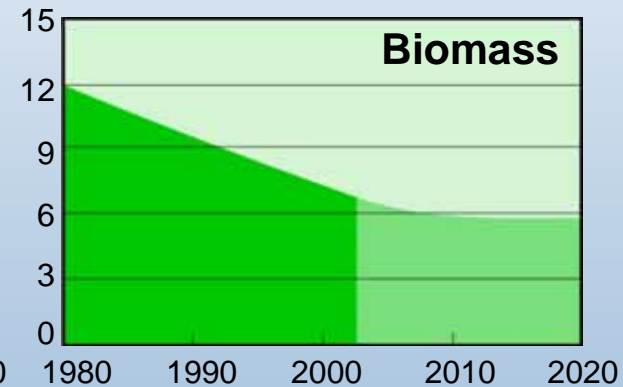
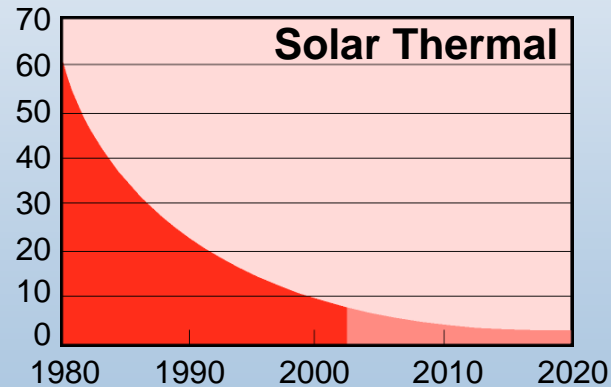
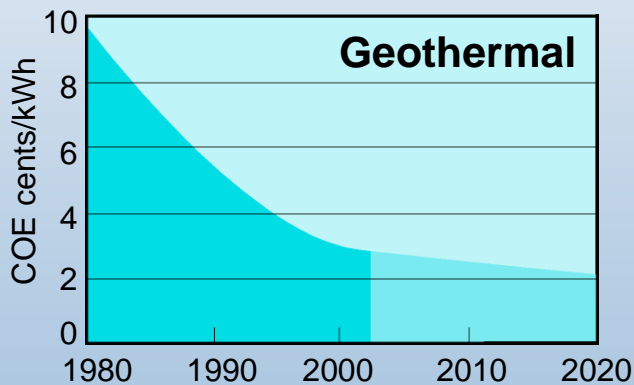
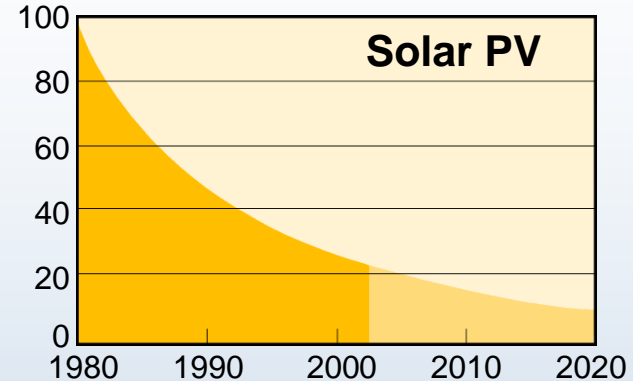
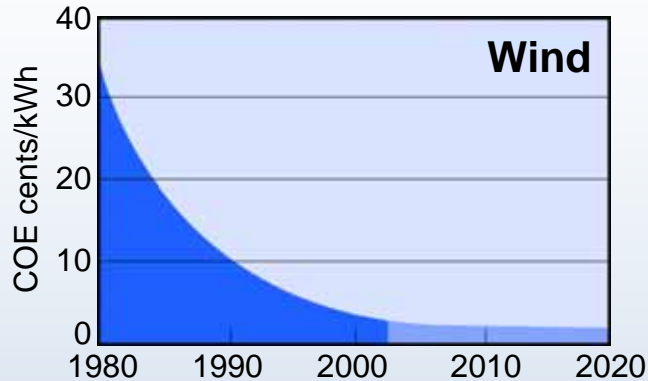


Renewable Energy Cost Trends

Levelized cents/kWh in constant \$2000¹



Source: NREL Energy Analysis Office (www.nrel.gov/analysis/docs/cost_curves_2002.ppt)

¹These graphs are reflections of historical cost trends NOT precise annual historical data.

Updated: October 2002

Renewable Electricity Technology Cost Trends

Chart Notes, Page 1

Background

- The Cost Curves are expressed in constant, 2000 year dollars and based on a uniform set of financial assumptions consistent with Generating Company Ownership (balance-sheet financing).
- Actual project costs can vary substantially – not only over time, but from project to project – based on variables such as siting and permitting costs, land costs, transmission access, labor costs, and financing terms.
- The Cost Curves are **not based on specific project data**, but are composite representations derived from a variety of sources outlined below.
- Historic costs from 1980 to 1995 generally reflect costs that were published in various DOE Renewable Energy Program plans such as five-year program plans, annual budgets, and other program publications.
- The Future Cost Curves generally reflect how the DOE Renewable Energy Programs expect the costs of renewable energy to decrease through lowered technology costs and improved performances, resulting from R&D efforts and other factors.
- Projections of cost to 2020 for biomass, geothermal, and photovoltaic energy technologies are based on the DOE/EPRI Renewable Energy Technology Characterizations published in 1997. Wind and solar thermal costs represent more recent DOE Renewable Energy Program projections.
- The Cost Curves generally assume the availability of high-quality resources. This is an important point because systems using lower quality resources are being built, in some cases with costs as much as double those shown.
- The Cost Curves do not include the effects of tax credits or production tax incentives.

Renewable Electricity Technology Cost Trends

Chart Notes, Page 2

General Observations

- The renewable technology cost trends typically show a steep decline from 1980 to the present. Projections show this decline to continue, but at a slower absolute pace as the technologies mature.
- Historic cost of energy trends reflected in this chart are in broad agreement with the trends published in “Winner, Loser, or Innocent Victim? Has Renewable Energy Performed as Expected?” Renewable Energy Policy Project, Report No. 7, April 1999.

Technology Specific Notes

- Wind technology cost projections represent wind power systems in locations with Class 6 resources. Low wind-speed turbine technology is under development, which will make available large amounts of usable wind resources that are closer to transmission. Lower costs will result from design and technology improvements across the spectrum from foundations and towers, to turbine blades, hubs, generators, and electronics.
- Biomass cost projections are based on gasification technology. Lower costs will result from technology improvements indicated by current pilot plant operations and evaluation, including improvements in feedstock handling, gas processing/cleanup, and overall plant design optimization.
- Geothermal cost projections are for Flash technology. Cost reductions will result from more efficient and productive resource exploration and characterization as well as from continued improvements in heat exchangers, fluid-handling technologies, turbines, and generators.
- Solar thermal cost projections are for Parabolic Trough and Power Tower Technologies and are based on a detailed due-diligence study completed in 2002 at the request of DOE. Cost reductions will result from improved reflectors and lower-cost heliostat designs, improved solar thermal receivers, heat exchangers and fluid handling technologies, and turbines and generators, as well as from volume manufacturing.
- Photovoltaic cost projections are based on increasing penetration of thin-film technology into the building sector. Likely technology improvements include higher efficiencies, increased reliability (which can reduce module prices), improved manufacturing processes, and lower balance of system costs through technology improvements and volume sales.