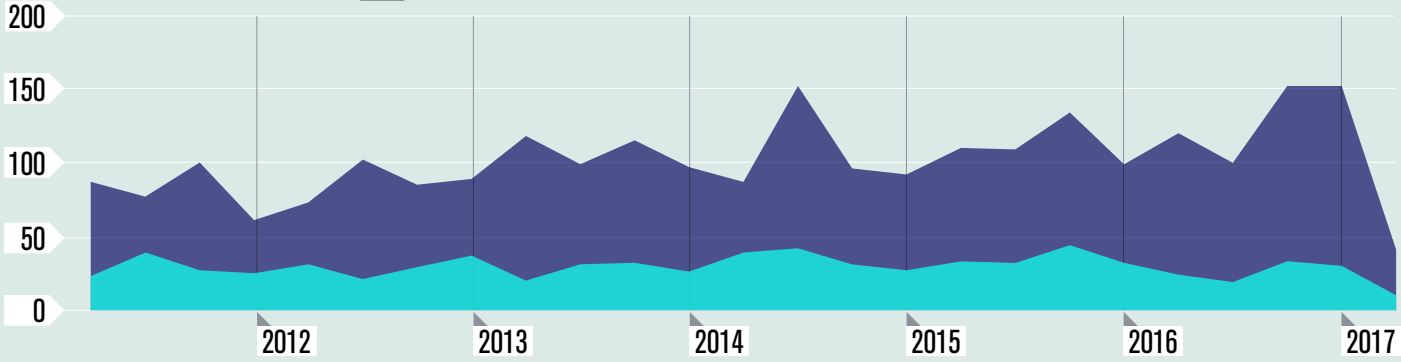


INNOVATION TRENDS

Innovation of nonosensor technology has been more extensive than nanomachine technology. Analysis of number of patents published by country identifies the USA as the primary location of both nanosensor and nanomachine technology innovation.

Analysis of number of patents published per year shows relatively flat innovation of both nanosensor and nanomachine technology over several years. This is particularly true of nanomachine technology, and could reflect the current inability to achieve its perceived potential.





QUT ife Institute for Future Environments

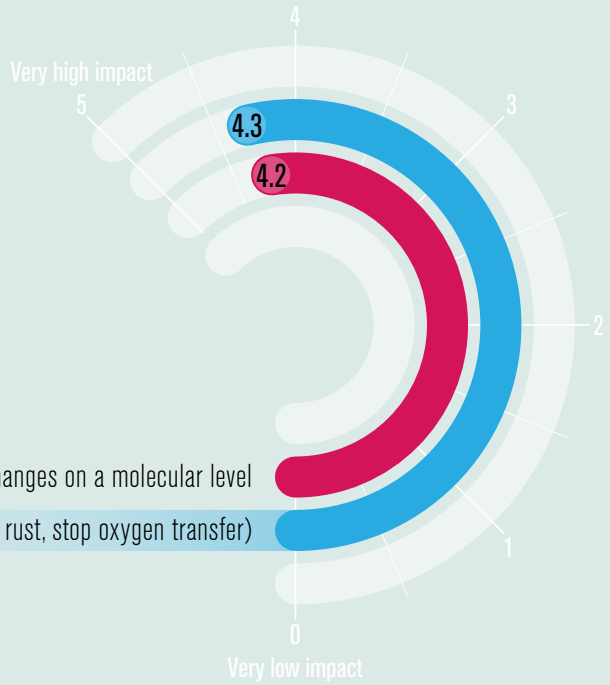
GRAPHENE

GRAPHENE SENSORS • GRAPHENE NANOCOMPOSITES

Graphene is a one atom thick material that is composed of carbon atoms. It exhibits mechanical strength that far exceeds steel, and thermal and electrical conductivity several orders of magnitude higher than copper. Graphene is projected to have extensive uses within many domains. It has received considerable interest for its use in sensors. As it is only one atom thick, graphene has an incredibly high surface-to-volume ratio where all atoms interact with stimuli being measured. This results in extreme sensitivity to environmental changes. It also has been used in the development of functional nanocomposite coatings that protect from various environmental conditions.

EXPERT OPINION

Experts were surveyed and asked to rate the impact of graphene technologies on a 5-point scale. On average, graphene facilitated technologies were perceived to have high potential impact for Australian rural industries. Functional graphene coatings that protect equipment from environmental effects were rated highest. The impact of graphene sensors capable of detecting slight environmental changes, down to a molecular level, was also determined to be substantial.



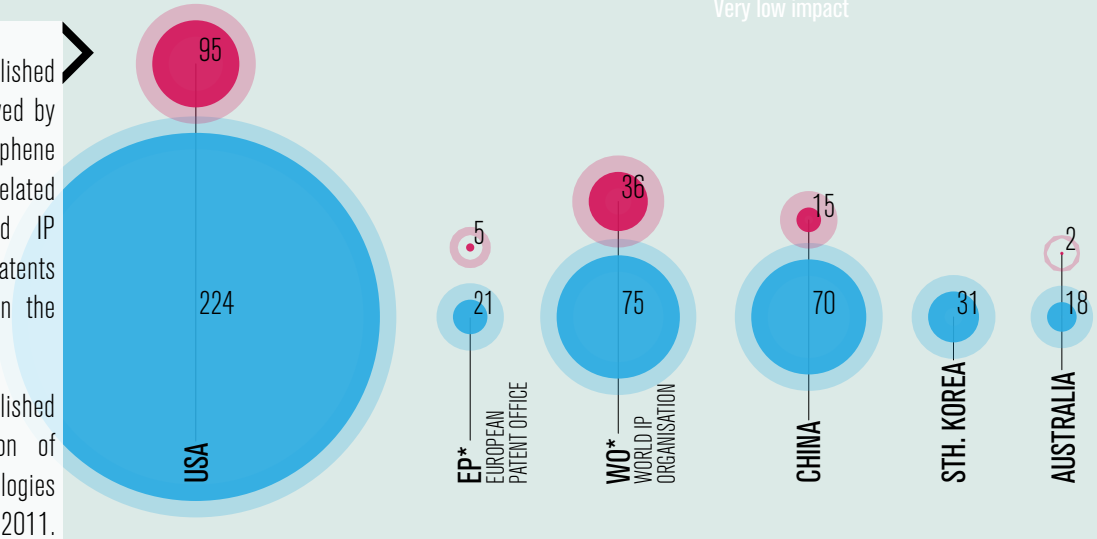
Sensors capable of detecting atmospheric conditions and event changes on a molecular level

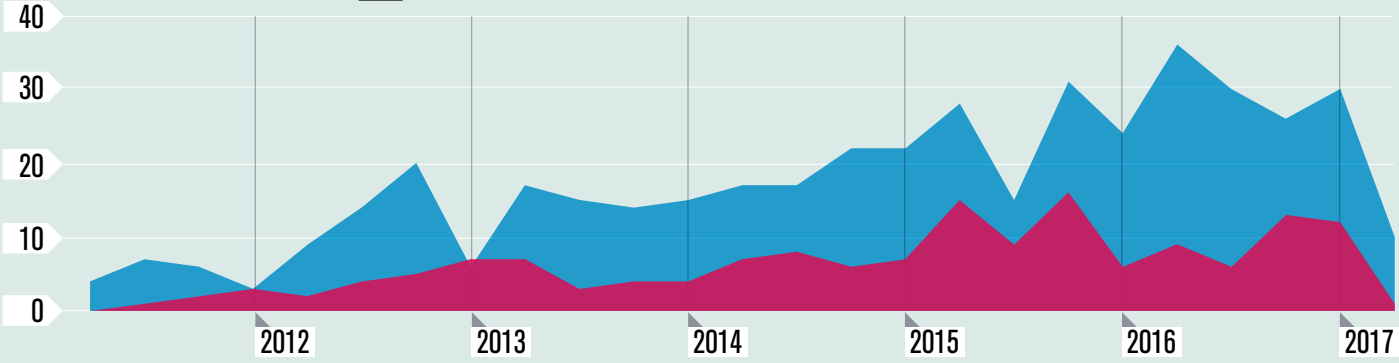
Coatings that can be applied to equipment to provide unique functions (e.g. eliminate rust, stop oxygen transfer)

INNOVATION TRENDS

Analysis of number of patents published by country shows the USA, followed by China, as the primary focus of graphene technology innovation. Graphene related patents filed with the World IP Organisation indicate that more patents will be filed in WO countries in the following years.

Analysis of number of patents published per year shows that innovation of graphene nanocomposite technologies has increased steadily since 2011. While less innovation has occured for graphene nanosensors, this technology demonstrates a similar upward trend.





QUT ife Institute for Future Environments