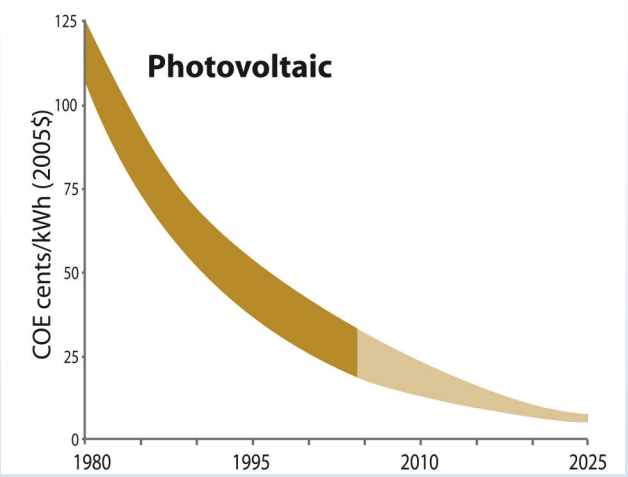
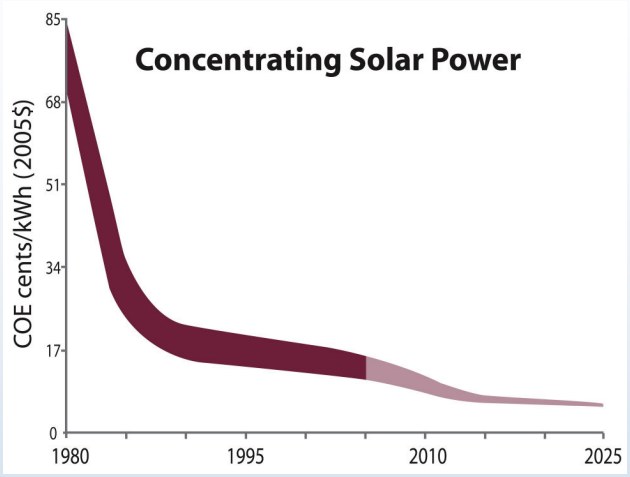
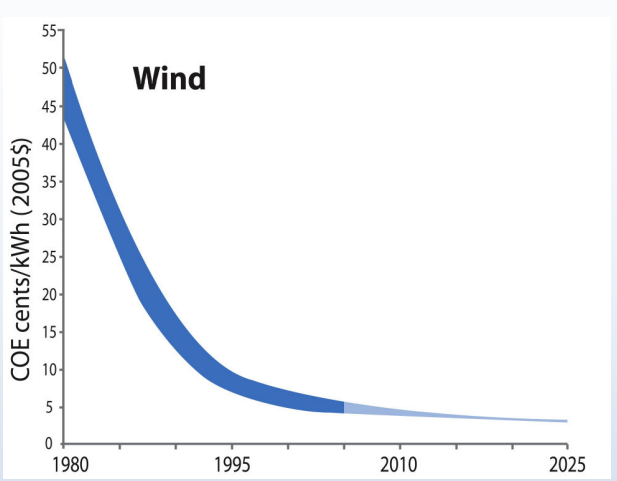
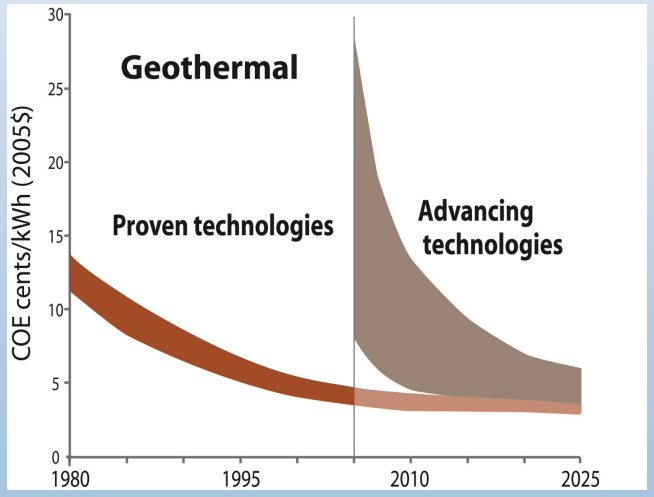
Renewable Energy Cost Trends

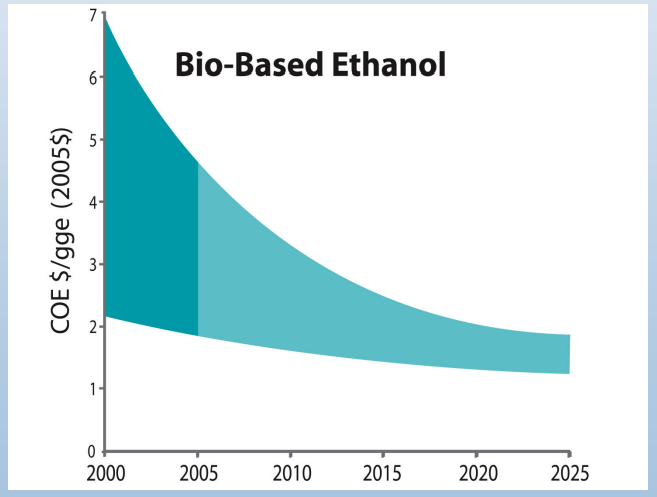
Levelized cost of energy in constant 2005$[1]











Source: NREL Energy Analysis Office (www.nrel.gov/analysis/docs/cost_curves_2005.ppt)

[1]These graphs are reflections of historical cost trends NOT precise annual historical data. DRAFT November 2005

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Background

- The Cost Curves are expressed as a band in constant, 2005 year dollars where the low to high range represents variations in resource quality, scale of installation and financing terms.
- Actual project costs can vary substantially – not only over time, but from project to project – based on variables such as citing 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 2000 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. DOE/EPRI Renewable Energy Technology Characterizations published in 1997
- 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 2025 for wind are based on GPRA 06 projections, for photovoltaic and CSP GPRA 06 and MYPP projections. For geothermal projections are based on modeling results from the GETEM model. For bio-based ethanol projections are based on program modeling efforts.
- The lower band of 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 much higher than for high quality resources.
- The Cost Curves do not include the effects of tax credits or production tax incentives.

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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 for the lower part of the band and Class 4 resources for the high part of the band. 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.
- Bio-based ethanol represents a combination of corn starch in the near term and lignocellulosic ethanol in the long term. Lignocellulosic production technologies that co-produce feed products and electricity with ethanol are projected to become the lower cost technology in the latter years of the projected values.
- Geothermal cost projections for Proven Technologies are largely Flash technology with a few binary technology systems. 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. The Advancing Technologies cover three general topics: energy conversion (power generation systems), drilling and wellfield construction systems, and geologic systems. The Advancing Technologies cost curve illustrates year 2005 projections of future LCOE values for this suite of technology topics, considering a wide range of potential research results that can lower the net costs of geothermal power. For conversion systems the principal improvements are expected to come from such benefits as raising process efficiencies and lowering the costs of systems to make it competitive to generate power with cooler temperatures than are now feasible. In drilling and wellfield construction, such issues as corrosion play a major role in well costs. Work is under way to identify new metal alloys and protective coating systems to lengthen the serviceable lifetime of piping components. Drilling costs are a substantial fraction of overall development costs, and R&D are focused on such things as drill bit design to raise ROP values (rate of penetration of drill bits, leading to less time and costs of the drilling operation).
- Solar thermal cost projections are for parabolic trough and power tower for historical values from 1980-1990. While 1980-1990 saw a significant reduction in COE due to R&D efforts, the 1990s R&D efforts were at lower levels and reductions in COE came largely from improvements in operation and maintenance (O&M) costs. Projected values for 2005-2025 are from the Solar program MYPP for 2005 and based on parabolic trough 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.