CLEAN ENERGY

TVA's Strategic Plan includes the objective to reduce its environmental footprint through demand reduction and by increasing clean energy resources in its generation mix. TVA aims to have 50 percent of its overall power supply to come from zero or near-zero carbon emitting resources by 2020. This will require increasing clean generation at TVA.

TVA defines clean energy as generation that has a zero or near-zero carbon emission rate or energy efficiency improvements. Examples of clean energy include nuclear, renewables, demand reduction, and waste heat recovery.

TVA defines renewable energy as resources that are sustainable and often naturally replenished. Examples of renewables include existing hydro, incremental hydro, wind, solar, landfill methane, biomass co-firing, dedicated biomass, and geothermal generation.

The TVA Board has approved the following set of guiding principles for renewable energy at TVA:

- Mitigate the impact on climate change, with renewable energy usage as one of many options;
- Renewable energy and energy efficiency should be part of a clean energy portfolio, which has a zero or near-zero carbon emission rate;
- Renewable energy portfolio requirements will be met with the lowest cost options available with preference for assets in the TVA region;
- Technology innovation should be considered to address the fact that much renewable generation is intermittent;
- Market and educational opportunities will be created for end-user and supplier participation; and
- Educational initiatives will be supported to foster public participation.

Current Initiatives

- TVA currently has approximately 450 MW of renewable capacity which includes 412 MW of incremental hydro. When you include TVA's existing conventional hydro, TVA's renewable capacity is approximately 3,830 MW.

- The TVA Board recently authorized the purchase of as much as 2,000 megawatts of renewable and clean energy by 2011 as part of TVA's plan to have half of its power supply from clean and renewable energy sources by 2020.

- TVA complies with the Energy Policy Act of 2005, which requires that all federal agencies, to the extent economically feasible and technically practicable, use not less than the following amounts of renewable electricity in their facilities:
  In fiscal year 2007 - 2009: 3%
  In fiscal year 2010 - 2012: 5%
  In fiscal year 2013 - thereafter: 7.5%

- TVA's Green Power Switch (GPS) program established in 2000 is an initiative that offers consumers a choice to buy renewable energy. The generation mix for GPS consists of solar, wind, and methane gas. The program has been successful with over 12,000 residential and 500 business subscribers.

- TVA's Expanded Generation Partners pilot program is an end-use renewable energy program that gives homeowners and businesses an opportunity to own and generate renewable energy. Under the program, customers sell all of the power they generate from renewable sources to TVA at a premium

price, and the local power company reimburses the customer for the generation received through a credit on their monthly electric bill.

- TVA's nuclear plants contribute 6,900 megawatts of clean electricity to the power grid. TVA has taken and is continuing to take significant steps in nuclear power that will reduce carbon intensity, including the recovery of Browns Ferry Unit 1, planned power up-rates of Browns Ferry Units 1, 2 and 3, and the completion of Watts Bar Unit 2. TVA has also filed with the NRC a combined operating license application for two advanced nuclear reactors at the Bellefonte Nuclear Plant, although no decision has been made to complete those units or to build the new reactors.

There is a good chance that a national Renewable Portfolio Standard will be passed by Congress very soon. TVA will meet renewable standards through a combination of the following measures.

- TVA owned renewable generation;
- Purchased renewable power;
- Energy efficiency and demand side management measures; and
- Purchase of renewable energy credits.

Challenges and Benefits

There are a number of challenges and benefits associated with clean energy. The greatest challenge for some of the renewable resources, such as wind and solar, is that they are intermittent and their capacity factor (the energy produced during a certain period of time divided by the energy that would have been produced had the device been running continually) is therefore low. For example:

- A 1,000-MW nuclear unit with a capacity factor of 92% generates approximately 8,000 GWh of electricity in a year, or enough for about 480,000 Valley households.

- A 1,000-MW wind farm with a capacity factor of 25% generates approximately 2,000 GWh of electricity in a year, enough for about 130,000 Valley households.

Also, the land requirements for some renewable technologies are much greater than that of other clean technologies. For instance, one 1000 megawatt nuclear unit requires 1,000 acres. It would take 12,160 acres of wind turbines, or 23,760 acres of solar panels to generate the equivalent amount of energy as the single 1000 megawatt nuclear unit.

Following are benefits and challenges of renewables and other clean energy resources:

Biomass

Biomass is commonly defined as material derived from living organic matter (e.g., trees, grasses, animal waste). It includes wood, wood waste, herbaceous crops, crop wastes, agribusiness wastes (e.g., food processing wastes such as bagasse), animal waste, methane-rich gas from wastewater treatment plants, and landfills.

TVA's portfolio currently consists of 7 MW of wood waste cofiring at Colbert Fossil Plant, and 8 MW of biogas cofiring at Allen Fossil Plant

• *Benefits:* Eligible resource for RPS compliance; carbon neutral; less wood waste sent to landfills; regional potential for a cash crop.

• *Challenges:* Uncertain cost and availability of biomass fuel supply; competition with others for biomass resource; significant costs to upgrade existing coal plants to allow them to burn biomass; overcoming problems with already installed emissions reduction equipment that could be caused when a new fuel source, biomass, is burned.

Wind

Wind turbines can be used as stand-alone applications, or they can be connected to a utility power grid. For utility-scale (megawatt-sized) sources of wind energy, a large number of wind turbines are usually built close together to form a wind farm.

TVA currently owns three wind turbines on Buffalo Mountain for a total of 2 MW. Additionally TVA has a long-term contract with Invenergy LLC, to purchase the output from their wind farm on Buffalo Mountain, which consists of fifteen wind turbines for a total of 27 MW.

- *Benefits:* No fuel costs; relatively simple design with short lead time for construction and operation; no emissions; offsets greenhouse gases.
- *Challenges:* Limited regional sites with no greater than Class 3 wind; siting resistance due to aesthetic, visual and potential noise concerns; competition for "choice" sites with regional competitors.

Solar

The Southeast and Tennessee Valley region is generally rated "good" for solar energy projects, higher than cloudier regions such as the Northeast but lower than arid regions such as southern California and Arizona. On average, a 1 kilowatt (kW) capacity (DC) solar PV system in the Tennessee Valley region will generate 1,200 to 1,300 kilowatt-hours (kWh) of usable energy (AC) in a given year. In comparison, 1 kW capacity of nuclear will generate 7,000 to 8,000 kWh in a given year.

Solar PV costs generally range from $6,000 to $8,000 per kW capacity installed, which is relatively more expensive than other generation resources today. However, solar enjoys free fuel costs when compared to other generation resources and does not emit greenhouse gases.

- *Benefits:* Can reduce household energy bill; no fuel costs; offsets greenhouse gases.
- *Challenges:* Costs are high; incentives necessary to help offset costs.

Landfill Gas

The natural decay of biomass in landfills produces methane, which can be captured and used in generators for power production. This also reduces the release of methane (a very potent greenhouse gas) into the atmosphere. Methane can also be produced from biomass through a process called anaerobic digestion as in wastewater treatment lagoons. Natural bacteria are used to decompose organic matter in the absence of oxygen producing methane-rich biogas, which is used to produce electricity in a generator.

TVA's portfolio currently consists of 2.2 MW of purchased landfill gas generation.

- *Benefits:* Converts waste materials to useable form of energy; practical for a large range of landfill sizes; methane is used productively; reduces emissions of greenhouse gases.
- *Challenges:* Transmission line availability; uncertain lifetime of gas from the landfill.

Geothermal

Geothermal energy is the conversion of heat from within the Earth to electricity. The heat arises from the Earth's molten interior in the form of hot springs, geysers, or deep hot rock formations. Electric power generation from geothermal resources has been a commercial reality in some parts of the United States for several decades.

- *Benefits*: Geothermal power production is dispatchable with no emissions.
- *Challenges:* There are very few accessible geological formations in the Valley, making this an unlikely source for renewable energy in our region.

Hydrokinetic

Hydrokinetic energy generates power by using small underwater turbines to harness the energy from the natural velocity of flowing water in river or ocean currents.

- *Benefits*: No emissions.
- *Challenges:* Has limited feasibility in the Tennessee River and its tributaries because of insufficient velocities and water depth.

Waste Heat

Waste heat is recovered from various industrial processes such as kilns, boilers, and furnaces, and converted to electricity using a number of thermal conversion processes.

- *Benefits*: No carbon emissions; efficient use of energy that would have been "dumped" into the environment.
- *Challenges:* Lack of standard design and equipment because of varied industrial processes and applications.

You can participate in TVA's integrated resource planning by submitting comments about the scope of the planning TVA should consider. You may submit comments at one of the public meetings or online at www.tva.gov/IRP.