



Energy Research & Development Expenditures by Area of Technology, 2005

DEFINITIONS

(Definitions below correspond to the area of technology items listed on page 2 of this questionnaire.)

1. RENEWABLE RESOURCES

- a) **Solar energy** includes passive, active, photovoltaics, and daylighting.
 - (i) **Solar photovoltaics:** design, construction and operation, use in applications such as stand alone power systems, improving the architectural and technical quality of PV systems and their economic viability.
 - (ii) **Solar thermal and cooling:** includes solar thermal collectors, heat storage, and building daylighting.
- b) **Bioenergy** includes forest and agricultural biomass including plantations, harvesting and conversion. Includes production and combustion of biomaterials.
- e) **Other renewable resources** – Examples: geothermal; ocean.

2. TRANSPORTATION AND TRANSMISSION

- a) **Transportation of energy commodities** includes pipelines conveyors or vehicles (including ships and railways), and associated storage, and safety aspects of liquefied natural gas.
- b) **Conversion, transmission, and distribution of electricity** includes conversion of shaft energy to electricity, storage of electricity, and air pollution from power plants; excluding CO₂.

Typical examples:

- turbo-engines, multifuel gas turbines, conventional and combined cycles;
- super-conducting generating machines;
- magnetohydrodynamic conversion;
- heat/electricity combined production;
- electricity generators and components;
- dry cooling towers;
- re-powering, retrofitting, life extensions and upgrading of fossil fuel power plants;
- thermal pollution from power plants;
- air pollution from power plants;
- boiler R&D;
- solid state power electronics, load management and control systems, network problems, superconducting cables, AC and DC high voltage cables, HVDC transmissions;
- all high temperature superconducting research.

3. CONSERVATION

- a) **Residential and Commercial buildings** includes space heating and cooling, ventilation and lighting control systems other than solar technologies, low energy housing design and performance other than solar technologies, new insulation and building materials, thermal performance of buildings, and domestic appliances.
- b) **Transportation** includes analysis and optimization of energy consumption in the transportation sector, public transportation systems, engine-fuel optimisation, diesel engines, and Stirling motors.
- c) **Industrial processes** includes industrial technologies such as combustion, separation, end-use electrotechnologies, hybrid processes, sensors and controls, process integration, bio-processes (using micro organisms).
- d) **Other** includes waste heat utilization, district heating, heat pump development, recycling and user of urban and industrial wasters, and use of wastes and low-temperature heat in the agricultural sector (drying, glasshouses).

4. FOSSIL FUELS

- a) (i) **Exploration and production** excludes enhanced recovery; also excludes delivery to the refinery gate which is included as part of "Transportation of energy commodities" in this questionnaire.
- (ii) **Production by enhanced recovery** includes incremental recovery of crude oils and/or natural gas by any secondary or tertiary means as distinct from primary recovery by natural depletion processes only.
- c) **Refining** includes refining, processing and cleaning of crude oils and natural gases, and residual fuel upgrading; excludes bitumen upgrading.
- d) **Coal** includes supply (exploration, mining and beneficiation including slurry preparation); combustion (including environmental control and coal slurries); and conversion (to solids, liquids and gases, including coprocessing of coal and bitumen). Excludes transportation to point of use, which is included as part of "Transportation of energy commodities" in this questionnaire.
- e) **CO₂ capture and storage** includes purification of site specific anthropogenic CO₂ emissions, transport of a concentrated CO₂ waste stream and storage of the CO₂ by injection into deep geological media that could be active or depleted oil, gas and coalbed methane reservoirs, saline aquifers and salt caverns.

5. NUCLEAR – (Includes both fission and fusion energy)

- b) **Energy generation** includes generation of electricity and heat by nuclear reactors, and safety and waste management.

6. OTHER CROSS-CUTTING TECHNIQUES OR RESEARCH

- a) **Energy system analysis** includes system analysis related to energy R&D; sociological, economical and environmental impact of energy which are not specifically related to one technology area listed in the section above.
- b) **Others (R&D on environment, climate change)** includes science of climate change, energy technology information dissemination, and studies not related to a specific technology area listed above.
- c) **Energy storage (fuels, batteries)** includes all forms of energy storage; including superconducting, magnetic, hot or cool, and kinetic energy storage technologies.
- d) **Alternative transportation fuels** includes use of alternative fuel, fuel additives, hydrogen, electric cars, hybrid cars and biofuels use (includes for transportation purposes: bio-fuels properties and utilisation, distribution of ethanol; for power production: cofiring, direct combustion, gasification).