

# GLOSSARY

This glossary defines key terms used in this report.

**actinides:** a series of 15 elements with an atomic number (i.e. the number of protons in the nucleus) between 89 and 103. The actinides include uranium (92), plutonium (94) and americium (95).

**activity (nuclear):** the number of decays per unit time taking place in a radioactive material. The unit of activity is the becquerel (Bq), equal to one decay per second.

**adsorption:** the adhesion of atoms or molecules from a gas or liquid as a thin film to a solid or liquid surface.

**advanced reactors:** reactor designs in which nuclear fission energy is captured and converted more efficiently than in standard water-cooled reactors. They operate at higher temperatures and employ heat-tolerant coolants such as liquid metal or molten salt, and robust fuel materials including graphite.

**alpha particle:** an energetic positively charged particle emitted from the nucleus of an atom during alpha radioactive decay and consisting of two protons and two neutrons (a helium nucleus).

**amortised capital cost:** represents the amount of principal (the original amount borrowed) and interest that would need to be paid in each period over a given repayment schedule, such that at the end of the repayment schedule all interest and principal would have been repaid.

**aquifer:** a body of permeable rock such as sand or gravel through which groundwater moves, and that can store considerable quantities of water, which is underlain by impermeable material.

**atom:** a particle of matter that cannot be broken up by a chemical process. Atoms have a nucleus containing positively charged protons and uncharged neutrons, and surrounding the nucleus, a cloud of negatively charged electrons.

**atomic number:** the number of protons in the nucleus of an atom. See also *mass number*.

**beta particle:** an energetic particle emitted from the nucleus of an atom during beta radioactive decay. Beta particles are electrons with a negative charge or positrons with a positive electric charge.

**borehole:** a hole drilled into rock to enable an assessment to be made of the characteristics of the rock itself and of the fluids it contains, e.g. groundwater, petroleum, or natural gas.

**brownfield:** vacant or unused former industrial land with potential for redevelopment.

**burn up:** the amount of energy generated from a fixed quantity of nuclear fuel, expressed typically as megawatt days per tonne (MWd/tonne).

**carbon dioxide equivalent (CO<sub>2</sub>-e):** a standard measure that allows different greenhouse gases to be compared in terms of their potential contribution to global warming. See *greenhouse gas*.

**capacity factor:** the percentage of time that a generator is producing electricity.

**carbon capture and storage:** technologies involving capturing carbon dioxide from exhaust gases produced by power plants and other industrial facilities and injecting it (sequestration) into a sealed underground storage site.

**centrifuge enrichment:** a uranium enrichment technology comprising cylinders rotating at high speed to physically separate gas molecules of slightly different masses i.e. uranium hexafluoride with <sup>238</sup>U and <sup>235</sup>U atoms.

**combined cycle gas turbine:** a gas fired power plant in which the gas turbine cycle is combined with a steam turbine cycle. The hot exhaust gases from the gas turbine are re-circulated and used to boil water (instead of being vented) and generate steam to spin a steam turbine.

**carbon price:** the cost—imposed by means of a tax, levy, permit or credit—of emitting carbon dioxide into the atmosphere.

**containment:** a gastight structure around a nuclear reactor made of reinforced concrete designed to prevent the escape of radioactive materials into the environment in the event of an incident.

**control rods:** moveable rods, plates or tubes containing boron, cadmium or some other strong absorber of neutrons that suppress the rate of the nuclear reaction in a reactor.

**craton:** a large, coherent domain of Earth's continental crust that has attained and maintained long-term stability, having undergone little internal deformation, except near its margins.

**cyclotron:** a device which accelerates charged particles to high energies by the application of electromagnetic forces. The accelerated particles may be used to bombard suitable target materials to produce radioisotopes.

**decay (radioactive):** the spontaneous disintegration of an atomic nucleus resulting in the release of energy in the form of particles (for example, alpha or beta), or gamma radiation, or a combination of these.

**depleted uranium:** uranium which has less than the natural percentage (0.7%) of the isotope <sup>235</sup>U.

**discount rate:** a rate that is used to convert future costs or revenues to their present value.

**dosimeter:** a device used to measure the radiation dose a person receives over a period of time.

**dose, absorbed:** a measure of the amount of energy deposited in a material by ionising radiation. The unit of measure is the gray (Gy).

**dose, effective:** a measure of the biological effect of radiation on the whole body. It takes into account the equivalent dose and the differing radiosensitivities of body tissues. The unit of measure is the sievert (Sv), but doses are usually measured in millisieverts (mSv) or microsieverts ( $\mu$ Sv).

**dose, equivalent:** a measure of the biological effect of radiation on a tissue or organ that takes into account the type of radiation. The unit is the sievert (Sv), but doses are usually measured in millisieverts (mSv) or microsieverts ( $\mu$ Sv).

**dose limit:** the maximum radiation dose, defined by regulation, that a person may receive over a stated period of time. It excludes doses from natural background radiation and medical sources.

**element:** a substance that cannot be divided into simpler substances by chemical means.

**electron:** a light, negatively charged subatomic particle found in all atoms.

**Emissions Reduction Fund (ERF):** a scheme established by the Australian Government which provides incentives for carbon emissions reduction activities in the Australian economy.

**enhanced geothermal system (EGS):** a geothermal energy technology that exploits thermal reservoirs found at depths of at least 3–5 km below the surface of the earth, whose permeability is increased (or enhanced) through a process of hydraulic fracturing to capture heat by creating a closed loop circuit of water.

**fast reactor:** a type of nuclear reactor in which the fission chain reaction is sustained by fast neutrons, in contrast to the slow, moderated neutrons in most thermal reactors. Fast reactors can burn a wider range of nuclides than thermal reactors, including transuranic elements regarded as wastes. They can be configured to produce or 'breed' more fissile material than they consume. Fast reactors generally use liquid metal coolants, such as sodium.

**fissile material:** any material containing fissile radionuclides capable of undergoing fission by thermal (or slow) neutrons. For example,  $^{235}\text{U}$  and  $^{239}\text{Pu}$  are fissile radionuclides.

**fission (nuclear):** the splitting of a heavy atom into smaller fragments, resulting in the release of neutrons, gamma radiation, and a large amount of energy.

**fission products:** isotopes of lighter elements created through the fission of fissile material. They are most often unstable and undergo radioactive decay, and include  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$  and  $^{129}\text{I}$  and  $^{131}\text{I}$  and  $^{90}\text{Sr}$ .

**fuel assembly:** an engineered array of fuel rods (long, sealed metal tubes) that contain pellets of fissionable material that is used in a nuclear reactor to generate thermal power.

**gamma radiation:** energetic short wavelength electromagnetic radiation of the same physical nature as light, x-rays, radio waves etc.

**gigawatt (GW):** one gigawatt is equal to one billion ( $10^9$ ) watts. See *Watt*.

**gigawatt hour (GWh):** a gigawatt hour (GWh) is a unit of electrical energy equal to one billion ( $10^9$ ) watt hours. See *Watt hours*.

**gray (Gy):** a measure of absorbed ionising radiation dose per unit of mass. 1 gray is equal to one joule absorbed into 1 kilogram of matter.

**greenfield:** land that has not previously been developed.

**greenhouse gas:** a gas that traps heat in the Earth's atmosphere by absorbing reflected solar infrared radiation from the earth, thereby causing the greenhouse effect. The main greenhouse gas is carbon dioxide, others include nitrous oxide, methane, fluorinated gases and water vapour.

**half-life, radioactive:** the period required for half of the atoms in a population of a particular radionuclide to decay. Half-lives vary, according to the isotope, from less than a millionth of a second to more than a billion years.

**heavy metal (HM):** commonly used in units such as tonnes Heavy Metal (tHM) and refers to the weight of the uranium and plutonium (if present) in nuclear fuel.

**heavy by products:** actinides produced in the fission of nuclear fuel.

**heavy water:** water in which both hydrogen atoms have been replaced with deuterium, the isotope of hydrogen containing one proton and one neutron.

**heavy water reactor:** a type of nuclear reactor which uses heavy water as both a moderator and coolant.

**highly enriched uranium:** uranium enriched to at least 20 per cent  $^{235}\text{U}$ .

**high level waste (HLW):** waste containing large concentrations of short- and long-lived radionuclides that generate significant quantities of heat and requires shielding and cooling.

**hot particles:** particles of nuclear fuel which are dispersed in a nuclear accident. They include radionuclides of strontium, plutonium and americium.

**Intergovernmental Panel on Climate Change (IPCC):** the international body for assessing the science related to climate change.

**intermediate level waste (ILW):** radioactive waste that contains some long-lived radionuclides and has higher levels of radioactivity than low-level waste. It requires shielding and does not generate significant quantities of heat.

**internal rate of return:** the interest rate that makes the net present value of an investment zero when applied to the projected cash flow from an asset, liability, or financial decision. It is used to assess the profitability of potential investments.

**Intended Nationally Determined Contributions (INDC):** the intended national efforts towards greenhouse gas emission reductions and climate change mitigation that were outlined by the parties to the United Nations Framework Convention on Climate Change (UNFCCC) in the lead up to the Paris Conference (COP21) in 2015.

**ion:** an atom that has become electrically charged having gained or lost an electron.

**ionising radiation:** radiation capable of causing ionisation of the matter through which it passes.

**ionisation:** process by which an atom or molecule gains or loses electrons.

**isotope:** Nuclides that have the same atomic number (same number of protons) but different mass numbers (different number of neutrons). Different isotopes of the same element have the same chemical properties but different physical properties.

**Large Scale Renewable Energy Target (LRET):** An Australian Government scheme which creates a financial incentive for the establishment of large scale renewable energy power stations, such as wind and solar farms. It forms part of the broader Renewable Energy Target (RET).

**lifecycle analysis:** a systematic procedure for compiling and examining the inputs and outputs of materials and energy consumed over the lifetime of an activity.

**light water reactor (LWR):** reactors that are moderated and cooled by natural water as opposed to heavy water. Types of light water reactors include pressurised water reactors (PWRs) and boiling water reactors (BWRs).

**low level waste (LLW):** radioactive waste that emits small amounts of gamma radiation, up to regulatory limits, and that can be handled by workers without shielding due to its small associated dose rates. LLW can contain a range of radionuclides, including small amounts of uranium and thorium, and does not produce heat.

**mass number:** the total number of protons and neutrons in the nucleus of an atom. Different isotopes of the same element will have different numbers of neutrons and therefore different mass numbers e.g.  $^{235}\text{U}$  and  $^{238}\text{U}$ .

**megawatt:** a unit of power equal to one million watts. See *watt*.

**mixed oxide fuel (MOX):** a reactor fuel comprising both uranium and plutonium oxides.

**moderator:** a material used in a reactor to slow down high speed neutrons, thus increasing the likelihood of further fission. Examples of moderators include normal water, heavy water, beryllium and graphite.

**natural uranium:** uranium that has not been enriched.

**net present value (NPV):** the current value of a security or an investment project, arrived at by discounting all present and future receipts and outgoings at an appropriate rate of discount.

**neutron:** an uncharged subatomic particle found in the nucleus of all atoms, except ordinary hydrogen. Neutrons are the links in a chain reaction in a nuclear reactor.

**nuclear reactor:** a structure in which a fission chain reaction can be maintained and controlled.

**nucleus:** the positively charged core of an atom. It contains nearly all of an atom's mass and contains both the protons and neutrons.

**open cycle gas turbine:** a gas fired power plant that uses a gas turbine engine to create electricity.

**ore grade:** the concentration of an element of interest in an ore deposit.

**plutonium (Pu):** a heavy, radioactive, man-made metallic element with an atomic number of 94. It has a number of isotopes produced by neutron irradiation of  $^{238}\text{U}$  in a reactor core.

**polymetallic deposit:** deposit containing economic grades of several metals such as iron, copper, gold and uranium.

**positron emission tomography (PET):** a nuclear medical three-dimensional imaging technique, based on injected short-lived radionuclides, able to identify diseased tissue with high resolution.

**Precambrian:** an expression which describes the Hadean, Archaean, and Proterozoic eons, which together comprise the longest period of geologic time beginning with the consolidation of the Earth's crust and ending approximately 4000 million years later with the beginning of the Cambrian Period around 542 million years ago.

**proliferation (nuclear):** the spread of nuclear weapons, and more generally, the spread of nuclear technology and knowledge that might be put to military use.

**proton:** a positively charged subatomic particle found in the nucleus of all atoms.

**proton therapy:** a type of radiotherapy that uses a beam of protons produced by an accelerator, which are capable of penetrating a defined distance into the body.

**radioactive waste:** material for which no further use is foreseen that contains or is contaminated with radionuclides above regulated limits.

**radioactivity:** the inherent property of certain nuclides to emit particles or gamma rays during their spontaneous decay into other stable nuclei.

**radioisotope:** an isotope of an element that is radioactive.

**radionuclide:** see *radioisotope*.

**radiopharmaceutical:** a medicine comprising a radioisotope attached to a molecule that targets diseased tissue or physiological function. Radiopharmaceuticals can be used both for diagnostic purposes (imaging) and for therapy (in certain cancer treatments).

**radon:** a naturally occurring radioactive element with an atomic number of 86, which is the heaviest known gas. It is produced by the radioactive decay of naturally occurring uranium and thorium.

**reactor core:** the innermost part of a nuclear reactor that contains the fuel, the moderator (in a thermal reactor), and a coolant; where the fission reaction takes place and the level of radiation is highest.

**safeguards, nuclear:** political and legal mechanisms, including accounting, surveillance and physical inspections, intended to deter the spread of nuclear weapons by early detection of misuse of nuclear material or technology.

**separative work unit (SWU):** the amount of enrichment effort required to increase the concentration of <sup>235</sup>U in a given amount of uranium to a higher concentration.

**short-run marginal cost:** the additional cost from a unit increase in an activity.

**sievert (Sv):** a unit of measurement of *equivalent dose* and *effective dose* equivalent to one joule per kilogram of tissue exposed.

**spot market:** a market for transactions with settlement at a spot date, usually being the normal, earliest date for delivery. The market price for delivery on the spot date is the spot price or spot rate.

**stope:** a step-like part of a mine where ore is being extracted.

**sulphide:** a group of minerals in which the element sulphur (S) is in combination with one or more metallic elements.

**tails:** the depleted uranium stream produced during the enrichment process.

**tailings:** the ground rock remaining after particular ore minerals (e.g. uranium oxides) are extracted

**tectonic plate:** one of the large sections or blocks of the Earth's crust. There are seven major plates (the North American, South American, African, Eurasian, Indo-Australian, Pacific, and Antarctic plates) and at least twelve minor plates.

**thorium:** a naturally occurring radioactive element with atomic number of 90.

**tracer:** a radioactive isotope used to follow a chemical or biochemical reaction.

**transuranic:** any elements with an atomic number greater than uranium. They include plutonium and americium.

**United Nations Framework Convention on Climate Change (UNFCCC):** An international treaty that aims to address climate change through international cooperation. It entered into force in 1994, and has a Secretariat to assist in making the UNFCCC operational.

**used fuel:** reactor fuel in its assembly following its discharge from a reactor.

**uranium:** a radioactive element with atomic number 92 with a number of important isotopes, such as naturally occurring  $^{235}\text{U}$  and  $^{238}\text{U}$ . Uranium is the basic raw material for nuclear energy.

**uranium, enriched:** uranium in which the content of the fissile isotope  $^{235}\text{U}$  has been increased above the ~0.71% natural content. Uranium must be enriched to be used as fuel for light water reactors. Material with 20 per cent or greater enrichment is called high enriched uranium; below 20 per cent is called low enriched uranium.

**uranium oxide concentrate (UOC):** a commercial product of a uranium mill, usually containing a high proportion (greater than 90%) of uranium oxide ( $\text{U}_3\text{O}_8$ ).

**watt (W):** a unit of power equal to the amount of energy (one joule) that is consumed in a second (J/s). A subscript that is used alongside references to gigawatt (GW) or megawatt (MW) refers to the generation of either electrical (e) or thermal (th) energy. When it is used in association with a power plant, typically in hundreds of MWe, it describes the capacity of that power plant to generate electricity.

**watt hour (Wh):** a unit of energy equal to a watt of power (thermal or electric) consumed continuously for one hour. A kilowatt hour (kWh) is a unit of electricity that is typically expressed on retail bills to denote the amount of electrical energy that has been consumed.

**venturi scrubber:** an air pollution control device that uses water or gas flows to remove fine particles from volatile, hazardous, or corrosive gas streams, or from gas streams containing solid materials that are difficult to handle.

**vitrification:** a technique for the incorporation of radionuclides into glass for storage and disposal.

**yellowcake:** see *uranium oxide concentrate*.