

ANNEX

# Glossary, Acronyms, Chemical Symbols and Prefixes

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# Glossary, Acronyms, Chemical Symbols and Prefixes

Glossary entries (highlighted in **bold**) are by preference subjects; a main entry can contain **subentries**, in bold italic, for example, *Final Energy* is defined under the entry **Energy**. The Glossary is followed by a list of acronyms/abbreviations, a list of chemical names and symbols, and a list of prefixes (international standard units). Some definitions are adapted from C.J. Cleveland and C. Morris, 2006: *Dictionary of Energy*, Elsevier, Amsterdam. Definitions of regions and country groupings are given in Section A.II.6 of Annex II of this report.

## Glossary

**Adaptation:** Initiatives and measures to reduce the vulnerability or increase the resilience of natural and human systems to actual or expected climate change impacts. Various types of adaptation exist, for example, anticipatory and reactive, private and public, and autonomous and planned. Examples are raising river or coastal dikes, retreating from coastal areas subject to flooding from sea level rise or introducing alternative temperature-appropriate or drought-adapted crops for conventional ones.

**Aerosols:** A collection of airborne solid or liquid particles, typically between 0.01 and 10 µm in size and residing in the atmosphere for at least several hours. Aerosols may be of natural or anthropogenic origin. See also black carbon.

**Afforestation:** Direct human-induced conversion of land that has not been forested historically to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.<sup>1</sup> See also deforestation, reforestation, land use.

**Annex I countries:** The group of countries included in Annex I (as amended since Malta was added after that date) to the UNFCCC, including developed countries and some countries with economies in transition. Under Articles 4.2 (a) and 4.2 (b) of the Convention, Annex I countries were encouraged to return individually or jointly to their 1990 levels of greenhouse gas emissions by 2000. The group is largely similar to the Annex B countries to the Kyoto Protocol. By default, the other countries are referred to as **Non-Annex I countries**. See also UNFCCC, Kyoto Protocol.

**Annex B countries:** This is the subset of Annex I countries that have specified greenhouse gas reduction commitments under the Kyoto Protocol. The group is largely similar to the Annex I countries to the UNFCCC. By default, the other countries are referred to as Non-Annex I countries. See also UNFCCC, Kyoto Protocol.

<sup>1</sup> For a discussion of the term *forest* and related terms such as *afforestation*, *reforestation* and *deforestation*, see IPCC 2000: *Land Use, Land-Use Change, and Forestry*, A Special Report of the IPCC [R.T. Watson, I.A. Noble, B. Bolin, N.H. Ravindranath, D.J. Verardo, D.J. Dokken (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

**Anthropogenic:** Related to or resulting from the influence of human beings on nature.

**Anthropogenic emissions** of greenhouse gases, greenhouse gas precursors and aerosols result from burning fossil fuels, deforestation, land use changes, livestock, fertilization, industrial, commercial and other activities that result in a net increase in emissions.

**Availability (of a production plant):** The percentage of time a plant is ready to produce, measured as uptime to total time (total time = uptime + downtime due to maintenance and outages).

**Balancing power/reserves:** Due to instantaneous and short-term fluctuations in electric loads and uncertain availability of power plants there is a constant need for spinning and quick-start generators that balance demand and supply at the imposed quality levels for frequency and voltage.

**Barrier:** Any obstacle to developing and deploying a renewable energy (RE) potential that can be overcome or attenuated by a policy, programme or measure. Barriers to RE deployment are unintentional or intentionally constructed impediments made by man (e.g., badly oriented buildings or power grid access criteria that discriminate against independent RE generators). Distinct from barriers are issues like intrinsically natural properties impeding the application of some RE sources at some place or time (e.g., flat land impedes hydropower and night the collection of direct solar energy).

**Barrier removal** includes correcting market failures directly or reducing the transactions costs in the public and private sectors by, for example, improving institutional capacity, reducing risk and uncertainty, facilitating market transactions and enforcing regulatory policies.

**Baseline:** The reference scenario for measurable quantities from which an alternative outcome can be measured, for example, a non-intervention scenario is used as a reference in the analysis of intervention scenarios. A baseline may be an extrapolation of recent trends, or it may assume frozen technology or costs. See also business as usual, models, scenario.

**Benchmark:** A measurable variable used as a baseline or reference in evaluating the performance of a technology, a system or an organization. Benchmarks may be drawn from internal experience, from external correspondences or from legal requirements and are often used to gauge changes in performance over time.

**Biodiversity:** The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, among species and of ecosystems.

**Bioenergy:** Energy derived from any form of biomass.

**Biofuel:** Any liquid, gaseous or solid fuel produced from biomass, for example, soybean oil, alcohol from fermented sugar, black liquor from the paper manufacturing process, wood as fuel, etc. Traditional biofuels include wood, dung, grass and agricultural residues.

*First-generation manufactured biofuel* is derived from grains, oilseeds, animal fats and waste vegetable oils with mature conversion technologies.

*Second-generation biofuel* uses non-traditional biochemical and thermochemical conversion processes and feedstock mostly derived from the lignocellulosic fractions of, for example, agricultural and forestry residues, municipal solid waste, etc.

*Third-generation biofuel* would be derived from feedstocks like algae and energy crops by advanced processes still under development. These second- and third-generation biofuels produced through new processes are also referred to as next-generation or advanced biofuels or advanced biofuel technologies.

**Biomass:** Material of biological origin (plants or animal matter), excluding material embedded in geological formations and transformed to fossil fuels or peat. The International Energy Agency (*World Energy Outlook 2010*) defines **traditional biomass** as biomass consumption in the residential sector in developing countries that refers to the often unsustainable use of wood, charcoal, agricultural residues and animal dung for cooking and heating. All other biomass use is defined as **modern biomass**, differentiated further by this report into two groups.

*Modern bioenergy* encompasses electricity generation and combined heat and power (CHP) from biomass and municipal solid waste (MSW), biogas, residential space and hot water in buildings and commercial applications from biomass, MSW, and biogas, and liquid transport fuels.

*Industrial bioenergy* applications include heating through steam generation and self generation of electricity and CHP in the pulp and paper industry, forest products, food and related industries.

**Black carbon:** Operationally defined aerosol species based on measurement of light absorption and chemical reactivity and/or thermal stability; consists of soot, charcoal and/or light-absorbing refractory organic matter.

**Business as usual (BAU):** The future is projected or predicted on the assumption that operating conditions and applied policies remain what they are at present. See also baseline, models, scenario.

**Capacity:** In general, the facility to produce, perform, deploy or contain.

*Generation capacity* of a renewable energy installation is the maximum power, that is, the maximum quantity of energy delivered per unit of time.

*Capacity credit* is the share of the capacity of a renewable energy unit counted as guaranteed available during particular time periods and accepted as a 'firm' contribution to total system generation capacity.

*Capacity factor* is the ratio of the actual output of a generating unit over a period of time (typically a year) to the theoretical output that would be produced if the unit were operating uninterruptedly at its **nameplate capacity** during the same period of time. Also known as rated capacity or nominal capacity, **nameplate capacity** is the facility's intended output level for a sustained period under normal circumstances.

**Capacity building:** In the context of climate change policies, the development of technical skills and institutional capability (the art of doing) and capacity (sufficient means) of countries to enable their participation in all aspects of adaptation to, mitigation of and research on climate change. See also mitigation capacity.

**Carbon cycle:** Describes the flow of carbon (in various forms, e.g., carbon dioxide, methane, etc) through the atmosphere, oceans, terrestrial biosphere and lithosphere.

**Carbon dioxide (CO<sub>2</sub>):** CO<sub>2</sub> is a naturally occurring gas and a by-product of burning fossil fuels or biomass, of land use changes and of industrial processes. It is the principal anthropogenic greenhouse gas that affects Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore it has a global warming potential of 1.

**Carbon dioxide capture and storage (CCS):** CO<sub>2</sub> from industrial and energy-related sources is separated, compressed and transported to a storage location for long-term isolation from the atmosphere.

**Cellulose:** The principal chemical constituent of the cell walls of plants and the source of fibrous materials for the manufacturing of various

goods like paper, rayon, cellophane, etc. It is the main input for manufacturing second-generation biofuels.

**Clean Development Mechanism (CDM):** A mechanism under the Kyoto Protocol through which developed (Annex B) countries may finance greenhouse gas emission reduction or removal projects in developing (Non-Annex B) countries, and receive credits for doing so which they may apply for meeting mandatory limits on their own emissions.

**Climate Change:** Climate change refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of these properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that Article 1 of the UNFCCC defines 'climate change' as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". The UNFCCC thus makes a distinction between 'climate change' attributable to human activities altering atmospheric composition, and 'climate variability' attributable to natural causes.

**CO<sub>2</sub>-equivalent emission (CO<sub>2</sub>eq):** The amount of CO<sub>2</sub> emission that would cause the same radiative forcing as an emitted amount of a greenhouse gas or of a mixture of greenhouse gases, all multiplied by their respective global warming potentials, which take into account the differing times they remain in the atmosphere. See also global warming potential.

**Co-benefits:** The ancillary benefits of targeted policies that accrue to non-targeted, valuable objectives, for example, a wider use of renewable energy may also reduce air pollutants while lowering CO<sub>2</sub> emissions. Different definitions exist in the literature with co-benefits either being addressed intentionally (character of an opportunity) or gained unintentionally (character of a windfall profit). The term co-impact is more generic in covering both benefits and costs. See also drivers and opportunities.

**Cogeneration:** At thermal electricity generation plants otherwise wasted heat is utilized. The heat from steam turbines or hot flue gases exhausted from gas turbines may be used for industrial purposes, heating water or buildings or for district heating. Also referred to as combined heat and power (CHP).

**Combined-cycle gas turbine (CCGT):** A power plant that combines two processes for generating electricity. First, gas or light fuel oil feeds a gas turbine that exhausts hot flue gases (> 600°C). Second, heat recovered from these gases, with additional firing, is the source for producing steam that drives a steam turbine. The turbines rotate separate alternators. It becomes an **integrated CCGT** when the fuel is syngas from

a coal or biomass gasification reactor with exchange of energy flows between the gasification and CCGT plants.

**Compliance:** Compliance is whether and to what extent countries adhere to the provisions of an accord or individuals or firms adhere to regulations. Compliance depends on implementing policies ordered, and on whether measures follow up the policies.

**Conversion:** Energy shows itself in numerous ways, with transformations from one type to another called energy conversions. For example, kinetic energy in wind flows is captured as rotating shaft work further converted to electricity; solar light is converted into electricity by photovoltaic cells. Also, electric currents of given characteristics (e.g., direct/alternating, voltage level) are converted to currents with other characteristics. A **converter** is the equipment used to realize the conversion.

**Cost:** The consumption of resources such as labour time, capital, materials, fuels, etc. as the consequence of an action. In economics, all resources are valued at their **opportunity cost**, which is the value of the most valuable alternative use of the resources. Costs are defined in a variety of ways and under a variety of assumptions that affect their value. The negative of costs are benefits and often both are considered together, for example, net cost is the difference between gross costs and benefits.

**Private costs** are carried by individuals, companies or other entities that undertake the action.

**Social costs** include additionally the external costs for the environment and for society as a whole, for example, **damage costs** of impacts on ecosystems, economies and people due to climate change.

**Total cost** includes all costs due to a specific activity; **average (unit, specific) cost** is total costs divided by the number of units generated; **marginal or incremental cost** is the cost of the last additional unit.

**Project costs** of a renewable energy project include **investment cost** (costs, discounted to the starting year of the project, of making the renewable energy device ready to commence production); **operation and maintenance (O&M) costs** (which occur during operation of the renewable energy facility); and **decommissioning costs** (which occur once the device has ceased production to restore the state of the site of production).

**Lifecycle costs** include all of the above discounted to the starting year of a project.

**Levelized cost of energy** (see Annex II) is the unique cost price of the outputs (US cent/kWh or USD/GJ) of a project that makes the

present value of the revenues (benefits) equal to the present value of the costs over the lifetime of the project. See also discounting and present value.

There are many more categories of costs labelled with names that are often unclear and confusing, for example, installation costs may refer to the hardware equipment installed, or to the activities to put the equipment in place.

**Cost–benefit analysis:** Monetary measurement of all negative and positive impacts associated with a given action. Costs and benefits are compared in terms of their difference and/or ratio as an indicator of how a given investment or other policy effort pays off seen from the society's point of view.

**Cost-effectiveness analysis:** A reduction of cost–benefit analysis in which all the costs of a portfolio of projects are assessed in relation to a fixed policy goal. The policy goal in this case represents the benefits of the projects and all the other impacts are measured as costs or as negative costs (benefits). The policy goal can be, for example, realizing particular renewable energy potentials.

**Deforestation:** The natural or anthropogenic process that converts forest land to non-forest. See also afforestation, reforestation and land use.

**Demand-side management:** Policies and programmes for influencing the demand for goods and/or services. In the energy sector, demand-side management aims at reducing the demand for electricity and other forms of energy required to deliver energy services.

**Density:** Quantity or mass per unit volume, unit area or unit length.

**Energy density** is the amount of energy per unit volume or mass (for example, the heating value of a litre of oil).

**Power density** is typically understood as the capacity deliverable of solar, wind, biomass, hydropower or ocean power per unit area (watts/m<sup>2</sup>). For batteries the capacity per unit weight (watts/kg) is used.

**Direct solar energy** - See solar energy

**Discounting:** A mathematical operation making monetary (or other) amounts received or expended at different points in time (years) comparable across time (see Annex II). The operator uses a fixed or possibly time-varying discount rate (>0) from year to year that makes future value worth less today. A **descriptive discounting approach** accepts the discount rates that people (savers and investors) actually apply in their day-to-day decisions (**private discount rate**). In a **prescriptive (ethical or normative) discounting approach**, the discount rate is fixed from a social perspective, for example, based on an ethical judgement about the interests of future generations (**social discount rate**).

In this report, potentials of renewable energy supplies are assessed using discount rates of 3, 7 and 10%.

**Dispatch (power dispatching / dispatchable):** Electrical power systems that consist of many power supply units and grids are governed by system operators. They allow generators to supply power to the system for balancing demand and supply in a reliable and economical way. Generation units are fully dispatchable when they can be loaded from zero to their nameplate capacity without significant delay. Not fully dispatchable are variable renewable sources that depend on natural currents, but also large-scale thermal plants with shallow ramping rates in changing their output. See also balancing, capacity, grid.

**District heating (DH):** Hot water (steam in old systems) is distributed from central stations to buildings and industries in a densely occupied area (a district, a city or an industrialized area). The insulated two-pipe network functions like a water-based central heating system in a building. The central heat sources can be waste heat recovery from industrial processes, waste incineration plants, geothermal sources, cogeneration power plants or stand-alone boilers burning fossil fuels or biomass. More and more DH systems also provide cooling via cold water or slurries (**district heating and cooling - DHC**).

**Drivers:** In a policy context, drivers provide an impetus and direction for initiating and supporting policy actions. The deployment of renewable energy is, for example, driven by concerns about climate change or energy security. In a more general sense, a driver is the leverage to bring about a reaction, for example, emissions are caused by fossil fuel consumption and/or economic growth. See also opportunities.

**Economies of scale (scale economies):** The unit cost of an activity declines when the activity is extended, for example, more units are produced.

**Ecosystem:** An open system of living organisms, interacting with each other and with their abiotic environment, that is capable of self-regulation to a certain degree. Depending on the focus of interest or study the extent of an ecosystem may range from very small spatial scales to the entire planet.

**Electricity:** The flow of passing charge through a conductor, driven by a difference in voltage between the ends of the conductor. Electrical power is generated by work from heat in a gas or steam turbine or from wind, oceans or falling water, or produced directly from sunlight using a photovoltaic device or chemically in a fuel cell. Being a current, electricity cannot be stored and requires wires and cables for its transmission (see grid). Because electric current flows immediately, the demand for electricity must be matched by production in real time.

**Emissions:** **Direct emissions** are released and attributed at points in a specific renewable energy chain, whether a sector, a technology or an activity. For example, methane emissions from decomposing submerged

organic materials in hydropower reservoirs, or the release of CO<sub>2</sub> dissolved in hot water from geothermal plants, or CO<sub>2</sub> from biomass combustion. **Indirect emissions** are due to activities outside the considered renewable energy chain but which are required to realize the renewable energy deployment. For example, emissions from increased production of fertilizers used in the cultivation of biofuel crops or emissions from displaced crop production or deforestation as the result of biofuel crops. **Avoided emissions** are emission reductions arising from mitigation measures like renewable energy deployment.

**Emission factor:** An emission factor is the rate of emission per unit of activity, output or input.

**Emissions trading:** A market-based instrument to reduce greenhouse gas or other emissions. The environmental objective or sum of total allowed emissions is expressed as an emissions cap. The cap is divided in tradable emission permits that are allocated—either by auctioning or handing out for free (grandfathering)—to entities within the jurisdiction of the trading scheme. Entities need to surrender emission permits equal to the amount of their emissions (e.g., tonnes of CO<sub>2</sub>). An entity may sell excess permits. Trading schemes may occur at the intra-company, domestic or international level and may apply to CO<sub>2</sub>, other greenhouse gases or other substances. Emissions trading is also one of the mechanisms under the Kyoto Protocol.

**Energy:** The amount of work or heat delivered. Energy is classified in a variety of types and becomes available to human ends when it flows from one place to another or is converted from one type into another. Daily, the sun supplies large flows of radiation energy. Part of that energy is used directly, while part undergoes several conversions creating water evaporation, winds, etc. Some share is stored in biomass or rivers that can be harvested. Some share is directly usable such as daylight, ventilation or ambient heat.

**Primary energy** (also referred to as energy sources) is the energy embodied in natural resources (e.g., coal, crude oil, natural gas, uranium, and renewable sources). It is defined in several alternative ways. The International Energy Agency utilizes the physical energy content method, which defines primary energy as energy that has not undergone any anthropogenic conversion. The method used in this report is the direct equivalent method (see Annex II), which counts one unit of secondary energy provided from non-combustible sources as one unit of primary energy, but treats combustion energy as the energy potential contained in fuels prior to treatment or combustion. Primary energy is transformed into **secondary energy** by cleaning (natural gas), refining (crude oil to oil products) or by conversion into electricity or heat. When the secondary energy is delivered at the end-use facilities it is called **final energy** (e.g., electricity at the wall outlet), where it becomes **usable energy** in supplying services (e.g., light).

**Embodied energy** is the energy used to produce a material substance (such as processed metals or building materials), taking into account energy used at the manufacturing facility (zero order), energy used in producing the materials that are used in the manufacturing facility (first order), and so on.

**Renewable energy** (RE) is any form of energy from solar, geophysical or biological sources that is replenished by natural processes at a rate that equals or exceeds its rate of use. Renewable energy is obtained from the continuing or repetitive flows of energy occurring in the natural environment and includes low-carbon technologies such as solar energy, hydropower, wind, tide and waves and ocean thermal energy, as well as renewable fuels such as biomass. For a more detailed description see specific renewable energy types in this glossary, for example, biomass, solar, hydropower, ocean, geothermal and wind.

**Energy access:** People are provided the ability to benefit from affordable, clean and reliable energy services for basic human needs (cooking and heating, lighting, communication, mobility) and productive uses.

**Energy carrier:** A substance for delivering mechanical work or transfer of heat. Examples of energy carriers include: solid, liquid or gaseous fuels (e.g., biomass, coal, oil, natural gas, hydrogen); pressurized/heated/cooled fluids (air, water, steam); and electric current.

**Energy efficiency:** The ratio of useful energy or other useful physical outputs obtained from a system, conversion process, transmission or storage activity to the input of energy (measured as kWh/kWh, tonnes/kWh or any other physical measure of useful output like tonne-km transported, etc.). Energy efficiency is a component of energy intensity.

**Energy intensity:** The ratio of energy inputs (in Joules) to the economic output (in dollars) that absorbed the energy input. Energy intensity is the reciprocal of energy productivity. At the national level, energy intensity is the ratio of total domestic primary (or final) energy use to gross domestic product (GDP). The energy intensity of an economy is the weighted sum of the energy intensities of particular activities with the activities' shares in GDP as weights. Energy intensities are obtained from available statistics (International Energy Agency, International Monetary Fund) and published annually for most countries in the world. Energy intensity is also used as a name for the ratio of energy inputs to output or performance in physical terms (e.g., tonnes of steel output, tonne-km transported, etc.) and in such cases, is the reciprocal of energy efficiency.

**Energy productivity:** The reciprocal of energy intensity.

**Energy savings:** Decreasing energy intensity by changing the activities that demand energy inputs. Energy savings can be realized by technical,

organizational, institutional and structural actions and by changed behaviour.

**Energy security:** The goal of a given country, or the global community as a whole, to maintain an adequate energy supply. Measures encompass safeguarding access to energy resources; enabling development and deployment of technologies; building sufficient infrastructure to generate, store and transmit energy supplies; ensuring enforceable contracts of delivery; and access to energy at affordable prices for a specific society or groups in society.

**Energy services:** Energy services are the tasks to be performed using energy. A specific energy service such as lighting may be supplied by a number of different means from daylighting to oil lamps to incandescent, fluorescent or light-emitting diode devices. The amount of energy used to provide a service may vary over a factor of 10 or more, and the corresponding greenhouse gas emissions may vary from zero to a very high value depending on the source of energy and the type of end-use device.

**Energy transfer:** Energy is transferred as work, light or heat. **Heat transfer** spontaneously occurs from objects at higher temperature to objects at lower temperature and is classified as conduction (when the objects have contact), convection (when a fluid like air or water takes the heat from the warmer object and is moved to the colder object to deliver the heat) and radiation (when heat travels through space in the form of electromagnetic waves).

**Externality / external cost / external benefit:** Externalities arise from a human activity, when agents responsible for the activity do not take full account of the activity's impact on others' production and consumption possibilities, and no compensation exists for such impacts. When the impact is negative, they are external costs. When positive they are referred to as external benefits.

**Feed-in tariff:** The price per unit of electricity that a utility or power supplier has to pay for distributed or renewable electricity fed into the grid by non-utility generators. A public authority regulates the tariff. There may also be a tariff for supporting renewable heat supplies.

**Financing:** Raising or providing money or capital by individuals, businesses, banks, venture funds, public instances, etc. for realizing a project or continuing an activity. Depending on the financier the money is raised and is provided differently. For example, businesses may raise money from internal company profits, debt or equity (shares).

**Project financing** of renewable energy may be provided by financiers to distinct, single-purpose companies, whose renewable energy sales are usually guaranteed by power purchase agreements.

**Non-recourse financing** is known as off-balance sheet since the financiers rely on the certainty of project cash flows to pay back the loan, not on the creditworthiness of the project developer.

**Public equity financing** is capital provided for publicly listed companies.

**Private equity financing** is capital provided directly to private companies.

**Corporate financing** by banks via debt obligations uses 'on-balance sheet' assets as collateral and is therefore limited by the debt ratio of companies that must rationalize each additional loan with other capital needs.

**Fiscal incentive:** Actors (individuals, households, companies) are granted a reduction of their contribution to the public treasury via income or other taxes.

**Fuel cell:** A fuel cell generates electricity in a direct and continuous way from the controlled electrochemical reaction of hydrogen or another fuel and oxygen. With hydrogen as fuel it emits only water and heat (no CO<sub>2</sub>) and the heat can be utilized (see cogeneration).

**General equilibrium models:** General equilibrium models consider simultaneously all the markets and feedback effects among them in an economy leading to market clearance.

**Generation control:** Generation of electricity at a renewable energy plant may be subject to various controls.

**Active control** is a deliberate intervention in the functioning of a system (for example, wind turbine **pitch control**: changing the orientation of the blades for varying a wind turbine's output).

**Passive control** is when natural forces adjust the functioning of a system (for example, wind turbine **stall control**: the design of the blade shape such that at a desired speed the blade spills the wind in order to automatically control the wind turbine's output).

**Geothermal energy:** Accessible thermal energy stored in the Earth's interior, in both rock and trapped steam or liquid water (hydrothermal resources), which may be used to generate electric energy in a thermal power plant, or to supply heat to any process requiring it. The main sources of geothermal energy are the residual energy available from planet formation and the energy continuously generated from radionuclide decay.

**Geothermal gradient:** Rate at which the Earth's temperature increases with depth, indicating heat flowing from the Earth's warm interior to its colder parts.

**Global warming potential (GWP):** GWP is an index, based upon radiative properties of well-mixed greenhouse gases, measuring the radiative forcing of a unit mass of a given well-mixed greenhouse gas in today's atmosphere integrated over a chosen time horizon, relative

to that of CO<sub>2</sub>. The GWP represents the combined effect of the differing lengths of time that these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation. The Kyoto Protocol ranks greenhouse gases on the basis of GWPs from single pulse emissions over subsequent 100-year time frames. See also climate change and CO<sub>2</sub>-equivalent emission.

**Governance:** Governance is a comprehensive and inclusive concept of the full range of means for deciding, managing and implementing policies and measures. Whereas *government* is defined strictly in terms of the nation-state, the more inclusive concept of *governance*, recognizes the contributions of various levels of government (global, international, regional, local) and the contributing roles of the private sector, of nongovernmental actors and of civil society to addressing the many types of issues facing the global community.

**Greenhouse gases (GHGs):** Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere and clouds. This property causes the greenhouse effect. Water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>) and ozone (O<sub>3</sub>) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Besides CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub>, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF<sub>6</sub>), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

**Grid (electric grid, electricity grid, power grid):** A network consisting of wires, switches and transformers to transmit electricity from power sources to power users. A large network is layered from low-voltage (110-240 V) distribution, over intermediate voltage (1-50 kV) to high-voltage (above 50 kV to MV) transport subsystems. Interconnected grids cover large areas up to continents. The grid is a power exchange platform enhancing supply reliability and economies of scale.

**Grid connection** for a power producer is mostly crucial for economical operation.

**Grid codes** are technical conditions for equipment and operation that a power producer must obey for getting supply access to the grid; also consumer connections must respect technical rules.

**Grid access** refers to the acceptance of power producers to deliver to the grid.

**Grid integration** accommodates power production from a portfolio of diverse and some variable generation sources in a balanced power system. See also transmission and distribution.

**Gross Domestic Product (GDP):** The sum of gross value added, at purchasers' prices, by all resident and non-resident producers in the economy, plus any taxes and minus any subsidies not included in the value of the products in a country or a geographic region for a given period, normally one year. It is calculated without deducting for depreciation of fabricated assets or depletion and degradation of natural resources.

**Heat exchanger:** Devices for efficient **heat transfer** from one medium to another without mixing the hot and cold flows, for example, radiators, boilers, steam generators, condensers.

**Heat pump:** Installation that transfers heat from a colder to a hotter place, opposite to the natural direction of heat flows (see energy transfer). Technically similar to a refrigerator, heat pumps are used to extract heat from ambient environments like the ground (geothermal or ground source), water or air. Heat pumps can be inverted to provide cooling in summer.

**Human Development Index (HDI):** The HDI allows the assessment of countries' progress regarding social and economic development as a composite index of three indicators: 1) health measured by life expectancy at birth; 2) knowledge as measured by a combination of the adult literacy rate and the combined primary, secondary and tertiary school enrolment ratio; and 3) standard of living as gross domestic product per capita (in purchasing power parity). The HDI only acts as a broad proxy for some of the key issues of human development; for instance, it does not reflect issues such as political participation or gender inequalities.

**Hybrid vehicle:** Any vehicle that employs two sources of propulsion, most commonly a vehicle that combines an internal combustion engine with an electric motor and storage batteries.

**Hydropower:** The energy of water moving from higher to lower elevations that is converted into mechanical energy through a turbine or other device that is either used directly for mechanical work or more commonly to operate a generator that produces electricity. The term is also used to describe the kinetic energy of stream flow that may also be converted into mechanical energy of a generator through an in-stream turbine to produce electricity.

**Informal sector/economy:** The informal sector/economy is broadly characterized as comprising production units that operate at a small scale and at a low level of organization, with little or no division between labour and capital as factors of production, and with the primary objective of generating income and employment for the persons concerned. The economic activity of the informal sector is not accounted for in determining sectoral or national economic activity.

**Institution:** A structure, a mechanism of social order or cooperation, which governs the behaviour of a group of individuals within a human



community. Institutions are intended to be functionally relevant for an extended period, able to help transcend individual interests and help govern cooperative human behaviour. The term can be extended to also cover regulations, technology standards, certification and the like.

**Integrated assessment:** A method of analysis that combines results and models from the physical, biological, economic and social sciences, and the interactions between these components in a consistent framework to evaluate the status and the consequences of environmental change and the policy responses to it. See also models.

**Kyoto Protocol:** The Kyoto Protocol to the UNFCCC was adopted at the Third Session of the Conference of the Parties in 1997 in Kyoto. It contains legally binding commitments, in addition to those included in the UNFCCC. Annex B countries agreed to reduce their anthropogenic greenhouse gas emissions (CO<sub>2</sub>, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) by at least 5% below 1990 levels in the commitment period 2008 to 2012. The Kyoto Protocol came into force on 16 February 2005. See also UNFCCC.

**Land use (change; direct and indirect):** The total of arrangements, activities and inputs undertaken in a certain land cover type. The social and economic purposes for which land is managed (e.g., grazing, timber extraction and conservation).

**Land use change** occurs whenever land is transformed from one use to another, for example, from forest to agricultural land or to urban areas. Since different land types have different carbon storage potential (e.g., higher for forests than for agricultural or urban areas), land use changes may lead to net emissions or to carbon uptake.

**Indirect land use change** refers to market-mediated or policy-driven shifts in land use that cannot be directly attributed to land use management decisions of individuals or groups. For example, if agricultural land is diverted to fuel production, forest clearance may occur elsewhere to replace the former agricultural production. See also afforestation, deforestation and reforestation.

**Landfill:** A solid waste disposal site where waste is deposited below, at or above ground level. Limited to engineered sites with cover materials, controlled placement of waste and management of liquids and gases. It excludes uncontrolled waste disposal. Landfills often release methane, CO<sub>2</sub> and other gases as organic materials decay.

**Leapfrogging:** The ability of developing countries to bypass intermediate technologies and jump straight to advanced clean technologies. Leapfrogging can enable developing countries to move to a low-emissions development trajectory.

**Learning curve / rate:** Decreasing cost-prices of renewable energy supplies shown as a function of increasing (total or yearly) supplies. Learning

improves technologies and processes over time due to experience, as production increases and/or with increasing research and development. The **learning rate** is the percent decrease of the cost-price for every doubling of the cumulative supplies (also called **progress ratio**).

**Levelized cost of energy** – See Cost.

**Lifecycle analysis (LCA):** LCA aims to compare the full range of environmental damages of any given product, technology, or service (see Annex II). LCA usually includes raw material input, energy requirements, and waste and emissions production. This includes operation of the technology/facility/product as well as all upstream processes (i.e., those occurring prior to when the technology/facility/product commences operation) and downstream processes (i.e., those occurring after the useful lifetime of the technology/facility/product), as in the 'cradle to grave' approach.

**Load (electrical):** The demand for electricity by (thousands to millions) power users at the same moment aggregated and raised by the losses in transport and delivery, and to be supplied by the integrated power supply system.

**Load levelling** reduces the amplitude of the load fluctuations over time.

**Load shedding** occurs when available generation or transmission capacity is insufficient to meet the aggregated loads.

**Peak load** is the maximum load observed over a given period of time (day, week, year) and of short duration.

**Base load** is power continuously demanded over the period.

**Loans:** Loans are money that public or private lenders provide to borrowers mandated to pay back the nominal sum increased with interest payments.

**Soft loans** (also called soft financing or concessional funding) offer flexible or lenient terms for repayment, usually at lower than market interest rates or no interest. Soft loans are provided customarily by government agencies and not by financial institutions.

**Convertible loans** entitle the lender to convert the loan to common or preferred stock (ordinary or preference shares) at a specified conversion rate and within a specified time frame.

**Lock-in:** Technologies that cover large market shares continue to be used due to factors such as sunk investment costs, related infrastructure development, use of complementary technologies and associated social and institutional habits and structures.

**Carbon lock-in** means that the established technologies and practices are carbon intensive.

**Low-carbon technology:** A technology that over its lifecycle causes very low to zero CO<sub>2</sub>eq emissions. See emissions.

**Market failure:** When private decisions are based on market prices that do not reflect the real scarcity of goods and services, they do not generate an efficient allocation of resources but cause welfare losses. Factors causing market prices to deviate from real economic scarcity are environmental externalities, public goods and monopoly power.

**Measures:** In climate policy, measures are technologies, processes or practices that reduce greenhouse gas emissions or impacts below anticipated future levels, for example renewable energy technologies, waste minimization processes, public transport commuting practices, etc. See also policies.

**Merit order (of power plants):** Ranking of all available power generating units in an integrated power system, being the sequence of their short-run marginal cost per kWh starting with the cheapest for delivering electricity to the grid.

**Millennium Development Goals (MDG):** A set of eight time-bound and measurable goals for combating poverty, hunger, disease, illiteracy, discrimination against women and environmental degradation. These were agreed to at the UN Millennium Summit in 2000 together with an action plan to reach these goals.

**Mitigation:** Technological change and changes in activities that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce greenhouse gas emissions and enhance sinks. Renewable energy deployment is a mitigation option when avoided greenhouse gas emissions exceed the sum of direct and indirect emissions (see emissions).

**Mitigation capacity** is a country's ability to reduce anthropogenic greenhouse gas emissions or to enhance natural sinks, where ability refers to skills, competencies, fitness and proficiencies that a country has attained and depends on technology, institutions, wealth, equity, infrastructure and information. Mitigation capacity is rooted in a country's sustainable development path.

**Models:** Models are structured imitations of a system's attributes and mechanisms to mimic appearance or functioning of systems, for example, the climate, the economy of a country, or a crop. Mathematical models assemble (many) variables and relations (often in a computer code) to simulate system functioning and performance for variations in parameters and inputs.

**Bottom-up models** aggregate technological, engineering and cost details of specific activities and processes.

**Top-down models** apply macroeconomic theory, econometric and optimization techniques to aggregate economic variables, like total consumption, prices, incomes and factor costs.

**Hybrid models** integrate bottom-up and top-down models to some degree.

**Non-Annex I countries** – See Annex I countries.

**Non-Annex B countries** – See Annex B countries.

**Ocean energy:** Energy obtained from the ocean via waves, tidal ranges, tidal and ocean currents, and thermal and saline gradients (note: submarine geothermal energy is covered under geothermal energy and marine biomass is covered under biomass energy).

**Offset (in climate policy):** A unit of CO<sub>2</sub>-equivalent (CO<sub>2</sub>eq) that is reduced, avoided or sequestered to compensate for emissions occurring elsewhere.

**Opportunities:** In general: conditions that allow for advancement, progress or profit. In the policy context, circumstances for action with the attribute of a chance character. For example, the anticipation of additional benefits that may go along with the deployment of renewable energy (enhanced energy access and energy security, reduced local air pollution) but are not intentionally targeted. See also co-benefits and drivers.

**Path dependence:** Outcomes of a process are conditioned by previous decisions, events and outcomes, rather than only by current actions. Choices based on transitory conditions can exert a persistent impact long after those conditions have changed.

**Payback:** Mostly used in investment appraisal as **financial payback**, which is the time needed to repay the initial investment by the returns of a project. A **payback gap** exists when, for example, private investors and micro-financing schemes require higher profitability rates from renewable energy projects than from fossil-fired ones. Imposing an x-times higher financial return on renewable energy investments is equivalent to imposing an x-times higher technical performance hurdle on delivery by novel renewable solutions compared to incumbent energy expansion. **Energy payback** is the time an energy project needs to deliver as much energy as had been used for setting the project online. **Carbon payback** is the time a renewable energy project needs to deliver as much net greenhouse gas savings (with respect to the fossil reference energy system) as its realization has caused greenhouse gas emissions from a perspective of lifecycle analysis (including land use changes and loss of terrestrial carbon stocks).

**Photosynthesis:** The production of carbohydrates in plants, algae and some bacteria using the energy of light. CO<sub>2</sub> is used as the carbon source.

**Photovoltaics (PV):** The technology of converting light energy directly into electricity by mobilizing electrons in solid state devices. The specially prepared thin sheet semiconductors are called PV cells. See solar energy.

**Policies:** Policies are taken and/or mandated by a government—often in conjunction with business and industry within a single country, or collectively with other countries—to accelerate mitigation and adaptation measures. Examples of policies are support mechanisms for renewable energy supplies, carbon or energy taxes, fuel efficiency standards for automobiles, etc.

*Common and co-ordinated or harmonized policies* refer to those adopted jointly by parties. See also measures.

**Policy criteria:** General: a standard on which a judgment or decision may be based. In the context of policies and policy instruments to support renewable energy, four inclusive criteria are common:

**Effectiveness** (efficacy) is the extent to which intended objectives are met, for instance the actual increase in the output of renewable electricity generated or shares of renewable energy in total energy supplies within a specified time period. Beyond *quantitative* targets, this may include factors such as achieved degrees of *technological diversity* (promotion of different renewable energy technologies) or of *spatial diversity* (geographical distribution of renewable energy supplies).

**Efficiency** is the ratio of outcomes to inputs, for example, renewable energy targets realized for economic resources spent, mostly measured at one point of time (*static efficiency*), also called cost-effectiveness. *Dynamic efficiency* adds a future time dimension by including how much innovation is triggered to improve the ratio of outcomes to inputs.

**Equity** covers the incidence and distributional consequences of a policy, including fairness, justice and respect for the rights of indigenous peoples. The equity criterion looks at the *distribution* of costs and benefits of a policy and at the *inclusion* and *participation* of wide ranges of different stakeholders (e.g., local populations, independent power producers).

**Institutional feasibility** is the extent to which a policy or policy instrument is seen as legitimate, able to gain acceptance, and able to be adopted and implemented. It covers **administrative feasibility** when compatible with the available information base and administrative capacity, legal structure and economic realities. **Political feasibility** needs acceptance and support by stakeholders, organizations and constituencies, and compatibility with prevailing cultures and traditions.

**Polluter pays principle:** In 1972 the OECD agreed that polluters should pay the costs of abating the own environmental pollution, for example by installation of filters, sanitation plants and other add-on techniques. This is the narrow definition. The extended definition is when polluters would additionally pay for the damage caused by their residual pollution (eventually also historical pollution). Another extension is the precautionary polluter pays principle where potential polluters are mandated to take insurance or preventive measures for pollution that may occur in the future. The acronym PPP has also other meanings, such as Preventing Pollution Pays-off, Public Private Partnership, or Purchasing Power Parity.

**Portfolio analysis:** Examination of a collection of assets or policies that are characterized by different risks and payoffs. The objective function is built up around the variability of returns and their risks, leading up to the decision rule to choose the portfolio with highest expected return.

**Potential:** Several levels of renewable energy supply potentials can be identified, although every level may span a broad range. In this report, **resource potential** encompasses all levels for a specific renewable energy resource.

**Market potential** is the amount of renewable energy output expected to occur under forecast market conditions, shaped by private economic agents and regulated by public authorities. Private economic agents realize private objectives within given, perceived and expected conditions. Market potentials are based on expected private revenues and expenditures, calculated at private prices (incorporating subsidies, levies and rents) and with private discount rates. The private context is partly shaped by public authority policies.

**Economic potential** is the amount of renewable energy output projected when all social costs and benefits related to that output are included, there is full transparency of information, and assuming exchanges in the economy install a general equilibrium characterized by spatial and temporal efficiency. Negative externalities and co-benefits of all energy uses and of other economic activities are priced. Social discount rates balance the interests of consecutive human generations.

**Sustainable development potential** is the amount of renewable energy output that would be obtained in an *ideal setting* of perfect economic markets, optimal social (institutional and governance) systems and achievement of the sustainable flow of environmental goods and services. This is distinct from economic potential because it explicitly addresses inter- and intra-generational equity (distribution) and governance issues.

**Technical potential** is the amount of renewable energy output obtainable by full implementation of demonstrated technologies or practices. No explicit reference to costs, barriers or policies is made.

Technical potentials reported in the literature being assessed in this report, however, may have taken into account practical constraints and when explicitly stated there, they are generally indicated in the underlying report.

**Theoretical potential** is derived from natural and climatic (physical) parameters (e.g., total solar irradiation on a continent's surface). The theoretical potential can be quantified with reasonable accuracy, but the information is of limited practical relevance. It represents the upper limit of what can be produced from an energy resource based on physical principles and current scientific knowledge. It does not take into account energy losses during the conversion process necessary to make use of the resource, nor any kind of barriers.

**Power:** Power is the rate in which energy is transferred or converted per unit of time or the rate at which work is done. It is expressed in watts (joules/second).

**Present value:** The value of a money amount differs when the amount is available at different moments in time (years). To make amounts at differing times comparable and additive, a date is fixed as the 'present.' Amounts available at different dates in the future are discounted back to a present value, and summed to get the present value of a series of future cash flows. **Net present value** is the difference between the present value of the revenues (benefits) and the present value of the costs. See also discounting.

**Project cost** – see Cost.

**Progress ratio** – see Learning curve / rate.

**Public finance:** Public support for which a financial return is expected (loans, equity) or financial liability is incurred (guarantee).

**Public good:** Public goods are simultaneously used by several parties (opposite to private goods). Some public goods are fully free from rivalry in use; for others the use by some subtract from the availability for others, creating congestion. Access to public goods may be restricted dependent on whether public goods are commons, state-owned or res nullius (no one's case). The atmosphere and climate are the ultimate public goods of mankind. Many renewable energy sources are also public goods.

**Public-private partnerships:** Arrangements typified by joint working between the public and private sector. In the broadest sense, they cover all types of collaboration across the interface between the public and private sectors to deliver services or infrastructure.

**Quota (on renewable electricity/energy):** Established quotas obligate designated parties (generators or suppliers) to meet minimum (often gradually increasing) renewable energy targets, generally expressed as percentages of total supplies or as an amount of renewable energy capacity, with costs borne by consumers. Various countries use

different names for quotas, for example, Renewable Portfolio Standards, Renewable Obligations. See also tradable certificates

**Reactive power:** The part of instantaneous power that does no real work. Its function is to establish and sustain the electric and magnetic fields required to let active power perform useful work.

**Rebound effect:** After implementation of efficient technologies and practices, part of the expected energy savings is not realized because the accompanying savings in energy bills may be used to acquire more energy services. For example, improvements in car engine efficiency lower the cost per kilometre driven, encouraging consumers to drive more often or longer distances, or to spend the saved money on other energy-consuming activities. Successful energy efficiency policies may lead to lower economy-wide energy demand and if so to lower energy prices with the possibility of the financial savings stimulating rebound effects. The rebound effect is the ratio of non-realized energy and resource savings compared to the potential savings in case consumption would have remained constant as before the efficiency measures were implemented. For climate change, the main concern about rebound effects is their impact on CO<sub>2</sub> emissions (carbon rebound).

**Reforestation:** Direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was previously forested but converted to non-forested land. See also afforestation, deforestation and land use.

**Regulation:** A rule or order issued by governmental executive authorities or regulatory agencies and having the force of law. Regulations implement policies and are mostly specific for particular groups of people, legal entities or targeted activities. Regulation is also the act of designing and imposing rules or orders. Informational, transactional, administrative and political constraints in practice limit the regulator's capability for implementing preferred policies.

**Reliability:** In general: reliability is the degree of performance according to imposed standards or expectations.

**Electrical reliability** is the absence of unplanned interruptions of the current by, for example, shortage of supply capacity or by failures in parts of the grid. Reliability differs from security and from fluctuations in power quality due to impulses or harmonics.

**Renewable energy** – see Energy

**Scenario:** A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key relationships and driving forces (e.g., rate of technological change, prices) on social and economic development, energy use, etc. Note that scenarios are neither predictions nor forecasts, but are useful to provide a view of the implications of alternative developments and actions. See also baseline, business as usual, models.

**Seismicity:** The distribution and frequency of earthquakes in time, magnitude and space, for example, the yearly number of earthquakes of magnitude between 5 and 6 per 100 km<sup>2</sup> or in some region.

**Sink:** Any process, activity or mechanism that removes a greenhouse gas or aerosol, or a precursor of a greenhouse gas or aerosol, from the atmosphere.

**Solar collector:** A device for converting solar energy to thermal energy (heat) of a flowing fluid.

**Solar energy:** Energy from the Sun that is captured either as heat, as light that is converted into chemical energy by natural or artificial photosynthesis, or by photovoltaic panels and converted directly into electricity.

**Concentrating solar power (CSP)** systems use either lenses or mirrors to capture large amounts of solar energy and focus it down to a smaller region of space. The higher temperatures produced can operate a thermal steam turbine or be used in high-temperature industrial processes.

**Direct solar energy** refers to the use of solar energy as it arrives at the Earth's surface before it is stored in water or soils.

**Solar thermal** is the use of direct solar energy for heat end-uses, excluding CSP.

**Active solar** needs equipment like panels, pumps and fans to collect and distribute the energy.

**Passive solar** is based on structural design and construction techniques that enable buildings to utilize solar energy for heating, cooling and lighting by non-mechanical means.

**Solar irradiance:** The rate of solar power incidence on a surface (W/m<sup>2</sup>). Irradiance depends on the orientation of the surface, with as special orientations: (a) surfaces perpendicular to the beam solar radiation; (b) surfaces horizontal with or on the ground. **Full sun** is solar irradiance that is approximately 1,000 W/m<sup>2</sup>.

**Solar radiation:** The sun radiates light and heat energy in wavelengths from ultraviolet to infrared. Radiation arriving at surfaces may be absorbed, reflected or transmitted.

**Global solar radiation** consists of **beam** (arriving on Earth in a straight line) and **diffuse radiation** (arriving on Earth after being scattered by the atmosphere and by clouds).

**Standards:** Set of rules or codes mandating or defining product performance (e.g., grades, dimensions, characteristics, test methods and rules for use).

**Product, technology or performance standards** establish minimum requirements for affected products or technologies.

**Subsidy:** Direct payment from the government or a tax reduction to a private party for implementing a practice the government wishes to encourage. The reduction of greenhouse gas emissions is stimulated by lowering existing subsidies that have the effect of raising emissions (such as subsidies for fossil fuel use) or by providing subsidies for practices that reduce emissions or enhance sinks (e.g., renewable energy projects, insulation of buildings or planting trees).

**Sustainable development (SD):** The concept of sustainable development was introduced in the World Conservation Strategy of the International Union for Conservation of Nature in 1980 and had its roots in the concept of a sustainable society and in the management of renewable resources. Adopted by the World Council for Environment and Development in 1987 and by the Rio Conference in 1992 as a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. SD integrates the political, social, economic and environmental dimensions, and respects resource and sink constraints.

**Tax:** A **carbon tax** is a levy on the carbon content of fossil fuels. Because virtually all of the carbon in fossil fuels is ultimately emitted as CO<sub>2</sub>, a carbon tax is equivalent to an **emission tax** on CO<sub>2</sub> emissions. An **energy tax**—a levy on the energy content of fuels—reduces demand for energy and so reduces CO<sub>2</sub> emissions from fossil fuel use. An **eco-tax** is a carbon, emissions or energy tax designed to influence human behaviour (specifically economic behaviour) to follow an ecologically benign path. A **tax credit** is a reduction of tax in order to stimulate purchasing of or investment in a certain product, like greenhouse gas emission-reducing technologies. A **levy** or **charge** is used as synonymous for tax.

**Technological change:** Mostly considered as technological *improvement*, that is, more or better goods and services can be provided from a given amount of resources (production factors). Economic models distinguish autonomous (exogenous), endogenous and induced technological change.

**Autonomous (exogenous) technological change** is imposed from outside the model (i.e., as a parameter), usually in the form of a time trend affecting factor or/and energy productivity and therefore energy demand or output growth.

**Endogenous technological change** is the outcome of economic activity *within* the model (i.e., as a variable) so that factor productivity or the choice of technologies is included within the model and affects energy demand and/or economic growth.

**Induced technological change** implies endogenous technological change but adds further changes *induced* by policies and measures, such as carbon taxes triggering research and development efforts.

**Technology:** The practical application of knowledge to achieve particular tasks that employs both technical artefacts (hardware, equipment) and (social) information ('software', know-how for production and use of artefacts).

**Supply push** aims at developing specific technologies through support for research, development and demonstration.

**Demand pull** is the practice of creating market and other incentives to induce the introduction of particular sets of technologies (e.g., low-carbon technologies through carbon pricing) or single technologies (e.g., through technology-specific feed-in tariffs).

**Technology transfer:** The exchange of knowledge, hardware and associated software, money and goods among stakeholders, which leads to the spread of technology for adaptation or mitigation. The term encompasses both diffusion of technologies and technological cooperation across and within countries.

**Tradable certificates (tradable green certificates):** Parties subject to a renewable energy quota meet the annual obligation by delivering the appropriate amount of tradable certificates to a regulatory office. The certificates are created by the office and assigned to the renewable energy producers to sell or for their own use in fulfilling their quota. See quota.

**Transmission and distribution (electricity):** The network that transmits electricity through wires from where it is generated to where it is used. The distribution system refers to the lower-voltage system that actually delivers the electricity to the end user. See also grid.

**Turbine:** Equipment that converts the kinetic energy of a flow of air, water, hot gas or steam into rotary mechanical power, used for direct drive or electricity generation (see wind, hydro, gas or steam turbines). **Condensing steam turbines** exhaust depleted steam in a heat exchanger (called condenser) using ambient cooling from water (river, lake, sea) or air sources (cooling towers). A **backpressure steam turbine** has no condenser at ambient temperature conditions, but exhausts all steam at higher temperatures for use in particular heat end-uses.

**United Nations Framework Convention on Climate Change (UNFCCC):** The Convention was adopted on 9 May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Economic Community. Its ultimate objective is the "stabilization of greenhouse gas concentrations in the atmosphere

at a level that would prevent dangerous anthropogenic interference with the climate system". It contains commitments for all parties. Under the Convention, parties included in Annex I aimed to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The convention came into force in March 1994. In 1997, the UNFCCC adopted the Kyoto Protocol. See also Annex I countries, Annex B countries and Kyoto Protocol.

**Valley of death:** Expression for a phase in the development of some technology when it is generating a large and negative cash flow because development costs increase but the risks associated with the technology are not reduced enough to entice private investors to take on the financing burden.

**Value added:** The net output of a sector or activity after adding up all outputs and subtracting intermediate inputs.

**Values:** Worth, desirability or utility based on individual preferences. Most social science disciplines use several definitions of value. Related to nature and environment, there is a distinction between intrinsic and instrumental values, the latter assigned by humans. Within instrumental values, there is an unsettled catalogue of different values, such as (direct and indirect) use, option, conservation, serendipity, bequest, existence, etc.

Mainstream economics define the total value of any resource as the sum of the values of the different individuals involved in the use of the resource. The economic values, which are the foundation of the estimation of costs, are measured in terms of the willingness to pay by individuals to receive the resource or by the willingness of individuals to accept payment to part with the resource.

**Vent (geothermal/hydrothermal/submarine):** An opening at the surface of the Earth (terrestrial or submarine) through which materials and energy flow.

**Venture capital:** A type of private equity capital typically provided for early-stage, high-potential technology companies in the interest of generating a return on investment through a trade sale of the company or an eventual listing on a public stock exchange.

**Well-to-tank (WTT):** WTT includes activities from resource extraction through fuel production to delivery of the fuel to vehicle. Compared to WTW, WTT does not take into consideration fuel use in vehicle operations.

**Well-to-wheel (WTW):** WTW analysis refers to specific lifecycle analysis applied to transportation fuels and their use in vehicles. The WTW stage includes resource extraction, fuel production, delivery of the fuel

to vehicle, and end use of fuel in vehicle operations. Although feedstocks for alternative fuels do not necessarily come from a well, the WTW terminology is adopted for transportation fuel analysis.

**Wind energy:** Kinetic energy from air currents arising from uneven heating of the Earth's surface. A **wind turbine** is a rotating machine including

its support structure for converting the kinetic energy to mechanical shaft energy to generate electricity. A **windmill** has oblique vanes or sails and the mechanical power obtained is mostly used directly, for example, for water pumping. A **wind farm**, **wind project** or **wind power plant** is a group of wind turbines interconnected to a common utility system through a system of transformers, distribution lines, and (usually) one substation.

## Acronyms

<b>AA-CAES</b>	Advanced adiabatic compressed air energy storage	<b>DDG</b>	Distillers dried grains
<b>AC</b>	Alternating current	<b>DDGS</b>	Distillers dried grains plus solubles
<b>AEM</b>	Anion exchange membrane	<b>DH</b>	District heating
<b>AEPC</b>	Alternative Energy Promotion Centre	<b>DHC</b>	District heating or cooling
<b>AFEX</b>	Ammonia fibre expansion	<b>DHW</b>	Domestic hot water
<b>APU</b>	Auxiliary power unit	<b>DLR</b>	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Centre)
<b>AR4</b>	4th assessment report (of the IPCC)	<b>DLUC</b>	Direct land use change
<b>AR5</b>	5th assessment report (of the IPCC)	<b>DME</b>	Dimethyl ether
<b>BC</b>	Black carbon	<b>DNI</b>	Direct-normal irradiance
<b>BCCS</b>	Biological carbon sequestration	<b>DPH</b>	Domestic pellet heating
<b>Bio-CCS</b>	Biomass with carbon capture and storage	<b>DSSC</b>	Dye-sensitized solar cell
<b>BIPV</b>	Building-integrated photovoltaic	<b>EGS</b>	Enhanced geothermal systems
<b>BMU</b>	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)	<b>EGTT</b>	Expert Group on Technology Transfer
<b>BNEF</b>	Bloomberg New Energy Finance	<b>EIA</b>	Energy Information Administration (USA)
<b>BOS</b>	Balance of systems	<b>EIT</b>	Economy In Transition
<b>BSI</b>	Better Sugarcane Initiative	<b>EMEC</b>	European Marine Energy Centre
<b>CAES</b>	Compressed air energy storage	<b>EMF</b>	Energy Modelling Form
<b>CBP</b>	Consolidated bioprocessing	<b>EMI</b>	Electromagnetic interference
<b>CC</b>	Combined cycle	<b>ENSAD</b>	Energy-Related Severe Accident Database
<b>CCiy</b>	China Coal Industry Yearbook	<b>EPRI</b>	Electric Power Research Institute (USA)
<b>CCS</b>	Carbon dioxide capture and storage	<b>EPT</b>	Energy payback time
<b>CDM</b>	Clean Development Mechanism	<b>E[R]</b>	Energy [R]evolution
<b>CEM</b>	Cation exchange membrane	<b>ER</b>	Energy ratio
<b>CER</b>	Certified Emissions Reduction	<b>ERCOT</b>	Electric Reliability Council of Texas
<b>CF</b>	Capacity factor	<b>EREC</b>	European Renewable Energy Council
<b>CFB</b>	Circulating fluid bed	<b>EROEI</b>	Energy return on energy investment
<b>CFD</b>	Computational fluid dynamics	<b>ESMAP</b>	Energy Sector Management Program (World Bank)
<b>CFL</b>	Compact fluorescent lightbulb	<b>ETBE</b>	Ethyl tert-butyl ether
<b>CHP</b>	Combined heat and power	<b>ETP</b>	Energy Technology Perspectives
<b>CIGSS</b>	Copper indium/gallium disulfide/(di)selenide	<b>EU</b>	European Union
<b>CIS</b>	Commonwealth of Independent States	<b>EV</b>	Electric vehicle
<b>CMA</b>	China's Meteorological Administration	<b>FACTS</b>	Flexible AC transmission system
<b>CNG</b>	Compressed natural gas	<b>FASOM</b>	Forest and Agricultural Sector Optimization Model
<b>CoC</b>	Chain of custody	<b>FAO</b>	Food and Agriculture Organization (of the UN)
<b>COP</b>	Coefficient of performance	<b>FFV</b>	Flexible fuel vehicle
<b>CPP</b>	Captive power plant	<b>FQD</b>	Fuel quality directive
<b>CPV</b>	Concentrating photovoltaics	<b>FIT</b>	Feed-in tariff
<b>CREZ</b>	Competitive renewable energy zone	<b>FOGIME</b>	Crediting System in Favour of Energy Management
<b>CRF</b>	Capital recovery factor	<b>FRT</b>	Fault ride through
<b>CSIRO</b>	Commonwealth Scientific and Industrial Research Organisation	<b>FSU</b>	Former Soviet Union
<b>CSP</b>	Concentrating solar power	<b>FTD</b>	Fischer-Tropsch diesel
<b>CPV</b>	Concentrating photovoltaics	<b>GBD</b>	Global burden of disease
<b>CSTD</b>	Commission on Science and Technology (UN)	<b>GBEP</b>	Global Bioenergy Partnership
<b>DALY</b>	Disability-adjusted life year	<b>GCAM</b>	Global Change Assessment Model
<b>dBA</b>	A-weighted decibels	<b>GCM</b>	Global climate model; General circulation model
<b>DC</b>	Direct current or district cooling	<b>GDP</b>	Gross domestic product
		<b>GEF</b>	Global Environment Facility
		<b>GHG</b>	Greenhouse gas
		<b>GHP</b>	Geothermal heat pump



<b>GIS</b>	Geographic information system	<b>LDV</b>	Light duty vehicle
<b>GM</b>	Genetically modified	<b>LED</b>	Light-emitting diode
<b>GMO</b>	Genetically modified organism	<b>LHV</b>	Lower heating value
<b>GO</b>	Guarantee of origin	<b>LNG</b>	Liquefied natural gas
<b>GPI</b>	Genuine progress indicator	<b>LPG</b>	Liquefied petroleum gas
<b>GPS</b>	Global positioning system	<b>LR</b>	Learning rate
<b>GSHP</b>	Ground source heat pump	<b>LUC</b>	Land use change
<b>HANPP</b>	Human appropriation of terrestrial NPP	<b>M&amp;A</b>	Mergers and acquisitions
<b>HCE</b>	Heat collection element	<b>MDG</b>	Millennium Development Goals
<b>HDI</b>	Human Development Index	<b>MEH</b>	Multiple-effect humidification
<b>HDR</b>	Hot dry rock	<b>MHS</b>	Micro-hydropower systems
<b>HDV</b>	Heavy duty vehicle	<b>MITI</b>	Ministry of International Trade and Industry (Japan)
<b>HFCV</b>	Hydrogen fuel cell electric vehicle	<b>MSW</b>	Municipal solid waste
<b>HFR</b>	Hot fractured rock	<b>NASA</b>	National Aeronautics and Space Administration (USA)
<b>HHV</b>	Higher heating value	<b>NDRC</b>	National Development and Reform Commission (China)
<b>HPP</b>	Hydropower plant	<b>NFFO</b>	Non Fossil Fuel Obligation
<b>HRV</b>	Heat recovery ventilator	<b>NG</b>	Natural gas
<b>HEV</b>	Hybrid electric vehicle	<b>NGO</b>	Nongovernmental organization
<b>HVAC</b>	Heating, ventilation and air-conditioning	<b>Nm<sup>3</sup></b>	Normal cubic metre (of gas) at standard temperature and pressure
<b>HVDC</b>	High voltage direct current	<b>NMVO</b>	Non-methane volatile organic compounds
<b>HWR</b>	Hot wet rock	<b>NPP</b>	Net primary production
<b>IA</b>	Impact assessment	<b>NPV</b>	Net present value
<b>IAP</b>	Indoor air pollution	<b>NRC</b>	National Research Council (USA)
<b>IBC</b>	interdigitated back-contact	<b>NREL</b>	National Renewable Energy Laboratory (USA)
<b>ICE</b>	Internal combustion engine	<b>NSDS</b>	National Sustainable Development Strategies
<b>ICEV</b>	Internal combustion engine vehicle	<b>O&amp;M</b>	Operation and maintenance
<b>ICLEI</b>	Local Governments for Sustainability	<b>OB</b>	Oscillating-body
<b>ICOLD</b>	International Commission on Large Dams	<b>OC</b>	Organic carbon
<b>ICS</b>	Improved cookstove or Integral collector storage (Ch 3)	<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>ICTSD</b>	International Centre for Trade and Sustainable Development	<b>OM</b>	Organic matter
<b>IEA</b>	International Energy Agency	<b>OPV</b>	Organic photovoltaic
<b>IEC</b>	International Electrotechnical Commission	<b>ORC</b>	Organic Rankine Cycle
<b>IEEE</b>	Institute of Electrical and Electronics Engineers	<b>OTEC</b>	Ocean thermal energy conversion
<b>IHA</b>	International Hydropower Association	<b>OWC</b>	Oscillating water column
<b>ILUC</b>	Indirect land use change	<b>PACE</b>	Property Assessed Clean Energy
<b>IGCC</b>	Integrated gasification combined cycle	<b>PBR</b>	Photobioreactor
<b>IPCC</b>	Intergovernmental Panel on Climate Change	<b>PCM</b>	Phase-change material
<b>IPR</b>	Intellectual property rights	<b>PDI</b>	Power density index
<b>IQR</b>	Inter-quartile range	<b>PEC</b>	Photoelectrochemical
<b>IREDA</b>	Indian Renewable Energy Development Agency	<b>PHEV</b>	Plug-in hybrid electric vehicle
<b>IRENA</b>	International Renewable Energy Agency	<b>PM</b>	Particulate matter
<b>IRM</b>	Inorganic mineral raw materials	<b>POME</b>	Palm oil mill effluent
<b>ISCC</b>	Integrated solar combined-cycle	<b>PPA</b>	Purchase power agreement
<b>ISES</b>	International Solar Energy Society	<b>PRO</b>	Pressure-retarded osmosis
<b>ISEW</b>	Index of sustainable economic welfare	<b>PROALCOOL</b>	Brazilian Alcohol Program
<b>ISO</b>	International Organization for Standardization	<b>PSA</b>	Probabilistic safety assessment
<b>J</b>	Joule	<b>PSI</b>	Paul Scherrer Institute
<b>JI</b>	Joint implementation	<b>PSP</b>	Pumped storage plants
<b>LCA</b>	Lifecycle assessment	<b>PTC</b>	Production tax credit
<b>LCOE</b>	Levelized cost of energy (or of electricity)	<b>PV</b>	Photovoltaic
<b>LCOF</b>	Levelized cost of fuel		
<b>LCOH</b>	Levelized cost of heat		

<b>PV/T</b>	Photovoltaic/thermal	<b>SSCF</b>	Simultaneous saccharification and co-fermentation
<b>PWR</b>	Pressurized water reactor	<b>SSF</b>	Simultaneous saccharification and fermentation
<b>R&amp;D</b>	Research and development	<b>SSP</b>	Space-based solar power
<b>RBMK</b>	Reaktor bolshoy moshchnosty kanalny	<b>STP</b>	Standard temperature and pressure
<b>RCM</b>	Regional climate model	<b>SWH</b>	Solar water heating
<b>RD&amp;D</b>	Research, development and demonstration	<b>TBM</b>	Tunnel-boring machines
<b>R/P</b>	Reserves to current production (ratio)	<b>TERM</b>	Tonga Energy Roadmap
<b>RD</b>	Renewable diesel	<b>TGC</b>	Tradable green certificate
<b>RE</b>	Renewable energy	<b>TPA</b>	Third-party access
<b>RE-C</b>	Renewable energy cooling	<b>TPES</b>	Total primary energy supply
<b>RE-H</b>	Renewable energy heating	<b>TPWind</b>	European Wind Energy Technology Platform
<b>RE-H/C</b>	Renewable energy heating/cooling	<b>TS</b>	Technical Summary or thermosyphon
<b>REC</b>	Renewable energy certificate	<b>US</b>	United States of America (adjective)
<b>RED</b>	Reversed electro dialysis	<b>USA</b>	United States of America (noun)
<b>REN21</b>	Renewable Energy Policy Network for the 21st Century	<b>UN</b>	United Nations
<b>RES</b>	Renewable electricity standard	<b>UNCED</b>	United Nations Conference on Environment and Development
<b>RM&amp;U</b>	Renovation, modernization and upgrading	<b>UNCTAD</b>	United Nations Conference on Trade and Development
<b>RMS</b>	Root mean square	<b>UNDP</b>	United Nations Development Programme
<b>RNA</b>	Rotor nacelle assembly	<b>UNEP</b>	United Nations Environment Programme
<b>RO</b>	Renewables obligation	<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>RoR</b>	Run of river	<b>USD</b>	US dollar
<b>RPS</b>	Renewable portfolio standard	<b>USDOE</b>	US Department of Energy
<b>RSB</b>	Roundtable for Sustainable Biofuels	<b>V</b>	Volt
<b>SCADA</b>	Supervisory control and data acquisition	<b>VKT</b>	Vehicle kilometres travelled
<b>SCC</b>	Stress corrosion cracking	<b>VRB</b>	Vanadium redox battery
<b>SD</b>	Sustainable development	<b>W</b>	Watt
<b>SEGS</b>	Solar Electric Generating Station (California)	<b>W<sub>e</sub></b>	Watt of electricity
<b>SHC</b>	Solar heating and cooling	<b>W<sub>p</sub></b>	Watt peak of PV installation
<b>SHP</b>	Small-scale hydropower plant	<b>WBG</b>	World Bank Group
<b>SI</b>	Suitability index	<b>WCD</b>	World Commission on Dams
<b>SME</b>	Small and medium sized enterprises	<b>WCED</b>	World Commission on Environment and Development
<b>SNG</b>	Synthesis gas	<b>WEA</b>	World Energy Assessment
<b>SNV</b>	Netherlands Development Organization	<b>WEO</b>	World Energy Outlook
<b>SPF</b>	Seasonal performance factor	<b>WindPACT</b>	Wind Partnership for Advanced Component Technologies
<b>SPM</b>	Summary for Policymakers	<b>WTO</b>	World Trade Organization
<b>SPP</b>	Small power producer	<b>WTW</b>	Well to wheel
<b>SPS</b>	Sanitary and phytosanitary		
<b>SR</b>	Short rotation		
<b>SRES</b>	Special Report on Emission Scenarios (of the IPCC)		
<b>SRREN</b>	Special Report on Renewable Energy Sources and Climate Change Mitigation (of the IPCC)		

## Chemical Symbols

<b>a-Si</b>	Amorphous silicon	<b>H<sub>2</sub>S</b>	Hydrogen sulphide
<b>C</b>	Carbon	<b>HFC</b>	Hydrofluorocarbons
<b>CdS</b>	Cadmium sulphide	<b>K</b>	Potassium
<b>CdTe</b>	Cadmium telluride	<b>Mg</b>	Magnesium
<b>CH<sub>4</sub></b>	Methane	<b>N</b>	Nitrogen
<b>CH<sub>3</sub>CH<sub>2</sub>OH</b>	Ethanol	<b>N<sub>2</sub></b>	Nitrogen gas
<b>CH<sub>3</sub>OCH<sub>3</sub></b>	Dimethyl ether (DME)	<b>N<sub>2</sub>O</b>	Nitrous oxide
<b>CH<sub>3</sub>OH</b>	Methanol	<b>Na</b>	Sodium
<b>CIGS(S)</b>	Copper indium gallium diselenide (disulfide)	<b>NaS</b>	Sodium-sulfur
<b>Cl</b>	Chlorine	<b>NH<sub>3</sub></b>	Ammonia
<b>CO</b>	Carbon monoxide	<b>Ni</b>	Nickel
<b>CO<sub>2</sub></b>	Carbon dioxide	<b>NiCd</b>	Nickel-cadmium
<b>CO<sub>2</sub>eq</b>	Carbon dioxide equivalent	<b>NO<sub>x</sub></b>	Nitrous oxides
<b>c-Si</b>	Crystalline silicon	<b>O<sub>3</sub></b>	Ozone
<b>Cu</b>	Copper	<b>P</b>	Phosphorus
<b>CuInSe<sub>2</sub></b>	Copper indium diselenide	<b>PFC</b>	Perfluorocarbon
<b>DME</b>	Dimethyl ether	<b>SF<sub>6</sub></b>	Sulfur hexafluoride
<b>Fe</b>	Iron	<b>Si</b>	Silicon
<b>GaAs</b>	Gallium arsenide	<b>SiC</b>	Silicon carbide
<b>H<sub>2</sub></b>	Hydrogen gas	<b>SO<sub>2</sub></b>	Sulfur dioxide
<b>H<sub>2</sub>O</b>	Water	<b>ZnO</b>	Zinc oxide

## Prefixes (International Standard Units)

Symbol	Multiplier	Prefix	Symbol	Multiplier	Prefix
Z	10 <sup>21</sup>	zetta	d	10 <sup>-1</sup>	deci
E	10 <sup>18</sup>	exa	c	10 <sup>-2</sup>	centi
P	10 <sup>15</sup>	peta	m	10 <sup>-3</sup>	milli
T	10 <sup>12</sup>	tera	μ	10 <sup>-6</sup>	micro
G	10 <sup>9</sup>	giga	n	10 <sup>-9</sup>	nano
M	10 <sup>6</sup>	mega	p	10 <sup>-12</sup>	pico
k	10 <sup>3</sup>	kilo	f	10 <sup>-15</sup>	femto
h	10 <sup>2</sup>	hecto	a	10 <sup>-18</sup>	atto
da	10	deca			