



## GLOSSARY

*Definitions are taken from the Intergovernmental Panel on Climate Change (IPCC) wherever possible. A list of sources is provided at the end of the glossary.*

*Terms in a definition that appear elsewhere in the glossary are italicised.*

**abatement** Activity that leads to a reduction in *greenhouse gas* emissions.

**abrupt climate change** The nonlinearity of the *climate system* may lead to abrupt *climate change*. The term 'abrupt' often refers to time scales faster than the typical time scale of the responsible *forcing*.

**adaptation** Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

**adaptive capacity** The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

**additionality** Reduction in emissions by sources or enhancement of removals by sinks that is additional to the reduction would occur in the absence of an incentive provided through a program.

**adverse selection** Situations where features of a market result in the market being dominated by poorer-quality goods. Adverse selection results from *information asymmetry*.

**aerosols** A collection of airborne solid or liquid particles, with a typical size between 0.01 and 10 micrometre (a millionth of a metre) that reside in the atmosphere for at least several hours. Aerosols may originate from natural processes or human activities. Aerosols may influence climate either directly by scattering and absorbing radiation, or indirectly by modifying formation, the optical properties and lifetime.

**afforestation** Planting of new forests on lands that historically have not contained forests.

**albedo** The fraction of *solar radiation* reflected by a surface or object, often expressed as a percentage. Snow-covered surfaces have a high albedo, the surface albedo of soils ranges from high to low, and vegetation-covered surfaces and oceans have a low albedo. The earth's planetary albedo varies mainly through varying cloudiness, snow, ice, leaf area and land cover changes.

**Annex B countries/Parties** Industrialised countries and economies in transition countries listed in Annex B to the *Kyoto Protocol* that have emissions reductions targets for the period 2008–12.

**Annex I countries/Parties** Industrialised countries and economies in transition listed in Annex I to the United Nations Framework Convention on Climate Change. They include the 24 original OECD members, the European Union, and 14 countries with economies in transition.

**anthropogenic** Resulting from or produced by human beings.

**atmosphere** The gaseous envelope surrounding the earth.

**atoll** Rings of coral reefs that enclose a lagoon. Around the rim of the reef are islets called 'motu' with a mean height above sea level of approximately two metres.

**Bali Roadmap** The key decisions agreed at the 2007 Bali Climate Change Conference, charting the way for the UN negotiations on a post-2012 UN climate agreement. The Roadmap comprises the Bali Action Plan establishing a new negotiating track under the *UNFCCC*, the *Kyoto Protocol* negotiations on second *commitment period* targets, and other decisions.

**biochar** A charcoal product made through anaerobic combustion of biomass (for example farm or wood waste) at high temperatures. Gas released during this process can be used to produce energy, while biochar can be applied as a fertiliser.

**biosequestration** The removal of *greenhouse gases* from the atmosphere through biological processes, such as growing trees.

**bounded rationality** The theory that individuals and firms may not be able to always make perfect or optimum decisions, due to gaps in their knowledge or cognitive abilities. Bounded rationality contrasts with the assumption often used in economics that individuals and firms always make perfect decisions.

**business as usual** An estimate of future patterns of energy consumption and *greenhouse gas* emissions that assumes that there will be no major changes in attitudes and priorities.

**carbon budget** The amount of carbon (or emissions, expressed as *carbon dioxide equivalent*) allowed to be released over a number of years, by a given party or parties.

**carbon cycle** The term used to describe the movement of carbon in various forms (for example, as carbon dioxide or methane) through the atmosphere, ocean, plants, animals and soils.

**carbon dioxide equivalent (CO<sub>2</sub>-e)** A measure that allows for the comparison of different *greenhouse gases* in terms of their potential influence on the climate system.

- Carbon dioxide equivalent concentration (measured in parts per million (ppm)) is the concentration of carbon dioxide that would lead to the same *radiative forcing* as a given mixture of carbon dioxide and other greenhouse gases.
- Carbon dioxide equivalent emissions (often measured in gigatonnes of carbon) is the amount of carbon dioxide emissions that would cause the same integrated *radiative forcing*, over a given time horizon, as an emitted amount of a well-mixed greenhouse gas. The equivalent carbon dioxide emission is obtained by multiplying the emission of a well-mixed greenhouse gas by its *global warming potential* for the given time period.

**carbon dioxide fertilisation** Increasing plant growth or yield by elevated concentrations of atmospheric carbon dioxide.

**carbon sink or reservoir** Parts of the *carbon cycle* that store carbon in various forms.

**carbon–climate feedback** See *feedback*.

**Clean Development Mechanism (CDM)** A flexibility mechanism under the *Kyoto Protocol*. The CDM allows *Annex I countries* to meet part of their obligation to reduce emissions by undertaking approved emissions reduction projects in developing countries. Emissions reductions under the CDM can create tradable permits, called certified emission reductions or CERs.

**climate change** A change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.

**climate sensitivity** A measure of the *climate system*'s response to sustained *radiative forcing*. Climate sensitivity is defined as the global average surface warming that will occur when the climate reaches equilibrium following a doubling of carbon dioxide concentrations. Models predict a wide range of climate sensitivities due to differing assumptions about the magnitude of *feedbacks* in the climate system. The 'effective' climate sensitivity reflects the warming occurring in the short term, and takes into account climate feedbacks at a particular time.

**climate system** A highly complex system consisting of the atmosphere, the water cycle, ice, snow and frozen ground, the land surface and plants and animals, and the interactions between them. The climate system changes over time under the influence of its own internal

dynamics and because of external forcings such as volcanic eruptions, variations in *solar radiation* and human influences such as the changing composition of the atmosphere.

**climate** Climate in a narrow sense is usually defined as the average weather or, more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

**CO<sub>2</sub>-e** See *carbon dioxide equivalent*.

**commitment period** The period in which countries listed in *Annex B countries* are required to meet their emissions reduction commitments. The first commitment period is 2008 to 2012. The dates of the second commitment period have not yet been agreed.

**committed warming** Due to the thermal inertia of the ocean and slow processes in ice sheets, biological sinks and land surfaces, the climate would continue to change even if the atmospheric composition were held fixed at today's values. Past change in atmospheric composition leads to a committed climate change. The further change in temperature after the composition of the atmosphere is held constant is referred to as committed warming.

**coordination externalities** The benefits (or cost) experienced by society that arise from multiple parties working together, beyond those experienced by those parties involved. See also *externality*.

**deadweight loss** Also known as allocative inefficiency, the loss of economic efficiency that can occur when the equilibrium price and quantity for a good or service is not suboptimal. A deadweight loss is usually due to a distortion in the market which results in over- or under-consumption of a good or service. Distortions that lead to deadweight losses can include monopoly pricing, *externalities*, taxes or subsidies, and binding *price ceilings* and *floors*.

**deforestation** Conversion of forest to non-forest.

**demand-pull** To increase the output of new inventions or technologies by stimulating market demand for those technologies.

**demonstration and commercialisation** Stages in *innovation chain*. Demonstration is an incomplete version of a product, put together with the primary purpose of showcasing the idea, performance, method or features of the product. Commercialisation is the process of introducing a new product into the market.

**direct emissions** Emissions at the point of final fuel combustion.

**discount rate** The rate at which future dollar values are discounted to the present. The discount rate allows a comparison of *utility* across generations.

**economic welfare** The level of real household consumption adjusted for the expenditure required to adapt to climate change. Consumption can be considered a measure of welfare as individuals are assumed to maximise *utility* through their consumption choices.

**economies of scale** Situations where the cost of producing each unit of a commodity, including services, decreases as the amount of output increases. This often occurs because fixed costs, such as information and equipment, can be spread over more units of output.

**ecosystem** A distinct system of interacting living organisms, together with their physical environment. The boundaries of what could be called an ecosystem are somewhat arbitrary, depending on the focus of interest or study. Thus the extent of an ecosystem may range from very small spatial scales to, ultimately, the entire earth.

**efficiency** The efficiency of a system describes how well it produces outputs with a given set of inputs. A system is said to be economically efficient if no one can be made better off without making someone else worse off. Governments may intervene to ensure markets are efficient.

**El Niño – Southern Oscillation (ENSO)** A coupled fluctuation in the atmosphere and the equatorial Pacific Ocean. The El Niño – Southern Oscillation leads to changes in sea surface temperature across the central tropical Pacific Ocean every three to seven years, and leads to changes in rainfall, floods and droughts on both sides of the Pacific. It is characterised by large exchanges of heat between the ocean and atmosphere, which affect global mean temperatures but also have a profound effect on the variability of the climate in Australia.

**elasticity** A measure of the responsiveness of one variable to another, defined in percentage changes.

**emissions (or carbon) intensity** A measure of the amount of *greenhouse gases*, or sometimes carbon dioxide, emitted per unit of, say, electricity or energy output.

**emissions case** One of four future emissions trajectories out to 2100 being investigated by the Review: a **no-mitigation case** with no action to mitigate climate change; an **ad hoc mitigation case** representing loosely coordinated mitigation action; an **ambitious global mitigation case** involving emissions reductions that lead to a stabilisation concentration of 450 ppm CO<sub>2</sub>-e with an *overshoot* to 500 ppm CO<sub>2</sub>-e, and a **strong global mitigation case** with emissions reductions leading to a stabilisation concentration of 550 ppm CO<sub>2</sub>-e.

**emissions limit** The limit on the number of tonnes of *greenhouse gas* that can be emitted under an *emissions trading scheme*. The limit could apply to the whole economy, or to all sectors covered under the scheme (sometimes called an ‘emissions cap’). The limit should generally be set below what emissions would be under *business as usual*. A specific time period may be set for which this limit applies.

**emissions permit** See *permit*.

**emissions trading scheme** An administrative approach used to reduce the cost of emissions control by providing a market-based and tradable instrument for achieving reductions in emissions. A cap and trade scheme places a limit on emissions allowed from all sectors covered by the scheme. It allows those reducing greenhouse gas emissions to use or trade excess emissions permits to offset emissions at another source. Trading can occur at the intra-company, domestic and international levels.

**emissions trading** A mechanism by which two emissions trading markets or two countries can buy and sell *emissions permits*.

**energy efficiency** The ratio of energy required to produce a certain level of a service, such as kilowatts per unit of heat or light. The term energy efficiency sometimes refers to the process of reducing the ratio of energy required to produce a service.

**energy intensity** A measure of the amount of energy supplied or consumed per unit of, say, *gross domestic product* or sales.

**enteric fermentation** Part of the digestive process of ruminant animals, such as cows and sheep, that results in the release of methane emissions.

**equity** A concept of fairness, including the notion that people with a greater ability to pay should pay more than those with a lesser ability to pay.

**evapotranspiration** The sum of evaporation and plant transpiration from the earth's land surface to the atmosphere. Evaporation accounts for the movement of water to the air from sources such as the soil and bodies of water. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapour through its leaves.

**exposure** The nature and degree to which a system is exposed to significant climatic variations.

**externality** An externality occurs when the participants in an economic transaction do not necessarily bear all of the costs or reap all of the benefits of the transaction. Positive externalities are sometimes referred to as *spillovers* or spillover benefits.

**feedback** An interaction mechanism between processes, where the result of an initial process triggers changes in a second process and that in turn influences the initial one. A positive feedback intensifies the original process, and a negative feedback reduces it.

**fluorinated gases** See *greenhouse gas*.

**forcing** An induced change to a system.

**geo-engineering** Technological efforts to stabilise the climate system by direct intervention in the energy balance of the earth to reduce global warming.

**geosequestration** Injection of carbon dioxide directly into underground geological formations.

**global warming potential** The index used to translate the level of emissions of various gases into a common measure in order to compare the relative *radiative forcing* of different gases without directly calculating the changes in atmospheric concentrations. The global warming potential represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing thermal infrared radiation. The *Kyoto Protocol* is based on global warming potential from pulse emissions over a 100-year time frame.

**greenhouse effect** The effect created by the *greenhouse gases* in the earth's *atmosphere* that allow short-wavelength (visible) solar radiation from the sun to reach the surface, but absorb the long-wavelength heat that is reflected back, leading to a warming of the surface and lower atmosphere. The increase in global temperatures caused by higher levels of greenhouse gases in the atmosphere as a result of human activity is often referred to as the 'enhanced greenhouse effect'.

**greenhouse gas** Any gas that absorbs infrared radiation in the atmosphere. This property causes the *greenhouse effect*. The primary naturally occurring greenhouse gases that can be managed directly by humans are carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>), all covered by the *Kyoto Protocol*. Water vapour (H<sub>2</sub>O) and ozone (O<sub>3</sub>) are also important greenhouse gases, but can only be indirectly managed by humans. There is also a range of entirely man-made greenhouse gases, including hydrochlorofluorocarbons (HCFCs) and chlorofluorocarbons (CFCs), which are ozone-depleting substances covered under the *Montreal Protocol*. The fluorinated gases—hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF<sub>6</sub>) are covered under the *Kyoto Protocol*. The man-made gases are sometimes referred to as 'halocarbons' (except SF<sub>6</sub>), or 'synthetic greenhouse gases'. With the exception of Chapter 3, where a wider range of greenhouse gases are discussed, the term 'greenhouse gases' in this Review relates to those gases covered by the *Kyoto Protocol*. These gases are the focus of most domestic and international policy.

- gross domestic product (GDP)** An aggregate measure of economic activity, usually for a country.
- gross value added** The value of output minus the value of intermediate consumption. The term is used to describe gross product by industry and by sector.
- halocarbons** See *greenhouse gas*.
- hoarding** Net banking of *permits* by the private sector. That is, permits purchased in excess of current acquittal liability may be held as an asset on a firm's balance sheet and saved for future use.
- ice sheet** A mass of land ice that is sufficiently deep to cover most of the underlying bedrock, so that its shape is mainly determined by the flow of the ice as it deforms internally and/or slides at its base. Most ice is discharged through fast-flowing ice streams or outlet glaciers, in some cases into the sea or into ice shelves floating on the sea. There are only three large ice sheets in the modern world, one on Greenland and two on Antarctica. During glacial periods there were others.
- indirect emissions** Emissions associated with the production of purchased electricity, heat and steam.
- information asymmetry** Situations where one party to a transaction has critical information that another party does not have.
- information market failures** Market failures relating to problems in the supply, consumption or use of information.
- innovation chain** A model of innovation that suggests that new knowledge progresses to become commercial technologies through a series of one-way linear stages.
- internalise** To remedy the presence of an *externality* by ensuring that parties to a transaction bear the costs and benefits of their actions.
- inter-temporal flexibility** The ability to use *emissions permits* at different points in time, made possible through the flexibility mechanisms of hoarding and lending.
- Joint Implementation** A *Kyoto Protocol* flexibility mechanism which allows an *Annex B country* to earn emissions reduction units in another Annex B country which can be counted towards meeting the former's Kyoto Protocol target.
- Kyoto Protocol** An agreement adopted under the United Nations Framework Convention on Climate Change in 1997, and entered into force in 2005. Countries listed in Annex B of the Protocol have committed to meet targets that reduce their greenhouse gas emissions over the period 2008–12, compared with 1990 levels. The Protocol has been ratified by most countries but not the United States.

**labour productivity** The ratio of labour to output.

**lending** Lending of *permits* by the authorities to the private sector, which are repaid to the authorities at a future date.

**long-lived greenhouse gases** The selection of greenhouse gases covered by the *Kyoto Protocol* are sometimes referred to as 'long-lived greenhouse gases' to distinguish them from ozone and water vapour, both of which are removed from the atmosphere relatively quickly

**long-wavelength radiation** Thermal radiation, or heat, emitted by the earth's surface, the atmosphere and the clouds. It is also known as infrared radiation.

**marginal costs** The change in total cost that arises when the quantity produced changes by one unit. For example, the average cost of a unit of electricity is the total cost of providing a unit of energy divided by the number of units provided. The marginal cost of a unit of energy is any additional costs borne in providing that additional unit. In some cases marginal costs may be lower than average costs, but if new infrastructure is required to provide an extra unit then marginal costs can be higher.

**marginal utility of consumption** The additional amount of utility gained from an each extra unit of consumption.

**market failure** Where a free market does not result in an efficient outcome. Market failures are often used in economics as one of the two justifications for government intervention, along with *equity*.

**materiality** The relative significance of something, such as information or an event, in affecting the performance of a firm.

**mitigation** An intervention to reduce the source of, or enhance the sinks for, *greenhouse gases*.

**Montreal Protocol** The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in Montreal in 1987. It controls the consumption and production chemicals that destroy stratospheric ozone, such as chlorofluorocarbons.

**network externality** When the purchase of a good or service by one individual indirectly benefits others who are also consuming the good or service (see also *externality*).

**non-traded** Firms or industries that produce goods for the domestic market, as opposed to exporting or being subject to import competition. Non-traded firms will mostly be in a position largely to pass through the *permit* price to domestic customers, unlike firms in the trade-exposed sector, for whom prices are set on world markets.

- obligation** A requirement to undertake a particular course of action. Parties with an obligation under an emissions trading scheme are legally required to monitor and report emissions, and acquit *permits* equal to those actual emissions during a compliance period. The point in the supply chain where the obligation is placed is referred to as the 'point of obligation'.
- offsets** Reductions or removals of *greenhouse gas* emissions that are used to counterbalance emissions elsewhere in the economy.
- opportunity costs** The opportunity forgone in choosing one alternative over another.
- overshoot scenario or profile** A mitigation scenario where concentrations of a *greenhouse gas* (or a mix of greenhouse gases) peak at a higher atmospheric concentration than the eventual target, and then reduce over time to achieve *stabilisation*.
- pass-through** Firms will attempt to recover costs of the emissions trading scheme (for example, the price of *permits*) by passing them down the supply chain in the form of higher prices. For example, the cost of compliance with the scheme will be applied to liquid fuel at the point of excise, but will be passed through to consumers in higher petrol prices. The proportion of cost pass-through is likely to vary between producers.
- peaking scenario or profile** A mitigation scenario where concentrations of a *greenhouse gas* (or a mix of greenhouse gases) stabilise or peak, and then continue to reduce indefinitely.
- permafrost** Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years.
- permit or emissions permit** A certificate created under the emissions trading scheme that enables the holder to emit a specified amount of greenhouse gas, generally one tonne of *carbon dioxide equivalent*.
- phenology** The study of the times of recurring natural phenomena. Examples include the date of emergence of leaves and flowers, and the first appearance of migratory birds.
- physiology** The study of the mechanical, physical and biochemical functions of living organisms.
- price ceiling and price floor** A price ceiling sets an upper limit on emissions prices; when it is reached, an unlimited amount of *permits* are issued at that price. A price floor sets a lower limit on emissions prices; when the floor price is reached, authorities may intervene to reduce the supply of permits, in order to keep prices at or above the floor.

- primary energy** Energy in the forms obtained directly from nature, such as black coal, brown coal, uranium, crude oil and condensate, naturally occurring liquid petroleum, gas, ethane and natural gas, wood, hydroelectricity, wind and solar energy.
- principal–agent** Principal–agent relationships exist where one party (the principal) assigns another party (the agent) to carry out a task for them. Principal–agent problems may occur where the principal cannot ensure that the agent acts in the principal’s best interests.
- prisoner’s dilemma** A term from economic game theory, which describes a ‘game’ or problem in which the cooperative outcome is the superior one, but in which agents (such as countries or individuals) have an incentive not to cooperate. It is named after the situation in which two suspects would receive short sentences if neither informs on the other, and long sentences if both inform on the other. If only one suspect informs on the other, the informant will go free. The best solution for the suspects is the cooperative one (neither informs on the other), but each has an incentive not to cooperate (to inform).
- proxy measure** A variable that can be measured and used in order to estimate something else that cannot be directly measured.
- public good** A good that is non-rival and non-excludable. This means, respectively, that consumption of the good by one individual does not reduce the amount of the good available for consumption by others; and no one can be effectively excluded from using that good.
- purchasing power parity.** A purchasing power parity exchange rate equalises the purchasing power of different currencies in their home countries.
- radiative forcing** A measure of the influence that a factor has on the energy balance of the *climate system*, and the importance of that factor as a potential *climate change* mechanism. Positive forcing tends to warm the surface, while a negative forcing tends to cool it. Radiative forcing is a measure of change. In this report, radiative forcing values are given in watts per square metre and represent the change between pre-industrial conditions (1750) and 2005.
- reference case** The evolution of the global and Australian economies and associated *greenhouse gas* emissions to the end of the current century in the complete absence of climate change.
- reforestation** Replanting of forests on lands that have previously contained forests but that have been converted to some other use.
- rents** See *resource rents*.
- rent-seeking** An attempt by an individual or firm to get greater income, without increasing productivity. Rent-seeking benefits the recipient at the expense of others in the economy.

**resource rents** Economic rent is a surplus value after all costs and normal economic returns have been accounted for. Resource rents refer specifically to the supernormal return from natural resources such as coastal space or minerals.

**risk** Refers to a situation where enough information is available for decision makers to construct a probability distribution.

**secondary market** A financial market for trading of *permits* that have already been issued, whether by auction or some other method of allocation. It may also include markets in physical or financial contracts for the future purchase or sale of permits, so-called forward contracts.

**sensitivity** With respect to the *climate system*, the degree to which the system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (for example, a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (for example, damage caused by an increase in the frequency of coastal flooding due to sea-level rise).

**sequestration** Carbon storage in terrestrial or marine reservoirs. Biological sequestration includes direct removal of carbon dioxide from the atmosphere through land-use change, afforestation, reforestation, carbon storage in landfills and practices that enhance soil carbon in agriculture.

**severe weather event** An event that is rare within its statistical reference distribution at a particular place. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called 'severe weather' may vary from place to place. An 'extreme climate event' is an average of a number of weather events over a certain period of time—an average which is itself extreme (for example, rainfall over a season).

**solar radiation** Electromagnetic radiation emitted by the sun. It is also referred to as short-wavelength radiation. Solar radiation has a distinctive range of wavelengths determined by the temperature of the sun, peaking in visible wavelengths. The intensity of solar radiation reaching the earth varies due to the seasons, the sunspot cycle, and changes to the earth's orbit and the tilt of its axis.

**split incentives** Describes the situation where there is an incentive for a principal to undertake certain actions (such as to reduce energy use) but the principal cannot act on the incentive because an agent with different incentives makes the relevant decision on their behalf. See *principal-agent*.

**stabilisation** In the climate change context, keeping constant the atmospheric concentrations of one or more *greenhouse gases* (such as carbon dioxide) or of a *carbon dioxide equivalent* mix of greenhouse gases.

**storm surge** The temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions (low atmospheric pressure and/or strong winds). A storm surge is defined as being the excess above the level expected from the tidal variation alone at that time and place.

**stratosphere** The highly stratified layer of the *atmosphere* above the *troposphere* extending from about 10 km (ranging from 9 km at high latitudes to 16 km in the tropics on average) to about 50 km altitude.

**streamflows** The volume of water flowing in streams, rivers and other channels, often measured at the entrance to storage facilities.

**structural adjustment** Changes to the allocation of resources (labour and capital) and changes to patterns of activity within the economy, in response to an external driver, such as *climate change* or an emissions price.

**substitutes** A good or service that can be consumed or used in place of another good or service in at least some of its possible uses.

**sunspot cycle** The sun exhibits periods of high activity observed in numbers of sunspots (small dark areas on the sun), as well as radiative output, magnetic activity and emission of high-energy particles. The sunspot cycle is a semi-regular modulation of solar activity with varying amplitude and a period of between nine and 13 years.

**supply-push** To increase the output of new inventions or technologies by putting more resources into research and development.

**technological lock-in** The state in which persistent biases towards the status quo inhibits the uptake of superior alternative technologies.

**temperature reference point or baseline** Unless otherwise specified, temperature changes discussed in this report are expressed as the difference from the period 1980–99, expressed as ‘1990 levels’ as per the IPCC Fourth Assessment Report (2007). Following the same convention, temperatures over the period 1850–99 are averaged to represent ‘pre-industrial’ levels. To compare temperature increases from 1990 levels to changes relative to pre-industrial levels, 0.5°C should be added. Projected changes to the end of the 21st century are generally calculated from the average of 2090–99 levels, but are often expressed as ‘2100’.

**thermal expansion** In connection with sea level, this refers to the increase in volume (and decrease in density) that results from warming water. A warming of the ocean leads to an expansion of the ocean volume and hence *sea-level rise*.

**thermohaline circulation** Large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density

intermediate and deep waters and returns those waters back to the upper ocean. It is driven by high densities at or near the surface, caused by cold temperatures and/or high salinities, in addition to mechanical forces such as wind and tides.

**threshold or tipping point** The level of magnitude of a system process at which sudden or rapid change occurs. More specifically, a point or level at which new properties emerge in an ecological, economic or other system, invalidating predictions based on mathematical relationships that apply at lower levels.

**total factor productivity** The ratio of all inputs to output.

**trade-exposed, emissions-intensive industries** Industries that are either exporters or compete against imports, and produce significant emissions (above a threshold) in their production of goods.

**transaction costs** Costs associated with a market exchange (which may include indirect costs of market participation, for example, information gathering).

**troposphere** The lowest part of the atmosphere, from the surface to about 10 km in altitude at mid latitudes (ranging from 9 km at high latitudes to 16 km in the tropics on average), where clouds and weather phenomena occur. In the troposphere, temperatures generally decrease with height.

**ultraviolet radiation** The high-energy, invisible part of light emitted by the sun. The majority of ultraviolet radiation is absorbed by the layer of ozone in the stratosphere.

**uncertainty** Where a future possible event is sufficiently unique that no data or information can be used to construct a probability distribution of possible outcomes for it.

### **United Nations Framework Convention on Climate Change**

**(UNFCCC)** An international treaty that sets general goals and rules for confronting climate change. It has the goal of preventing 'dangerous' human interference with the climate system. Signed in 1992, it entered into force in 1994, and has been ratified by all major countries of the world.

**upstream point of obligation** Designating the point of obligation at a point higher or earlier in the supply chain. For example, the obligation for emissions from petrol can be placed upstream at the point of excise.

**utility** Personal satisfaction or benefit derived by individuals from the consumption of goods and services.

**vector-borne disease** A disease that is transmitted between hosts by a vector organism (such as a mosquito or tick—for example, dengue virus).

**volumetric control** imposing a restriction on the amount of something allowed. For example, a cap and trade *emissions trading scheme* sets a limit on the amount of emissions that may be released over a given time without incurring a penalty. By contrast, an emissions trading scheme with a price control would limit the cost of emissions or *permits*, but not the amount.

**vulnerability** The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity.

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