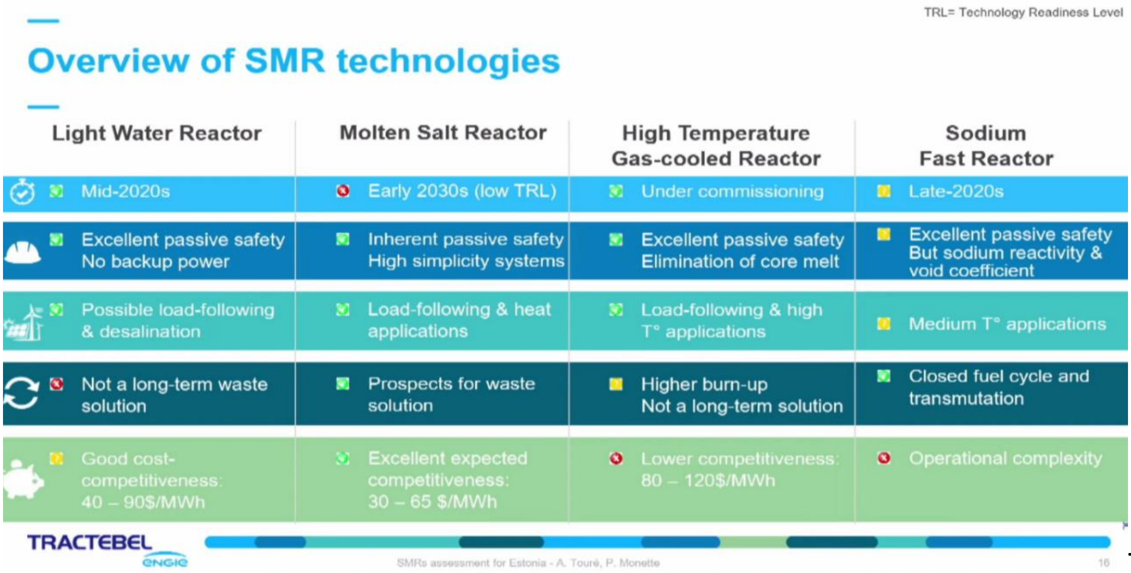
We commenced our look at the technology and potential use of SMRs around the world and saw that there is a great deal of interest. A PowerPoint presentation is available here.

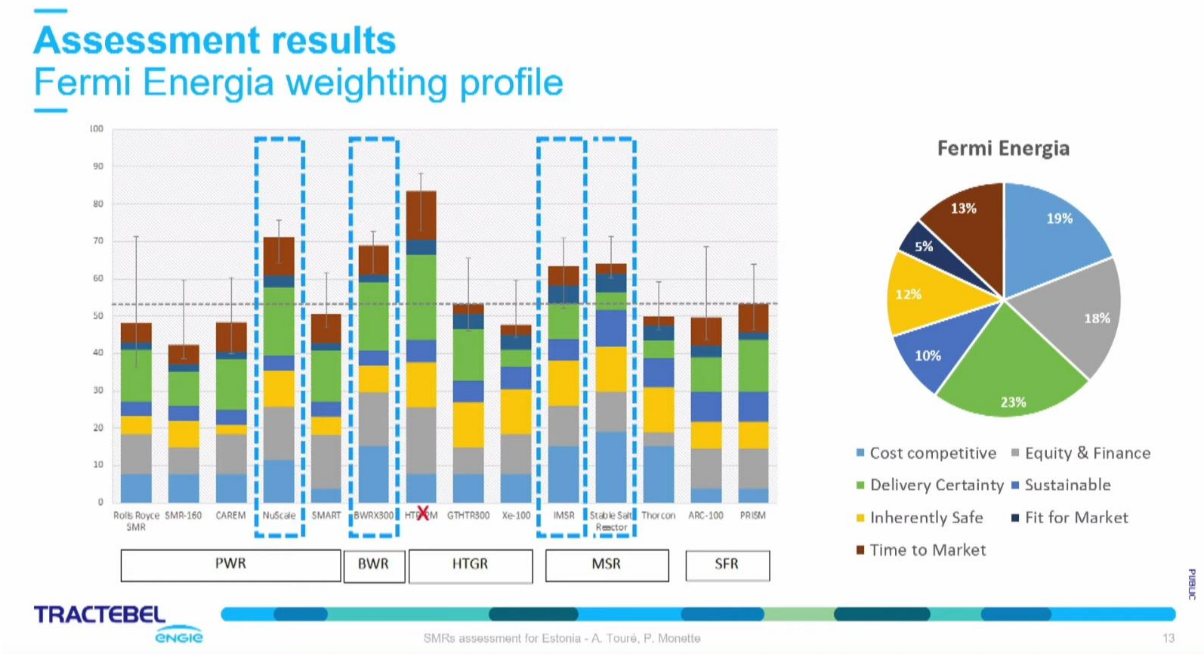
Small modular reactors (**SMR**s) are nuclear fission reactors that are smaller than conventional nuclear reactors and typically have an electrical power output of less than 300 MW_e or a thermal power output of less than 1000 MW_{th}.

Some of the slides used are from a presentation by an Italian firm Fermi Energia using information from the French energy provider Tractebel. The purpose of the study was to provide Estonia with recommendations concerning the possibility of using SMRs in their network.

A review of SMR technologies is shown in the slide below:



The Light Water reactors use current **GenIII** nuclear technology while the last three use **GenIV** technology



Light Water Reactors

The **PWR** and **BWR** (Pressurised Water and Boiling Water Reactors) differ in that the PWRs operate at a pressure of 160 bar and 315 C to suppress boiling while the BWR uses boiling water at lower pressure which can feed directly to a turbine. PWRs require an intermediate heat exchanger to reduce pressure for the turbine. Both these types of reactors have the disadvantage using only a small amount of the energy in uranium ore and the need for disposal of long term nuclear waste.

Gen IV reactors are a set of nuclear reactor designs currently being researched for commercial applications by the **Generation IV International Forum**. They are motivated by a variety of goals including improved safety, sustainability, efficiency, and cost.

Molten salt reactors

Molten Salt reactors are much more efficient than light water reactors. They use fuel dissolved in a molten fluoride or chloride salt which functions as both the reactor's fuel and its coolant. This means that such a reactor could not suffer from a loss of coolant leading to a meltdown. Terrestrial Energy's **IMSR** integrates the primary reactor components, including primary heat exchangers, to a secondary clean salt circuit, in a sealed and replaceable core vessel. It is designed as a modular reactor for factory fabrication, and could be used for electricity production and industrial process heat generation. The company aims to commercialise the modular reactor design in the late 2020s. The reactor uses a **Thermal Spectrum** requiring a graphite moderator and can burn waste fuel from light water reactors.

Fast Spectrum MSR designs do not use a moderator. They achieve criticality by having a sufficient volume of salt with sufficient fissile material. Being Fast Spectrum they can consume much more of the fuel and leave only short lived waste. The **stable salt reactor** (SSR) is a design developed by Moltex Energy Ltd,https://en.wikipedia.org/wiki/Stable_salt_reactor - cite_note-1 based in the United Kingdom and Canada. The SSR incorporates elements of the molten salt reactor, and aims to be **intrinsically safe** and more economical (LCOE of $45/MWh or less) than light water reactors. Stable salt reactors do not need expensive containment structures and components to mitigate radioactive releases in accident scenarios. Hazardous airborne isotopes are chemically bound to the coolant. There is no operator or active system required to maintain the reactor in a safe and stable state.

The **HTGR** or **High Temperature Gas Reactor** operates at temperatures of around 1000 C and use thermal spectrum technology requiring a moderator for the fuel as do the light water reactors The unique construction and high **BurnUp (** MWdays per tonne**)** potential of the fuel enhances proliferation resistance. Helium gas is often used as the coolant. These reactors have higher LCOEs than other GENIV SMRs

The Chinese HGPR reactor **HTR_PM** has undergone commissioning tests during last year with a view of connecting to the grid after a trial period. In China, its role will also be to replace coal-fired power plants in the country's interior.

Sodium Cooled SMRs

A sodium cooled fast reactor uses low-pressure liquid sodium as the reactor coolant, thus allowing high power density with low coolant volume. The SFR closed fuel cycle enables regeneration of fissile fuel and allows actinide management. The fast neutron spectrum greatly extends the uranium resources compared to thermal reactors.

The **PRISM** is a typical metal-fuelled, sodium cooled **SFR**. PRISM employs passive safety and modular fabrication techniques to expedite plant construction. The PRISM has a rated thermal power of 840 MW and an electrical output of 311 MW. PRISM has an intermediate sodium loop that exchanges heat between the primary sodium coolant from the core with water-steam in a sodium-water-steam generator.

Conclusion

There are 10 countries involved in developing 50 products using 6 technologies in the field of Small Modular Reactors. The above is an outline of a small number with some available this decade and others in the next decade. There are currently at least four government legislations which do not allow the use of this technology in Australia so it is unlikely that any will be used in Australia this decade. There may be a number of new technologies available by the end of this decade.