Glossary

absorbed dose: the ratio of the mean energy imparted to an element of material exposed to ionizing radiation, over the mass of that element. This is expressed in **grays** (**Gy**): 1 gray corresponding to an absorbed energy of 1 joule per kilogram of material.

actinides (**An**)**: radioelements** of **atomic number** ranging from 89 (actinium) to 103 (lawrencium). **Major actinides:** atoms of **uranium** and **plutonium**, present, or generated, in nuclear **fuel**. **Thorium** may also be counted a major actinide. **Minor actinides** (**MAs**)**:** atoms, other than of uranium or plutonium, generated in relatively small amounts in reactors, through successive **neutron captures**, from fuel nuclei, or through radioactive **decay**. These elements, mainly neptunium (Np), americium (Am), and curium (Cm), exhibit a long **half-life**, either themselves, or for at least one of their decay products.

activation: process whereby certain elements become **radioactive**, through bombardment by **neutrons** or other particles.

activity: the number of **decays** per unit time within a material. This is expressed in **becquerels** (**Bq**), this unit corresponding to one decay of a **radionuclide** per second; it is thus a quasi-infinitesimal unit. **Specific activity** is expressed as a function of molar mass, and **half-life**.

aerosol: very fine (0.01–100 **micrometers**) solid or liquid particles, held in suspension in a gas.

ALARA (principle) (As Low As Reasonably Achievable)**:** an approach whereby measures, taken e.g. for protection against ionizing radiation, are designed and implemented in such a manner as to ensure exposure to such radiation is kept to the lowest level that may reasonably be achieved, taking on board economic and social factors.

alpha: see **radioactivity**.

amorphization: process resulting in a state (**amorphous** state) characterized by complete loss of the crystalline order.

assembly (**fuel**)**:** a structure made up of **fuel elements**, loaded into a nuclear reactor as a single unit.

Atalante (originally standing for ATelier Alpha et Laboratoires pour ANalyses, Transuraniens et Études de retraitement: Alpha Workshop and Laboratories for Analyses, Transuranics and Reprocessing Investigations)**:** a group of laboratories, equipped with lines of shielded cells, at CEA's Marcoule Center, dedicated to investigations on **spent fuel reprocessing**, fabrication of recyclable **actinide** compounds (**transmutation** targets), and the conditioning of high-level waste.

atomic number: the number of **protons** in the nucleus.

beta: see **radioactivity**.

biosphere: the ensemble of ecosystems on the planet, comprising all living beings and the environments in which they live.

breeding: a process that allows a nuclear reactor to generate more **fissile** material than it uses up, new fissile nuclei being generated, through the **capture** of **fission neutrons** by **fertile** nuclei, after a certain number of successive **radioactive decays**.

burnable poison: an element, having a high **neutron capture** capability, used to compensate for excess **reactivity** in **fissile** media, which disappears gradually during in-reactor burnup. One example is **soluble boron** (used in the water of the primary circuit of a water-cooled reactor).

burnup rate: the ratio, usually expressed as a percentage, of the number of atomic nuclei of a given **heavy** element, or group of heavy elements, disappearing through **fission**, relative to the number of such nuclei initially present in the **fuel**. This is expressed in % FIFA (percent fission per initial fissile atom), or % FIMA (percent fission per initial metal atom), the latter unit commonly being noted **at%**. Commonly used to evaluate specific burnup, i.e. the quantity of thermal energy generated per unit mass of fuel, in a reactor, from loading to discharge, it is then expressed in megawatt (thermal)–days per tonne (**MWd/t**), or gigawatt–days per tonne (**GWd/t**). The mass of fuel is expressed, as a rule, in terms of tonnes of initial heavy metal (**uranium** and **plutonium**) (tihm). The relationship between burnup and specific burnup depends on reactor type, and fuel type (for example, for a **thermal-neutron** reactor using **UOX** fuel, 3.54 at% corresponds to 33 GWd/tihm).

catalysis: process involving a substance (the **catalyst**) having the ability to accelerate a chemical reaction, without itself becoming a constituent of the end products.

ceramic: inorganic, nonmetallic material, polycrystalline as a rule, featuring atomic **bonds** that are prevalently **ionic** or **covalent**.

chain reaction: sequence of nuclear **fissions**, in the course of which the **neutrons** released cause further fissions, which in turn yield neutrons causing further fissions, and so on. When the chain reaction generates as many neutrons as it uses up, the **multiplication factor *k*** is equal to 1.

code (**computation**)**:** software representing the expression of the numerical **model** of a system, or process.

cogeneration (by a nuclear reactor)**:** use of the heat from the reactor for a number of concomitant applications (e.g., the generation of electric power, and of hydrogen).

complexation: the formation, from **ions** and molecules of aqueous species, of a larger structure (a **complex**), resulting from the assembly of these ions or molecules by way of (often weak) chemical bonds.

composite: a material formed by assembly of a number of materials, exhibiting properties the latter do not have in isolation.

convection: the ensemble of motions generated inside a fluid mass owing to differences in density, temperature, or hydraulic pressure at various points in this mass, contributing to heat transport, or equalization of these pressures. **Natural convection** is the automatic transfer of heat through such circulation, with no use of further mechanical agitation means.

coolant: a gas or liquid used to extract the heat generated by **fission** processes inside a nuclear reactor.

core: the region, inside a **fission** nuclear reactor, holding the nuclear **fuel**, with a layout designed to ensure it is the seat of a **chain reaction**.

covalent bond: a bond set up when two atoms, in order to saturate their outermost orbitals, share one or more electron pairs. As a rule, covalent bonds are the strongest and most stable ones.

cross-section: the measure of the probability of interaction between a particle and a target nucleus, expressed in **barns** (1 barn = 10^{-24} cm^2).

cycle (fuel)**:** the ensemble of industrial operations to which nuclear **fuel** is subjected, from ore extraction to fabrication (front-end of the cycle), through to **reprocessing**, if required, of the **spent fuel** and disposal of the waste (back-end of the cycle), after its use in a reactor.

decay: the transformation of an unstable nucleus into a stable, or unstable, nucleus, whereby the number, and nature, of nucleons (constituent **neutrons** and **protons** in the atomic nucleus) are altered.

decay heat: see **residual power**.

Diamex (DIAMide EXtraction)**:** process for the separation of **fission products** (**FPs**) from all **lanthanides** (**Ln**) and **minor actinides** (**MAs**).

dispersion: a mix of small particles (mineral or organic) distributed in a homogeneous medium.

doping: the introduction, into a crystalline or **amorphous** (e.g. glass) network, of an extraneous atom, to alter that network's properties.

Doppler effect: variation in the **reactivity** of a nuclear reactor **core**, subsequent to a change in **fuel** temperature. This instantaneous effect is a major safety factor.

dose factor: coefficient allowing a dose for a human to be calculated (in **sieverts**), corresponding to the ingestion, or inhalation, of an **activity** of 1 **becquerel**, from a given **radionuclide**.

dose rate: the ratio of the **dose** increment, over the length of time over which it occurs. The legal unit is the **gray** per second (**Gy**/s).

dosimetry: theory and practice of principles and techniques for the measurement, or estimation, of doses from ionizing radiation received, or that may be received.

effective dose: the sum of **equivalent doses** delivered to the various organs and tissues of an individual, weighted by a factor specific to each organ or tissue. This is expressed in **sieverts** (**Sv**).

electronvolt (**eV**)**:** unit of energy, in nuclear physics: 1 **eV** = $1.6 \cdot 10^{-19}$ joule. Multiples include the **kiloelectronvolt** (1 **keV** = 10^3 eV), the **megaelectronvolt** (1 **MeV** = 10^6 eV), and the **gigaelectronvolt** (1 **GeV** = 10^9 eV).

enrichment: process whereby a chemical element reaches an increased content with respect to one of its **isotopes**. In the case of **uranium**, this allows an increase, by means of various processes, in the concentration of ^{235}U, relative to ^{238}U, which is predominant in **natural uranium**.

EPR (European Pressurized-Water Reactor)**:** a new-generation pressurized-water reactor (PWR) design, developed by Areva NP (formerly Framatome–ANP), featuring many improvements in terms of safety, **fuel** usage, and operating economics.

eutectic: for a mixture of two or more pure substances, the composition, in well-defined proportions, for which melting temperature is lowest (eutectic temperature), and for which that mixture behaves as a pure substance, with respect to melting.

fertile: term used to refer to a **nuclide**, or material, having the ability to undergo transformation, directly or indirectly, into a **fissile** nuclide, through **neutron capture**. This is the case of **uranium** 238, which yields **plutonium** 239.

fissile (material)**:** term used to refer to a **nuclide**, or material, the nuclei of which are liable to undergo **fission** under the effect of **neutrons** of any energy, however weak (e.g. **uranium** 235, or **plutonium** 239).

fission: the division (splitting) of a **heavy nucleus** into several fragments (**fission products**), with concomitant emission of **neutrons**, radiations, and a considerable release of energy.

fission products: nuclides yielded either directly, through nuclear **fission**, or indirectly, by the **decay** of fission fragments.

formulation: the determination of the composition of a material, or molecule.

fuel (nuclear)**:** material containing **fissile** nuclei, enabling a **chain reaction** to be sustained in the **core** of a reactor. **Fuel element:** basic component in the core, used to form **assemblies**. **Spent fuel:** fuel that is unable to further sustain nuclear reactions; this is discharged from the reactor.

gamma: see **radioactivity**.

Ganex (Group ActiNide EXtraction)**:** concept for a process of grouped extraction of **actinides**, developed at CEA.

geosphere: the ensemble of the various parts of the Earth that support the **biosphere**, comprising the inner layers, the outermost layer (lithosphere), the hydrosphere, and the atmosphere.

half-life: the time required for the **decay** to occur of one half of the atoms in a **radionuclide** sample.

heavy metals: metals (zinc, cadmium, lead...) having a density greater than a certain value. This term is sometimes solely used for **actinides**.

heavy nuclei: isotopes of elements of **atomic number** equal to, or higher than, a certain value (80, for instance). All **actinides** and some of their daughter products are included in this group.

hydrolysis: the decomposition of a chemical compound by water.

hydrometallurgical (path)**:** in **spent fuel reprocessing**, the path involving its dissolution in an acid medium, and use of liquid–liquid extraction processes.

ion: an atom or molecule that has lost, or gained, electrons. An **anion** is negatively charged, a **cation** positively charged.

ionic bond: a bond characterized by electrostatic interactions between structures bearing charges, with no sharing of electrons.

isotopes: forms of one and the same chemical element, for which the nuclei have the same number of **protons**, and different numbers of **neutrons**.

isotopic vector: a description, in terms of percentages, of the various respective fractions of each **isotope** making up a chemical element. The isotopic vector (or isotopic composition) of **natural uranium**, for example, has the following expression: ^{238}U = 99.27%, ^{235}U = 0.72%, ^{234}U < 0.01%.

lanthanides (**Ln**)**:** the family of elements of **atomic number** ranging from 57 (lanthanum) to 71 (lutetium).

leaching: slow dissolution by water or a **solvent**.

ligand: in **hydrometallurgy**, a molecule, or **ion**, present in an aqueous solution, having the ability to bind to a metal ion by way of coordination bonds.

linear-no-threshold (extrapolation)**:** a form of extrapolation defining a relationship to the cause, whereby the effect is proportional with respect to that cause, with no level below which no effect would be found. For ionizing radiations, extrapolation may also be linear-quadratic, quadratic...

long-lived: a term used to refer to **radionuclides** having a **half-life** longer than 30 years, other radionuclides being termed **short-lived**, or **medium-lived**, depending on their half-life.

micrometer (or **micron**)**:** unit of length, 1 **µm** being equal to 10^{-6} m.

modeling: providing a representation of a system, or process, for the purposes of simulating it, this leading to a **computation model**, taking the form of a piece of software (**code**).

moderator: material formed of light nuclei, which slow **neutrons** down, through elastic scattering. This material must exhibit a low **capture** capability, to preclude "wasting" neutrons, and be dense enough to slow them down effectively.

molecular dynamics: simulation technique allowing a step-by-step description of the dynamics of the ensemble of atoms in a molecular system, once the forces exerted on each atom are known. According to the method used to compute forces, this is known as classical molecular dynamics, or *ab-initio* molecular dynamics.

MOX (Mixed OXides)**:** a mixture of (**natural**, or **depleted**) **uranium** and **plutonium** oxides.

multiplication factor *k*: the ratio, for a given length of time, of the number of **neutrons** generated by **fission**, over the number of neutrons disappearing. In an infinite environment, with no neutron loss, this is noted k_∞; in a finite environment, and hence allowing for losses, this is termed the effective multiplication factor, noted k_{eff}.

nanometer: a unit of length, 1 **nm** being equal to 10^{-9} m.

near field: that part of a **radioactive** waste geological disposal facility which is subject to marked thermal, hydraulic, mechanical, and chemical disturbances emanating from the disposal area (around the waste packages and galleries), as opposed to the **far field**, which is the part of the **geosphere** not subject to such disturbance.

neutron capture: absorption of a free **neutron** by a nucleus, not resulting in **fission**.

neutron spectrum: the energy distribution of the **neutron** population present in the **core** of a reactor.

neutrons: electrically neutral fundamental particles, the constituents, together with **protons**, of atomic nuclei; they induce **fission** reactions in **fissile** nuclei, inside nuclear reactors. **Delayed neutrons:** neutrons expelled by fission fragments, with a delay, on average, of a few seconds after fission has occurred. Accounting for less than 1% of neutrons released, it is these neutrons that, owing to this timeshift, ultimately allow reactors to be controlled. **Epithermal neutrons:** neutrons having an energy in the 10 **eV**–20 **keV** range (approximately), with a velocity higher than that of thermal neutrons. **Fast neutrons:** neutrons released at the time of fission, traveling at very high velocity (20,000 km/s); they have an energy of around 2 **MeV**. **Prompt neutrons:** neutrons expelled immediately, at the very instant of fission. **Thermal neutrons:** also known as **slow** (or **thermalized**) **neutrons**, these are neutrons in thermal equilibrium with the material within which they travel, at a velocity of some 2–3 km/s. Their energy stands at less than 1 eV. **Thermalization** is the slowing down of fast neutrons, in order to bring them gradually to such a state of equilibrium.

noble metals: precious metals, resistant to air and water (silver, gold, platinum), also including ruthenium, rhodium, and palladium.

nuclide: a material made up of atoms having identical nuclei, and thus with the same **atomic number** (*Z*), and the same mass number *A* (the sum of the number of **neutrons** *N*, and number of **protons** *Z*).

outlet: final destination (for a category of waste, for instance). Opening allowing the outflow of a substance, water in particular, out of a given environment.

oxidation state (or number)**:** a figure representing the number of electrons that must be supplied to, or taken from, an atom, whether free or within a compound, to make it neutral. A decrease in this figure corresponds to a **reduction**, an increase to an **oxidation**.

oxidizing agent: a substance causing an atom or **ion** to lose electrons; **oxidation:** a reaction whereby an atom, or an ion, loses electrons.

passivity: term used to describe systems based on natural actions and forces, such as **convection** and gravity, making the safety of a facility less dependent, in theory, on active systems and components (pumps, motors, etc.).

pH: the measure of the concentration in hydrogen **ions**. Below 7, this is said to be **acid**; above that value, it is said to be **alkaline** (or **basic**).

photon: the quantum of energy of an electromagnetic radiation. An elementary particle, having zero mass and no electric charge, associated to such radiation.

plutonium: chemical element of **atomic number** 94, and symbol Pu, having **isotopes** ranging from ^{232}Pu to ^{247}Pu. Five of these isotopes are important, from ^{238}Pu to ^{242}Pu, especially ^{239}Pu, a **fissile** element, generated inside reactors from **uranium** 238.

potential radiotoxicity or **radiotoxic inventory:** the product of the **activity** of a certain quantity of **radionuclides**, multiplied by ingestion **dose factors**: this is the dose received by a group of individuals taking in that amount of material.

precipitation: the formation of a solid, insoluble substance, through the reaction of two liquids, two gases, or a liquid and a gas.

processing (or **reprocessing**)**:** operation involving the selective sorting of materials contained in **spent fuel**, in order to extract such materials as are **recyclable** (**uranium** and **plutonium**), or possibly **transmutable**, and condition the various types of ultimate waste in a form suitable for disposal. For spent fuel, this is known as reprocessing. For waste, processing thus includes **treatment** and conditioning.

protons: fundamental particles bearing a positive electric charge, the constituents, together with **neutrons**, of atomic nuclei.

Purex (Plutonium Uranium Refining by EXtraction)**:** a **hydrometallurgical** process for the separation of **uranium** and **plutonium** from **spent fuel**.

R7T7 glass: conditioning glass for high-level waste, produced at La Hague, so named after the **vitrification** workshops at the UP2-800 (R7) and UP3 (T7) plants.

radioactive (or **decay**) **chain** of an element**:** the succession of the various elements appearing through the spontaneous transformation of an unstable nucleus, over time. This chain ends in a stable (non-**radioactive**) element.

radioactivity: the property, exhibited by some natural or artificial elements, of spontaneously emitting **alpha** particles (helium nuclei), **beta** particles (positrons [beta$^+$ emission] or electrons [beta$^-$ emission]), and/or **gamma** radiation (high-energy **photons**). More broadly, this term is used to refer to the emission of radiation concomitant with the **decay** of an unstable element, or **fission**.

radioelement: strictly speaking, an element all **isotopes** of which are **radioactive**. Commonly used to refer to an element of which some isotopes are radioactive.

radiolysis: the breaking of chemical bonds, through the effects of ionizing radiations. Organic materials, such as the **solvents** used in **hydrometallurgy**, are most sensitive to this effect.

radionuclide: a **radioactive isotope**, also known sometimes as a radioisotope, of an element.

rare earths: group of elements including the **lanthanides**, i.e. elements of **atomic number** ranging from 57 (lanthanum) to 71 (lutetium), to which are added, owing to their chemical properties, yttrium and scandium.

reactivity: a dimensionless quantity, used to evaluate small variations in the **multiplication factor *k*** around the critical value, and defined by the formula: $\rho = (k - 1)/k$. Its value being very small, it is generally expressed in **pcm** (percent millirho). Inside a reactor, reactivity is equal to zero when the reactor is **critical**, positive when it is **supercritical**, and negative when it is **subcritical**.

recoil nucleus: a nucleus to which, subsequent to a nuclear reaction or a **radioactive** emission, kinetic energy is imparted. In an

alpha decay, for instance, the energy released takes the form of kinetic energy, shared between the alpha particle (98%) and the recoiling nucleus (2%).

recycling: the recovery of reusable materials, or the destruction of waste, after a production cycle. In a nuclear reactor, the use, in **fuel**, of **fissile** materials (generated **plutonium**, residual **uranium** 235...) yielded by a previous cycle (**monorecycling**, in the case of a single irradiation, **multirecycling** in the case involving several successive passes).

reducing agent: a substance that yields electrons to an atom, or **ion**; **reduction:** a reaction whereby an atom, or an ion, gains electrons.

residual power: the thermal power released by **fuel** (inside a shutdown nuclear reactor, in a storage pool, etc.), essentially due to the **activity** of **fission products** (also referred to as **decay heat**).

Sanex (Selective ActiNide EXtraction)**:** a process for the separation of **lanthanides** from **actinides**.

Sesame (Selective Extraction and Separation of Americium by Means of Electrolysis)**:** a process for the separation of americium from curium.

sintering: heat treatment, to achieve densification and consolidation of powdered precursors, at a temperature lower than the melting point of the main constituent, to yield a continuous, tough solid mass.

sol–gel: a chemical synthesis process, using a solution holding reactive precursors (alkoxides, metal salts...), in two steps: **hydrolysis**, and condensation (**formulation** of a **covalent** network). The colloid suspension (**sol**) consists of a solid phase, with a granulometry in the 1 **nm**–1 **µm** bracket, **dispersed** in a liquid. After condensation, the solution evolves into a system of greater molecular complexity, imprisoning the **solvent**: the **gel**.

solvent: a substance having the ability to dissolve another substance.

sorption: interaction process between a solid surface and an atom (whether **ionized** or not) or a molecule (physisorption, or chemisorption, according to the nature of the bond involved). **Adsorption** is the retention of a vapor phase on the surface of a solid medium. **Desorption** is the reverse process to that of sorption, whatever the mechanism involved (chemisorption, physisorption, adsorption).

spallation: a nuclear reaction involving a target **heavy nucleus** and a particle, most commonly a **proton**, accelerated to an energy ranging from several hundred **MeV** to a few **GeV**. By way of successive reactions, a beam of such particles allows a large number of **neutrons** to be generated. A 1-GeV proton, directed onto a lead target, may thus yield 25–30 neutrons.

subcritical: term used to describe a reactor **core**, when the number of **neutrons** released by **fission** is lower than the number of neutrons disappearing through absorption, and losses, **criticality** being the state of an environment in which a **chain reaction** is sustained at a constant level, this entailing an precise balance between generation and consumption. The subcriticality ratio is the ratio of the number of neutrons generated by fission, over the number of neutrons disappearing.

supercritical (**fluid**)**:** a fluid which, when brought to temperature and pressure conditions higher than the critical values, exhibits a viscosity close to that of gases, density close to that of liquids, and high diffusivity. Its solvent power varies with pressure and temperature conditions. Most commonly used such fluids: carbon dioxide (CO_2), owing to its low critical temperature (31 °C), and water (H_2O), owing to its high **oxidizing** ability.

SWU: separative work unit, applied to **fissile isotope** separation, this is used to evaluate the production capacity of an **enrichment** facility; it is proportional to the amount of **uranium** processed.

thorium: chemical element of **atomic number** 90, and symbol Th, having **isotopes** ranging from ^{223}Th to ^{235}Th. Isotopes ^{227}Th, ^{229}Th and ^{233}Th are **fissile** by means of **thermal neutrons**. Natural isotope ^{232}Th may be included in the composition of **fuel** for **fast-neutron** reactors, and as a **fertile** material, yielding ^{233}U as primary fuel.

transmutation: the transformation of one **isotope** into another, through a nuclear reaction, preferably induced by **neutrons** (**capture**, **fission**). This makes it possible to transform **long-lived radioactive** isotopes into **short-lived**, or stable, isotopes, in order to reduce waste long-term **radiotoxic inventory**. This process is sometimes termed **incineration**, a term best used for the operation whereby "thermally" combustible materials are destroyed by combustion, yielding a mineral residue.

transuranic elements: all elements of **atomic number** higher than that of **uranium**. In reactors, heavy elements yielded by uranium through **neutron capture**. These include **isotopes** of neptunium, **plutonium**, americium, curium, and, beyond, of berkelium, californium...

treatment: see **processing**.

tritium: the heaviest **isotope** of hydrogen, and the only **radioactive** one. Its nucleus comprises one **proton** and two **neutrons**.

UOX: the standard **fuel** for light-water reactors, consisting of **uranium** 235-**enriched uranium** oxide. UOX fuels are classified, in France, into three categories, according to initial ^{235}U content and **burnup rate**, to wit: **UOX1** (3.5%, 33 **GWd/t**), **UOX2** (3.7%, 45 GWd/t), and **UOX3** (4.5%, 60 GWd/t).

uranium: chemical element of **atomic number** 92, and symbol U, having three natural **isotopes**: ^{234}U, ^{235}U, and ^{238}U. ^{235}U is the only natural **fissile nuclide**, hence its use for energy generation purposes. **Depleted uranium** (**DU**)**:** uranium having a content of isotope 235, the only fissile isotope, lower than its natural level (0.72% by mass). This is mainly obtained as the byproduct of an **enrichment** operation (with around 0.3% ^{235}U). **Enriched uranium** (**EU**)**:** uranium in which content of isotope 235, the only fissile isotope, has been increased from its low, natural level to, for example, 3.5%, for a **fuel** intended for a pressurized-water reactor. **Natural uranium** (**NU**)**:** natural, **radioactive** metal element present in a number of ores, pitchblende in particular. It is present in the form of a mixture of isotopes, comprising: **fertile** ^{238}U (99.27%), fissile ^{235}U (0.72%), and traces of ^{234}U (< 0.01%). **Reprocessed uranium** (**RU**)**:** uranium yielded by **reprocessing** of **spent fuel**, subsequent to its passage in a reactor, this being discharged with a ^{235}U content of about 1%.

valence: the number of bonds an atom may set up.

vitrification: an operation consisting in solidifying, after mixing at high temperature with a mineral glass paste, concentrated **fission product** and **transuranic element** solutions, extracted through **reprocessing** of **spent fuel**.

voiding effect: effect on the **reactivity** of a nuclear reactor **core**, ascribable to a **coolant** leak, or accidental phase change.

watt: a unit of power (**W**), corresponding to production of 1 joule per second. Main multiples include: the kilowatt (1 **kW** = 10^3 W), the megawatt (1 **MW** = 10^6 W), the gigawatt (1 **GW** = 10^9 W), and the terawatt (1 **TW** = 10^{12} W). **Kilowatt–hour:** a unit of work and energy, the product of power multiplied by time: 1 **kWh** = 3.6 million joules. This is one of the multiples of the **watt–hour** (**Wh**), together with the **megawatt–hour** (1 **MWh** = 10^6 Wh), the **gigawatt–hour** (1 **GWh** = 10^9 Wh), and the **terawatt–hour** (1 **TWh** = 10^{12} Wh).