Appendices

- **Glossary/List of Acronyms**
- **Annotated Bibliography (provided as a separate volume)**

GLOSSARY AND LIST OF ACRONYMS[153]

Abatement: Reducing the degree or intensity of, or eliminating, pollution.

AC: Alternating current.

ADB: Asian Development Bank

ADB or AfDB: African Development Bank

AFUR: African Forum of Utility Regulators

Aggregator: An entity responsible for planning, scheduling, accounting, billing, and settlement for energy deliveries from the aggregator's portfolio of sellers and/or buyers. Aggregators seek to bring together customers or generators so they can buy or sell power in bulk, making a profit on the transaction.

Ampere (or Amp, A): A measure of electrical current.

Ancillary Services: Services by generators and/or by the operators of the interconnection to the power grid or grids, including services, such as spinning reserve, short-term regulation of grid stability, and electricity for "black start" of power plants, that allow for the smooth operation of grid systems and maintenance of power quality.

Autoproducer: Autoproducers are industries or other (typically larger) electricity users that generate electricity and/or heat, wholly or partly for their own use, as an activity that supports their primary activity. Autoproducers may be privately or publicly owned.

Availability Factor: The ratio of the time a generating facility is available (that is, fueled and ready to operate) to produce electricity at its rated capacity to the total amount of time in the period being measured (for example, one year/8760 hours).

Avoided Costs: The total economic costs (consisting of the capital and operating costs to provide generation capacity and fuel, transmission, storage, distribution, and customer service) to serve end-use energy requirements using a given set of resources. These costs are referred to as "avoided" when an alternative set of resources is used to serve requirements. Avoided cost must be determined to assess the cost-effectiveness of potential supply-side and demand-side resources.

Base load: The minimum average electric load on a given system over a given period of time.

Base Load Generation: Those generating facilities within a utility system that are operated to the greatest extent possible to maximize system mechanical and thermal efficiency and minimize system operating costs.

153 The entries in this Glossary and List of Acronyms draw upon a variety of sources, and sometimes adopt text from those sources verbatim. Major sources used include the "Glossary" volume of Regional Electricity Cooperation and Integration (RECI), E7 Guidelines for the pooling of resources and the interconnection of electric power systems, prepared by the E7 Network of Expertise for the Global Environment, dated approximately 2000, and available from *http://www.e7.org*, the World Bank Group (1998): Pollution Prevention and Abatement Handbook: Glossary of Environmental Terms, available as *http://lnweb18.worldbank.org/ESSD/envext.nsf/47ByDocName/WorldBankPollutionPreventionandAbatementHandbookGlossaryofEnvironmentalTerms199881KBPDF/$FILE/WorldBankPollutionPreventionandAbatementHandbookGlossaryofEnvironmentalTerms1998.pdf*. Swisher, J., et al (1997), Tools and Methods for Integrated Resource Planning, (UNEP Collaborating Centre for Energy and the Environment, Risø National Laboratory, Denmark; David F. Von Hippel, and the EEIGGR IRP Project Team (2002), Proposed Integrated Resource Planning (IRP) Framework Document for the Restructured Electricity Industry of the Arab Republic of Egypt; and from other sources. Note that in some cases entries in this glossary are not featured in the text of the report, but are included here because they are terms that a reader is likely to find useful in studying interconnection projects.

Base Load Unit/Station: Units or plants which are designed for nearly continuous operation at or near full capacity to provide all or part of the base load. An electric generation station normally operated to meet all, or part, of the minimum load demand of a power company's system over a given amount of time.

British Thermal Unit (Btu): A measure of energy (most often applied to heat) equal to 1055 Joules.

Carbon dioxide (CO_2): A colorless, odorless, nonpoisonous gas that results from fossil fuel combustion and is normally a part of the ambient air.

Carbon monoxide (CO): A colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion.

Carcinogen: Any substance that can cause or contribute to the production of cancer.

Clean Development Mechanisms (CDMs): Flexible mechanisms of the Kyoto Protocol (see Kyoto Protocol). CDMs enable industrialized countries to finance emissions-avoiding projects in developing countries and receive credit for doing so.

Capacity: The maximum quantity of electrical output for which a supply system or component is rated.

Capacity expansion plan: The schedule of power supply investments that is planned in order to meet forecasted future electricity demand

Capacity Factor: The ratio of the average output of an electric power generating unit for a period of time to the capacity rating of the unit during that period. A capacity factor of 50 percent means that, for example, a power plant produces on average half of the electricity that it could have produced if operated continuously at its full capacity rating.

Capacity rating: A measure of the electrical power that a piece of equipment can be expected to produce or use if used fully under normal (non-emergency) conditions.

Capacity value: The contribution of a supply resource to the maximum capacity of an electric system. Capacity value is a measure of the reliability and predictability of a resource.

Capital recovery rate: This is the rate of return paid on the debt plus the rate of return paid on the principal.

Cogeneration (or Combined Heat and Power—CHP): The generation of electricity together with the recovery of heat as a usable by-product, or the production of electricity as a by-product of the production of heat. Cogeneration, or CHP, involves the recovery of heat or primary energy that would otherwise be wasted.

Coincident demand: The rate of electricity demand of a customer or group of customers at the time of an electric system's total peak demand.

Coincident peak: Customer demand at the time of electric system peak demand.

Combined cycle: A two-stage electrical generation process. In a common type of combined-cycle configuration, in the first stage electricity is generated by a gas turbine. The waste heat from the gas turbine is then used with a steam turbine to generate additional power. Gas-fired combined-cycle power plants are becoming increasingly popular, inexpensive, and efficient alternatives for intermediate and base-load power generation when affordable gas is available.

Combined heat and power (CHP): See cogeneration.

Competitive Bidding: The process of acquiring supply-side or demand-side resources from private or public-sector companies or organizations by issuing "bid documents" or "requests for proposals", distributing these

documents to potential suppliers, reviewing proposals and bids received based on a set of defined criteria, and selecting the best proposal or proposals for implementation (or further study).

Conductance: The ability of an object, such as an electric wire, to allow electric currents to flow.

Control Area: An electric system or systems, bounded by interconnection metering and telemetry, capable of controlling generation to maintain its interchange schedule with other control areas and contributing to frequency regulation of the interconnection.

Current: The flow rate of electric charge, measured in amperes (A) or kilo-amperes (kA).

DC: Direct Current

Demand forecast: Projected future demand for electric power. A demand (or load) forecast may be short-term (for example, 15 minutes ahead) for system operation purposes, medium to long-term (5 to 20 years) for generation planning purposes, or for any range in between. Load forecasts may include projections of peak demand (kW), energy (kWh), reactive power (kVAR), and/or load profile. Forecasts may be made of total system load, transmission load, substation/feeder load, individual customers' loads, or appliance loads.

Demand-side management (DSM): The implementation of one or more demand-side management programs. Demand-side management denotes the increases in energy efficiency, reduced demand, improved load factors, or improved customer power factor resulting from hardware, equipment, devices, or practices that are installed or implemented at a customer's facility.

Demand-side management measures: Any hardware, equipment, device, or practice that is installed or instituted resulting in increased efficiency in the utilization of energy at an energy consumer's facility, and/or shifts the timing of a customer's consumption of electricity so as to lower the overall costs to society of providing power. Demand-side management measures can include fuel-switching.

Demand-side management programs: Planned efforts, implemented by utilities or other organizations, to influence energy consumers to adopt or use one or more DSM measures.

Discount rate: A rate at which the value of money changes over time, discount rates are applied to future costs or benefits to reflect the fact that funds received in the present are worth more than funds received some time in the future. Discount rates are used in computing present value and net present value of streams of benefits or costs.

Dispatching: The operating control of an integrated electric system to: 1) Assign load to specific generating stations and other sources of supply to effect the most reliable and economical supply as the total of the significant area loads rises of falls, 2) Control operations and maintenance of high-voltage lines, substations, and equipment, including the administration of safety procedures, 3) Operate the interconnection, and 4) Schedule energy transactions with other interconnected electric utilities.

Dispatchability: The ability of the utility to schedule and control, directly or indirectly, manually or automatically, the generating plants and DSM measures.

Dispatch Order: The order of priority in which each unit of generation capacity is selected for operation during a given time interval.

Disposal: Final placement or destruction of toxic, radioactive, or other wastes; surplus or banned pesticides or other chemicals; polluted soils; and drums containing hazardous materials from removal actions or accidental

releases. Disposal may be accomplished through use of approved secure landfills, surface impoundments, land farming, deep well injection, ocean dumping, or incineration.

Distribution: The process of transferring electricity from the transmission system to final users. Electricity is distributed along local networks of overhead and/or underground power lines.

E7 Group: An association of some of the largest electric utilities in the Group of Seven (G7) industrialized nations. The E7 Group created the "E7 Network of Expertise for the Global Environment to act as a pro bono environmental, technical and industrial advisory group for electric utilities and governments in developing and Eastern European countries".[154]

Economic Dispatch: The start-up, shutdown, and allocation of load to individual generating units to effect the most economical production of electricity for customers.

Ecosystem: The interacting system of a biological community and its nonliving environmental surroundings.

EDF: Electricité de France, the French national utility.

Effectiveness Measure: The criterion for measuring the degree to which an objective (for example, an IRP objective) has been attained.

Emission: Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities, from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts.

Emission factor: The relationship between the amount of pollution produced and the amount of raw material processed. For example, an emission factor for a blast furnace making iron would be the number of pounds of particulates per ton of raw material.

End-use: Useful work, such as light, heat, and cooling, which is produced by electricity or other forms of energy.

Energy, Electric: As commonly used in the electric utility industry, electric energy means kilowatt-hours.

Energy, Off-Peak: is supplied during periods of relatively low system demands as specified by the supplier.

Energy, On-Peak: is supplied during periods of relatively low system demands as specified by the supplier.

Energy efficiency measure: A technology, device, piece of equipment, behavioral change, or other action that allows an energy service to be provided using less fuel (for example, less electricity).

Energy efficiency program: A DSM program aimed at reducing overall electricity consumption (kWh). Such savings are generally achieved by substituting technically more efficient equipment to produce the same level of end-use services with less electricity. Compare with conservation; contrast with load management.

Energy services: Those services provided to society by (or partially by) the consumption of fuels. Examples of energy services include transporting a person one kilometer, boiling a liter of water for tea, or making a ton of cement "clinker" from limestone and other ingredients. In each case, the application of different technologies and/or fuels uses different amounts of energy, but produces the same *energy service*.

Environment: The sum of all external conditions affecting the life, development, and survival of an organism.

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154 Quote is from the Foreword to the "Guidelines" volume of *Regional Electricity Cooperation and Integration (RECI), E7 Guidelines for the pooling of resources and the interconnection of electric power systems*, prepared by the E7 Network of Expertise for the Global Environment, dated approximately 2000, and available from *http://www.e7.org*.

Environmental assessment (EA): A process whose breadth, depth, and type of analysis depend on the proposed project. EA evaluates a project's potential environmental risks and impacts in its area of influence and identifies ways of improving project design and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and by enhancing positive impacts.

Environmental impacts: Physical impacts on the environment (air, land and water) associated with the full fuel-cycle, that is, the development, extraction, processing, transportation, storage and combustion of fuels. If these impacts are measured relative to a specific point in the fuel-cycle, such as the point of combustion, they may be categorized as "upstream" or "downstream", that is, occurring earlier or later in the fuel cycle than the reference point.

Expansion Plan: The schedule of planned power-supply investments to produce sufficient electricity (including reserve margins) to meet forecasted future demand.

External costs and benefits (externalities): Externalities are costs or benefits from production or consumption that are not accounted for in market prices. Costs and benefits that do not have market value, and thus current or projected prices, are externalities. For example, the costs of damage to human health from certain air pollutants are negative environmental externalities.

EPRI: Electric Power Research Institute, an organization of the electric utility industry in the United States.

Exposure: A potential health threat to the living organisms in the environment due to the amount of radiation or pollutant present in the environment.

Flexible AC Transmission System (FACTS): Transmission technologies based on power electronics and advanced control technologies that are used to optimize AC power flows and increase grid stability.

Fly ash: Noncombustible residual particles from the combustion process carried by flue gas.

Food chain: A sequence of organisms each of which uses the next lower member of the sequence as a food source.

Frequency: The rate at which an alternating current changes from positive to negative polarity, measured in cycles per second, or **hertz (Hz)**.

Fugitive emissions: Emissions not caught by a capture system.

GJ: Gigajoule; one billion (10^9) Joules

Greenhouse effect: The warming of the Earth's atmosphere caused by a buildup of carbon dioxide or other trace gases; many scientists believe that this buildup allows light from the sun's rays to heat the Earth but prevents a counterbalancing loss of heat.

Groundwater: The supply of fresh water found beneath the Earth's surface (usually in aquifers), which is often used for supplying wells and springs. Because groundwater is a major source of drinking water, there is growing concern about areas where leaching agricultural or industrial pollutants or substances from leaking underground storage tanks are contaminating it.

GW: Gigawatt; one billion (10^9) Watts

GWh: Gigawatt-hour; one billion (10^9) Watt-hours

Habitat: The place where a population (such as human, animal, plant, or microorganism) lives, and its surroundings, both living and nonliving.

Hazardous wastes: By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Substances classified as hazardous wastes possess at least one of four characteristics—ignitability, corrosivity, reactivity, or toxicity—or appear on special lists.

Heat rate: Generating unit efficiency, usually expressed in BTU's (British Thermal Units), kilojoules, or kilocalories of input energy required to produce a kWh of electrical output in a given power plant.

Heavy metals: Metallic elements with atomic number greater than 20, such as mercury and lead. They can damage living things at low concentrations and tend to accumulate in the food chain.

Hertz (Hz). See Frequency.

HVAC: High Voltage Alternating Current.

HVDC: High Voltage Direct Current.

Hydrocarbons (HC): Chemical compounds that consist entirely of carbon and hydrogen.

IIASA: International Institute for Applied Systems Analysis, located in Austria.

Incremental cost: As used in demand-side management options review, incremental cost is the difference in cost between an alternative (typically, electric energy-saving) appliance, piece of equipment, device, or procedure (that is, a DSM measure for the provision of an energy service) and a standard appliance, piece of equipment, device, or procedure (that is, the means by which the energy service would be provided in the absence of the DSM measure. As a simple example, if an higher-than-standard efficiency refrigerator cost 1500 LE, and a standard refrigerator cost 1200 LE, then the incremental cost for a purchaser of a new refrigerator choosing the higher-than-standard efficiency unit would be 300 LE.

Integrated resource planning (IRP): The process of planning for meeting all or a portion of the energy service needs of a utility's customers over the planning period (20 years). Integrated resource planning include systematic consideration of needs (demand forecasting), electricity supply alternatives, demand-side management resources, and the environmental impacts and other "externalities" of plans that combine supply- and demand-side alternatives. Integrated resource planning selects a Preferred Plan (and, if needed, Contingency Plans), and justifies the selection of the plan with regard to planning objectives selected at the outset of the process.

Investment costs: With regard to DSM measures or supply-side infrastructure purchase, investment costs will denote the capital cost of a purchase, sometimes including costs of financing the purchase as well.

IPCC: Intergovernmental Panel on Climate Change

Intertie: An interconnection permitting passage of current between two or more electric utility systems.

ISO: Independent System Operator; for example, the operator of an electricity transmission system that is governed independently from the generation organizations that feed power to the transmission system and the distribution utilities and/or other customers that take power from the transmission system.

Joule: A unit of energy in the metric (MKS) system. One joule equals one watt-second, or 1 kg-m^2/s^2, or $9.48x10^{-4}$ Btu, or 4.184 calories (cal).

kJ: kilojoule; one thousand (10^3) Joules

kW: kilowatt; one thousand (10^3) Watts

kWh: kilowatt-hour; one thousand (10^3) Watt-hours

Kyoto Protocol: At a conference held in December 1997, in Kyoto, Japan, the Parties to the United Nations Framework Convention on Climate Change agreed to a Protocol to reduce greenhouse gas emissions.

Levelized cost: The uniform annual cost that results in the same net present value over the planning horizon as the stream of actual annual average costs. An example of a levelized cost is a monthly mortgage payment. When comparing, for example, the cost of electricity production from different types of power plants, the **nominal levelized cost** is the uniform cost of electricity, in mixed current year (nominal) dollars, for which the present value of the cost of electricity produced over the life of the plant is equal to the present value of the costs of the plant, while the **real levelized cost** is the uniform cost of electricity, in constant (real) dollars, for which the present value of the electricity produced equals the present value of the costs of the plant.

Life-cycle costs: The full cost of owning and operating an appliance, piece of equipment, or other energy-using device over the lifetime of the device. Life-cycle costs include the purchase, installation, operating and maintenance, energy, and sometimes externalities costs incurred over the lifetime of the device, typically discounted to calculate a net present value.

Line Losses: Kilowatt-hours and kilowatts lost in the transmission and distribution lines under specified conditions.

Load Building Programs: Utility sponsored efforts designed to increase customer usage of the fuel provided by the sponsoring utility.

Load-Duration Curve. A graph showing a utility's hourly demand, sorted by decreasing size, and the amount of time a given level of demand is exceeded during the year.

Load Factor: The ratio of average requirements to peak requirement for the same time period. Load factor may be calculated for a customer, customer class or the entire system. An "improved" load factor implies that the peak requirement is reduced while average requirement is held constant, such that there is an increase in the ratio of the average to peak requirement.

Load-Following: The ability of a supply resource to respond to variations in demand.

Load forecasting: See demand forecasting

Load management: The controlling, by rescheduling or direct curtailment, of the power demands of customers or groups of customers in order to reduce the total load that a utility must meet at times of peak demand. Load management strategies are designed to either reduce or shift demand from on-peak to off-peak, while conservation (see energy efficiency) strategies reduce net usage over larger multi-hour periods. Load management may take the form of normal or emergency procedures. Utilities often encourage load management by offering customers a choice of service options with varying price incentives (including Time-of-Use tariffs).

Load Shape: The time-of-use pattern of customer demand for energy.

Load Shedding: The turning off of electrical loads to limit peak electrical demand.

Load Shifting: Shifting load from peak to off-peak periods. Applications include use of storage water heating, storage space heating, cool storage, and customer load shifts to take advantage of time-of-use or other special rates.

Loss of load probability (LOLP): A measure of the probability that system demand will exceed available capacity during a given period.

LWR: Light-water reactor, the type of nuclear power generation reactor most common in most countries.

Methane: A colorless, nonpoisonous, flammable gas created by anaerobic decomposition of organic compounds.

MJ: Megajoule; one million (10^6) Joules

Modeling: An investigative technique using a mathematical or physical representation of a system or theory that accounts for all or some of its known properties. Models are often used to test the effect of changes in system components on the overall performance of the system.

Monitoring: Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements or pollutant levels in various media or in humans, animals, and other living things.

MW: Megawatt; one million (10^6) Watts

MWh: Megawatt-hour; one million (10^6) Watt-hours

Net Present Value: See Present Value.

Nitrogen oxides (NOx): Products of combustion from transport and stationary sources and major contributors to acid deposition and the formation of ground-level ozone in the troposphere.

Objective: A statement of the end-result, product, or condition desired, for which a course of action is taken. In an IRP, for example, an objective is an end-result desired from the implementation of a resource plan.

Ohm(Ω): A measure of resistance.

Operating and Maintenance costs (O&M costs): Recurring costs of operating, supporting, and maintaining infrastructure or programs, including costs for labor, materials, supplies, other current expenses, and (if not accounted for separately) fuel.

Peaking Unit: A power generator used by a utility to produce extra electricity during peak load times.

Pollutant: Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the U.S. Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, and radiological integrity of water.

Present value: The current value of a cost or stream of yearly costs that have been discounted to reflect the fact that future benefits or expenditures are worth less than current benefits or expenditures. Also called Present Worth. See: discount rate.

Program: A combination of resources and activities designed to achieve an objective or objectives.

RAINS-Asia: Regional Air Pollution INformation and Simulation)-Asia, a modeling project and software tool for simulating the sources and impacts of "acid precipitation" in Asia.

Renewable resource: Any facility, technology, measure, plan or action utilizing a renewable "fuel" source such as wind, solar, biomass, geothermal, waste, or small-scale hydroelectric energy.

RERA: Southern Africa's Regional Electricity Regulators Association

Reserve Margin: The difference between an electric system's maximum capacity and the expected peak demand.

Resistance: The degree to which an object resists the flow of current. Resistance, the reciprocal of conductance, is measured in ohms (Ω). The resistance of wire is a product of its resistivity (an inherent property of the material from which it is made, such as copper or aluminum, for a given temperature) and the dimensions of the wire.

Revenue requirements: The amount of revenues that a utility needs to receive in order to cover operating expenses, pay debt service, and provide a fair return to common equity investors.

Risk: Potential changes in the net present value of revenue requirements and the electric tariffs associated with a particular resource portfolio, which result when the probability distributions associated with the various planning assumptions (for example, demand forecasts, fuel prices, technology costs, or other parameters) are considered.

Runoff: That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water; can carry pollutants from the air and land into the receiving waters.

SAPP: The Southern African Power Pool

Sediments: Soil, sand, and minerals washed from land into water, usually after rain. Sediments pile up in reservoirs, rivers, and harbors, destroying fish-nesting areas and holes of water animals and clouding the water so that needed sunlight may not reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to be washed off the land after rainfalls.

Societal Cost: The total cost of a resource to society as a whole, including both "internal" costs (those costs already associated with a monetary value) and "external" costs, whether associated with a monetary value or not. Societal costs are evaluated independent of who in society pays the costs or receives benefits.

Solid wastes: Nonliquid, nonsoluble materials, ranging from municipal garbage to industrial wastes, that contain complex, and sometimes hazardous, substances. Solid wastes include sewage sludge, agricultural refuse, demolition wastes, and mining residues. Technically, solid wastes also refer to liquids and gases in containers.

Spinning Reserve: Electric power available from generating units connected to the system and ready to deliver power promptly.

Stakeholders: Groups and individuals who will or could be directly affected by the plans and activities related (for example) to an electricity interconnection. Examples include not only the different public companies operating in the sector, but consumers, local residents, other government agencies, environmental and other nongovernmental organizations, and business groups.

Strip mining: A process that uses machines to scrape soil or rock away from mineral deposits just under the earth's surface.

Sulfur dioxide (SO_2), or Sulfur Oxides (SO_x): A heavy, pungent, colorless, gaseous air pollutant formed primarily by processes involving fossil fuel combustion (usually coal or heavy fuel oil).

Supply-side planning: Planning for the infrastructure used to supply electricity to users, which can include central, local or distributed generation capacity and related equipment such as fuel supply and emissions control devices, transmission infrastructure, and distribution infrastructure.

Supply-side resource: A resource that can provide electrical energy or capacity to a utility. Supply-side resources can include utility-owned generating facilities, and energy or capacity purchased from other utilities (such as EETC) and non-utilities.

Surface water: All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.); also refers to springs, wells, or other collectors that are directly influenced by surface water.

Tailings: Residue of raw materials or waste separated out during the processing of crops or mineral ores.

TCE: Metric ton of coal equivalent, equal to 29.2 GJ.

TOE: Metric ton of oil equivalent, equal to 41.84 GJ.

Tie Line (or Intertie): A circuit connecting two or more control areas or systems of an electric system.

Transmission: The bulk transport of electricity via high voltage lines.

Unbundling: Disaggregating electric utility service into its basic components and offering each component separately for sale with separate rates for each component. For example, generation, transmission and distribution could be unbundled and offered as discrete services.

UN/DESA: United Nations Department of Economic and Social Affairs

UNFCCC: United Nations Framework Convention on Climate Change

Unserved Energy: The expected amount of energy curtailment per year due to demand exceeding available capacity. It is usually expressed in megawatt-hours (MWh).

Uprating: Increasing the rating or stated measure of generation or transfer capability.

Valley filling: The building of off-peak loads. An example valley filling technology is thermal storage (water heating and/or space heating or cooling) that increases nighttime loads and reduces peak period loads. Valley filling may be desired in periods when the long-run incremental cost of supply is less than the average price of electricity. (Adding off-peak load under those circumstances decreases the average price.)

VAR: Volt-amperes reactive power

Volatile organic compound (VOC): Any organic compound that participates in atmospheric photochemical reactions; generally have a boiling point of less than 145° Celsius.

Volt (V): The measure of voltage.

Voltage: The difference in electric potential between two points in an electric circuit.

Water pollution: The presence in water of enough harmful or objectionable material to damage water quality.

Watershed: The land area that drains into a stream or river.

Watt (W): A unit of power equal to a Joule of energy per second.

Watthour: The total amount of energy used in one hour by a device that requires one watt of power for continuous operation. Electric energy is commonly sold by the kilowatt-hour (defined above).

Wetlands: An area that is regularly saturated by surface water or groundwater and is subsequently characterized by a prevalence of vegetation adapted for life in saturated soil conditions. Examples include swamps, bogs, fens, marshes, and estuaries.

Wheeling: The contracted use of electrical facilities of one or more entities to transmit electricity for another entity.

WB: The World Bank Group

Annotated Bibliography To Accompany Multi-dimensional issues in international electric power grid interconnections

PREPARED FOR THE UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS (UN/DESA)

Bibliography prepared by Steve Eaton

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NOTE: The bibliography provided below include most of the documents reviewed in preparing the Report Multi-Dimensional Issues in International Electric Power Grid Interconnections. As such, it is intended to be a resource for users of the Report, providing access to original and summary materials on the topic of grid interconnections. This bibliography is not intended, however, to be an exhaustive review of all literature on the topic. UN/DESA makes no claim as to the accuracy of the information in the documents listed below, and the inclusion of specific documents in this listing should not be interpreted as endorsement of those documents by UN/DESA.

1. El-Sharkawi and Lokolo, The Potential for Regionally Integrated Energy Development in Africa, The World Energy Council, October 2003, available as: *http://www.worldenergy.org/wec-geis/publications/reports/africa/foreword/foreword.asp*

   http://www.worldenergy.org/wec-geis/global/downloads/africa/AfricaInt03.pdf (this is the link to the PDF version)

Key Words: Africa, Interregional Power Grid Interconnections

- This is a detailed report on the case for developing an integrated electricity grid for the continent of Africa, to be used as a tool for development and poverty alleviation in the region. It outlines the benefits and costs of such a network, and has a strong section on the factors that affect cooperation and integration of the continent's energy sources. The report also gives a thorough evaluation of the current state of the energy industry and of the varying levels of regional integration in Africa. There is a detailed and informative section on the energy geography of the continent. Though the focus of the report is specifically on the African continent it can be used for any developing country or region of the world looking to improve the consistency and distribution of its energy sources.

2. Eynon, Leckey, and Hale, The Electric Transmission Network: A Multi-region Analysis, The Energy Information Agency, available as: *http://www.eia.doe.gov/oiaf/analysispaper/transmiss.html*

Key Words: North America, Interregional Power Grid Interconnections, Competitive Electricity Markets

- This report looks at the expected increase in inter-regional power trading, and the pressure this will put on the existing electricity networks in four regions in the Northeast of the US as competitive electricity markets become more widespread. Potential negative impacts of increased inter-regional electricity trading/sharing are among the topics highlighted.

3. Regional Electricity Cooperation and Integration (RECI), E7 Guidelines for the pooling of resources and the interconnection of electric power systems, E7 Network of Expertise for the Global Environment, available as: *http://www.e7.org*

Key Words: Interregional Power Grid Interconnections, Sustainable Development

- This is a relatively short pamphlet (approx. 20 pages) providing an overview of the topic, and useful for seminars and training on interconnection issues. Associated with the pamphlet is a CD ROM that includes documents that examine the issues in much more detail. The main purpose of the pamphlet and CD ROM, as described by the E7 Group, is to help develop the electricity supply industry of developing countries, and to help promote and enhance the industry's contribution to the sustainable development of those countries. The document/CD ROM examines in depth the necessary conditions for the successful implementation of integrated regional electricity networks, and outlines the political, social, economic and environmental benefits from the pooling/sharing of electricity networks and resources. This is a very well- organized and relevant source of information on grid interconnections.

4. Technical and Economic Aspects of the Establishment of a Regional Electricity Network, United Nations Economic and Social Commission for Western Asia, 1997

Key Words: Asia, Interregional Power Grid Interconnections, Technical, Economic, Environmental

- This report examines the technical and economic aspects of creating a regional electricity network in the ESCWA (Economic and Social Commission of Western Asia) countries of western Asia. It is broken down into 5 chapters: chapter I is an overview of the interregional electric interconnections in ESCWA with a focus on the economic, technical, and environmental benefits, as well as the power system constraints and techno-economic limitations of interconnection; chapter II is an overview of the power systems of the ESCWA members; chapter III examines the varying levels of electricity interconnections between the countries of the ESCWA region; chapter IV focuses on the prospects for establishing a regional electricity grid in Western Asia; and the conclusion, chapter V, looks at the technological and economic viability of creating and maintaining interconnected electricity networks in the ESCWA region.

5. An Integrated European Market, Centre for Economic Policy Research, February 1st, 2005, available as: *http://www.cepr.org/press/MED2.htm*

Key Words: Europe, Interregional Power Grid Interconnections

- This report argues that the liberalization of electricity markets in Europe is progressing, but that "new policies and radical changes are needed if markets are to be integrated and further liberalized across Europe." For a single European market of electricity to truly function efficiently the processes must be implemented to make cross-border electricity trade just as easy as domestic trade. To accomplish this task the report argues for the implementation of access charges. The above link is for the summary of the report, not the report in its entirety.

6. Towards a Common Electricity Market in the Baltic Sea Region, Baltic Ring Electricity Co-operation Committee (BALTRAL), Co-Financed by the European Commission, 2002, available as: *http://www.baltrel.com/Reports/Baltrel_021202.pdf*

Key Words: Europe, Interregional Power Grid Interconnections, Electricity Markets

- This report looks at the current electricity market situation in the Baltic Sea region, and evaluates the procedures necessary to move towards an integrated electricity network for the region. The paper starts with a general background and brief history on the region, then examines in more detail the market rules and infrastructure in the Baltic region, and concludes with an analysis of what needs to be done to further facilitate the move towards a common electricity market in the region and the role that BALTRAL can play in that process. The main goals of the "BALTRAL vision" are to: improve the infrastructure for electricity exchange and trade; create conditions for competition based on responsibility for efficiency and reliability; give equal rights to all market participants, and increase the right of choice for customers to choose their energy supplier; and to achieve environmental improvements. This report provides a case study for a transitional region in the process of integrating its electricity sector.

7. David Streets, Environmental Aspects of Electricity Grid Interconnection in Northeast Asia, Argonne National Laboratory, Decisions and Information Science Division, 1/2/05, available as: *http://www.nautilus.org/archives/energy/grid/papers/streets.pdf*

Key Words: Asia, Environmental, Hydroelectric Power

- Examined within this document are the environmental benefits of connecting the electricity grid networks of the countries of Northeast Asia including; Russia, Mongolia, China, Japan, DPRK, and the Republic of Korea. The focus is on how the promotion of alternative sources of energy, namely hydro and to a lesser extent nuclear, to reduce the use of coal, combined with integrating the electricity networks of the different countries involved could significantly help to combat the air pollution of the region and provide more widespread and consistent electricity.

8. Ralph Turvey, Interconnector Economics, ELSEVIER, 2004

Key Words: Economic, Interregional Power Grid Interconnections

- This paper, published recently in the Energy Policy journal by ELSEVIER press, examines from an economic standpoint why grid interconnection can at times be inefficient. Turvey explains that although there are undoubtedly benefits from interconnection, they may be difficult to quantify and may not cover the costs associated with it. The paper is pretty technical in general. It starts with a brief section on definitions and descriptions of terms in the context of the paper, and then examines the costs and benefits of international grid interconnections. The 3rd, and by far biggest section of the document, titled "Interconnector Utilization', consists of the bulk of Turvey's analysis.

9. Won-Cheul Yun, A Strategic Approach for Electric Power Cooperation in North-East Asia, Hanyang University Department of Economic and Finance, South Korea, 2004, available as: *http://fbweb.cityu.edu.hk/hkapec/Conference/Papers/Won-Cheol.pdf*

Key Words: Asia, Interregional Power Grid Interconnections, Political

- This study creates a scenario of grid interconnection between the Russian Far East, North Korea, and South Korea to evaluate the possibility of regional electricity cooperation in North-east Asia. Through this scenario the paper looks at the electricity market structure, the prospects for the restructuring of the electric power industries in Russia and South Korea, and the political aspects related to grid interconnection with North Korea. The paper looks at two possible options for achieving a successfully integrated grid; an inter-governmental project, and a private sector led initiative, which the author finds more feasible.

10. Stephen Karekezi, Jennifer Wangeci, and Ezekiel Manyara, Sustainable Energy Consumption in Africa, African Energy Policy Research Network (AFREPREN/FWD), UN DESA Final Report, May 2004, available as:

http://www.un.org/esa/sustdev/sdissues/consumption/Marrakech/EnergyConsumption.pdf

Key Words: Africa, Sustainable Development

- The authors examine current energy consumption in three different regions in Africa, North Africa, Sub-Saharan Africa and South Africa, and discuss the need for sustainable energy consumption initiatives. The paper focuses on three consumption sectors; household, transport and agriculture. The authors argue that if managed correctly, these industries in African countries can jump straight to sustainable energy consumption patterns, as compared to many industrialized countries that progressed from traditional energy consumption to unsustainable consumption. Although this report does not cover electricity grid interconnections, there is some useful information regarding the energy consumption patterns of the three regions and categories mentioned above.

11. Report of the World Summit on Sustainable Development, United Nations, Johannesburg, South Africa, 26 August – 4 September, 2004, available as:

    http://daccessdds.un.org/doc/UNDOC/GEN/N02/636/93/PDF/N0263693.pdf?OpenElement

Key Words: Africa, Sustainable Development

- This report summarizes the World Summit on Sustainable Development in Johannesburg, South Africa in 2004. It covers many different topics related to sustainable development, and has some specific information pertaining to poverty alleviation through increasing the number of Africans who have access to consistent energy. Additional reports on the Summit are available at: *http://www.un.org/jsummit/html/documents/summit_docs.html*

12. Itai Madamombe, Energy Key To Africa's Prosperity: Challenges in West Africa's Quest for Electricity, Africa Renewal, Vol.18 #4, January 2005, available as: *http://www.un.org/ecosocdev/geninfo/afrec/vol18no4/184electric.htm*

Key Words: Africa, Interregional Power Grid Interconnections, Environmental

- This recently-produced article in the Africa Renewal outlines the current energy issues in West Africa, and discusses the benefits that can be obtained through grid integration in this region, and in Africa in general. Madamombe focuses on the aging electricity infrastructure as one of the major problems African countries are facing. Environmental and health issues associated with energy use are raised as well due to the fact that a large portion of the population relies on burning traditional biomass for energy. A brief outline of current and completed grid projects is included, in addition to some of the major challenges ahead regarding electricity grid interconnection.

13. Michael Wolfe, Peter Donalek and Peter Meisen, The Economic, Environmental and Developmental Benefits of High-Voltage Interconnections Between South and North America via Central America and the Caribbean, ENERLAC 93, Bogota, Columbia, June 1993

    Accessed from the Global Energy Network Institute (GENI) website at: *http://www.geni.org/energy/library/technical_articles/transmission/interconnect.html*

Key Words: North America, South America, Economic/Financial, Environmental, Hydroelectric

- As the title suggests, this report looks at the benefits of a North American/South American electricity grid interconnection connected through Central America and the Caribbean. The authors examine the role renewable energy, largely from hydro dams in South America, can play in grid interconnection, and the export markets that could be created. Their focus is on the economic and environmental benefits that would be achieved in the overall context of the development of the region. The authors also look at the necessary role of the international and regional banks in financing this initiative.

14. Briony Hale, Africa's Grand Power Exporting Plan, BBC, October, 2002

    Accessed from the Global Policy Forum website as: *http://www.globalpolicy.org/socecon/develop/africa/2002/1017power.htm*

Key Words: Africa, Interregional Power Grid Interconnections, Hydroelectric

- This is a short news article discussing Africa's goal of linking its electricity grid with Europe and the Middle East and exporting electricity abroad. The plan is centered around the Inga rapids in Democratic Republic of Congo (DRC), which it is believed could supply Africa with all of its energy needs and have leftover capacity to be exported and sold overseas. In addition, the article touches very briefly on the technical and financial barriers that may be a detriment to the prospect of interconnecting Africa with Europe and the Middle East in the near future.

15. With Power Anything is Possible, address by Thulani Gcabashe at the ESKOM Business Leaders Forum, Business in Africa Online, Oct. 2004, available as: *http://www.businessinafrica.net/eskom_leaders_forum/385701.htm*

Key Words: Africa, Interregional Power Grid Interconnections

- Thulani Gcabashe is the chief executive of ESKOM, South Africa's power utility. In his address, given last year at the 2nd ESKOM Business Leaders Forum, Gcabashe stresses the need to significantly increase the number of people who have direct access to electricity. In order to do so, regional grids will need to be established first, which will then facilitate as easier transition to a completely integrated continent.

16. A. Cherian, Development and Operation of Trans-border Interconnections of Electric Power Grids in Africa, UN DESA, September 2003

Key Words: Africa, Interregional Power Grid Interconnections, Political

- This DESA paper gives a general overview of the current status of operational and planned regional interconnections in Africa, and some of the major constraints that need to be addressed. The constraints the paper examines fall into three categories: capacity, political and policy. The paper starts with a background section on electricity in Africa, then covers the constraints on interconnection as relevant to each region covered; Central Africa, East Africa, West Africa, North Africa, and Southern Africa.

17. Regional Electricity Trading: Issues and Challenges, Workshop on Regional Power Trade, Kathmandu, Nepal, March 2001, available as:

    http://64.224.32.197/Publications/shean.pdf

Key Words: Asia, Interregional Power Grid Interconnections

- In this paper the South Asia Regional Initiative on Energy examines the benefits of regional electricity interconnection and trade among South Asian countries in light of the growing population and increased demand for electricity in the region. The main benefits the paper focuses on are improved security of supply, better economic efficiency, and environmental enhancement and protection implications. The paper then addresses some of the major challenges including; technical challenges, commercial issues, the effect of subsidies on prices, the inclusion of environmental considerations, market structure differences, governance and legal issues, financial issues, and national policy and security issues.

18. Panel Session: Status of International Connections and Electricity Deregulation in Africa, IEEE Power Engineering Society, Energy Development and Power Generating Committee, Denver, Colorado, July 2004, available as: *http://www.ewh.ieee.org/cmte/ips/2004GM/2004GM_Africa.pdf*

Key Words: Africa, Interregional Power Grid Interconnections, Economic, Hydroelectric

- This document is a very informative collection of essays written on various subjects related to regional electricity interconnections and electricity deregulation in Africa. In total there are 11 reports, most of which function as case studies representing a specific topic related to the issues outlined previously. For example, the reports cover such topics as the economic impact of interconnections for the Southern African Power Pool, and the potential positives and negatives resulting from large hydro projects through an evaluation of the 3 Gorges Dam in China for example. The first section of the report also provides detailed biographical information on each of the authors of the reports in the document, who presented the reports at the panel session in Colorado in 2004.

19. Powering Africa's Development, an Interview with Thulani Gcabashe, Chairman of ESKOM Enterprises, World Energy Council, date not available, available as:

http://www.worldenergy.org/wec-geis/global/downloads/first/africa/gcabashe.pdf

Key Words: Africa, Interregional Power Grid Interconnections

- This interview with the Chairman of ESKOM, Thulani Gcabashe, is directed towards his company's directives and future plans of growth and expansion in Africa, and his thoughts on the energy situation in Africa more generally. The interview also looks at ESKOM's role in regional initiatives, such as the New Partnership for Africa's Development (NEPAD), the SAPP, and the Union of Producers, Conveyers and Distributors of Electrical Energy in Africa (UPDEA), all of which ESKOM is integrally involved. Gcabashe also discusses the importance of developing an integrated, continent wide electricity grid as a method for poverty alleviation.

20. Vladislav Vucetic, South Asian Regional Energy Trade: Opportunities and Challenges, the World Bank, October 2004, available as:

http://siteresources.worldbank.org/INTSOUTHASIA/Resources/Energy_a.pdf

Key Words: Asia, Interregional Power Grid Interconnections

- This paper gives a general overview on the current energy situation in South Asia, including installed capacity and production information for Bangladesh, Bhutan, Nepal, Pakistan, Afghanistan, Iran, India, and Sri Lanka. The paper also includes a brief section on interregional trade in comparison to the levels of trade in other regions of the world. A rationale for interregional energy trade in South Asia is given, including the benefits, costs, and obstacles.

21. Enrique Crousillat, Developing International Power Markets in East Asia, Public Policy for the Private Sector, no. 143, May 1998, available as:

http://rru.worldbank.org/Documents/PublicPolicyJournal/143crous.pdf

Key Words: Asia, Interregional Power Grid Interconnections

- This "note", as it is referred to by the author, describes the different market development options for regional power trade in East Asia, examines the reforms of the power industry, looks at the benefits from and obstacles to regional electricity trade, and gives a brief overview of the efforts and current infrastructure regarding power trade in the greater Mekong region. This area includes Cambodia, Laos, Vietnam, the Yunnan Province of southern China, Myanmar, and Thailand.

22. Theun-Hinboun Hydropower - Project Profile, ADB, March 3, 2005, available as: *http://www.adb.org/Projects/TheunHinboun/*

Key Words: Asia, Hydroelectric

- "The main objective of the Project is to support economic growth through the enhancement of foreign exchange earnings by the export of electric power to Thailand. The Project represented a new policy direction in the power subsector, which has been initiated through discussions with the Bank. It is the first time that the Government of Lao PDR formed a joint venture (JV) with the private sector for financing, construction and operation of a power plant."

23. Theun-Hinboun: an assessment of early project performance, prepared for Probe International by Wayne White, March 2001, available as:

http://www.probeinternational.org/pi/documents/mekong/TheunHinboun2.html#Introduction

Key Words: Asia, Hydroelectric

- This paper is an evaluation of the Theun-Hinboun Hydropower project between Lao PDR and Thailand by an independent observer. The purpose of the report is to use the power generated

and revenue history to assess the performance of the project during the first two years of its operation. Based on the company's initial findings, they report that from the perspective of the Lao Government, who borrowed money from ADB to finance the project, the project is currently performing well and will continue to do so for the duration of its lifetime (25 years.)

24. Trading Away the Future: the Mekong Power Grid, International Rivers Network, March 8th 2005, available as: *http://www.irn.org/programs/mekong/030620.powergrid-bp.pdf*

Key Words: Asia, Hydroelectric

- In this International Rivers Network (IRN) briefing paper, the threats of the ADB-supported region power grid in the Mekong River region, which would facilitate dam construction throughout mainland Southeast Asia, are outlined and criticized.

25. Problems and Prospects for Hydropower Development in Africa, prepared by Kalitsi & Associates for the Workshop for African Energy Experts on Operationalizing the NGPAD Energy Initiative, June 2003, available as:

http://www.un.org/esa/sustdev/sdissues/energy/op/nepadkalitsi.pdf

Key Words: Africa, Hydroelectric

- This paper outlines the prospects and problems of hydro power development in Africa, and focuses on recommending concrete proposals to help facilitate the development of this sector of Africa's energy infrastructure. These policy proposals and strategies fall under the auspices of the New Partnership for African Development (NEPAD) initiative. The various sections of the paper outline Africa's power sector, the current hydro initiatives underway in Africa, the benefits and environmental and social costs associated with hydro power, funding issues, and an action plan for the development of hydro power in Africa.

26. Margaret Matinga, Pooling African Power: Challenges and Issues in a Reforming and Integrating in a Southern African Power Sector, March 10th 2005, available as:

http://www.nepru.org.na/Regional%20Intergration/Power%20sector%20integration.pdf

Key Words: Africa, Interregional Power Grid Interconnections

- This document provides an overview of the Southern African Power Pool (SAPP), the various initiatives the Pool is undertaking and the issues it is facing. The author discusses the benefits of SAPP including; economic efficiency, supply diversity and reliability, and the environmental benefits associated with pooling and distributing southern Africa's power sources. Also included in the paper is an overview of the various regulatory organizations involved in the SAPP, and a section examining the challenges facing this power pool.

27. F.T. Sparrow and William Masters, Modeling Electricity Trade in Southern Africa, project proposal for funding under the USAID co-operative agreement on Equity and Growth through Economic Research/Trade Regimes and Growth (EAGER/TRADE), 1998, available as: *https://engineering.purdue.edu/IE/Research/PEMRG/PPDG/SAPP/1998proposal.pdf*

Key Words: Africa, Interregional Power Grid Interconnections, Technical

- The authors of this report provide an overview to the SAPP, and examine the objectives and workplan of research conducted by Purdue University and planners at the Southern African Development Community (SADC) in 1997. It also outlines a long-term study proposed by these same groups to examine capacity expanding initiatives by modeling capital investments for new regional power links and cooperative construction of new power generators.

28. Donald O'Leary, Jean-Paul Charpentier, and Diane Minogue, Promoting Regional Power Trade – The Southern African Power Pool, Public Policy for the Private Sector, June 1998, available as: *http://rru.worldbank.org/Documents/PublicPolicyJournal/145olear.pdf*

Key Words: Africa, Interregional Power Grid Interconnections

- This article gives a brief overview of the Southern African Power Pool (SAPP), reviews the circumstances that have paved the way for the successful development of SAPP, and outlines the challenges that (at the time the article was written) lay ahead.

29. Xolani Mkhwanazi, Power Sector Development in Africa, paper for the NEPAD Energy Workshop in Senegal, June 2003, available as:

http://www.un.org/esa/sustdev/sdissues/energy/op/nepadmkhwanazi.pdf

Key Words: Africa, Power Sector Overview, Technical

- This paper was designed to provide background materials on the power sector in Africa and to promote discussion of related topics for a workshop of African energy experts in Senegal in 2003. Its primary objectives were to outline the status of the energy sector in Africa and to discuss some of the current problems it is facing, including the technical and non-technical barriers to electricity trade; to promote the need for regional and sub-regional initiatives for power sector development; and to propose strategies and policies to address infrastructural issues, and more broadly, policies promoting the further development of the power sector.

30. Patrick McCully, Tropical Hydropower is a Significant Source of Greenhouse Gas Emissions: A response to the International Hydropower Association. International Rivers Network, December 2004, available as: *http://www.irn.org/basics/conferences/cop10/pdf/TropicalHydro.12.08.04.pdf*

Key Words: Hydroelectric, Environmental

- This paper is a response to information provided by the International Hydropower Association regarding the emissions of greenhouse gases from hydro facilities. It examines the effects

that large reservoirs have in terms of methane gas emissions, and also sites and critiques several reports written on greenhouse gas emissions of hydropower plants.

31. Patrick McCully and Susanne Wong, Powering a Sustainable Future: The Role of Large Hydropower in Sustainable Development. International Rivers Network, Prepared for the UN Symposium on Hydropower and Sustainable Development, Beijing, China, October 27-29, 2004, available as: *http://www.irn.org/basics/conferences/beijinghydro/pdf/irnbei.pdf*

Key Words: Hydroelectric, Environmental, Economic, Social

- The focus of this paper is on the role of large hydropower facilities on sustainable development. It looks at the social, environmental, and economic impacts that result from the limitations of large hydro plants, and provides recommendations for environmentally friendly, cost-efficient, and socially equitable development for projects of this nature.

32. Environmental, Social and Economic Impacts of Dams: Environmental Impacts, International Development Studies Network, date not available, available as: *http://www.idsnet.org/Resources/Dams/Development/impact-enviro.html*

Key Words: Hydroelectric, Environmental

- This report looks at the major environmental impacts of dams, which it organizes into two categories. The first category is the impacts that arise from the existence of a dam and reservoir, such as loss of habitat, increased erosion, changes in downstream water quality, and reduction of biodiversity. The second category is the issues that arise due to the pattern of dam operation, such as changes to downstream hydrology, morphology and water quality, and also a reduction in habitat diversity.

33. Fred Pearce, Water-Reservoirs and Greenhouse Emissions, the Independent, London, 13 October 2000 Water-Reservoirs and greenhouse emissions, available as: *http://www.rivernet.org/general/dams/greenhouse.htm*

Key Words: Hydroelectric, Environmental

- This article examines the environmental impacts of reservoir dams, with a specific focus on greenhouse gas emissions and the resulting effect on global warming. It argues that hydroelectric power, once touted as a "green" energy source, produces significant quantities of carbon dioxide and methane, making many of the large reservoir dams as pollution causing as a typical fossil-fuel burning plant.

34. PSC Overview Series, Environmental Impacts of Electric Transmission Lines, Public Service Commission of Wisconsin (1998), available as: *http://psc.wi.gov/consumer/electric/cnstrenv/envirimp.pdf*

Key Words: Environmental, Social

- The Public Service Commission of Wisconsin provides background information on the environmental and social impacts of the construction of electricity transmission lines. The piece was designed to assist landowners, local officials, and other citizens who might be affected by the construction of such a line, and more generally to serve as a guide in helping to develop Wisconsin's long-term energy plans.

35. Randa Alami, Financial Aspects Of Arab Power Development, Oxford Institute for Energy Studies, January 2005, available as: *http://www.oxfordenergy.org/pdfs/F9.pdf*

Key Words: Middle East, Economic/Financial

- This report looks at the financial aspects of the development of the electricity sector in the Middle East. The author examines the role of public and private partnerships and the strong regional cooperation occurring in the region today in regards to the financing of power sector projects. The report begins with an overview of the current trends for financing of this industry in the developing world, then more specifically in the rest of the piece focuses on developments in the Arab world.

36. New Partnership for Africa's Development text, from a conference held in Abuja, Nigeria in October, 2001, available as: *http://www.uneca.org/eca_resources/Conference_Reports_and_Other_Documents/nepad/NEPAD.htm*

Key Words: Africa, Sustainable Development

- The New Partnership for Africa's Development is a pledge made by Africa's leaders to eradicate poverty while simultaneously pursuing a path of sustainable development and growth. This is a general initiative that covers many different topics and issues related to poverty reduction and development, including specific information on energy and development. Some of the major objectives outlined in the report related to energy initiatives are the following: to provide clean and affordable energy to 35 percent of the African population within 20 years; improve the reliability and lower the cost of energy supply; and to facilitate cross-border energy flows by integrating transmission grids and pipelines.

37. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Chapter 4 of US Nuclear Regulatory Commission (NRC, 1996), (Report # NUREG-1437 Vol. 1), available as:

http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/v1/

Key Words: Nuclear, Environmental

- The purpose of this report is to assess the potential environmental impacts associated with license renewals of nuclear power plants, or from the continued operation of nuclear plants for a further 20 years. In addition, the report serves to provide the technical basis for amend-

ing the Nuclear Regulatory Commission's (NRC's) regulations regarding the renewal of these operating licenses.

38. R. Grunbaum, J. Charpentier, and R. Sharma (2000), Improving the efficiency and quality of AC transmission systems, Joint World Bank-ABB Paper, available as: *http://www.worldbank.org/html/fpd/em/transmission/efficiency_abb.pdf*

Key Words: Power Sector Overview, Interregional Power Grid Interconnections

- This report looks at the opportunities and challenges presented by the fast-changing electricity supply industry, which largely stem from the significant increase in inter-utility power sharing, deregulation of the electricity market, and the political, economic and environmental aspects of building new transmission lines. The paper addresses other solutions, known as "Flexible AC Transmission Systems (FACTS)", for overcoming capacity and quality limitations as opposed to following the more traditional path of building new lines.

39. John Bickel, Grid Stability and Safety Issues Associated with Nuclear Power Plants, Paper prepared for the Second Workshop on Grid Interconnections in Northeast Asia, May 7, 2001, available as *http://nautilus.org/archives/energy/grid/papers/Bickel.pdf*

Key Words: Asia Nuclear, Technical

- This paper provides a brief summary of the technical issues associated with using nuclear power generation on existing grid networks, and how there are unique requirements and standards that these grids must meet in order to safely be able to accommodate nuclear power facilities. More specifically, the paper looks at how design standards and safety regulations relate to grid reliability and nuclear safety.

40. T. Hughes, Networks of Power: Electrification in Western Society, 1880-1930, Johns Hopkins University, Baltimore, MD, 1983

Key Words: North America, Power Sector Overview, Europe, Technical,

- Thomas Hughes, a professor at the University of Pennsylvania, looks at the history of electrification of the Western world in his "Networks of Power." Hughes thoroughly examines the development of electrical supply systems, and outlines in detail the technology of these various systems.

41. R.G. Rincliffe, Planning and Operation of a Large Power Pool, IEEE Spectrum: 91-96. January 1967. available as: *http://blackout.gmu.edu/archive/pdf/planning_ops.pdf*

Key Words: North America, Power Sector Overview, Benefits of Interregional Power Grid Interconnections

- Rincliffe looks at the history of the development of power pools in the United States, primarily focusing on the Pennsylvania-New Jersey-Maryland pool which can be dated back to

1927. The main focus of the article is tracing the evolvement of interconnections into full fledged power pools, and the benefits these pools provide.

42. F. Meslier, Historical Background and Lessons for the Future, in J. Casazza and G. Loehr, The Evolution of Electric Power Transmission Under Deregulation, IEEE, Piscataway, NJ, 1999

Key Words: North America, Power Sector Overview

- Meslier's article, "Historical Background and Lessons for the Future", is part of a collection of articles on power transmission systems included in Casazza and Loehr's, The Evolution of Electric Power Transmission Under Deregulation. The areas covered in the book as a whole include: an overview of deregulation issues; transmission system planning and design; transmission system operation; transmission transfer capacity; and restructuring, reliability and transmission.

43. J. Blackburn, Protective Relaying: Principles and Applications, 2nd ed. Marcel Dekker, New York, 1998

Key Words: Power Sector Overview

- Blackburn outlines the basic theories and applications regarding relays used in protecting electric power systems. This is the second addition of a widely-used resource, providing information on topics such as: large and small, industrial and commercial power systems; power generator protection; power system grounding; and the performance of power systems during abnormal conditions.

44. L. A. Koshcheev, Basic Principles of Interstate Electrical Power Links Organization in North-East Asia, paper prepared for the Workshop on Grid Interconnections in Northeast Asia, May 14, 2001, available as: *http://nautilus.org/archives/energy/grid/papers/koshcheev.PDF*

Key Words: Asia, Technical, Economic

- This article looks at the technical and economic reasons for the creation of interconnected electrical ties in North-East Asia. It stresses that due to peculiarities in these ties, preference should be given to HVDC transmission systems. The paper also analyses data collected in preliminary investigations of selected interstate electrical ties in North-East Asia in 2000.

45. Thomas Overbye, Power System Simulation: Understanding Small- and Large-System Operations, IEEE Power Engineering Society Techtorial, available as: *http://www.ieee.org/organizations/pes/public/2004/jan/pestechtorial.html*

Key Words: Technical, Power Sector Overview

- This simulation provides an overview of small and large-scale electric systems operations. It is part of the series, "Power System Basics for Business Professionals", which is geared towards educating professionals in the electricity industry who have not had technical training related

to power systems. This simulation builds on the foundation provided by the "Electricity Basics" portion of the course.

46. E. Lerner, "What's Wrong with the Electric Grid?", The Industrial Physicist, October/November 2003

Key Words: North America, Technical, Economic, Power Sector Overview

- Eric Lerner looks at the physical components of electricity grids, and the economic rules that govern them, to examine the reasons for why power transmissions systems fail. Lerner looks at the case of the blackout in the Northeast United States of 2003. It is his premise that to avoid such blackouts in the future, the US system must either transform to accommodate the new economic rules governing power systems, or create new rules to match the physical structure of power grids.

47. J. Glover and M. Sarma, Power System Analysis and Design, 3rd edition. Brooks/Cole, Pacific Grove, CA, 2002

Key Words: Technical, Power Sector Overview

- This textbook is designed to provide a general overview of the basic concepts of power systems and the tools and skill set needed to apply these concepts. Basic theories and modeling techniques are presented giving the reader a foundation which can be easily extended towards understanding some of the new and more complex issues facing the industry today. Several updated case studies are incorporated in the text book.

48. W. Stevenson, Elements of Power System Analysis, 4th Edition, McGraw-Hill Series in Electrical Engineering, 1982

Key Words: Technical, Power Sector Overview

- This textbook, used often in electrical engineering university classes, provides an in depth examination of the electrical theory behind generation, transmission, system protection, and power flow and system stability analysis.

49. A. Fitzgerald, C. Kingsley, and S. Umans, Electric Machinery, 6th Edition. McGraw-Hill, New York, 2003

Key Words: Technical, Power Sector Overview

- This textbook introduces the basic rules of magnetic circuits, magnetic materials, transformers, and electromechanical energy conversion, then describes the operating principles of specific machines types: rotating, synchronous, induction, DC, variable- reluctance, single phase, and two phase. (Review taken from Book News, Inc., Portland, OR.)

50. E. Ewald and D. Angland, Regional Integration of Electric Power Systems, IEEE Spectrum, April 1964, available as: *http://blackout.gmu.edu/archive/pdf/regional_intg.pdf*

Key Words: Economic, Interregional Power Grid Interconnections

- This excerpt examines the economic concepts related to the planning of large-scale power systems, and looks at a few specific regional integration plans developed for the western United States. The authors also look at how the development of EHV and supersized generators has made it economically feasible a power pool comprised of 10 states and 22 utilities.

51. H. Happ, Power Pools and Superpools, IEEE Spectrum, March 1973, available as: *http://blackout.gmu.edu/archive/pdf/power_pools.pdf*

Key Words: Technical, Regional Power Pools

- This reports looks at the how generation is controlled in large power pools. It starts with a review of the development of power sharing and pools, the benefits of them, and the key components necessary for them to function efficiently. The report then presents three different methods for controlling the generation of pools and superpools, addressing the positives and negatives of each.

52. K. Hicks, Disaster Control Coordination for Large Interconnected Systems, IEEE Spectrum, November 1967. available as: *http://blackout.gmu.edu/archive/pdf/disaster_control.pdf*

Key Words: Technical, Interregional Power Grid Interconnections

- Hicks looks at the new approaches to confronting interconnection problems and the coordination of disaster control efforts that evolved in the 1960's to combat the possibility of widespread power failures in the United States. In this article, Hicks also provides methods for "load shedding, spinning-reserve rules, and area separation.

53. North American Reliability Council (NERC), Transmission Transfer Capability: A Reference Document for Calculating and Reporting the Electric Power Transfer Capability of Interconnected Systems, May 1995, available as: *ftp://www.nerc.com/pub/sys/all_updl/docs/pubs/TransmissionTransferCapability_May1995.pdf*

Key Words: North America, Technical, Interregional Power Grid Interconnections

- This report looks at the capability of transmission transfers from the standpoint of a transfer system's physical limitations and core characteristics. Various definitions, concepts, technical issues, and simulations used to calculate and report transmission transfer capability are also presented to provide background information related to transfer capability.

54. Francois Verneyre, presentation entitled European Challenges, Overcoming Challenges, prepared for the KEEI & IEA Joint Conference "Northeast Asia Energy Security and Regional Cooperation", March, 16-17, 2004, available as: *http://www.keei.re.kr/web_keei/en_news.nsf/0/4dfb5e1e76aa3c1349256e4800150eab/$FILE/Francois%20Verneyre.pdf*

Key Words: Europe, Asia, Technical, Interregional Power Grid Interconnections

- This presentation looks at the various components, issues and challenges of the European electricity industry, and what East Asia can learn from it. The major issues to be examined include: fragmented markets, blackouts and their causes, and price spikes. The challenges looked at include: the security of supply and the realization of IEM (Internal Electricity Market), and associated challenges such regional integration and creating a balanced energy mix.

55. B. Biewald et al, Societal Benefits of Energy Efficiency in New England, 1995, available as *http://www.cs.ntu.edu.au/homepages/jmitroy/sid101/npfdsm.html*

Key Words: North America, Social, Environmental

- This report examines the social benefits of Demand Side Management (DSM) relating to electric power generation in New England. It specifically focuses on the health, environment and public amenities resulting from the reduced demand of power generation that DSM can provide.

56. Paul Joskow and Edward Kahn, A Quantitative Analysis of Pricing Behavior In California's Wholesale Electricity Market During Summer 2000: The Final Word, 2002, available as: *http://stoft.com/metaPage/lib/Joskow-KahnE-2002-CA-Mrkt-Pwr-Final.pdf*

Key Words: North America, Economic

- The purpose of this report is to examine the price surge of electricity in California during the summer of 2000, and provide an explanation for why this extreme price increase occurred. It begins by looking at normal changes to supply and demand in the market to determine how much of the price increase occurred naturally. The second section of the paper looks at how much of an effect the trading of NOx permits had on the price of electricity, while the final section of the report looks at whether or not the gap between the benchmark of competitive prices and the actual prices fits with the available data on supplier behavior.

57. Electric Power System Interconnection Agreement between CLECO Power LLC and the Southwestern Power Company, November 2001, section 5.15, available as: *http://www.cleco.com/uploads/RS17.pdf*

Key Words: North America, Legal

- This document is a typical example of a power purchase agreement (PPA) between two companies in the United States, and is therefore a good legal reference for what information is generally covered in a PPA.

58. Robert Kay, Impact of the Financial Crisis of the Energy Sector: a Developer's Perspective, GMS Power Public Company Limited, Bangkok, Thailand, (date not provided, but probably 1999) available as: *http://www.worldbank.org/html/fpd/energy/energyweek/kay_pres.doc*

Key Words: Asia, Economic

- This papers looks at the impact the Asian financial crisis had on the financing of new power projects in Southeast Asia, and on the role of private sector producers in energy projects more generally. It specifically examines the experience of GMS Power Public Company Ltd. in regards to a project it completed after the crisis began.

59. Karsten Neuhoff, Economic Considerations for International Electricity Interconnections in North-East Asia, prepared for the "Workshop on Power Grid Interconnection in Northeast Asia", Beijing, China, May 14-16, 2001, available as: *http://www.nautilus.org/archives/energy/grid/papers/neuhoff.pdf*

Key Words: Asia, Economic, Interregional Power Grid Interconnections

- Neuhoff looks at the economic aspects of grid interconnection between Russia, DPRK, and the Republic of Korea in relation to the experiences of other countries. His focus is strictly on the economic benefits to be obtained, and the paper stresses that political aspects of interconnection are intentionally left out of the analysis. The first section of the paper analyses the economic benefits, while the second examines how the benefits would be attributed to the various parties involved. Neuhoff also looks at the financing options for interconnection, and stresses that public/private partnerships, public ownership or ownership by the national transmission grids are preferable.

60. The UN Global Compact, available as: *http://www.unglobalcompact.org*

Key Words: Economic, Interregional Power Grid Interconnections

- This website includes a number of references, case studies and tools in areas relevant to assessing the social benefits and costs of business ventures (such as interconnections and other large energy ventures) and their impacts on sustainable development. Issues such as transparency and multi-stakeholder processes are covered in documents (including the Banfield et al document referenced below) available on the UN Global Compact site.

61. Vladislav Vucetic, World Bank's South Asia Energy Program, presentation at the USAID SARI/Energy Semi Annual Meeting, New Delhi, October 12-13, 2004, available as:

http://sari-energy.org/DynamicPPTShow/PPTDownloads/PPT103OCT04.zip

Key Words: Asia, Power Sector Overview

- This PowerPoint presentation looks at the energy environment of South Asia, and outlines some of the major issues and challenges facing the region today. It briefly outlines the installed

power generation capacity of each country, and discusses the rising demand for energy in the region as a whole. The presentation examines in detail seven countries including Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka

62. Jessica Banfield, Adam Barbolet, Rachel Goldwyn, and Nick Killick, Conflict-Sensitive Business Practice: Guidance for Extractive Industries, prepared for International Alert, dated March, 2005, available as: *http://www.international-alert.org/pdf/pubbus/conflict_sensitive_business_practice_all.pdf*

Key Words: Environment, Sustainable Development

- This report examines the role that businesses in extractive industries, such as oil, gas and mining projects, can have in developing countries, and how these businesses, if inadequately prepared to operate in a potentially unstable environment or managed improperly, can often times be a catalyst for conflict within a region. The report provides information on understanding conflict risk, and how in the sphere of corporate social responsibility, businesses can be better prepared to work in societies at risk of conflict.

63. D. F. Von Hippel and J. H. Williams, Environmental Issues for Regional Power Systems in Northeast Asia, prepared for the Third Workshop on Northeast Asia Power Grid Interconnections, September 30 - October 3, 2003, Vladivostok, Russian Federation, December 2003, available as: *http://nautilus.org/archives/energy/grid/2003Workshop/Env_Issues_DVH_JW_final_pdf.PDF*

Key Words: Environment, Interregional Power Grid Interconnections

- This report looks at the positive and negative environmental impacts of power grid interconnections in Northeast Asia. The main areas of focus of the report include air pollution, water pollution, solid and hazardous waste, land use, biodiversity and wildlife, and human health. The final sections of the paper evaluate the institutional issues related to the environmental impact of power grid interconnections.

64. A. Vallée and G. Jean Doucet, Environmental Implications or international Connections: The New Arena, IEEE Power Engineering Review, August 1998, "International High-Voltage Grids and Environmental Implications", available as: *http://www.geni.org/energy/library/technical_articles/transmission/IntlGridandEnvironment.html*

Key Words: Asia, Africa, Europe, North America, Environment, Interregional Power Grid Interconnections

- This report looks at the environmental impacts resulting from interregional power grid interconnections, focusing on case studies from North Africa, East Asia, Europe and North America, and quality of life and renewable energy opportunities with long distance transmission. It is segmented into seven different sections covering these topics respectively.

65. Jungmin Kang, Environmental Impacts and Benefits of Regional Power Grid Interconnections for the Republic of Korea: Potential Impacts on Nuclear Power Generation and Nuclear Waste Production, prepared for the Third Northeast Asia Grid Interconnection Workshop, and available as: *http://www.nautilus.org/archives/energy/grid/2003Workshop/Jungmin_KANG_final.pdf*

Key Words: Asia, Environment, Interregional Power Grid Interconnections

- This report examines the environmental impacts and benefits of interregional power grid interconnections, with a focus on nuclear power generation in the Republic of Korea. More specifically it looks at the economic and environmental benefits that Korea could obtain by importing power from Russia, and therefore reducing the waste generated during nuclear power production.

66. World Bank, Environmental Assessment Source Book 1999. World Bank, Washington, D.C., USA, 1999. A complete 1991 version of this work is available in 3 volumes as: *http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/1991/07/01/000009265_3971126124401/Rendered/PDF/multi_page.pdf*

Key Words: Environment, Sustainable Development

- This source book, published by the World Bank, is intended to assist all those working on issues of environmental assessment (EA). It follows the main premise that sustainable development is achieved when negative environmental externalities are identified and targeted at the earliest possible stage of the planning and development of a project. It also serves to provide specific information for EA professionals, the World Bank, and governments borrowing from the Bank regarding environmental assessment.

67. The United States Environmental Protection Agency, AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, often referred to simply as "AP-42". Available in multiple sections and volumes through the "CHIEF" emissions factor clearinghouse, at *http://www.epa.gov/ttn/chief/ap42/*. Volume 2 of this compendium, which deals with mobile sources of air pollutants, is available as: *http://www.epa.gov/otaq/ap42.htm*

Key Words: Environment

- AP-42 and the CHIEF website offer a comprehensive set of source documents and databases for emission factors for all sorts of air pollutant-producing processes.

68. Intergovernmental Panel on Climate Change, IPCC Guidelines for National Greenhouse Gas Inventories. Revised 1996 versions of the three-volume Guidelines documents are available as *http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm*

Key Words: Environment

- These international guidelines provide both methods and emission factors for estimating greenhouse gas emissions from a variety of human activities, including energy-sector emissions. In many instances, the "tier 1" or "tier 2 and 3" emission factors from this compilation are good starting estimates for the estimation of net emissions (or avoided emissions) from many activities related to interconnections.

69. Charles Concordia (1999), "Electric power systems: past, present, and future", IEEE Power Engineering Review, Feb. 1999, pp. 7-8. Abstract available from *http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=16028&arnumber=743416&count=4&index=0*, full text available online by subscription. Abstract from article as quoted from this source above is as follows:

- "The author mostly discusses the future of electric power systems, mentioning the past primarily to point out mistakes and so, hopefully, to avoid repeating them. The author discusses frequency and voltage control, complexity of systems, energy sources, and structure of the electric utility industry."

70. John Casazza (1998), "Blackouts: Is the Risk Increasing?", Electrical World, April 1998, page 63.

71. A. Edris (2000), "FACTS Technology Development: An Update," IEEE Power Engineering Review, March 2000, pp. 4-9. Abstract available from *http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=17866&arnumber=825623&count=8&index=0*; full text available online by subscription. Abstract from article as quoted from this source above is as follows:

- "This overview of the FACTS program sponsored by EPRI identifies the significant challenges and the adopted technology-based solutions that have been developed. FACTS technology has been successfully demonstrated and continues to be implemented at transmission locations in the United States. A STATCOM, UPFC, and convertible static compensator are discussed. The installed FACTS controllers have provided new possibilities and unprecedented flexibility aiming at maximizing the utilization of transmission assets efficiently and reliably. As the development and implementation of FACTS controllers evolve, there will be a need for an overall controller "hierarchical" logic to optimize transmission system operations."

72. Karl Stahlkopf and Philip Sharp (1998), "Reliability in Power Delivery: Where Technology and Politics Meet," Public Utilities Fortnightly, January 15, 1998. Available by subscription from *http://www.pur.com/puftocs/jan1598.cfm.*

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