



This is the print version of the [Skeptical Science](#) article '[Renewable energy is too expensive](#)', which can be found at <http://sks.to/expensive>.

The true cost of fossil fuels

What The Science Says:

When you account for the effects which are not reflected in the market price of fossil fuels, like air pollution and health impacts, the true cost of coal and other fossil fuels is higher than the cost of most renewable energy technologies.

Climate Myth: Renewable energy is too expensive

"[Wind energy] is a more expensive way of producing energy than the alternative." ([David Montgomery](#))

Due to its abundance and low market price, coal combustion is the largest source of energy production in the world, accounting for 40% of all electricity worldwide. [In the USA it accounts for 45%](#) of electricity generation, and approximately [75% in Australia](#).

Unfortunately, coal combustion is a major contributor to global greenhouse gas emissions as well, accounting for 30% of total anthropogenic carbon dioxide (CO₂) emissions worldwide, and 72% of CO₂ emissions from global power generation. In addition, non-power generation uses increase its contribution to global human CO₂ emissions to a whopping 41% (as of 2005).

Many people prefer coal combustion to renewable energy because it seems to be cheaper. However, when accounting for the true costs of coal power, most renewable energy sources are actually significantly cheaper in the long-run.

Coal Externalities

A major problem with coal is that its full costs are not reflected in its market price, and thus while we may seemingly purchase and burn coal cheaply, in reality we are paying a much higher cost in the long run, if we look at the big picture. Economists refer to the impacts on human and environmental health which are not reflected in the price of coal as "externalities". Those who benefit from the seemingly cheap electricity don't pay for these externalities directly, but the public eventually has to pay in the form of medical bills, environmental cleanups, etc.

A [2013 report published by the International Monetary Fund](#) concluded that global fossil fuel subsidies amount to \$1.9 trillion annually. \$1.4 trillion of this is due to externalities, \$800 billion due to climate change. This estimate is based on a conservative [social cost of carbon](#) of \$25 per tonne of CO₂ emitted. An [arguably more realistic estimate of \\$100 per tonne](#) of CO₂ would bring global fossil fuel subsidies to over \$4 trillion per year, with \$3.2 trillion due to climate change.

In a report published in the *Annals of the New York Academy of Sciences*, [Epstein et al. \(2011\)](#) do a full cost accounting for the life cycle of coal, taking these externalities into account. Among the factors included in this analysis were:

- government coal subsidies
- increased illness and mortality due to mining pollution
- climate change from greenhouse gas emissions
- particulates causing air pollution
- loss of biodiversity
- cost to taxpayers of environmental monitoring and cleanup
- decreased property values

- infrastructure damages from mudslides resulting from mountaintop removal
- infrastructure damage from mine blasting
- impacts of acid rain resulting from coal combustion byproducts
- water pollution

Most of these external factors do not apply to most renewable energy sources. The majority of the externality costs come from reduction in air quality, contribution to climate change, and impacts to public health. Epstein et al. find that the total cost of these externalities ranges from approximately 9 to 27 cents per kilowatt-hour (kWh) of electricity generated, with a median of approximately 18 cents per kWh. The authors note that this is a conservative estimate, because they have not accounted for every associated impact.

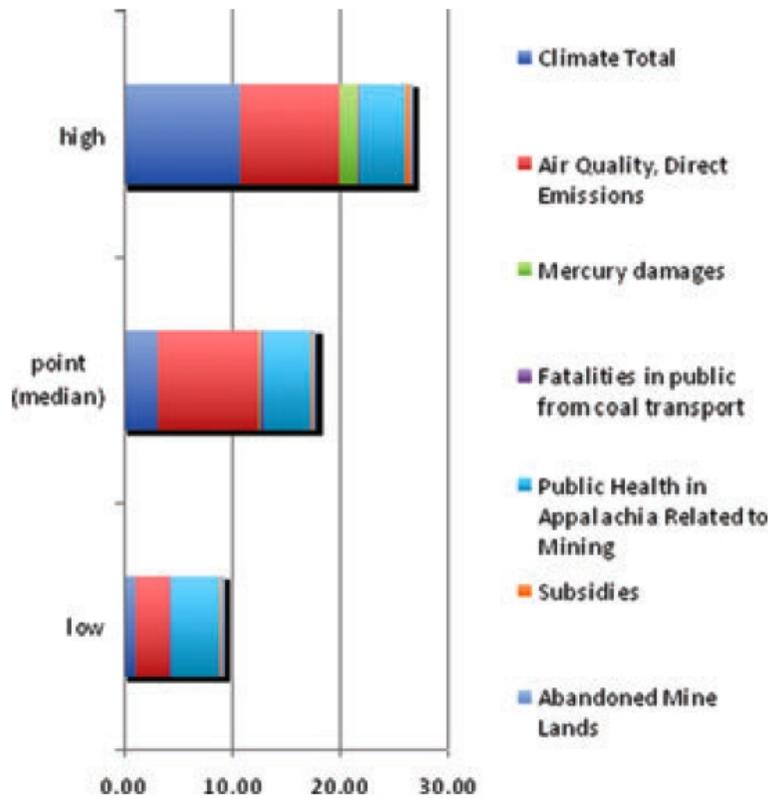


Figure 1: Coal externalized cost (cents per kWh) from [Epstein et al. \(2011\)](#)

[Another study by economists Muller, Mendelsohn, and Norhaus \(MMN11\)](#) looked at just the external costs associated with the damage done by air pollution, and arrived at a best estimate of 3.6 cents per kWh of external costs, despite being [unrealistically conservative](#) (Figure 2).

Coal Power Price and External Costs

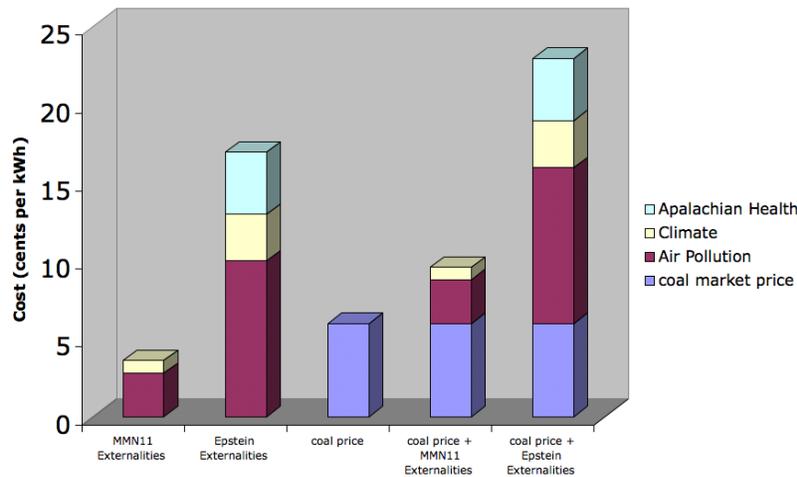


Figure 2: Average US coal electricity price vs. MMN11 and Epstein 2001 best estimate coal external costs.

Cost Comparison

The [US Energy Information Administration](#) provides a comparison of levelized costs for different power generation sources. Levelized cost represents the present value of the total cost of building and operating a generating plant over a period of time, and reflects overnight capital cost, fuel cost, operation and maintenance costs, financing costs, and an assumed utilization rate for each plant type. To convert from dollars per megawatt-hour to cents per kWh, move the decimal point in the table below one spot to the left (for example, conventional coal is 9.48 cents per kWh on average).

Table 2. Regional Variation in Levelized Cost of New Generation Resources, 2016.

Plant Type	Range for Total System Levelized Costs (2009 \$/megawatthour)		
	Minimum	Average	Maximum
Conventional Coal	85.5	94.8	110.8
Advanced Coal	100.7	109.4	122.1
Advanced Coal with CCS	126.3	136.2	154.5
Natural Gas-fired			
Conventional Combined Cycle	60.0	66.1	74.1
Advanced Combined Cycle	56.9	63.1	70.5
Advanced CC with CCS	80.8	89.3	104.0
Conventional Combustion Turbine	99.2	124.5	144.2
Advanced Combustion Turbine	87.1	103.5	118.2
Advanced Nuclear	109.7	113.9	121.4
Wind	81.9	97.0	115.0
Wind – Offshore	186.7	243.2	349.4
Solar PV ¹	158.7	210.7	323.9
Solar Thermal	191.7	311.8	641.6
Geothermal	91.8	101.7	115.7
Biomass	99.5	112.5	133.4
Hydro	58.5	86.4	121.4

Source: Energy Information Administration, Annual Energy Outlook 2011, December 2010, DOE/EIA-0383(2010)

As you can see, the externalities are sufficient to triple the cost of coal power, if they were reflected in its price. If we include the coal externalities, it increases the levelized costs to approximately 18 to 28 cents per kWh, which is more than hydroelectric, onshore wind, geothermal, biomass, nuclear, natural gas, and on par with solar photovoltaic and solar thermal (whose costs are falling rapidly), and offshore wind. Suddenly coal doesn't look like such a good deal.

Recommendations

Epstein et al. conclude by offering a number of recommendations:

- Comprehensive comparative analyses of life cycle costs of all electricity generation technologies and practices are needed to guide the development of future energy policies.
- Begin phasing out coal and phasing in cleanly powered smart grids, using place-appropriate alternative energy sources.
- A healthy energy future can include electric vehicles, plugged into cleanly powered smart grids; and healthy cities initiatives, including green buildings, roof-top gardens, public transport, and smart growth.
- Alternative industrial and farming policies are needed for coal-field regions, to support the manufacture and installation of solar, wind, small-scale hydro, and smart grid technologies. Rural electric co-ops can help in meeting consumer demands.
- We must end mountaintop removal (MTR) mining, reclaim all MTR sites and abandoned mine lands, and ensure that local water sources are safe for consumption.
- Funds are needed for clean enterprises, reclamation, and water treatment.
- Fund-generating methods include: maintaining revenues from the workers' compensation coal tax; increasing coal severance tax rates; increasing fees on coal haul trucks and trains; reforming the structure of credits and taxes to remove misaligned incentives; reforming federal and state subsidies to incentivize clean technology infrastructure.
- To transform our energy infrastructure, we must realign federal and state rules, regulations, and rewards to stimulate manufacturing of and markets for clean and efficient energy systems. Such a transformation would be beneficial for our health, for the environment, for sustained economic health, and would contribute to stabilizing the global climate.

Real World Data

[In the USA, there is no correlation](#) between state renewable electricity production and electricity price (Figure 3) or renewable production and electricity price increase over the past two decades (Figure 4).

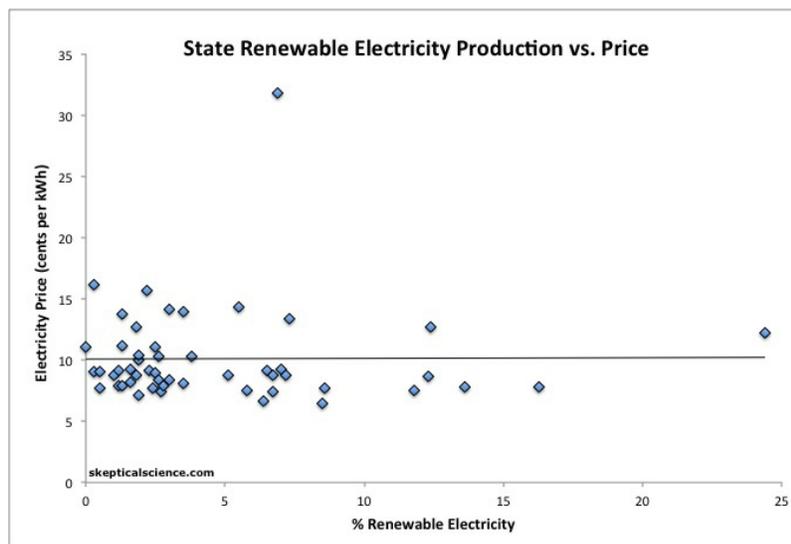


Figure 3: State renewable (excluding hydroelectricity) electricity percentage of total electricity generation vs. electricity price (blue diamonds) with a linear trend (black line). Data from EIA

([here](#) and [here](#)).

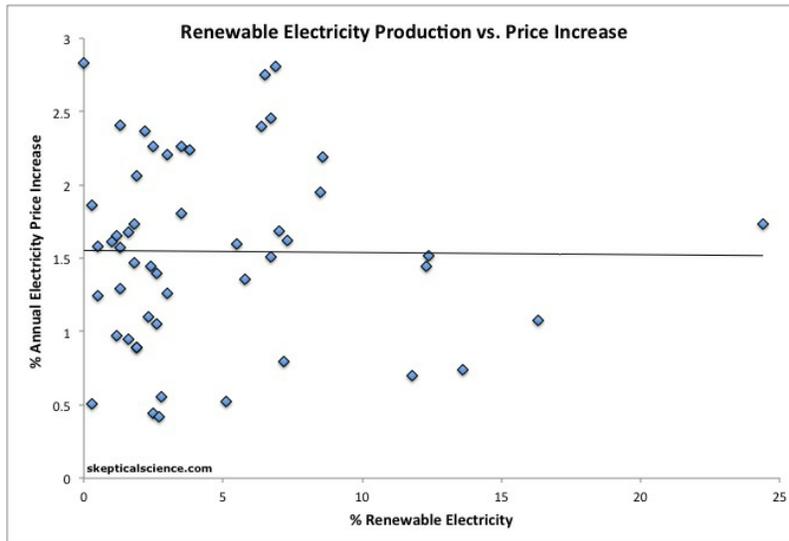


Figure 4: State renewable (excluding hydroelectricity) electricity percentage of total electricity generation vs. the percent annual increase in electricity price 1990–2011 (blue diamonds) with a linear trend (black line). Data from EIA ([here](#) and [here](#)).

If deploying renewable energy does not raise electricity prices, then clearly it is not an expensive proposition.

Bottom Line

Ultimately it's a significant problem that we rely so heavily on coal to meet our energy needs due to its artificially low market price. It's like eating junk food for every meal. It's cheap, it tastes good, but it's not healthy and eventually you'll pay the price through poor health, high medical bills, and a shortened lifespan.

We may not pay the costs of climate change, lost biodiversity, air and water pollution, adverse health effects, etc. up front, but we do have to pay them eventually. We need to follow the recommendations of Epstein et al., transform our energy infrastructure, and move away from our dependence on coal and other fossil fuels.



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