True Cost of Electricty Generation

by Bretwood Higman, Erin McKittrick, David Coil, Elizabeth Lester

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Summary

Low price or low environmental impact, which is the priority?

Debates over energy sources often pit these two factors against each other. But the arguments over price and impact are often missing some important information. The nominal (sticker) price of electricity excludes two large economic factors that are relevant to power generation: subsidies and externalities. Subsidies are direct financial incentives given to power generators, often in the form of tax breaks. Externalities are costs or benefits to society that are not included in the market price of an item, forming the basis for the idea of “true cost” (/Issues/OtherIssues/TrueCost.html). Pollution is the most commonly cited negative externality because the buyer or the seller of a polluting consumable does not directly bear the cost of clean-up.

When subsidies and externalities are considered, non-renewable energy, especially coal, is significantly more expensive than most renewable options. Coal provides around half the electricity used in the U.S., and has the highest total cost to society (/Issues/AlaskaCoal/CoalTrueCost.html). Since virtually all forms of energy are subsidized, and the economic costs of pollution and environmental damage are higher for non-renewables, the cost of fossil fuels is greater for society as a whole.

“Levelized Cost” provides a base for comparison of sources

Source| Levelized Cost (cents/kWh)
—|—
Conventional Coal| 9.48
Advanced Coal| 10.9
Advanced Coal w/CCS| 13.6
Natural Gas CCC| 6.6
Natural Gas ACC| 6.3
Natural Gas ACC w/CCS| 8.9
Natural Gas CCT| 12.5
Natural Gas ACT| 10.4
Advanced Nuclear| 11.4
Wind| 9.7
Wind - Offshore| 24.3
Solar - PV| 21.1
Solar - Thermal| 31.2

Geothermal| 10.2
Biomass| 11.3
Hydro| 8.6

A large number of factors influence the retail prices producers charge for electricity. Retail price includes subsidies, but not externalities. Transmission costs, profit by the utility, taxes, and other expenses factor into the retail price. Wide variability in such expenses makes economic comparisons of different types of energy production difficult.

To peel away the variables of taxation, regulation, location, and other factors not intrinsic to energy production, analysts use the concept of "levelized cost" (http://www.eia.gov/oiaf/aeo/electricity_generation.html), which provides one measure of the base price to produce one kilowatt hour of electricity. Basically, levelized cost takes into account the capital costs of building a facility and fuel costs of running that facility for a specified period (e.g. 30 years). The analysis annualizes costs over the life of the facility while also adjusting for inflation.

The method has some shortcomings. It ignores regional variation in costs, doesn't include the costs of storing/distributing power, and is forced to estimate fuel costs decades into the future. However, it provides a good starting place for comparing the different operating costs of electricity generation technologies. For example, coal and wind have very similar levelized costs (9.5 cents/kWh and 9.7 cents/kWh respectively) whereas the relatively new technology of solar thermal is currently very expensive (31.2 cents/kWh).

Electricity subsidies in the U.S.

The Energy Information Administration (EIA) has published a report (http://www.eia.gov/oiaf/servicerpt/subsidy2/index.html) detailing all US energy subsidies for 2007. It calculated a total of $16.5 billion in energy subsidies, of which 40% ($6.7 billion) were specifically for electricity generation. Within this category, all renewable sources combined accounted for 15% of subsidies, but provided only around 7% (http://www.eia.gov/cneaf/solar.renewables/page/trends/rentrends.html) of the electricity generated that year. However, the EIA may have underestimated subsidies by billions of dollars (http://www.earthtrack.net/documents/eia-energy-subsidy-estimates-review-assumptions-and-omissions), particularly for fossil fuels, because of overly narrow definitions of subsidies and other issues. For example, the EIA excludes energy subsidies that also benefit non-energy businesses from its definition of an energy subsidy.

A 2009, independent study (http://www.eli.org/research-report/estimating-us-government-subsidies-energy-sources-2002-2008) by the Environmental Law Institute looked in detail at subsidies to both renewable and non-renewable energy sources in the U.S, without specifying electricity generation. Renewable subsidies totaled $29 billion over the study period (2002-2008), with corn ethanol claiming about half. Non-renewable subsidies over this time period totaled $72 billion, most of which was consumed by transportation fuels. The study also noted that

most of the renewable subsidies were temporary or had sunset provisions, whereas the non-renewable subsidies were permanent provisions in the U.S. tax code.

However, calculating subsidies over any time period shorter than the life of a facility provides only a snapshot of costs over that time period. It does not account for past public investments. For example, if large subsidies were available to build a nuclear power plant 50 years ago, those would not be reflected in this kind of analysis, but they would still have the effect of artificially reducing nuclear electricity prices today. A 2011 study (http://www.dblinvestors.com/documents/What-Would-Jefferson-Do-Final-Version.pdf) looking at the entire 200-year history of energy subsidies in the U.S. attempted to address this very issue. The authors found that fossil fuel and nuclear energy received far greater subsidies in the early years of their development than that currently given to renewable energy.

Energy Externalities

Non-renewable sources of energy tend to have much larger negative externalities, mainly in the form of pollution and environmental destruction. Externalities represent costs that are paid outside of the market price of electricity, often by the taxpayers or the general public. Examples include pollution cleanup, health care for people sickened by pollution, loss of productivity and life, and damages increased by climate change, including storms and droughts.

When externalized costs are added to the sticker price of electricity, polluting forms of power, particularly coal (/Issues/AlaskaCoal/CoalTrueCost.html), become more expensive than cleaner energy sources.

One of the first attempts to quantify externalities on a large scale was ExternE project (http://www.externe.info/), funded by the European Union. The 10-year project, which ended in 2005, calculated the cost per kilowatt hour of the negative externalities associated with each type of energy generation. Costs ranged (depending on the country and type) from .03 euro-cent/kWh in the case of Portuguese hydropower, to 15 euro-cents/kWh in the case of lignite coal (/Issues/AlaskaCoal/TypesOfCoal.html) in Belgium. ExternE's calculations include some, but not all, climate changed related effects.

Coal has the largest externalities of any major power source, and is also one of the world's primary sources of power. The true cost of coal (/Issues/AlaskaCoal/CoalTrueCost.html) has been calculated by several different organizations. On average, externalities more than double the U.S. sticker price of coal power, making it more expensive than most alternatives.

A 2011 academic study (http://www.chgeharvard.org/sites/default/files/epstein_full%20cost%20of%20coal.pdf) calculated the hidden cost of coal as ranging from 9 cents/kWh to 27 cents/kWh with a median estimate of 18 cents/kWh. The reason for the broad range is the uncertainly in quantifying climate-change associated impacts. Application of the same statistical model to older data (http://www.nap.edu/catalog.php?

record_id=12794) compiled by the National Resource Council (NRC) in 2005 gives a mid-range cost of 12 cents/kWh for coal*. The reason that these two studies are somewhat higher than the average ExternE data for coal (which ranged from 2-15 euro-cents/kWh) has to do with the assumption of numerous additional externalities in the calculations of the newer studies, such as subsides, impacts associated with transportation, changes in land use, and different ways of calculating the impacts of climate change.

However, even these newer efforts probably underestimate true cost, because they don't attempt to quantify second-order effects such as national security considerations (i.e. military spending to protect energy supplies) or the possible negative effects of pollution on ecosystem services (http://en.wikipedia.org/wiki/Ecosystem_services).

_*According to Epstein 2011, the older NRC study used an outdated statistical model for their baseline case of non-climate related damages (3.2 cents/kWh). Using the more appropriate model would result in a number of 9.3 cents/kWh (still non-climate change). Adjusting this number by the climate-change related estimates used in Epstein 2011 gives 12.3 cents/kWh for the median estimate of true cost for coal. _

Conclusions

Subsidies and externalities are both large forces that make electricity artificially cheaper to the consumer, hiding costs paid by government and society. Both fossil fuel and renewable

energy sources receive subsidies, with most money going to fossil fuels, but higher subsidies per kilowatt hour for renewables. Externality costs are far higher for fossil fuels, particularly coal, than for renewables. Taking all costs into account makes most fossil fuel power likely more expensive than most renewable power.

Pricing the true cost (/Issues/OtherIssues/TrueCost.html) of energy production (both subsidies and externalities) into the market price would, most likely, dramatically change the landscape of energy production. Forms of energy production with large negative externalities would be less competitive. Subsidies clearly distort the market for both renewable and non-renewable energy. Removing them might bring the market more in line with true cost.

Governments are increasingly aware that energy subsidies, particularly for fossil fuels, distort the market and may be counter-productive. In fact, the leaders of the G20 group of counties (including the U.S.) have pledged (http://www.sustainablebusiness.com/index.cfm/go/news.display/id/21422) to phase out fossil fuel subsidies over the “medium term” although progress to date has been slow.

*See our related articles on*True Cost (/Issues/OtherIssues/TrueCost.html) *and* True Cost of Coal (/Issues/AlaskaCoal/CoalTrueCost.html)*.*

Further Reading

> "ExternE" (External costs of Energy) European Research Network website (http://www.externe.info/)

> "Externalties of Energy: Extension of Accounting Framework and Policy Applications" (2005). Produced by the ExternE project (http://www.externe.info/externe_2006/expolwp6.pdf)

> "Estimating U.S. Government Subsidies to Energy Sources: 2002-2008". (2009) by the Environmental Law Institute (http://www.eli.org/research-report/estimating-us-government-subsidies-energy-sources-2002-2008)

> "Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use (2010)". Produced by the National Resource Council. (http://www.nap.edu/catalog.php?record_id=12794)