Annexes

Contents

1. Abbreviations and Acronyms

10^3	kilo (k)
10^6	mega (M)
10^9	giga (G)
10^{12}	tera (T)
10^{15}	peta (P)
10^{18}	exa (E)
10^{21}	zetta (Z)
ABWR	advanced boiling water reactor
AC	alternating current
AHWR	advanced heavy water reactor
API	American Petroleum Institute
APR	advanced pressurised reactor
APWR	advanced pressurised water reactor
b/d	barrels per day
bbl	barrel
bcf	billion cubic feet
bcm	billion cubic metres
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe
billion	10^9
BIPV	building integrated PV
BNPP	buoyant nuclear power plant
boe	barrel of oil equivalent
BOO	build, own, operate
BOT	build, operate, transfer
bpsd	barrels per stream-day
bscf	billion standard cubic feet
Btu	British thermal unit
BWR	boiling light-water-cooled and moderated reactor
C	Celsius
CBM	coal-bed methane
cf	cubic feet
CHP	combined heat and power
CIS	Commonwealth of Independent States
cm	centimetre
CMM	coal mine methane
CNG	compressed natural gas
CO_{2e}	carbon dioxide equivalent
COP3	Conference of the Parties III, Kyoto1997
cP	centipoise
CSP	centralised solar power
d	day
DC	direct current
DHW	domestic hot water
DOWA	deep ocean water applications
ECE	Economic Commission for Europe
EIA U.S.	Energy Information Administration / environmental impact assessment
EOR	enhanced oil recovery
EPIA	European Photovoltaic Industry Association
EPR	European pressurised water reactor
ESTIF	European Solar Thermal Industry Federation
ETBE	ethyl tertiary butyl ether
F	Fahrenheit
FAO	UN Food and Agriculture Organization
FBR	fast breeder reactor
FID	final investment decision
FSU	former Soviet Union
ft	feet
g	gram
gC	grams carbon
GEF	Global Environment Facility
GHG	greenhouse gas
GTL	gas to liquids
GTW	gas to wire
GW_e	gigawatt electricity
GWh	gigawatt hour
h	hour
ha	hectare
HDR	hot dry rocks
hm^3	cubic hectometre

HPP	hydro power plant
HTR	high temperature reactor
Hz	hertz
IAEA	International Atomic Energy Agency
IBRD	International Bank for Reconstruction and Development
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
IMF	International Monetary Fund
IMO	International Maritime Organization
IPP	independent power producer
IPS	International Peat Society
J	joule
kcal	kilocalorie
kg	kilogram
km	kilometre
km^2	square kilometre
kPa	kilopascal
ktoe	thousand tonnes of oil equivalent
kV	kilovolt
kW_e	kilowatt electricity
kWh	kilowatt hour
kWp	kilowatt peak
kWt	kilowatt thermal
lb	pound (weight)
LNG	liquefied natural gas
LPG	liquefied petroleum gas
l/s	litres per second
l/t	litres per tonne
LWGR	light-water-cooled, graphite-moderated reactor
LWR	light water reactor
m	metre
m/s	metres per second
m^2	square metre
m^3	cubic metre
mb	millibar
Mcal	megacalorie
MJ	Megajoule
Ml	megalitre
mm	millimetre
MOU	memorandum of understanding
MPa	megapascal
mPa s	millipascal second
MSW	municipal solid waste
mt	million tonnes
mtpa	million tonnes per annum
mtoe	million tonnes of oil equivalent606
MW	megawatt
MWe	megawatt electricity
MWh	megawatt hour
MW_p	megawatt peak
MW_t	megawatt thermal
N	negligible
NEA	Nuclear Energy Agency
NGLs	natural gas liquids
NGO	non governmental organisation
Nm^3	normal cubic metre
NPP	nuclear power plant / net primary productivity
OAPEC	Organization of Arab Petroleum Exporting Countries
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
OTEC	ocean thermal energy conversion
OWC	oscillating water column
p.a.	per annum
PBMR	pebble bed modular reactor
PDO	plan for development and operation
PFBR	prototype fast breeder reactor
PHWR	pressurised heavy-water-moderated and cooled reactor
ppm	parts per million
ppmv	parts per million by volume
psia	pounds per square inch, absolute

PV	photovoltaic
PWR	pressurised light-water-moderated and cooled reactor
RBMK	reaktor bolchoi mochtchnosti kanalni
R&D	research and development
RD&D	research, development and demonstration
R/P	reserves/production
rpm	revolutions per minute
SER	Survey of Energy Resources
SHS	solar home system
SWH	solar water heating
t	tonne (metric ton)
tb/d	thousand barrels per day
tC	tonnes carbon
tce	tonne of coal equivalent
tcf	trillion cubic feet
tcm	trillion cubic metres
toe	tonne of oil equivalent
tpa	tonnes per annum
TPP	tidal power plant
tpsd	tonnes per stream day
tscf	trillion standard cubic feet
trillion	10^{12}
ttoe	thousand tonnes of oil equivalent
tU	tonnes of uranium
TWh	terawatt hour
U	uranium
$U_3 O_8$	uranium oxide
UN	United Nations
UNDP	United Nations Development Programme
vol	volume
W	watt
WEC	World Energy Council
W_p	watts peak
WPP	wind power plant
wt	weight
WTO	World Trade Organization
WWER	water-cooled water-moderated power reactor
yr	year
¾	unknown or zero
~	approximately
<	less than
>	greater than
≥	greater than or equal to

2. Conversion Factors and Energy Equivalents

Basic Energy Units

1 joule (J) = 0.2388 cal

1 calorie (cal) = 4.1868 J

(1 British thermal unit [Btu] = 1.055 kJ = 0.252 kcal)

WEC Standard Energy Units

1 tonne of oil equivalent (toe) = 42 GJ (net calorific value) = 10 034 Mcal

1 tonne of coal equivalent (tce) = 29.3 GJ (net calorific value) = 7 000 Mcal

Note: the tonne of oil equivalent currently employed by the International Energy Agency and the United Nations Statistics Division is defined as 10^7 kilocalories, net calorific value (equivalent to 41.868 GJ).

Volumetric Equivalents

1 barrel = 42 US gallons = approx. 159 litres

1 cubic metre = 35.315 cubic feet = 6.2898 barrels

Electricity

1 kWh of electricity output = 3.6 MJ = approx. 860 kcal

Representative Average Conversion Factors

1 tonne of crude oil = approx. 7.3 barrels

1 tonne of natural gas liquids = 45 GJ (net calorific value)

1 000 standard cubic metres of natural gas = 36 GJ (net calorific value)

1 tonne of uranium (light-water reactors, open cycle) = 10 000–16 000 toe

1 tonne of peat = 0.2275 toe

1 tonne of fuel wood = 0.3215 toe

1 kWh (primary energy equivalent) = 9.36 MJ = approx. 2 236 Mcal

Note: actual values vary by country and over time. Because of rounding, some totals may not agree exactly with the sum of their component parts.

3. Definitions

Coal

Proved amount in place is the resource remaining in known deposits that has been carefully measured and assessed as exploitable under present and expected local economic conditions with existing available technology.

Maximum depth of deposits and **minimum seam thickness** relate to the proved amount in place.

Proved recoverable reserves are the tonnage ***within*** the proved amount in place that can be recovered in the future under present and expected local economic conditions with existing available technology.

Estimated additional amount in place is the indicated and inferred tonnage ***additional to*** the proved amount in place that is of foreseeable economic interest. It includes estimates of amounts which could exist in unexplored extensions of known deposits or in undiscovered deposits in known coal-bearing areas, as well as amounts inferred through knowledge of favourable geological conditions. Speculative amounts are not included.

Estimated additional reserves recoverable is the tonnage ***within*** the estimated additional amount in place that geological and engineering information indicates with reasonable certainty might be recovered in the future.

Crude Oil

Crude oil is a naturally occurring mixture consisting predominantly of hydrocarbons that exists in liquid phase in natural underground reservoirs and is recoverable as liquids at typical atmospheric conditions of pressure and temperature. Crude oil has a viscosity no greater than 10 000 Pa.s (centipoises) at original reservoir conditions; oils of greater viscosity are included in Chapter 4 - Natural Bitumen and Extra-Heavy Oil.

Natural gas liquids (NGLs) are hydrocarbons that exist in the reservoir as constituents of natural gas but which are recovered as liquids in separators, field facilities or gas-processing plants. Natural gas liquids include (but are not limited to) ethane, propane, butanes, pentanes, natural gasoline and condensate; they may include small quantities of non-hydrocarbons. If reserves/resources/production/consumption of NGLs exist but cannot be separately quantified, they are included (as far as possible) under crude oil. In the tables the following definitions apply to both crude oil and natural gas liquids:

Proved amount in place is the resource remaining in known natural reservoirs that has been carefully measured and assessed as exploitable under present and expected local economic conditions with existing available technology.

Proved recoverable reserves are the quantity ***within*** the proved amount in place that can be recovered in the future under present and expected local economic conditions with existing available technology.

Estimated additional amount in place is the resource ***additional to*** the proved amount in place that is of foreseeable economic interest. Speculative amounts are not included.

Estimated additional reserves recoverable is the quantity *within* the estimated additional amount in place that geological and engineering information indicates with reasonable certainty might be recovered in the future.

Natural Gas

Natural gas is a mixture of hydrocarbon and small quantities of non-hydrocarbons that exists either in the gaseous phase or is in solution in crude oil in natural underground reservoirs, and which is gaseous at atmospheric conditions of pressure and temperature.

Natural gas liquids (hydrocarbons that exist in the reservoir as constituents of natural gas but which are recovered as liquids in separators, field facilities or gas-processing plants) are discussed in Chapter 2 – Crude Oil and Natural Gas Liquids.

Proved amount in place is the resource remaining in known natural reservoirs that has been carefully measured and assessed as exploitable under present and expected local economic conditions with existing available technology.

Proved recoverable reserves are the volume *within* the proved amount in place that can be recovered in the future under present and expected local economic conditions with existing available technology.

Estimated additional amount in place is the volume *additional to* the proved amount in place that is of foreseeable economic interest. Speculative amounts are not included.

Estimated additional reserves recoverable is the volume *within* the estimated additional amount in place that geological and engineering information indicates with reasonable certainty might be recovered in the future.

Production - where available, gross and net (marketed) volumes are given, together with the quantities re-injected, flared and lost in shrinkage (due to the extraction of natural gas liquids, etc.).

Consumption - natural gas consumed within the country, including imports but excluding amounts re-injected, flared and lost in shrinkage.

R/P (reserves/production) ratio is calculated by dividing proved recoverable reserves at the end of 2008 by production (gross less reinjected) in that year. The resulting figure is the time in years that the proved recoverable reserves would last if production were to continue at the 2008 level. As far as possible, natural gas volumes are expressed in standard cubic metres, measured dry at 15^{o} C and 1 013 mb, and the corresponding cubic feet (at 35.315 cubic feet per cubic metre).

Uranium & Nuclear

Uranium does not occur in a free metallic state in nature. It is a highly reactive metal that interacts readily with non-metals, and is an element in many intermetallic compounds. This *Survey* uses the system of ore classification developed by the Nuclear Energy Agency (NEA) of the Organisation for Economic Cooperation and Development (OECD) and the International Atomic Energy Agency (IAEA). Estimates are divided into separate categories according to different levels of confidence in the quantities reported. The estimates are

further separated into categories based on the cost of uranium recovered at ore-processing plants. The cost categories are: less than US$ 40/kgU; less than US$ 80/kgU; less than US$ 130/kgU and less than US$ 260/kgU. Costs include the direct costs of mining, transporting and processing uranium ore, the associated costs of environmental and waste management, and the general costs associated with running the operation (as defined by the NEA). The resource data quoted in the present ***Survey*** reflect those published in the 2009 'Red Book'. Cost categories are expressed in terms of the US dollar as at 1 January 2009. The WEC follows the practice of the NEA/IAEA and defines estimates of discovered reserves in terms of uranium recoverable from mineable ore and not uranium contained in the ore (i.e. to allow for mining and processing losses). Although some countries continue to report ***insitu*** quantities, the major producers generally conform to these definitions. All resource estimates are expressed in terms of tonnes of recoverable uranium (U), not uranium oxide (U_3O_8).

Note: 1 tonne of uranium = approximately 1.3 short tons of uranium oxide; US$ 1 per pound of uranium oxide = US$ 2.60 per kilogram of uranium; 1 short ton U3O8 = 0.769 tU.

Reasonably Assured Resources (RAR) refer to recoverable uranium that occurs in known mineral deposits of delineated size, grade and configuration such that the quantities which could be recovered within the given production cost ranges with currently proven mining and processing technology can be specified. Estimates of tonnage and grade are based on specific sample data and measurements of the deposits and on knowledge of deposit characteristics. RAR have a high assurance of existence.

Inferred Resources (IR) refer to recoverable uranium (in addition to RAR) that is inferred to occur, based on direct geological evidence, in extensions of well-explored deposits and in deposits in which geological continuity has been established, but where specific data and measurements of the deposits and knowledge of their characteristics are considered to be inadequate to classify the resource as RAR.

Undiscovered Resources refer to uranium in addition to reasonably assured resources and inferred resources and covers the two NEA categories, 'Prognosticated Resources' (PR) and 'Speculative Resources' (SR): PR refer to deposits for which the evidence is mainly indirect and which are believed to exist in well defined geological trends or areas of mineralisation with known deposits. SR refer to uranium that is thought to exist mostly on the basis of indirect evidence and geological extrapolations in deposits discoverable with existing exploration techniques.

Annual production is the production output of uranium ore concentrate from indigenous deposits, expressed as tonnes of uranium.

Cumulative production is the total cumulative production output of uranium ore concentrate from indigenous deposits, expressed as tonnes of uranium, produced in the period from the initiation of production until the end of the year stated.

Hydropower

This chapter is restricted to that form of hydraulic energy that results in the production of electrical energy as a result of the natural accumulation of water in streams or reservoirs being channelled through water turbines. Energy from tides and waves is discussed in Chapters 13 and 14. Annual generation and capacity attributable to pumped storage is excluded. Where such installations produce significant energy from natural run-off, the

amount is included in the total for annual generation. It must be recognised that for some countries it is not possible to obtain comprehensive data corresponding exactly to the definitions. This particularly applies to small hydro schemes, many of which are owned by small private generators. Also, not all countries use the same criteria for the distinction between small and large hydro. In this Survey, small hydro mainly applies to schemes of less than 10 MW. However, some countries and other sources of data make the distinction between small and large schemes at other levels. In the tables, the following definitions apply:

Gross theoretical capability is the annual energy potentially available in the country if all natural flows were turbined down to sea level or to the water level of the border of the country (if the watercourse extends into another country) with 100% efficiency from the machinery and driving water-works. Unless otherwise stated in the notes, the figures have been estimated on the basis of atmospheric precipitation and water run-off. Gross theoretical capability is often difficult to obtain strictly in accordance with the definition, especially where the data are obtained from sources outside the WEC. Considerable caution should therefore be exercised when using these data. Where the gross theoretical capability has not been reported, it has been estimated on the basis of the technically exploitable capability, assuming a capacity factor of 0.40. Where the technically exploitable capability is not reported, the value for economically exploitable capability has been adopted, preceded by a ">" sign.

Technically exploitable capability is the amount of the gross theoretical capability that can be exploited within the limits of current technology.

Peat

There are three main forms in which peat is used as a fuel:

- Sod peat - slabs of peat, cut by hand or by machine, and dried in the air; mostly used as a household fuel;
- Milled peat - granulated peat, produced on a large scale by special machines; used either as a power station fuel or as raw material for briquettes;
- Peat briquettes - small blocks of dried, highly compressed peat; used mainly as a household fuel.

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