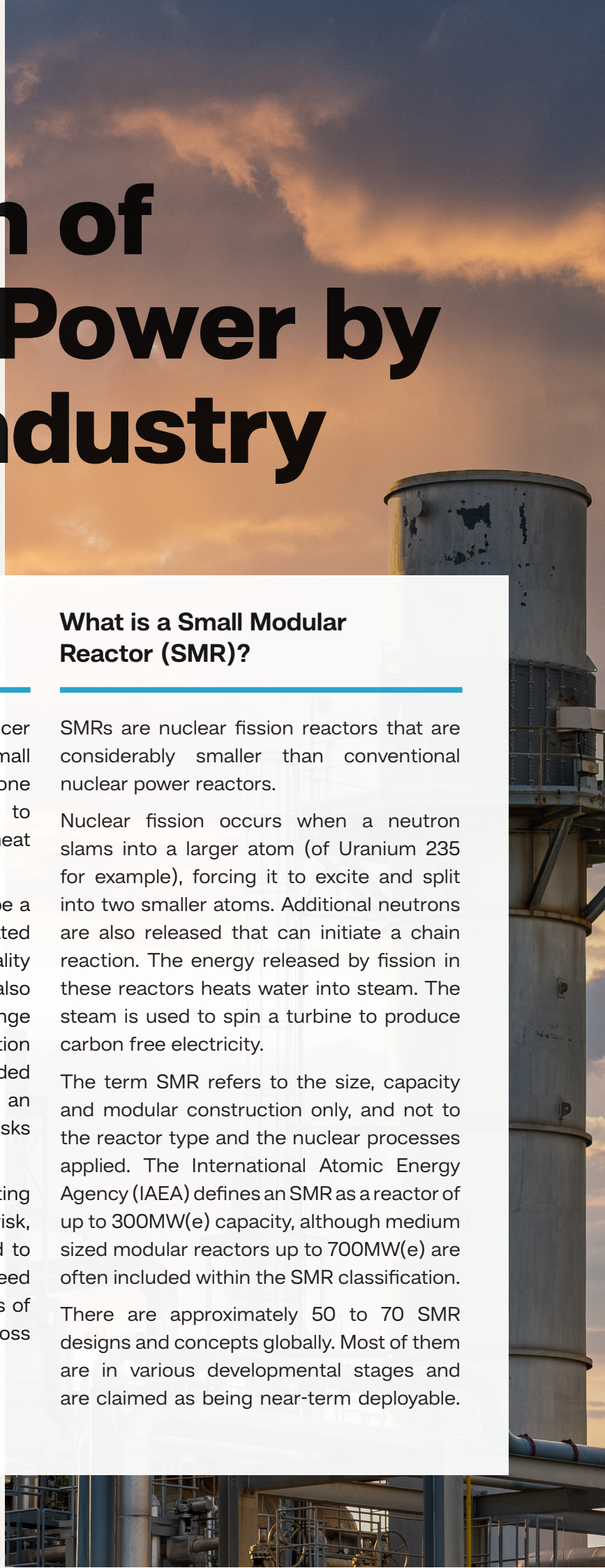
Global Risk Solutions

Adoption of Nuclear Power by Heavy Industry

The Path to 'Net-Zero'



Heavy Industry – A Nuclear Future?

In August 2022, a major chemicals producer announced that it plans to install Small Nuclear Modular Reactors (SMRs) at one of its Gulf Coast production facilities, to provide low carbon power and process heat for its chemicals operations.

Whilst this announcement appears to be a major step forward in the Company's stated ambition of achieving carbon neutrality across all its operations by 2050, it also represents a significant material change to the inherent nature of that production facility. As with any new process and added complexity, this potentially presents an operational challenge and creates new risks for the industry and their Insurers.

The integration of SMRs into existing industrial infrastructure is an emerging risk, and the way in which Insurers respond to the adoption of this technology will need careful consideration should these sorts of projects become a common trend across the industry.

What is a Small Modular Reactor (SMR)?

SMRs are nuclear fission reactors that are considerably smaller than conventional nuclear power reactors.

Nuclear fission occurs when a neutron slams into a larger atom (of Uranium 235 for example), forcing it to excite and split into two smaller atoms. Additional neutrons are also released that can initiate a chain reaction. The energy released by fission in these reactors heats water into steam. The steam is used to spin a turbine to produce carbon free electricity.

The term SMR refers to the size, capacity and modular construction only, and not to the reactor type and the nuclear processes applied. The International Atomic Energy Agency (IAEA) defines an SMR as a reactor of up to 300MW(e) capacity, although medium sized modular reactors up to 700MW(e) are often included within the SMR classification.

There are approximately 50 to 70 SMR designs and concepts globally. Most of them are in various developmental stages and are claimed as being near-term deployable.

The technological approach adopted by these different designs varies, with some employing light water as a coolant, and others electing for non-light water coolants, such as gas, liquid metal, or molten salt.

Recent announcements refer to an intention to deploy an X-Energy Xe-100 high temperature, gas cooled reactor (helium) to a Gulf Coast site. Each reactor is engineered to operate as a single 80MW(e) unit and is optimized as a four-unit plant delivering 320 MW(e), providing capability to provide baseload power to an electricity system, or to support industrial applications with 200MW thermal output per unit of high pressure, high temperature steam [1].

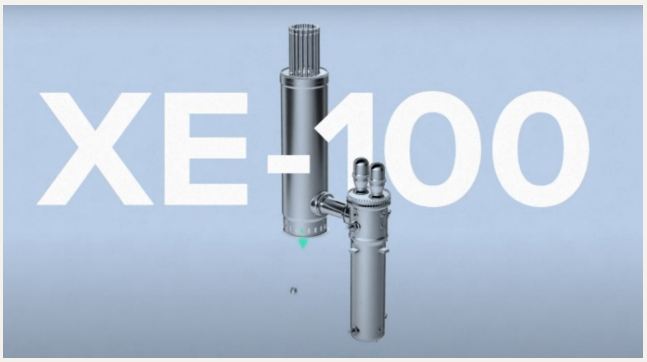


Figure 1 – XE-100

As companies within energy intensive industries increasingly look to establish ambitious 'Net Zero' targets, nuclear power, via SMR technology, may become an increasingly attractive proposition in the search for low carbon solutions.

Some of the main benefits of the use of SMRs include:

Low Carbon Power and Process Heat

Nuclear is a low carbon energy source that can be adopted to support 'Net Zero' targets.

Factory Built / Modularity

SMRs can be almost completely built in a controlled factory setting and installed module by module, improving the level of fabrication quality, construction quality, efficiency, and installation time.

Siting Flexibility

Due to their reduced footprint, SMRs can provide power in locations or for applications where large plants would be unsuitable. As a result, SMRs are an attractive option for the replacement of aging fossil fuel plants, or to provide an option for complementing existing industrial infrastructure with an energy source that does not emit greenhouse gases. Further, SMRs reportedly have a lower requirement for access to cooling water, making them suitable for remote regions and specific applications such as mining or desalination.

Scalability

The modular design of SMRs lends itself to having multiple units on the same site, where units can be added incrementally, as the demand for energy increases.

Future Affordability

As this technology develops and becomes more well established, centralised SMR manufacturing costs will reduce, thanks to the principles of economies of scale, which may lead to a future situation where SMRs are seen as a highly cost-effective option for energy and process heat production applications.

The first SMRs to be introduced globally are planned for existing nuclear sites. According to the International Atomic Energy Agency (IAEA), the four SMRs currently under construction are in Argentina, China and Russia. Meanwhile, the US, Canada and UK have all signalled growing support for SMRs, with Rolls-Royce SMR leading the UK's efforts.

Social and Political Landscape - Are SMRs the Future?

Since the adoption of the Paris Agreement and release of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming, a growing number of countries have committed to 'Net-Zero' emissions targets [2]. As of August 2022, 77 parties, representing 84 countries and 73.3% of global greenhouse gas emissions, have communicated a 'Net-Zero' target either in law, a policy document or via a political pledge [3].

According to estimates by OurWorldInData, in 2016 energy production accounted for 73.2% of greenhouse gas emissions, of which 24.2% was via energy use in industry [4].

Figure 2 – How Many Countries Have Net Zero Targets [5]

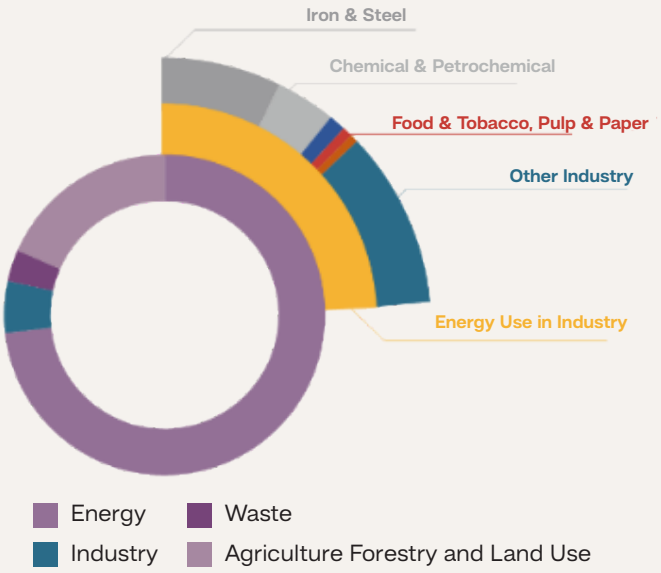


Figure 3 – Where Do Greenhouse Gas Emissions Come From?

What is clear from this data is that energy use via industry is a significant contributor to greenhouse gas emissions. It therefore follows that energy intensive industries, including the Petrochemical and Chemical industries, will be under increasing pressure to utilise modern technological solutions to reduce their emissions to support international 'Net-Zero' targets. Such a strategy will also have a direct effect on the bottom line of companies in these industries, with emissions reductions resulting in a reduced spend on carbon credits.

Whilst much of the conversation to date has focussed on Carbon Capture & Storage and low carbon hydrogen production & use, the emergence of SMR technology, and its associated benefits may lead to nuclear power being seen as another key pillar for consideration in any 'Net-Zero' strategy for energy intensive, heavy industry operators.

Insurance of Nuclear Power Facilities

One of the defining characteristics of nuclear power is the very remote possibility of an accident with disastrous economic and safety consequences. For example, the clean-up and victim compensation costs associated with the Fukushima disaster are thought to be in the order of USD 180 billion [5].

The magnitude of the potential exposures within the nuclear power sector, as well as insurer risk appetite and technical underwriting challenges, leads to a situation of insufficient capacity being attracted to this class of business via individual insurance companies.

As a result, insurance of the nuclear power industry operates through 'pools', a mechanism whereby a number of insurers, through association, jointly underwrite a technically challenging type of accumulation risk. Nuclear pools were established in the mid-1950s to insure civil nuclear power risks, and to provide inter-pool reinsurance (reciprocation). Reciprocation is arranged on a Net of Treaty or Facultative Reinsurance basis, given that nuclear is a general exclusion in the insurance market. Net capacity is pooled from Insurers who are willing to expose their balance sheets to these civil nuclear risks.

Today over 300 insurance companies in 31 countries pool their net capacity in this way,

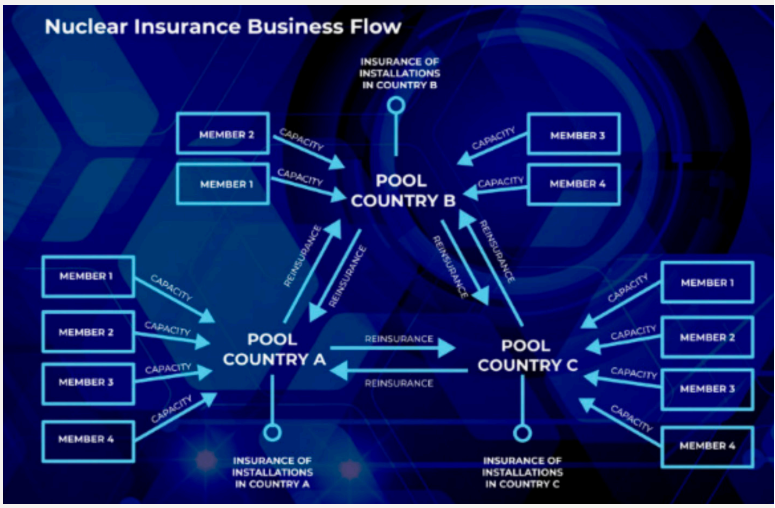


Figure 4 – Nuclear Insurance Pools

However, to date, this approach has largely focussed on large, civil nuclear power plants, associated with grid-connected electricity. Whilst this is a role that SMRs will look to support, their scale and flexibility may mean that SMRs become a favourable option as a clean energy source as part of an integrated solution for existing heavy industry infrastructure.

SMRs are an emerging technology, in the early stages of acceptance. It can be argued that SMR technology is a fundamental evolution in the nuclear power industry from what has come before, both in terms of its scale and its potential applications.

The introduction of SMR technology into Petrochemical and Chemical industries represents a coming together of what has previously been two very separate industries, insured in two very distinct ways. This combination poses an interesting challenge to the insurance market, as insurers look to understand how their coverage offerings need to evolve as part of the 'Global Energy Transition'.

It is possible that SMRs will be considered to pose a significantly reduced exposure relative to traditional, full scale nuclear power plants. Their limited size may give rise to reduced consequences should an accident occur. As well as this, the latest technology designs may be considered to be inherently safer than the traditional designs that have come before, potentially reducing the likelihood of an accident. Should this be proven over time, perhaps this will be followed by an evolution in the insurance approach to these assets.

However, it is not just a question of the structure of the insurance programme concerning the SMRs, but also the impact that their introduction has on the risk profile and insurance coverage of the extant facility to which the SMR is being introduced.

Such a major change to a facility introduces complexity both in terms of technology and operations. Uniquely, such a change will also introduce some significant cross exposures by way of radiation hazards, the effects of which could range from endangering personnel, to lengthy business interruption, or at worst, the rendering of permanent inaccessibility of existing industrial facilities.

Should SMRs become a critical new feature in these sorts of facilities, Insureds may require greater levels of cover from Insurers, specifically designed to reflect the presence of SMRs in the heart of existing heavy industrial operations.

As a result, we may soon be reaching a point where Insurers may need to consider the appropriateness of standard nuclear risk exclusions in these instances and therefore the requirement for coverage to evolve.

Such an evolution will require close collaboration between Insurers, Insureds and SMR Manufacturers to better understand how the introduction of an SMR into existing heavy industrial plants will affect their risk profiles, and how policies can be evolved to ensure that they continue to be fit for purpose for Insureds on their Energy Transition journey.

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