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The Business of Chemistry Essential for Life

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Critical Technologies
Department of Industry, Science and Resources

Chemistry Australia submission – 2022 List of Critical Technologies in the National Interest.

Chemistry Australia welcomes the opportunity to provide this submission into the consultation for the 2022 List of Critical Technologies in the National Interest.

The $38B chemistry industry plays a vital role in the Australian economy, supplying products, technologies and innovations to 108 of Australia's 114 industry sectors. It is essential to healthcare, defence, mining, agriculture, construction, infrastructure, transport and manufacturing. In addition, the products of the chemistry industry support urban and regional communities and the daily lives of all Australians, including providing clean and safe drinking water and keeping food fresh from farm to plate.

The Australian chemistry sector delivers capability into many of the technologies in the current List of Critical Technologies, notably: Advanced materials and manufacturing; Biotechnology, gene technology and vaccines; Energy and environment; Transportation, robotics and space, and Sensing, timing and navigation. Chemistry will also be an ongoing provider of capability into revisions for the 2022 List update and those subsequent.

Commercial sensitivities

Chemistry Australia notes that there are a range of technologies important to the objectives of this consultation process that are unable to be included due to their commercially sensitive nature. Therefore, a complete picture is unable to be provided here.

Chemistry Australia recommends the Government works with the sector, including considering other approaches, so it can identify the full potential the sector has to offer. Chemistry Australia would be pleased to assist with this process.

Response to questions posed:

1. **Are there technologies that should be considered for inclusion or removal from the original list? What are your reasons or suggestions?**

   1a. Inclusion of all current mainstream chemical processing technologies, given they continue to underpin a range of critical supply chains and strongly align with the List's criteria of technologies ie: capacity to significantly enhance our national interest; provide the country with a clear competitive advantage; accelerate productivity growth; create well-paying jobs and secure supply chains. Given the ongoing geopolitical dynamics in play, these foundational technologies will need to remain key parts of the national economy.

These technologies include:

i. Methane feedstock into Ammonia: fertilisers / Urea for agriculture, explosives and reagents for mining and gold and other mineral processing; AdBlue diesel fuel additives, CO_2 for industrial, food processing, and other products
ii. Methane feedstock into Hydrogen Peroxide: gold and other mineral processing; paper and pulp processing, personal care products
iii. Methane into domestic Micro-LNG applications: for stationary and remote power generation
iv. Ethane into Polyethylene: Food packaging; water storage; water and gas distribution for domestic; agriculture; commercial and industrial markets and other applications
v. Ethane into Ethylene Oxide: surfactants for agriculture; glycols for automotive and industrial applications
vi. Chlor Alkali processing technologies for Chlorine production ensuring safe drinking water
vii. Water purification and treatment technologies including flocculants, coagulants and similar technologies.

1b. Inclusion of Silicone Chemistry

Silicone chemistry is an enabler of the technological innovations important for improvements in energy efficiency and sustainability and will be critical for Australia's transition to a carbon neutral and circular economy.

Silicon metal is currently produced in Western Australia. Those metals are exported overseas for further processing. into the silicone chemistries technologies identified below as well as other advanced manufacturing applications. Capturing a greater share of the silicon/silicones value chain should be a key priority for Australia.

Silicone Chemistry and Circularity

Silicone chemistry contributes markedly to circularity in several sectors by increasing energy efficiency, reducing the primary energy demand, and reducing the demand for fossil and non-regenerative energy sources. Moreover, silicone chemistry is an important enabler of the renewable energy transition in areas like EV mobility and renewable energy production. Product longevity is also significantly improved in several sectors, as silicone chemistry withstands harsh external conditions and facilitates high durability. By enabling longer lasting products, silicone chemistry facilitates a reduction in the demand for primary material.

Silicone Chemistry in Renewable Energy

Silicone is used as a frame sealant, junction box adhesive, junction box potting agent, and encapsulant for microinverters in the fabrication of photovoltaic (PV) systems. Thereby, silicone chemistry provides a reliable interconnection of solar cells, supports flexibility and contributes to lower material costs. Solar panels can reach up to 150°C under extreme conditions (usually 80°C). In most cases under such extreme conditions, silicone-based adhesives are used, as they offer durable bonds and seals. In addition, silicone chemistry provides protection against severe weather conditions as well as UV radiation and ozone. In comparison to alternatives, such as PU or epoxy, an improvement of the junction box lifetime due to the improved protection of electronics, can been observed. Thus, higher durability and functionality of solar panels is enabled by silicone chemistry. The use of solar panels as a source of renewable energy is a high priority in energy systems and supports a circular economy.

Silicone Chemistry in the Construction Sector

LED Lighting Systems

High-RI silicone or high-performance LED systems provide a higher lumen output compared to optical grade epoxy as an encapsulant. Silicone-based materials used for LED lighting provide strong sunlight UV (A/B in the range 280-380nm) resistance, ingress (IP) and impact (IK) protection, non-yellowing under harsh environmental exposures, low impurity levels, and high optical transmittance with low haze. Additionally, silicones show higher heat resistance and reliability (no inner tensions / micro-cracks upon temperature cycling). Consequently, by using silicone solutions in LEDs, product longevity can be enhanced as it provides additional protection.

Structural Systems

By using water repellants in concrete, the energy consumption in buildings can be reduced significantly and therefore contributes to a higher energy efficiency. The reduced energy consumption can be explained by reducing the causes of structure heat loss. Concrete, which is bonded with sealants and adhesives, offers a very high durability and is resistant to severe weather conditions, including moisture and sunlight. In addition, silicone sealants allow the absorption of slight movements from fluctuations in temperature, humidity, wind, and other environmental effects. Thus, water repellants in concrete increase the lifetime of buildings. By using silicone polymer-based treatments in concrete, lower water absorption and better fragmentation resistance can be reached. This allows the recycling of concrete. Therefore, silicones can be seen as an enabler for the recycling of concrete and thereby contribute to circular economy.

Window Systems

Silicone-based sealants and adhesives provide a direct solution to higher energy demand, offering options for sealing and bonding the glass in the window frame, the glass panes in the insulating windows and for sealing the whole window in the building envelope. The use of the appropriate sealants and adhesives significantly improves the overall performance of the window system. Energy consumption in buildings can be reduced by 30 to 80 % using proven and commercially available technologies. Silicones are inherently waterproof, and provide a greater UV stability, and a better temperature and weather resistance than organic materials. Additionally, due to their longer durability, they need to be replaced less frequently, which reduces life cycle costs and contributes to sustainability of buildings. It also allows long-term adhesion durability to glass under temperature extremes and movements. Additionally, when using sliding agents consisting of silicone industry products, the maintenance process (e.g., exchange, repair) becomes easier.

As the most resource-intensive sector, construction and buildings are of special interest for the Circular Economy. The products mentioned above which are enabled by silicone chemistry are major contributors to enhancing the lifetime of buildings. Substantial increases in building lifetime leads to a significant reduction in resource consumption, which is particularly important in view of a strong global population growth. In addition to increased lifetime and less primary material demand, silicone chemistry facilitates more energy efficient buildings. Silicone chemistry also contributes to the reusability of concrete, one of the most heavily used materials of the construction industry.

Conclusion

Identifying silicone chemistry as a critical technology is consistent with the goals of promoting Australia as a secure nation of excellence for investment, research, innovation, collaboration, and adoption of critical technologies. Recognizing silicone chemistry as a critical technology for Australia will also help ensure secure, critical technology supply chains by creating opportunities for expanding domestic capability for silicone processing which will also provide additional high-paying technology jobs in Australia. Acknowledging silicone chemistry as a critical technology in Australia will also help to maintain the integrity of domestic research, science, ideas, information, and capabilities by enabling Australian industries to thrive.

1c. Inclusion of Advanced Recycling of plastics

Advanced recycling of end-of-life plastics into new plastics, also known as circular plastics, is a critical emerging technology that will create a truly circular plastics economy and new industry for Australia and significantly increase the plastics recycling rate. This technology is able to handle mixed waste plastics – including soft plastics packaging waste – and convert them into a hydrocarbon feedstock to make new plastics again.

The technology uses chemical transformation to deconstruct the molecular structure of plastics, allowing for deep purification and subsequent remanufacture into circular plastics with identical properties to virgin material that is suitable for high performance and food contact packaging applications. A large part of the infrastructure required for this technology to be adopted at scale in Australia already exists in or very close to the two largest cities, Sydney and Melbourne, in the form of steam cracking and polymerisation assets operated by Qenos and Viva Energy for polyethylene and polypropylene, respectively. It is complementary to mechanical recycling by being able to treat those waste plastics that cannot be recycled using conventional techniques.

The CSIRO Report: Advanced Recycling Technologies to address Australia's plastic waste provides a comprehensive understanding of the types of technologies involved, the contribution they are able to make in Australia and the pathway considerations for their introduction.

Advanced / chemical recycling is growing in capacity globally and provides Australia with the critical capability to move beyond the recognised 30-35% threshold able be delivered by mechanical recycling. Advanced recycling is complementary to mechanical recycling.

An example of what this could look like in Australia can be seen on https://alkanew.com.

Creating a circular economy for materials (including plastics, ceramics, metals, glass, paper) is critical for Australia to reduce depletion of fossil resources, reduce greenhouse gas emissions, improve management of waste and reduce litter. A circular economy adopts the principles of the waste hierarchy in prioritising avoidance, reuse, and recycling over energy recovery or landfill. The use of plastics enables significant avoidance of material use compared to alternatives and consequently delivers high cost efficiency coupled with low environmental impact in the vast majority of applications where it is used today [McKinsey 2022]. Reuse models for plastic products and packaging are becoming increasingly adopted, supported by the toughness and durability that plastics can provide. However, the recycling rate for plastics is still low at only 13% according to the latest National Waste Report [DAWE 2020].

Advanced circular plastics recycling is able to handle those mixed plastic waste streams not currently addressed by mechanical recycling and, if implemented in Australia, will enable a significant increase in recycling rate and availability of recycled content to domestic packaging and plastic product manufacturers. Currently, they have to rely on high priced imports due to the global scarcity of high quality food grade recycled plastics required to meet sustainability pledges by brand owners and National Packaging Targets managed by the Australian Packaging Covenant Organisation (APCO).

Investment for this infrastructure is required now and research and development is needed to further improve the efficiency of the process and broaden its applicability further.

Plastic waste has been recognised as a national priority in the National Plastics Plan [DAWE 2021]. However, advanced technologies to address the issue at scale are notably absent from the 2022 list of critical technologies in the national interest. We therefore strongly recommend that advanced circular plastics recycling will be added to this list.

1d. Inclusion of Catalysis technologies and materials.

As Australia moves to circular economies, it will need to convert materials to usable inputs for processes or create processes that can utilise what we currently consider as excess or waste. Critical to that is the ability to breakdown, build up or alter molecules (i.e. catalysis). 75% of all chemical goods require a catalyst. Australia is well behind in catalysis technology and will need to accelerate its capability as these are required for renewable energy and kick-starting chemical manufacturing.

1e. Inclusion of Systems Integration Technologies

Individual technologies will often require alignment and integration to produce a final product or other outputs. For example, you can have an electric battery, but can it be integrated into an autonomous waste processing unit? Integration technologies that enable component development and manufacturing to efficiently deliver completed assemblies of finished goods will increasingly be important as Australia seeks to improve its economic complexity capability. The Harvard Business School currently ranks Australia 91 out of 133 nations, having lost 8 places in recent years and having been 55th in 2015.

2. Do you have any comments on the individual technology definitions?

The current categorizations appear relevant for the purposes of the List. However, consideration might be given to also categorising them, in parallel for example, according to the benefits they are able to deliver, and the risks / benefits needing to be managed.

Examples of categorization might include how they assist in improving: sovereign manufacturing capability; critical supply chain security; geo-political risks; climate change mitigation capability and decarbonisation; circular economy outcomes; Economic Complexity.

3. Do you have a view on the frequency of updates to the list?

The proposed biennial review process is likely suitable. However, Chemistry Australia notes this relates to technologies able to be published in the public domain. There remains a gap in technology capability due to the commercially confidential nature of emerging technology that Government is encouraged to further investigate.

Chemistry Australia has also suggested in question 4 that a set of complementary metrics be included that reflect the risks to the potential impacts being delivered. As these risks are dynamic, an annual review would be better suited to understanding the changes in these risks.

4. Do you have any feedback on the content of the Critical Technologies Profiles?

The Critical Technology Profiles provide a set of helpful lenses through which to view the technology's status, research capability, outcomes, potential for impact, and a view of the associated opportunities and risks of the technologies themselves.

However, the profiles should also provide a view of the risks to the technologies continued utility within the economy, and / or their ongoing development. These will be critical to a complete understanding of what could prevent the technologies delivering the identified impact to the national interest - a key objective of the List itself.

In the case of the chemistry industry and other elaborately manufactured products, there are a range of known risks, including unprecedented gas feedstock and gas/electricity price and supply constraints, Covid related labour shortages and others. Many of these factors are both escalating and cumulative in their constraining effect on technologies delivering capability. These types of factors will continue to be dynamic over time and influenced by a range of domestic and global factors. As such, there should be both visibility and review of their influence.

It may be that across the technology areas, a standard set of categories could be developed that complement the existing metrics of: "Estimated impact on National Interest". This would provide a more complete, and balanced, picture of both potential impact and the risks/barriers to the potential being delivered. A standard methodology may apply in similar areas that could be adopted here.

Chemistry Australia recommends the Department investigate and include a suitable range of complementary metrics to better inform the risks associated with the technologies delivering identified impacts.

4. **Has the List influenced decisions in your organisation about technology investment or adoption.**

The List has been beneficial to the chemistry industry reviewing its capability to enable many parts of the economy, and the importance of continuing to work with Governments to provide a complete picture of that capability, and to support its future development.

Chemistry Australia would be pleased to provide you with any additional information or clarification.

Yours sincerely,

Peter Bury

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