

Supercapacitors



Electrochemical devices that can store large amounts of energy in small volumes. Supercapacitors store less energy and for shorter durations than rechargeable batteries (hours or days, rather than months or years), but can accept and deliver charge much faster than rechargeable batteries, and tolerate many more discharge cycles than rechargeable batteries before performance degrades.

Key Sectors

Impacts all sectors, including:

- Agriculture, Forestry and Fishing
- Communications
- Construction
- Defence & Defence Industry
- Energy
- Health
- Manufacturing
- Mining & Resources
- Space
- Transport & Logistics

Estimated impact on national interest	Low	Med	High
Economic Prosperity		X	
National Security		X	

Key Australian Government Actions	Example Outcomes	Underpinning Science	Example Applications
<p>Initiatives</p> <ul style="list-style-type: none"> • CSIRO Centre for Hybrid Energy Systems • CSIRO Stored Energy Integration Facility • Project Rail – Rail Manufacturing Cooperative Research Centre • Low Emissions Technology Statement • Australian Research Council Training Centre for Future Energy Storage Technologies <p>Regulations</p> <ul style="list-style-type: none"> • Defence and Strategic Goods List 2021 	<ul style="list-style-type: none"> • Increased renewable electricity reliability and competitiveness from supercapacitor enabled storage systems • Significant reduction in battery waste from longer lifecycles and reduced source materials • More convenient electric vehicles through reducing charging time from hours to minutes • Improved mobility of computing devices through greater recharging capacity • More comprehensive computer backup solutions which store the contents of caches and other Static Random-Access Memory (SRAM) 	<p>ANZ Standard Research Classification</p> <ul style="list-style-type: none"> • Electrical engineering • Electronics, sensors and digital hardware • Materials engineering • Physical chemistry 	<p>Readiness Level – Now</p> <ul style="list-style-type: none"> • Regenerative braking systems for vehicles and elevators • Computer memory backup • Starters for diesel train engines • Electricity grid stabilisation • Rapid charging stations for electric buses • Flash on mobile phones • Used in combination with lead-acid batteries, such as CSIRO-developed Ultrabattery® <p>Readiness Level – 2-5 years</p> <ul style="list-style-type: none"> • Ultra-thin, flexible supercapacitors to power wearable electronic devices • Hybrid supercapacitor batteries that can fully charge in a matter of seconds • Battery-free IoT devices using a combination of solar energy harvesting and high-powered supercapacitors <p>Readiness Level – Beyond 5 years</p> <ul style="list-style-type: none"> • Transparent energy storage devices for "invisible" electronics

Australia's place in the world

China ranks 1st and has 9 of the top 10 research institutions internationally, with the United States a distant 2nd. The total quantity of research is growing rapidly, with 41% p.a. increase over the 2016–2020 period. Australia ranks 5th for research impact, led by the University of Wollongong, which ranks 34th internationally. The United States is ranked first for venture capital (VC) investment, followed by Estonia and Canada; Australia is unranked. VC investment in supercapacitors has been increasing by 35% p.a. since 2016. Globally, the number of new patents being lodged has been decreasing by around 1% since 2015, with China having the greatest number of patents lodged. Japan is ranked 2nd for patents, and Australia is 12th.

As a major energy producer and exporter, there are opportunities to enhance our competitive advantage in this field. We are well situated and increasingly connected to major partner nations to leverage our research skill and to maximise commercial opportunities from the effective development and implementation of this technology.

Opportunities and Risks

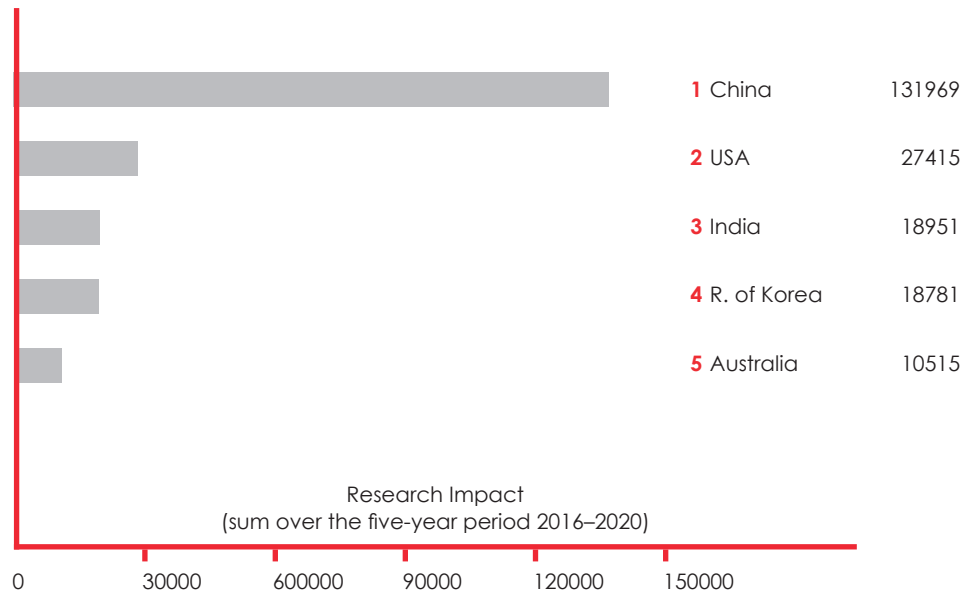
Supercapacitors have the potential to enable more reliable and efficient consumer electronics, benefiting all Australians. In particular, as Australia produces more renewable energy and the grid is subject to bursts or deficits of power, supercapacitors may have a potential role to play in helping smooth the impact on the grid through rapid charging ability in conjunction with traditional batteries.

Supercapacitors also promise to be greener than existing sources of energy storage, thereby enhancing Australia's green capability and credentials, by improving the longevity and efficiency of batteries, and from use in small devices. They are also more stable at lower temperatures, making them useful in a broader range of environments.

As high energy supercapacitors are still an emerging technology, there are various risks associated with them. As the technology continues to be too expensive for mass consumption, this may dampen its potential benefits and lessen the return on investment for Australian research. A further risk is that industry standards surrounding the implementation of the product are not developed in a timely manner, creating long term inefficiencies from various competing standards for implementing and utilising the technology.

Research Impact (RI)

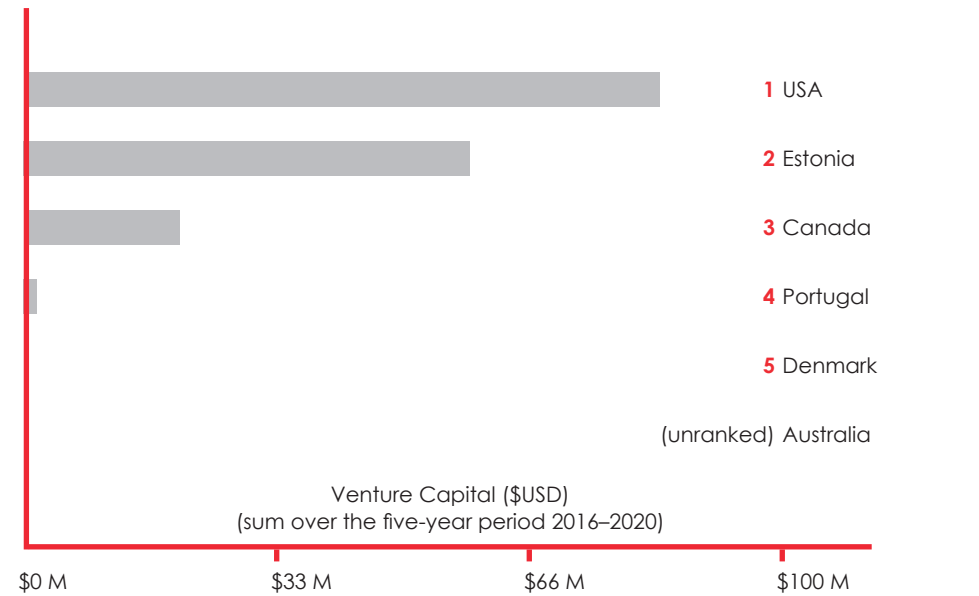
China has the highest research impact in this area, ahead of the United States. Australia is ranked 5th. Total volume of published research has been increasing at 41% p.a. over the 5 year period 2016–2020, with 23% of research involving international collaboration.



The research impact provides an indication of the productivity of a country or institution. Here, productivity was assumed to be represented by the volume of publications (i.e. scholarly output) as an indicator of the resources & facilities, and the level of interest in the publications as an indicator of quality.

VC Investment

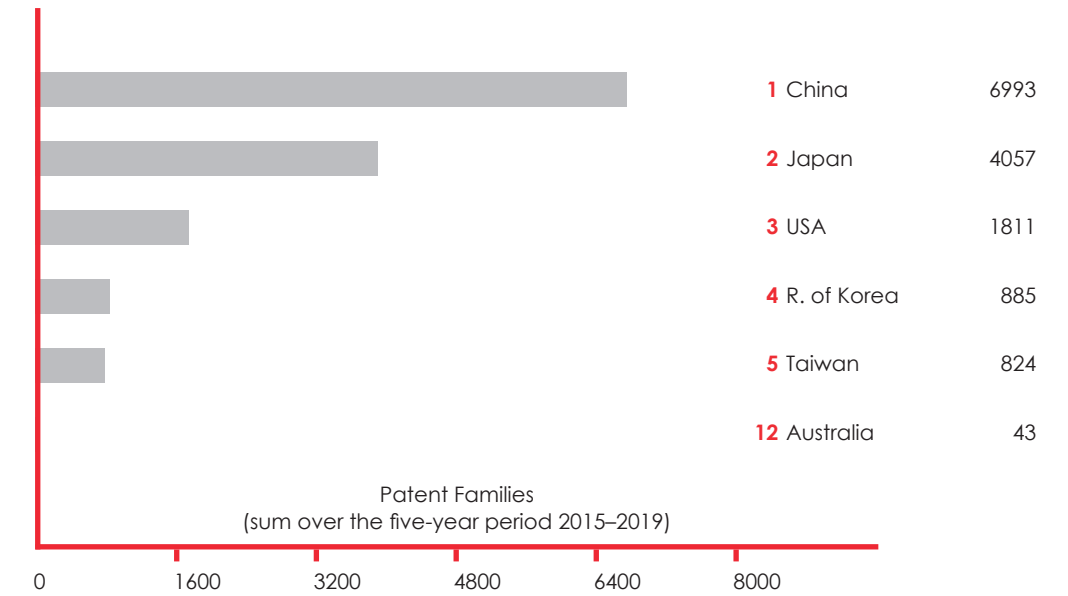
The United States has the greatest amount of VC investment in supercapacitors, ahead of Estonia and Canada, while Australia is unranked. Investment in this area has been growing at 35% p.a. since 2016.



Data from Crunchbase. The Crunchbase database provides a partial view of the global VC landscape. However the quantity, quality and richness of the data are considered to be statistically significant, and indicative of global trends.

Patents - International

The number of patents being lodged annually in this field has been decreasing by around 1% since 2015. Most patents in this field were filed by applicants or inventors from China. Australia is ranked 12th.



Research Institutions - International

China has 9 of the global top 10 institutions. Singapore is the only other country with an institution in the top 10.

Rank	Top International Institution	Research Impact
1	Chinese Academy of Sciences China	14560
2	University of Chinese Academy of Sciences China	4537
3	Harbin Institute of Technology China	4193
4	Tsinghua University China	4097
5	Chongqing University China	3871
6	Nanyang Technological University Singapore	3312
7	Beijing University of Chemical Technology China	3289
8	Peking University China	3244
9	Tianjin University China	3194
10	Yangzhou University China	3193

Research Institutions - Australia

Within Australia, the University of Wollongong has the highest research impact, and is ranked 34th internationally.

Rank	Top Australian Institution	Research Impact
1	University of Wollongong	2086
2	University of Queensland	1622
3	University of New South Wales	1520
4	Deakin University	1513
5	Queensland University of Technology	1070
6	University of Adelaide	1017
7	Swinburne University of Technology	1015
8	University of Melbourne	991
9	Australian National University	898
10	University of Sydney	855

Patents - Australia

Top Australian Patent Applicants	Patent Families
Monash University	4
Deakin University	3
Anteo Tech	2
Gelion Technologies	2
NewSouth Innovations	2

Patents filed by Australian businesses, 2015–2019.