Review of EPA's June 2013 Steam Electric Effluent Limitations and Guidelines (40 CFR Part 423)

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1. EXECUTIVE SUMMARY

This report reviews the U.S. Environmental Protection Agency's (EPA's) *Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category; Proposed Rule* (EPA 40 CFR Part 423), with particular focus on their Best Available Technology (BAT) determination for existing power plants.

Steam-electric power generation is responsible for one-half of all water pollution from U.S. industry. Much of this pollution is the result of new technologies installed at coal-fired plants to control air pollution over the last decade in response to requirements of the Clean Air Act. The Clean Water Act requires EPA to periodically review all effluent limitations guidelines and standards (ELGs) to determine whether revisions are warranted, but the steam-electric ELGs have not been changed or updated for more than 30 years. In June 2013, EPA released eight regulatory options for new, proposed steam-electric ELGs; of these eight options, four are recommended by EPA as "preferred."

The benefits of steam-electric ELGs are both significant and far reaching. The environmental controls for the steam electric industry proposed by EPA prevent the release of arsenic, mercury, nitrate-nitrite, selenium, and total dissolved solids into U.S. waters. Benefits from reduced water pollution include:

- Reduced incidence of cancer and other health effects from fish consumption
- Improved water quality for recreational uses and aesthetic enjoyment, as well as improved protection of threatened and endangered species and other ecological benefits
- Reduced groundwater contamination and associated health risks
- Lower costs from combustion residual impoundment failures and water treatment, and reduced damages to commercial fisheries, tourism, and property values
- Reduced air emissions—CO_2, NO_x, SO_2, and particulate matter—as a result of curtailed generation at high-emission power plants
- Reduced water use for power generation

The proposed steam electric ELGs will protect the environment, save human lives, and play a critical role in bringing to fruition the Clean Water Act's ultimate goal of eliminating pollution in U.S. surface waters. The most stringent of the regulatory options—Options 4 and 5—would eliminate more water pollution from power plants, do more to protect the environment, and save more human lives than would their less stringent preferred counterparts.

1.1. Benefit-cost analysis

While EPA presents a lengthy benefit-cost analysis for the proposed steam electric ELGs, it is important to note that benefit-cost analysis is not a permissible metric for determining BAT under the Clean Water

Act. Benefit-cost analysis is not considered to be a reliable means of assessing the value to society of regulations; these studies notoriously overestimate costs and underestimate benefits. The benefit-cost analysis for the proposed steam electric ELGs is no exception and even so, all eight regulatory options are well within the range of benefit-cost ratio estimated for approved ELGs.

EPA omits numerous critical benefits in its valuation of the proposed ELGs including: reduced adverse health effects due to less exposure to pollutants from recreational water uses; reduced deposition of arsenic, selenium, and other pollutants in sediment on stream and lake beds; improved fisheries yield and harvest quality due to aquatic habitat improvement for commercial fisheries; benefits to the tourism industry from increased participation in water-based recreation; increased property values from water quality improvements; fewer fish trapped and killed by water intake systems (i.e., reduced impingement and entrainment mortality); reduced costs to processing drinking water; reduced health effects from limiting exposure to pollutants in drinking water; eliminated attractive nuisances; reduction of bromide pollution; additional recycling of coal combustion residuals; value of land for impoundments for redevelopment; reduced air emissions from impoundments' parasitic load; reduced air emissions from true dry handling of ash; avoided costs of BPJ determinations; avoided costs of TMDLs; reduced surface water withdrawals and consumptive use; and avoided costs of litigation.

In addition, EPA underestimated numerous benefits including: reduced risk of impoundment failures due to changes in the use of impoundments; reduced mortality from exposure to NO_x, SO_2 and particulate matter and reduced CO_2 emissions resulting in avoided climate change impacts; improved aquatic and wildlife habitat from improved ambient water quality in receiving reaches; enhanced swimming, fishing, boating, and near-water activities from improved water quality; increased aesthetics from improved water clarity, color, odor, including nearby site amenities (residing, working, traveling); enhanced existence, option, and bequest values from improved ecosystem health; reduced risks to aquatic life from exposure to steam electric pollutants; improved threatened and endangered habitat and thus potential increase in threatened and endangered population; reduced incidence of cancer due to less exposure to arsenic from fish consumption; reduced IQ losses to infants due to less in-utero mercury exposure from maternal fish consumption; reduced IQ losses to children ages 0 to 7 due to less childhood exposure to lead from fish consumption; reduced need for specialized education due to less childhood exposure to lead from fish consumption; and reduced other adverse health effects (cancer and non-cancer) due to less exposure to other pollutants (arsenic, lead, etc.) from fish consumption.

1.2. Economic screening analysis

The Clean Water Act establishes a simple, clear standard for the choice of pollution control technologies to be enforced by EPA: For each industry, the most stringent, but still technologically achievable, control measures are identified. These are the measures to be enforced, unless there is evidence that a particular technology will place a prohibitive burden on the industry as a whole. In the proposed steam-electric ELGs, this standard has been ignored. Control technologies were identified, sorted into eight regulatory options, and ordered in terms of their relative impact on controlling the discharge of pollutants. Regrettably, the two most stringent of these options were then eliminated from further consideration—that is, not designated as "preferred"—without EPA presenting evidence demonstrating that they were either technologically or economically unachievable.

Congress' mandate to EPA in the Clean Water Act requires that pollution control technologies be eliminated from consideration for BAT only on grounds of:

1. ***Stringency:*** There are other more effective technologies for controlling the discharge of pollutants from a particular effluent stream.
2. ***Technological achievability:*** The proposed technology is not achievable (i.e. cannot be purchased or installed).
3. ***Economic achievability:*** The cost of proposed technology is, in EPA's determination, an unreasonable burden to the industrial category as a whole (here, all steam electric generators other than oil-fired generating units and generating units with capacities 50 MW or smaller).

EPA's original proposal recommended Options 3 and 4 as preferred, and only performed its full economic analysis using the IPM model on those two options. The EPA proposal found Options 1 and 2 to be too lax—"neither option would represent the best available technology level for steam electric power plant discharges"—and rejected Option 5 even though "without question, Option 5 would remove the most pollutants from steam electric power plant discharges." EPA's elimination of Option 5 from consideration for this rulemaking was made on economic grounds: "EPA did not select Option 5 as its preferred option for BAT because of the high total industry cost for the option…and because of preliminary indications that Option 5 may not be economically achievable."

1.3. The Merits of Options 4 and 5

Option 4 is less stringent only than Option 5, and is both technologically and economically achievable. Option 5 passes all three tests for BAT.

Option 4 should be among EPA's preferred options

Control technologies for Option 4—dry handling of bottom ash transport water for units with capacities 400 MW or smaller, and chemical precipitation of combustion residual leachate—are more effective at controlling the discharge of pollutants than are the Options selected by EPA as preferred. These control technologies are also—as documented by EPA in this rulemaking—technologically achievable. Furthermore, EPA itself describes Option 4 for as "economically achievable" and fails to make a case that it would be a burden to industry. EPA's rationale for eliminating Option 4 from consideration is based entirely on a subcategorization of the steam-electric industry that has not been appropriately justified in this docket.

Option 5 is BAT for the steam-electric industry

The sole additional control technology found in Option 5 but not in Option 4—vapor-compression evaporation—makes Option 5 the most effective of all the proposed steam-electric regulatory options at controlling the discharge of pollutants. Option 5 is technologically achievable; zero-liquid discharge technologies are used to control similar pollutants in many other industries, in several steam-electric plants in the United States, and in several more abroad.

Option 5 is also economically achievable. EPA has not demonstrated that Option 5 would be a burden to the steam electric industry. The measures of economic achievability presented by EPA are deeply flawed; EPA itself states that the metric for which it presents an adverse result for Option 5—the cost-to-revenue ratio—"does not generally indicate whether profitability is jeopardized, cash flow is affected, or risk of financial distress is increased." Option 5's cost-effectiveness is within the bounds of those of approved ELGs (and is biased upward by the same faulty assumption used in the cost-to-revenue ratio), EPA presents no evidence of its plant closures, its household costs are negligible, and it results in an average annual increase of 2,112 jobs.

Option 5 is BAT for the steam-electric ELGs.

2. BACKGROUND TO THE STEAM ELECTRIC ELGS

In 1972, Congress passed the Clean Water Act to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[1] The Clean Water Act prohibits the discharge of pollutants from a point source into U.S. waters, except as authorized under the Clean Water Act through National Pollutant Discharge Elimination System (NPDES) permits,[2] and requires the U.S. Environmental Protection Agency (EPA) to establish national technology-based effluent limitations guidelines and standards (ELGs) for the discharge of pollutants from particular categories of point sources,[3] such as steam electric power generating facilities.

The Clean Water Act requires EPA to regulate both direct dischargers of pollutants (i.e., those discharging directly to surface waters) and indirect dischargers (those who discharge through publicly owned treatment works). Direct dischargers must comply with the effluent limitations assigned to them in NPDES permits, while indirect dischargers are subject to pretreatment standards. The ELGs set by EPA establish technology-based effluent limitations that are a floor in NPDES permits; where EPA has not promulgated an applicable effluent guideline or new source performance standard, limitations are developed by permit writers case by case based on best professional judgment. ELGs are set by category of industrial discharger and are based on the degree of control that can be achieved using available pollution control technologies.[4]

In its newly released revisions to the ELGs for steam electric power generating facilities, EPA is proposing updated requirements for four of the six types of standards common to ELG rules.[5] Our review focuses on the eight regulatory options (described in detail in Section 5) proposed for a ***Best Available Technology Economically Achievable*** standard for existing direct dischargers. The proposed ELGs also include two options for ***New Source Performance Standards***, and, for indirect dischargers, eight options for ***Pretreatment Standards for Existing Sources*** and one option for ***Pretreatment Standards for New Sources***.[6]

Best Available Technology Economically Achievable (BAT) is generally established based on the level of control being achieved at the highest-performing facilities in the source category. Technological and economic feasibility of control technologies are factors in determining BAT, but EPA is not required to

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[1] 33 U.S.C. § 1251.

[2] 33 U.S.C. §§ 1311(a), 1342.

[3] 33 U.S.C. §§ 1311(d), 1314(b).

[4] 33 U.S.C. §§ 1311, 1314, 1316, 1342(a)(1)(B).

[5] Best Practicable Control Technology Currently Available and Best Conventional Pollutant Technology standards were not included in this rulemaking.

[6] 78 Fed. Reg. 34,432, 34,437-34,438 (June 7, 2013).

perform a benefit-cost analysis—that is, to demonstrate benefits exceeding costs—for BAT.[7] BAT standards may require a higher level of performance than is currently being achieved in an industry, or may be based on technology transferred from a different source category, on bench scale or pilot plant studies, or on performance at foreign plants. BAT may also be based upon process changes or internal controls, even when these technologies are not common industry practice.[8]

2.1. A history of steam electric ELGs

EPA issued the first ELGs for the steam electric power generating point source category in 1974 with subsequent revisions in 1977 and 1982. Despite Clean Water Act requirements that EPA periodically review all effluent limitations guidelines and standards to determine whether revisions are warranted,[9] the ELGs have not been changed or updated for more than 30 years.[10]

During a 2005 review of the existing effluent guidelines for all categories, EPA identified the steam electric category for possible revision.[11] At that time, publicly available data reported through the NPDES permit program and the Toxics Release Inventory indicated that the industry ranked high in discharges of toxic and non-conventional pollutants. Because of these findings, EPA initiated a more detailed study of steam electric generation to determine if its effluent guidelines should be revised. This detailed study, completed in 2009, revealed that much of this toxic pollution was associated with ash handling and wet flue gas desulfurization (FGD) systems—the use of which had increased significantly since 1982 and is anticipated to continue to grow in the next decade with more stringent federal air quality regulations.[12]

EPA's analysis revealed that electric steam generators are producing new waste streams that were not evaluated or were evaluated to only a limited extent during the previous rulemakings due to insufficient information. Such waste streams include FGD wastewater, flue gas mercury control wastewater, carbon capture wastewater, and gasification wastewater. EPA found that these waste streams, together with other combustion-related waste streams at power plants (e.g., fly ash and bottom ash transport water,

[7] EPA v. Nat'l Crushed Stone Ass'n, 449 U.S. 64, 71 (1980).

[8] U.S. Environmental Protection Agency, *Technical Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category*, EPA-821-R-13-002, April 2013; hereafter, "Technical Development Document"; p.1-3. See also Jennifer Duggan and Craig Segall, *Closing the Floodgates: How the Coal Industry is Poisoning Our Water and How We Can Stop It*, Environmental Integrity Project, Sierra Club, Clean Water Action, Earthjustice, and Waterkeeper Alliance, July 2013.

[9] 33 U.S.C. §§ 1311(d), 1314(b).

[10] Technical Development Document at 1-8.

[11] Id.

[12] U.S. Environmental Protection Agency, Steam Electric Power Generating Point Source Category: Final Detailed Study Report, EPA 821-R-09-008, October 2009.

and leachate) contain pollutants in concentrations that are causing documented environmental impacts, and that treatment technologies are available to reduce or eliminate the pollutant discharges.

From these analyses, EPA determined that the current ELGs have not kept pace with the significant changes that have occurred in the fleet of steam electric generators over the last three decades. In 2010, Sierra Club and Defenders of Wildlife filed a lawsuit against EPA for failing to meet the Clean Water Act requirements to review and revise the ELGs periodically.[13] EPA settled the lawsuit and entered into a consent decree, which set a deadline of July 23, 2012 (later extended to April 19, 2013) for the EPA Administrator to sign a notice of proposed rulemaking to revise the ELGs.[14] EPA published in the Federal Register the *Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category; Proposed Rule* (EPA 40 CFR Part 423) on June 7, 2013.[15] Pursuant to the consent decree, the final ELGs for steam electric generators must be adopted by May 22, 2014.[16]

EPA's proposed steam electric ELGs would strengthen the regulation of water pollution at approximately 2,200 power plants with a total generating capacity of 741,000 MW—approximately 70 percent of total U.S. capacity in 2011 (see Table 1).[17]

Table 1. Estimated number of steam electric generating units and capacity by primary fuel source

Primary fuel source	Number of generating units	Nameplate capacity (MW)	Share of capacity
Coal	1,080-1,090	328,000-330,000	44.4%
Petroleum Coke	12	1,000	0.1%
Oil	75-100	23,900-25,400	3.3%
Gas	929	282,000	38.1%
Nuclear	99	104,000	14.0%
Total Industry	**2,195-2,230**	**741,000**	**100.0%**

Source: 78 Fed. Reg. at 34,447, Table VI-1; authors' calculations.

2.2. Effluents and controls

At 89 percent of coal- and petroleum coke-fired plants, the use of water to clean combustion equipment or transport pollutants results in the release of waterborne pollutants into waterways. The vast majority of these effluents are released directly into surface waters. EPA identified only approximately ten plants that release effluents into publicly-owned water treatment systems.[18] There are several avenues for the

13 *Defenders of Wildlife v. Jackson*, D.D.C., No. 1:10-cv-01915 (2012).

14 *Id.*, stipulated extension, Dec. 10, 2012.

15 78 Fed. Reg. 34,432 (June 7, 2013). EPA released the pre-publication copy of the rule on its web site on April 19, 2013.

16 *Defenders of Wildlife v. Jackson*, D.D.C., No. 1:10-cv-01915 (2012).

17 U.S. Energy Information Administration, Form EIA-860.

18 78 Fed. Reg. at 34,448.

release of polluted effluents from steam electric power generators, as shown for EPA's eight proposed regulatory options in Table 2.

Table 2. Steam electric regulatory options

Pollution Streams and Controls	Current Requirement	Option 1	Option 3a	Option 2	Option 3b	Option 3	Option 4a	Option 4	Option 5
Flue Gas Desulfurization Wastewater									
Surface Impoundments	✓								
Chemical Precipitation		✓	BPJ*	✓	✓	✓	✓	✓	✓
Biological Treatment <2,000 MW				✓	BPJ*	✓	✓	✓	
Biological Treatment ≥2,000 MW				✓	✓	✓	✓	✓	
Vapor-Compression Evaporation									✓
Fly Ash Transport Water									
Surface Impoundments	✓	✓		✓					
Zero Discharge/Dry Handling			✓		✓	✓	✓	✓	✓
Bottom Ash Transport Water									
Surface Impoundments ≤400 MW	✓	✓	✓	✓	✓	✓	✓		
Surface Impoundments >400 MW	✓	✓	✓	✓	✓	✓			
Zero Discharge/Dry Handling ≤400 MW								✓	✓
Zero Discharge/Dry Handling >400 MW							✓	✓	✓
Combustion Residual Leachate									
Removal of Suspended Solids	✓	✓	✓	✓	✓	✓	✓		
Chemical Precipitation								✓	✓
Flue Gas Mercury Control Wastewater									
Surface Impoundments	✓	✓		✓					
Zero Discharge/Dry Handling			✓		✓	✓	✓	✓	✓
Gasification Processes Wastewater									
Vapor-Compression Evaporation		✓	✓	✓	✓	✓	✓	✓	✓
Nonchemical Metal Cleaning Wastewater									
Chemical Precipitation		✓	✓	✓	✓	✓	✓	✓	✓

Source: 78 Fed. Reg. at 34,458, Table VIII-1; at 34,504, Table XII-1

*Note: * BPJ is best professional judgment*

Removal of sulfur and mercury from flue gases very often results in wastewaters, which EPA's current regulations allow power plants to store in unlined surface impoundments (artificial ponds for storage of polluted wastewater) that are designed primarily to remove suspended solids from the wastewater before it is discharged to a nearby surface water such as a river, lake, or stream. In EPA's new rulemaking, the proposed controls for this wastewater vary by option and include combinations of chemical precipitation, biological treatment, and vapor-compression evaporation. Only Option 5, which requires chemical precipitation of FGD wastewater followed by a vapor-compression evaporation system, offers the maximum limitation of these discharges that is possible with available technology.[19] In addition, six of the eight regulatory options improve on current practices for flue gas mercury control wastewater by requiring zero-discharge dry handling.

Water used to transport coal combustion residuals (fly ash and bottom ash) is also currently stored in surface impoundments before discharge. Six of the eight regulatory options improve on current practices for fly ash transport water by requiring zero-discharge dry handling. Only three of the proposed options require zero-discharge dry handling either for all power plants (Options 4 and 5) or for plants with capacities greater than 400 MW (Option 4a).

Leachate (drainage) from surface impoundments and landfills holding combustion residuals is currently treated only to the extent that it is captured through gravity settling in impoundments that are designed to remove suspended solids.[20] Only Options 4 and 5 require chemical precipitation treatment for that wastewater stream.

Two additional sources of wastewater at electric steam generators are currently unregulated. Wastewater from the gasification process at integrated gasification combined cycle (IGCC) plants—of which only there are only three plants currently in operation in the United States[21]—is required to undergo vapor-compression evaporation in all eight regulatory options. Wastewater from nonchemical cleaning of metal processing equipment is required to undergo chemical precipitation in all options.

Several waste streams were not evaluated by EPA for new or updated limitations. EPA does not propose to update the ELGs for once-through cooling water and cooling tower blowdown, which may contain chlorine, iron, copper, nickel, aluminum, boron, chlorinated organic compounds, suspended solids, brominated compounds, and nonoxidizing biocides, often in low concentrations, as a result of chlorination and corrosion/erosion of the piping, condenser, and cooling tower materials.[22] Nor does EPA propose to update ELGs for coal pile runoff, even though EPA found that "[c]oal pile runoff from the coal-fired power industry generates approximately 3.5 million gallons of wastewater per year."[23] EPA also chose not to address possible new waste streams generated as a result of increased use of selective catalytic reduction and selective non-catalytic reduction technologies.[24]

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[19] 78 Fed. Reg. at 34,451-34,452.

[20] 78 Fed. Reg. at 34,462-34,463.

[21] See EIA Form 8260, 2012. 78 Fed. Reg. at 34,450 states that there are two IGCC plants in operation, but a 570 MW plant (summer capacity) was opened at Edwardsport, Indiana in June 2013. Another 2,100 MWs at 8 sites are proposed or under construction.

[22] Technical Development Document, p. 4-41 – 4-42.

[23] Technical Development Document, p. 4-41.

[24] Technical Development Document, p. 4-43 – 4-44.

EPA's proposed steam electric ELGs have the potential to remove up to 8.2 billion pounds-equivalent (lb-eq) of toxic-weighted pollutants from U.S. waterways, resulting in immeasurable benefits to human health and natural ecosystems.[25]

This report reviews EPA's evaluation of benefits and costs for the different regulatory options in the proposed steam-electric rule, an assessment which was central to EPA's selection of preferred regulatory options. Section 3 gives an overview of the important benefits expected to result from reducing waterborne pollution released by steam electric power generators. Section 4 discusses EPA's benefit-cost analysis of the proposed steam electric ELGs, finding it to be both inappropriate—benefit-to-cost comparisons are not permissible in Clean Water Act decisions—and inaccurate, with biases towards overestimating costs and underestimating benefits. Section 5 examines the criteria used to determine which steam electric ELG regulatory options are "preferred" and, therefore, advanced for further consideration for BAT determination; Options 4 and 5—the most stringent technical controls proposed by EPA—are inappropriately eliminated from further consideration. Section 6 provides a brief conclusion and summary of the main arguments of this report.

[25] 78 Fed. Reg. at 34,504.

3. STEAM ELECTRIC ELGS HAVE SIGNIFICANT BENEFITS

The environmental controls for the steam electric industry proposed by EPA prevent the release of arsenic, mercury, nitrate-nitrite, selenium, and total dissolved solids into U.S. waters. Benefits from reduced water pollution include:[26]

- Reduced incidence of cancer and other health effects from fish consumption
- Improved water quality for recreational uses and aesthetic enjoyment, as well as improved protection of threatened and endangered species and other ecological benefits
- Reduced groundwater contamination and associated health risks
- Lower costs from combustion residual impoundment failures and water treatment, and reduced damages to commercial fisheries, tourism, and property values
- Reduced air emissions—CO_2, NO_x, SO_2, and particulate matter—as a result of curtailed generation at high-emission power plants
- Reduced water use for power generation

The proposed steam electric ELGs will protect the environment, save human lives, and play a critical role in bringing to fruition the Clean Water Act's ultimate goal of eliminating pollution in U.S. surface waters. The most stringent of the regulatory options—Options 4 and 5—would eliminate more water pollution from power plants, do more to protect the environment, and save more human lives than would their less stringent "preferred" counterparts.

In its 2009 detailed study of the steam electric industry, EPA made clear the importance of updating these ELGs:

> Numerous studies have shown that the pollutants found in wastewater associated with coal combustion wastes can impact aquatic organisms and wildlife, and can result in lasting environmental impacts on local habitats and ecosystems. Many of these impacts may not be realized for years due to the persistent and bioaccumulative nature of the pollutants released. The total amount of toxic pollutants currently being released in wastewater discharges from coal-fired power plants is estimated to be significant and raises concerns regarding the long-term impacts to aquatic organisms, wildlife, and human health that are exposed to these pollutants.[27]

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[26] 78 Fed. Reg. at 34,509-34,510, Table XIV-1.

[27] U.S. Environmental Protection Agency, Steam Electric Power Generating Point Source Category: Final Detailed Study Report, EPA 821-$-09-008, October 2009, p.6-1.

New, more stringent ELGs are a first step towards reversing damage done by past pollution, and a down payment on the well-being of future generations.

Pollutants from steam electric generating units into U.S. surface waters dwarf pollutants from all other ELG industrial categories. The steam electricity industry releases 8.3 million lb-eq of toxic-weighted waterborne pollutants each year. The two next most polluting industries—pulp, paper and paperboard, and petroleum refining—each release 1.0 million lb-eq (see Table 3), and pollution from all 55 ELG categories other than steam electric combined amounts to 8.1 million lb-eq.[28]

Table 3. Pollutant loadings for 2010 effluent guidelines: Top 10 point source categories

40 CFR Part	Point Source Category	Total TWPE (lb-eq/yr)
423	**Steam Electric Industry**	**8,320,000**
430	Pulp, Paper And Paperboard	1,030,000
419	Petroleum Refining	1,030,000
421	Nonferrous Metals Manufacturing	994,000
418	Fertilizer Manufacturing	826,000
414	Organic Chemicals, Plastics And Synthetic Fibers	649,000
440	Ore Mining And Dressing	448,000
415	Inorganic Chemicals Manufacturing	299,000
444	Waste Combustors	254,000
410	Textile Mills	250,000

Source: EPA Environmental Assessment, p.3-14, Table 3-3

The proposed ELGs would prevent further degradation of our nation's natural environment, reduce the release of toxins that threaten endangered species, and preserve the natural beauty of our waterways. Updating the ELGs would reduce the number of illnesses, disabilities, and deaths caused by toxic pollutants. Fewer carcinogenic pollutants in our waters will result in fewer cancer cases and fewer deaths from cancer. Less mercury in our water will mean fewer children growing up with mental disabilities. These are invaluable benefits to our society.

3.1. Benefits to the environment

By greatly reducing the amount of pollution steam electric power plants are permitted to discharge into waterways, the proposed ELGs will provide a wide range of difficult-to-monetize benefits to our natural environment. Steam electric wastewater flows into important—and sensitive—environments, such as impaired waters, waters with fish consumption advisories, the Great Lakes, critical estuaries, and drinking water sources.[29] Many of the pollutants from this wastewater find their way into the food chain, and can have dramatic impacts on ecological systems. As EPA explains, "Population decline [of aquatic life] attributed to exposure to combustion wastewater can alter the structure of aquatic

[28] Environmental Assessment p.3-14, Table 3-3, and http://water.epa.gov/lawsregs/lawsguidance/cwa/304m/upload/tsd_effluent_program_10_2011.pdf Table 5-3.

[29] Environmental Assessment, p. 3-2.

communities and cause cascading effects within the food web that result in long-term impacts to ecosystem dynamics."[30]

Chesapeake Bay water quality provides a useful example of the tremendous impact steam electric pollutants can have. Chesapeake Bay has had its waters polluted by heavy industry (including the electric industry) for so long that, according to the EPA,

> "Most of the Chesapeake Bay and its tidal waters are listed as impaired for excess nitrogen, phosphorus, and sediment. These pollutants cause oxygen-consuming algae blooms and create "dead zones" where fish and shellfish cannot survive, block sunlight that is needed for underwater grasses, and smother aquatic life... in the Bay."[31]

The steam electric industry is contributing an important portion of these pollutants (see Table 4), and EPA has estimated that the combined pollution of the 20 steam electric power plants discharging into the Chesapeake Bay is equivalent to many times that of a typical publicly owned water treatment facility:

- More than 100 times the discharge of arsenic and lead
- More than 450 times the discharge of cadmium
- More than 550 times the discharge of nickel and selenium; and
- More than 1,600 times the discharge of thallium.[32]

Table 4: Steam electric and other point source discharges to the Chesapeake Bay Watershed

Discharges to the Chesapeake Bay Watershed	Steam Electric Baseline Loadings to the Chesapeake Bay Watershed (lbs/year)	Total Point Source Loadings to the Chesapeake Bay Watershed (lbs/year)	Percentage of Point Source Loadings from Steam Electric Plants
Arsenic	5,180	3,500	100%
Cadmium	1,820	3,000	61%
Copper	5,150	78,100	7%
Lead	5,630	15,000	38%
Mercury	168	2,660	6%
Zinc	21,500	125,000	17%
Total Nitrogen	2,200,000	7,340,000	30%
Total Phosphorus	60,000	1,270,000	5%

Source: EPA Environmental Assessment, p. 3-20, Table 3-6

[30] Environmental Assessment, p. 3-25.

[31] Environmental Assessment p. 3-19.

[32] Environmental Assessment, p.3-21.

In addition to discharging numerous better-known toxins such as arsenic, lead, and mercury, the steam electric industry also releases less familiar toxins into waterways, including selenium, which threatens both aquatic ecosystems and human health. According to EPA's research:

> A number of scientific studies expressed concern over selenium exposure within lakes and reservoirs where longer residence times allow for further bioaccumulation and a greater potential to reach lethal concentrations. In particular, studies concluded that elevated selenium concentrations were likely the primary contributor to fish kills in lakes and reservoirs, decreasing population density and community diversity.[33]

A pristine environment, including clean water and clean air, provides critical use and non-use values to human society.

3.2. Benefits to human health

The steam electric industry discharges polluted wastewater into water bodies that serve both non-use recreational purposes and are used directly by human populations. Pollutants follow "toxic exposure pathways" that lead to impacts on human health. When a known carcinogen—arsenic, for example—is discharged by a coal power plant into a stream inhabited by aquatic life, the pollutant makes its way through the food chain into fish that are consumed by humans. The concentration of pollutants may be so high that the fish in waters that receive wastewater discharge die from toxic overload. The EPA points to these fish kills as an indication of "an ongoing human health concern."[34] Adverse chronic effects (malformations, metabolic and hormonal changes) are another important area of concern: Aquatic life is slowly poisoned, resulting in both ecological impacts and the risk of consumption of toxic fish by human populations.[35]

The toxic exposure pathway may be even more direct. For example, leachate (drainage) from steam electric surface impoundments and landfills flow into groundwater and drinking water wells. Leachate may contaminate these waters to a degree considered unsafe—as determined by the maximum contaminant level for drinking water standards. The EPA describes these types of contamination events as currently "posing a potential threat to human health."[36]

The proposed steam electric ELGs will reduce human exposure to a variety of toxic metals including selenium (which can damage the kidneys, liver, and nervous and circulatory systems), mercury (which can cause mental retardation if exposure occurs during fetal development), arsenic (which is a known carcinogen), cadmium (a probable carcinogen which can cause kidney and liver failure), thallium (which

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[33] Environmental Assessment, p.3-21.

[34] Environmental Assessment, p. 3-1.

[35] Environmental Assessment, pp. 3-40, 7-3.

[36] Environmental Assessment, p.3-21.

changes blood chemistry; damages the liver, kidney, and intestinal and testicular tissues; and causes hair loss), lead (which causes serious damage to the brain, kidneys, nervous system, and red blood cells, especially in children), and other metals.[37]

Many of these poisons—particularly lead, mercury, and arsenic—have disproportionate impacts on children. The proposed steam electric ELGs have an important role to play in safeguarding children's health—a top priority of the EPA.[38]

[37] Environmental Assessment, pp. 3-6 - 3-8.

[38] http://www2.epa.gov/aboutepa/seven-priorities-epas-future.

4. BENEFIT-COST ANALYSIS IS INAPPROPRIATE AND INACCURATE

This section discusses two main concerns with EPA's benefit-cost analysis for the proposed steam electric ELGs. First, benefit-cost analysis is not a permissible criterion for determining BAT under the Clean Water Act. Second, regulatory benefit-cost analyses notoriously overestimate costs and underestimate benefits; the benefit-cost analysis for the proposed steam electric ELGs is no exception.

4.1. Use of benefit-cost analysis for ELGs is inappropriate

The Clean Water Act precludes EPA from conducting a benefit-cost analysis when issuing BAT guidelines. "[I]n assessing BAT, total cost is no longer to be considered in comparison to effluent reduction benefits."[39] As the D.C. Circuit has explained, Congress affirmatively rejected amendments which would have required benefit-cost balancing for BAT.[40] Seven circuit courts of appeal have affirmed, in accord with the Supreme Court's decisive pronouncement in *National Crushed Stone*, that EPA cannot base BAT guidelines on benefit-cost analysis. The Supreme Court's recent discussion of benefit-cost analysis under a separate Clean Water Act provision, 33 U.S.C. § 1326, reinforces this long-settled law.[41]

Congress forbade benefit-cost analysis when developing the BAT standards for sound policy reasons. The sponsors of the 1972 Clean Water Act amendments recognized that the costs of pollution controls are more easily quantified than the benefits, and therefore any benefit-cost analysis would be biased toward emphasizing costs over benefits.[42] Additionally, Congress believed that a technology-forcing mandate that did not weigh costs against benefits would spur the development of cheaper control technologies over the long run.[43]

As discussed in the next sub-section, benefit-cost analysis compares complete (and sometimes overestimated) costs of compliance with incomplete (and very often underestimated) social benefits. EPA's qualitative analysis and—where data exist—empirical treatment of human health and environmental impacts is detailed and helpful to understanding the many important positive benefits of strengthening the steam electric ELGs. In contrast, EPA's monetization of benefits that are never traded in a market and are, quite literally, priceless is incomplete, inaccurate, and—to the extent that it distracts from the legitimate decision-making process associated with the Clean Water Act—unhelpful.

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[39] EPA v. Nat'l Crushed Stone, 449 U.S. 64, 71 (1980); see also Am. Iron & Steel, 526 F.2d 1027, 1051-52 (3rd Cir. 1975) ("With respect to the [BAT] standards," Congress intended "that there should be no cost-benefit analysis.").

[40] See Weyerhauser v. Costle, 590 F.2d 1011, 1046 (D.C. Cir. 1978).

[41] See Entergy Corp. v. Riverkeeper, Inc., 556 U.S. 208 (2009) (only certain specific Clean Water Act standards "authorize cost-benefit analysis," and the BAT analysis does not fall within this group).

[42] S. Rep. No. 92-414, at 47 (1971).

[43] Id. at 50-51.

Table 5 presents the benefit-to-cost ratios calculated by EPA for the proposed steam electric ELGs in relation to ratios for other categories. With one exception, ELGs have been approved either with no benefit-cost analysis or with costs that exceed measured benefits. The benefit-cost ratios of all eight proposed steam electric regulatory options are well within the range of those of approved ELGs.

Table 5. Clean Water Act ELGs and proposed steam electric ELGs: Benefit-cost ratios

Industry	Citation For Final Rule	Benefit-cost ratio (B/C)
Landfills	65 FR 3008 (Jan. 19, 2000)	1.02
Concentrated Animal Feeding Operations	68 FR 7176 (Feb. 12, 2003)	0.87
Proposed Steam Electric, Option 3a[a]	**78 FR 34,432 (June 7, 2013)**	**0.75**
Proposed Steam Electric, Option 3b[a]	**78 FR 34,432 (June 7, 2013)**	**0.73**
Organic Chemicals and Plastics and Synthetic Fibers	52 FR 42522 (Nov. 5, 1987)	0.58
Proposed Steam Electric, Option 3	**78 FR 34,432 (June 7, 2013)**	**0.54**
Proposed Steam Electric, Option 4a[a]	**78 FR 34,432 (June 7, 2013)**	**0.51**
Proposed Steam Electric, Option 4	**78 FR 34,432 (June 7, 2013)**	**0.44**
Construction and Development	74 FR 62996 (Dec. 1, 2009)	0.38
Transportation Equipment Cleaning	65 FR 49666 (Aug. 14, 2000)	0.34
Proposed Steam Electric, Option 1[b]	**78 FR 34,432 (June 7, 2013)**	**0.31**
Concentrated Aquatic Animal Production	69 FR 51892 (Aug. 23, 2004)	0.29
Proposed Steam Electric, Option 2[b]	**78 FR 34,432 (June 7, 2013)**	**0.29**
Centralized Waste Treatment	65 FR 81242 (Dec. 22, 2000)	0.26
Proposed Steam Electric, Option 5[c]	**78 FR 34,432 (June 7, 2013)**	**0.26**
Pulp, Paper, and Paperboard Mills	63 FR 18504 (Apr. 15, 1998)	0.20
Hazardous Waste Combusters	65 FR 4360 (Jan. 27, 2000)	0.19
Pharmaceutical Industry	63 FR 50388 (Sep. 21, 1998)	0.19
Metal Products and Machinery	68 FR 25686 (May 13, 2003)	0.09
Aluminum Forming	48 FR 49126 (Oct. 24, 1983)	No BCA provided
Leather Tanning	47 FR 52848 (Nov. 23, 1982)	No BCA provided
Porcelain Enameling	47 FR 53172 (Nov. 24, 1982)	No BCA provided
Metal Molding and Casting (Foundries)	50 FR 45212 (Oct. 30, 1985)	No BCA provided
Electrical and Electronic Components	48 FR 15382 (Apr. 8, 1983)	No BCA provided
Coil Coating	47 FR 54232 (Dec. 1, 1982)	No BCA provided
Copper Forming	48 FR 36942 (Aug. 15, 1983)	No BCA provided
Steam Electric Power Generators (Final 1982)	47 FR 52290 (Nov. 19, 1982)	No BCA provided
Battery Manufacturing	49 FR 9108 (Mar. 9, 1984)	No BCA provided
Airport Deicing	77 FR 29168 (May 16, 2012)	No BCA provided

a EPA infers benefits for Options 3a, 3b, and 4a from analysis for Options 3 and 4. See 78 Fed. Reg. at 34,519, Table XIV-9.

b EPA omitted air-related benefits for Options 1 and 2. See 78 Fed. Reg .at 34,519, Table XIV-9.

c EPA omitted air-related benefits for Option 5. Here, we have added Option 4's air-related benefits to Option 5's non-air-related benefits to provide a lower bound for Option 5 benefits. See 78 Fed. Reg. at 34,519-34,518, Tables XIV-8 and XIV-9.

4.2. Use of benefit-cost analysis for ELGs is inaccurate

Uncertainty affects many aspects of EPA's massive evaluation of costs and benefits of the proposed steam electric ELGs. As in many benefit-cost analyses, the uncertainties are not symmetrical: costs of meeting a standard, commonly based on *ex ante* engineering estimates, are often overestimates of actual, *ex post* compliance costs, while health and environmental benefits of the same standard are surrounded by different types of uncertainty. Standard practices in calculation of monetized benefits, particularly the high threshold requirements for including any nonzero value, tend to underestimate the true magnitude of benefits.

The result is a systematic imbalance in EPA's benefit-cost analyses: Complete and sometimes overestimated costs of regulation are weighted against incomplete and often underestimated benefits of regulation. It can be no surprise that, using this highly biased methodology, costs exceed the measured benefits of the proposed steam electric ELGs.

Uncertainty in cost estimates

In benefit-cost analyses, regulatory costs often involve well-defined, monetized categories, as is the case with engineering cost estimates. Nonetheless, these costs are not free of errors, imprecision, or uncertainty. There is a research literature documenting the tendency for *ex ante* estimates of regulatory costs to overstate the true, *ex post* costs.

One widely cited study, by Winston Harrington and colleagues at Resources for the Future, identified 25 major rules for which they could find both *ex ante* agency cost estimates and *ex post* cost calculations, the latter usually provided by independent researchers. In twelve of the 25 cases, the *ex ante* estimates were more than 25 percent higher than the actual costs, compared to only six cases in which the estimates were more than 25 percent lower.[44] The study discusses a number of reasons for overestimates, including:

- Technological innovation, spurred in part by regulation, may lead to reduced costs and/or improved efficiency in compliance technologies, as apparently happened with scrubbers for coal plants. In other words, once industry begins investing in compliance with a rule, a market develops in compliance technologies, and compliance costs often go down in ways that *ex ante* cost estimates do not project.
- Advance analyses also tend to estimate maximum rather than most likely compliance costs. This may occur inadvertently, if expensive technologies are available off the shelf and are better known; it may result from strategic considerations by affected industries, seeking to inflate cost estimates as an argument against regulation; or it may result

[44] Harrington, W., R.D. Morgentstern, and P. Nelson. "On the accuracy of regulatory cost estimates." *Journal of Policy Analysis and Management* 19, no. 2 (2000): 297-322.

from deliberate choices by agencies, seeking to minimize grounds for court challenges from industry.

- Error correction may be asymmetric—the affected industries will reliably call attention to gross underestimates of compliance costs, while there may be no corresponding pressure to reduce gross overestimates. The affected industry tends to have better access to information about compliance costs than the agency or members of the public, making the rulemaking record subject to this inherent bias.

In another study comparing prospective and actual costs of major regulations, legal scholar Thomas McGarity and economist Ruth Ruttenberg also find a preponderance of overestimates.[45] Their description of potential grounds for upward bias in *ex ante* costs includes the points identified by Harrington et al., plus some additional possibilities:

- For lack of information, agencies may compare the costs of a proposed regulation to a zero regulation, zero compliance baseline, rather than appropriately measuring the incremental costs relative to prior regulations and the actual level of voluntary compliance.

- Companies may include the costs of upgrading other equipment in their reported costs of regulatory compliance.

In a more recent study, Frank Ackerman examines the debate surrounding regulatory cost impacts, and reviews reports by the Office of Management and Budget and by consultants to the Small Business Administration, which claim to find substantial regulatory compliance costs.[46] He finds a series of errors and misrepresentations, which tend to exaggerate the widely reported bottom-line estimates of regulatory costs. The Small Business Administration, in particular, has sponsored an annual series of studies estimating ever-more-alarming total costs of regulation; careful examination shows that these costs are based on fanciful extrapolation at best, combined with misuse of statistical evidence. The 2010 study, for example, reports an alarming $1.75 *trillion* annual cost of regulations. Two-thirds of that putative cost, however, is based on a single regression estimate linking per capita income to a World Bank index of regulatory quality. That regression analysis suffers from multiple fundamental flaws, including misunderstanding and misrepresenting the World Bank index, boosting significance levels by padding the database with 7 years of near-identical data, and failing to distinguish between correlation and causation. (Additional serious problems affect the remaining one-third of the estimated cost of regulations.)[47]

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[45] McGarity, T.O., and R. Ruttenberg. "Counting the cost of health, safety, and environmental regulation." *Texas Law Review*, 2001: 1997-2058.

[46] Ackerman, F. "The unbearable lightness of regulatory costs." *Fordham Urban Law Journal* 33 (2005): 1071-1095.

[47] Heinzerling, L., and F. Ackerman, "The $1.75 trillion lie," *Michigan Journal of Environmental and Administrative Law* 1 (2012): 127-158.

Another recent study examines predicted and actual price impacts of Department of Energy (DOE) appliance and equipment energy efficiency standards. Across nine rulemakings, DOE estimated an average increase in the manufacturers' selling prices of $148; the actual average change was a *decrease* of $12.[48]

Uncertainty in benefits

Valuation of the benefits of regulation involves a sequence of stages, each of which can be the locus of uncertainty. Three main stages can be distinguished:

- An ***event***, such as release of a pollutant, occurs.
- The event has a health or environmental ***impact*** on a human or natural receptor.
- A ***monetary valuation*** is assigned to the impact.

For example, there could be uncertainty about whether and to what extent a coal ash impoundment or landfill failure, or other unplanned release of polluted wastewater, will occur (and more particularly, uncertainty about whether a proposed ELG standard affects the likelihood of such a release); subsequent uncertainty about the health or environmental impact of any toxic chemicals released in that event; and finally, uncertainty about appropriate monetary valuation of those impacts, once they have occurred.

Monetization: Are uncertain values always zero?

Another problem with benefits calculations is perhaps even more serious than the uncertainty in physical risks. In order to enter a benefit-cost calculation, benefits must be not only quantified, but also monetized. EPA maintains relatively strict and demanding standards for monetization; the default for benefit categories that cannot meet the standard is a qualitative discussion with a zero value. While often informative, EPA's qualitative discussions of such benefits do not result in numerical valuations, and are therefore treated as equivalent to a finding of zero in any simple summary of benefits and costs. This imparts an asymmetric bias to the overall calculations: There is no comparable category of costs that default to zero for lack of data; there are no offsetting categories of benefits where there is a structural bias toward overestimation.

The difficulty in monetization results from the artificial, synthetic nature of benefits valuations. One of the widely discussed virtues of a market economy is that up-to-date prices for marketed goods are continually available to all, at little or no cost; it is difficult to imagine another system that provides equally timely, inexpensive information on prices. It is unfortunately clear that environmental economics has not come close to matching that performance in pricing non-marketed health and

[48] Steven Nadel and Andrew deLaski, "Appliance Standards: Comparing Predicted and Observed Prices," American Council for an Energy-Efficient Economy, 2013, http://www.aceee.org/research-report/e13d.

environmental benefits. Research standards for monetizing benefits are sufficiently demanding that EPA frequently relies on "benefit transfers" – that is, making the best available approximations based on the published literature on valuation of similar benefits experienced elsewhere.

Even with extensive use of benefit transfer calculations, there are large gaps remaining in the valuation of benefits, due to inherent limitations of quantification and/or monetization. In the benefit-cost analysis conducted for the proposed steam electric ELGs, numerous benefits are effectively valued at zero dollars due to lack of data, including the following examples:

> EPA expects that there would also be material health benefits via the fish consumption pathway arising from reduced discharges of other steam electric pollutants, such as cadmium, selenium, and zinc. Analyses of these health benefits are not possible due to lack of data…[49]
>
> EPA quantified but did not monetize the expected reduction of pollutant concentrations in excess of human health-based aquatic water quality criteria (AWQC) limits.[50]
>
> By reducing discharges of pollutants to receiving reaches, the proposed ELGs would reduce the future contamination of waterbody sediments, thereby mitigating impacts to benthic organisms and reducing the probability that the pollutants would later be released into the water column and affect surface water quality and the waterbody food chain. Due to data limitations, EPA did not quantify or monetize this benefit.[51]
>
> EPA did not quantify or monetize benefits from enhanced quality of drinking and agricultural water sources arising from the proposed ELGs due to data limitations.[52]
>
> Reduced surface water intake would reduce impingement and entrainment mortality. Due to data limitations, EPA did not quantify and monetize these benefits as part of this analysis.[53]

The last of these example omissions is particularly striking, since in other proceedings EPA has devoted extensive effort to quantification and monetization of changes in impingement and entrainment mortality, due to changes in cooling water intake systems. It should have been possible to arrange a "benefits transfer" between different parts of EPA itself.

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[49] U.S. Environmental Protection Agency, Benefit and Cost Analysis for the Proposed Effluent Limitation Guidelines and Standards for the Steam Electric Power Generating Point Source Category, EPA-821-R-13-004, April 2013; hereafter, Benefit-Cost Analysis; p.2-4.

[50] Benefit-Cost Analysis, p.2-5.

[51] Benefit-Cost Analysis, p.2-8. Receiving reaches are areas into which effluents are discharged.

[52] Benefit-Cost Analysis, p.2-10.

[53] Benefit-Cost Analysis, p.2-11.

The asymmetric bias in benefits monetization, with substantial benefit categories omitted from monetization (implicitly valued at zero) but no comparable offsetting bias in the other direction, causes a fundamental distortion in bottom-line benefit-cost estimates. The virtue of benefit-cost analysis, in theory, is that it provides objective, transparent comparison of costs and benefits, calculated on an equal footing. This requires comparably complete estimates on both sides. There is no theoretical argument for the use of an "overestimated cost—incomplete benefit" estimate; no useful conclusion can be drawn from the finding that relatively complete estimates of costs exceed substantially incomplete estimates of benefits.[54]

As the above quotes from EPA confirm, the benefit-cost calculations for the proposed steam electric ELGs are indeed comparisons of complete and often over-estimated costs with incomplete benefits. The bottom-line estimates presented in this case are the estimates that would apply if all the un-monetized benefits were known to be worth precisely zero—which is a very different state of knowledge from genuine uncertainty about the magnitude of these important but hard-to-measure (and sometimes impossible-to-measure) categories. EPA presents no argument that the un-monetized benefits are all worthless; nor could it, as many of them are of obvious value. As a result, the conclusion is inescapable that EPA's bottom-line comparisons of costs and benefits are fundamentally wrong, albeit by uncertain amounts.

4.3. Valuing the benefits

The environmental controls discussed in the proposed steam electric ELGs will prevent the discharge of billions of pounds of pollutants each year and result in important benefits to society.[55] EPA correctly identifies most of the benefits of the proposed rule (see Table 6 and Table 7 below), but many of these benefits, either in whole or in part, were not included in EPA's calculations of the total monetary benefit of the regulatory options, and, therefore, were not included in the benefit-cost ratio. The monetary value of benefits is either omitted or undervalued for improvements to human health, the environment and ecosystems, and economic productivity. When EPA is unable to quantify or monetize an ELG impact with sufficient certainty, it effectively values the benefit at zero dollars.

This sub-section first reviews three types of benefits for which monetary values are omitted from the proposed steam electric ELGs:

- ***Benefits discussed in EPA's Benefit-Cost Analysis but not given a monetary value:*** In EPA's *Benefit-Cost Analysis*, some benefits that are discussed qualitatively but never given a monetary value. These benefits are effectively valued at zero dollars.

[54] Ackerman, F. and L. Heinzerling, Priceless: On Knowing the Price of Everything and the Value of Nothing (New York: New Press, 2004).

[55] 78 Fed. Reg. at 34,504-34,522; and Benefit-Cost Analysis.

- ***Benefits discussed in EPA other documentation but not included in the Benefit-Cost Analysis:*** EPA discusses several benefits in other supporting documents to the steam electric ELGs but does not include any discussion or monetization of these values in the *Benefit-Cost Analysis*. These benefits are effectively valued at zero dollars.

- ***Benefits not discussed by EPA:*** Several additional benefits are not discussed in any of the steam electric ELG supporting documents. These benefits are effectively valued at zero dollars.

and then provides an overview of the benefits the EPA did monetize:

- ***Benefits assigned monetary values by EPA.*** Fifteen benefits of the ELGs are monetized by EPA; 13 of these are, as acknowledged by EPA, underestimated.

The omitted benefits are summarized in Table 6; monetized benefits are summarized in Table 7 below.

Table 6. Benefits omitted from EPA analysis of proposed steam electric ELGs

Benefit	Inclusion	Quantification	Monetization
Reduced other adverse health effects (cancer and non-cancer) from reduced exposure to other pollutants (arsenic, lead, etc.) via fish consumption	Discussed in BCA but not given monetary value	Quantified (Low)	Not Monetized
Improved fisheries yield and harvest quality due to aquatic habitat improvement of commercial fisheries	Discussed in BCA but not given monetary value	Not Quantified	Not Monetized
Benefits to tourism industries from increased participation in water based recreation	Discussed in BCA but not given monetary value	Not Quantified	Not Monetized
Increased property values from water quality improvements	Discussed in BCA but not given monetary value	Not Quantified	Not Monetized
Reduced impingement and entrainment mortality from reduced surface water withdrawals	Discussed in BCA but not given monetary value	Not Quantified	Not Monetized
Reduced deposition of toxic pollutants to sediment	Discussed in BCA but not given monetary value	Not Quantified	Not Monetized
Reduced adverse health effects from reduced exposure to pollutants from drinking water uses	Discussed in BCA but not given monetary value	Not Quantified	Not Monetized
Reduced water treatment costs for drinking water and irrigation water from improved quality of source water used for drinking and irrigation	Discussed in BCA but not given monetary value	Not Quantified	Not Monetized
Reduced adverse health effects from reduced exposure to pollutants from recreational water uses	Discussed in BCA but not given monetary value	Not Quantified	Not Monetized
Reduced bromide pollution in drinking water	Discussed in EPA documentation but not included in BCA	Not Quantified	Not Monetized
Attractive Nuisance: Reduced direct exposure to wildlife from surface impoundments	Discussed in EPA documentation but not included in BCA	Not Quantified	Not Monetized
Recycling coal combustion residuals	Discussed in EPA documentation but not included in BCA	Not Quantified	Not Monetized
Reduced air emissions from impoundments' parasitic load	Completely omitted benefits	Not Quantified	Not Monetized
Reduced air emissions from true dry handling of ash	Completely omitted benefits	Not Quantified	Not Monetized
Value of land used for impoundments for redevelopment	Completely omitted benefits	Not Quantified	Not Monetized
Avoided costs of BPJ determinations	Completely omitted benefits	Not Quantified	Not Monetized
Avoided costs of TMDLs	Completely omitted benefits	Not Quantified	Not Monetized
Reduced withdrawals and consumptive use of surface water	Completely omitted benefits	Not Quantified	Not Monetized
Avoided costs of litigation	Completely omitted benefits	Not Quantified	Not Monetized

Discussed in EPA's Benefit-Cost Analysis but not given a monetary value

EPA discusses many benefits to which it fails to assign a monetary value, stating that it could not find adequate information to appropriately quantify a dollar impact to society. The benefits discussed qualitatively in EPA's *Benefit-Cost Analysis* but omitted from the total monetary value of the steam electric ELGs include:

- Reduced adverse health effects due to less exposure to pollutants from recreational water uses
- Reduced deposition of arsenic, selenium, and other pollutants in sediment on stream and lake beds
- Improved fisheries yield and harvest quality due to aquatic habitat improvement for commercial fisheries
- Benefits to the tourism industry from increased participation in water-based recreation
- Increased property values from water quality improvements
- Fewer fish trapped and killed by water intake systems (i.e., reduced impingement and entrainment mortality)

There are also two benefits of the proposed ELGs that are mentioned in the *Benefit-Cost Analysis*, but for which EPA does not provide any qualitative assessment:

Reduced costs to processing drinking water: EPA includes reduced costs to treat drinking water as a benefit and mentions in a footnote that, "There may also be market benefits associated with the decreased need for drinking water treatment, but EPA did not estimate these benefits as part of its analysis of the proposed ELG."[56] Consequently, this benefit is not quantified or monetized.[57]

Reduced health effects from limiting exposure to pollutants in drinking water: EPA's *Benefit-Cost Analysis* omits the reduction in negative health effects caused by improved drinking water quality: "The analysis of human health benefits focuses on the fish consumption pathway only, since EPA assumed that drinking water is treated to reduce pollutant concentrations below [maximum contaminant levels]."[58] EPA acknowledges, however, that there are "documented exceedances of drinking water maximum contaminant levels (MCLs) downstream of steam electric power plants."[59] The benefits of reduced cancer exposure from pollutants other than arsenic are omitted because, according to EPA, "[a]mong steam electric pollutants analyzed in the [*Environmental Assessment*], arsenic is the only confirmed

[56] Benefit-Cost Analysis, p.2-5.

[57] Benefit-Cost Analysis, p.2-13.

[58] Benefit-Cost Analysis, p.3-1.

[59] Environmental Assessment, p. 3-1.

carcinogen with a published dose response function."[60] As such, any potential reduction in cancer rates from exposure to other carcinogens is omitted.

By default, EPA assigns these benefits a zero dollar value in the total monetized benefit of the regulatory options. These values of these omitted benefits are not reflected in the final number EPA uses to estimate the social value of the proposed ELG rules.

Discussed in EPA's other documentation but not included in the Benefit-Cost Analysis

Several other benefits are discussed in background documentation to the steam electric ELGs, but not in the *Benefit-Cost Analysis* itself. These benefits, too, are effectively valued at zero dollars in the total monetary benefits of the regulatory options.

Eliminated attractive nuisances: According to EPA's *Environmental Assessment* the proposed steam electric ELGs will reduce the exposure of wildlife to pollutants at surface impoundments and constructed wetlands:

> Documented case studies demonstrate that wildlife living near steam electric surface impoundments exhibit elevated levels of arsenic, cadmium, chromium, lead, mercury, selenium, strontium, and vanadium... Multiple studies have linked attractive nuisance areas at steam electric power plants to diminished reproductive success… EPA estimates that the pollutant loadings associated with the preferred options will decrease the exposure of wildlife populations to toxic pollutants and reduce the threat combustion residuals surface impoundments pose to surrounding wildlife.[61]

While EPA makes note of this important benefit of the proposed ELGs and cites several published reports to support their claims, this benefit does not appear in the *Benefit-Cost Analysis*.

Reduction of bromide pollution: Regulatory Option 5 (discussed in detail in Section 5 below) includes the only control technology in the proposed steam electric ELGs that would address pollutants from FGD wastewater that are particularly dangerous in drinking water: boron, bromides, and total dissolved solids. EPA explains that:

> [B]romide in wastewater discharges from steam electric power plants located upstream from a drinking water intake has been associated with the formation of trihalomethanes, also known as THMs, when it is exposed to disinfectant processes in water treatment plants. Bromate, a disinfection byproduct (DBP) associated with drinking water treatment plants that employ ozonation may also increase under the

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[60] Benefit-Cost Analysis, p.3-2.

[61] Environmental Assessment, p. 6-48.

> influence of increased bromide in the source water. Human exposure to THMs and DBPs in chlorinated drinking water is associated with bladder cancer.[62]

EPA's *Benefit-Cost Analysis* does not discuss or monetize benefits of reduced bromide pollution in drinking water.

Additional recycling of coal combustion residuals: EPA does not discuss or monetize the benefits of the additional recycling of coal combustion residuals that would occur if FGD and other wet handling systems were converted to dry handling systems. Approximately 15 to 18 percent of coal combustion residuals stored in wet surface impoundment are recycled, as compared to 22 to 27 percent of these residuals when subjected to dry handling. If the wet-stored residuals from 2009 through 2011 had instead been recycling at the same rate as dry residuals, annual recycled materials would have increased by 1.6 million tons.[63] Using a dollars per ton value of $99—which includes social benefits and the cost of avoided disposal—the annual benefit of this additional recycling would be $154 million.[64]

Not discussed by EPA

Finally, there is no discussion whatsoever of several benefits of the steam electric ELGs.

Value of land for impoundments for redevelopment: The reduction in wastewater storage should result in less land used to build new impoundments, and more land available for redevelopment. This land has a value, either to the power plant itself for multiple potential purposes, or for sale to another prospective user. EPA neither discusses nor monetizes this benefit.

Reduced air emissions from impoundments' parasitic load: EPA's calculation of reduced air emissions appears to omit several sources of reductions. Surface impoundments require electricity to operate (a type of so-called "parasitic load"). Fewer impoundments would result in air emission benefits from reduced parasitic load. These reduced air emissions are neither discussed nor monetized by EPA.

Reduced air emissions from true dry handling of ash: Similarly, the costs the EPA associates with bottom-ash handling are not based on true dry handling (as called for by the proposed ELGs), but rather on wet handling with zero discharge.[65] True dry handling would greatly improve total unit efficiency and thereby producing more energy with less air emissions. These benefits are neither discussed nor monetized by EPA.

Avoided costs of BPJ determinations: Options 3a and 3b (for plants with less than 2,000 MW wet-scrubbed capacity) would leave effluent limitations for FGD wastewater to be set on a case-by-case basis

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[62] 78 Fed. Reg. at 34,477.

[63] Troy Sanders, Environmental Integrity Project, "Coal Combustion Waste Recycling Analysis," September 17, 2013.

[64] See Frank Ackerman and Elizabeth A. Stanton comments on Docket ID EPA-HQ-RCRA-2009-6040 on behalf of Earthjustice.

[65] Incremental Costs and Pollutant Removals at 8-1.

by permitting authorities.[66] This is not only inconsistent with EPA's mandate under the Clean Water Act to set effluent limitations, but it also creates additional costs for permitting authorities, permitees, and interested third parties to develop, implement, and sometimes litigate BAT limitations for individual plants instead of having those limitations established by a national rule. The other options proposed by EPA avoid those costs, but EPA did not describe, let alone attempt to quantify or monetize, these benefits.

Avoided costs of TMDLs: EPA estimates that 78 power plants discharge a pollutant into a water body that is listed under the Clean Water Act as "impaired" for that pollutant under Section 303(d) of the Clean Water Act.[67] Pursuant to that section of the Act, states are required to established total maximum daily loads ("TMDLs") in those waters for pollutants that are contributing to water quality impairments.[68] EPA last published a comprehensive study of the costs of developing and implementing TMDLs in 2001.[69] According to that study, the average TMDL costs $52,000 in administrative costs to develop,[70] and the study estimates that, nationwide, a total of 36,000 TMDLs are needed that will cost between $900 million and $3.2 billion per year to implement.[71] With respect to the 78 power plants governed by the ELG rule that are contributing to water quality impairments, EPA found that both Options 4 and 5 would eliminate close to 100% of the pollution that those plants are contributing to those impairments, whereas other options proposed in the rule would reduce that pollution by lesser amounts.[72] Thus, the ELG rule would produce benefits by avoiding some or all of the costs of the TMDLs needed for the impaired water bodies into which those 78 power plants discharge. These benefits were neither discussed nor monetized by EPA.

Reduced surface water withdrawals and consumptive use: EPA calculated that power plants would reduce water use by 153 billion gallons per year, or about 419 million gallons per day, under Options 4 and 5, due to reductions in water use for ash transport and recycling of FGD wastewater.[73] Although power plant withdrawals of cooling water are substantially greater than this amount, the amount of process water that can be saved by these effluent guidelines is about as much water as is used by all the homes in South Carolina,[74] and thus a significant amount of water to save with any single regulatory measure. The water savings resulting from the rule will be especially helpful for those states facing

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[66] 78 Fed. Reg. at 34,458, Table VIII-1.

[67] Environmental Assessment at 6-36 to 6-37.

[68] 33 U.S.C. § 1313(d)(1)(C).

[69] EPA, Office of Water, "The National Costs of the Total Maximum Daily Load Program (Draft Report)" (2001), available at http://nepis.epa.gov/Exe/ZyNET.exe/901K0800.TXT.

[70] Id. at 18.

[71] Id. at i-ii.

[72] Environmental Assessment at 6-37.

[73] TDD at 12-13 to 12-14.

[74] Kenny, J.F., Barber, N.L., Hutson, S.S., Linsey, K.S., Lovelace, J.K., and Maupin, M.A., 2009, Estimated use of water in the United States in 2005: U.S. Geological Survey Circular 1344.

deepening water-scarcity challenges caused by climate change. Yet EPA did not describe any of these benefits of the rule, let alone attempt to quantify or monetize them.

Avoided costs of litigation: EPA also failed to quantify and monetize benefits from avoided litigation and related costs associated with illegal discharges, and ground and surface water pollution. Litigation costs can be substantial. There has been a wave of recent lawsuits filed against utilities for ground and surface water pollution in recent years, many of which have or will impose damages, penalties, monitoring and reporting requirements, corrective action to clean up ground and/or surface waters, installation of liner and leachate collection systems, replacement of drinking water, and/or closure.

Benefits assigned monetary values by EPA

EPA enumerates 23 benefits from water pollution reductions due to the proposed steam electric ELGs, fifteen of which are monetized (see Table 7 below). Of these, thirteen benefits have been—by EPA's own account—underestimated in the total monetary benefits of the regulatory options; just one is overestimated. The dollar values attributed to each benefit are summed to the total monetized value of each option (see Table 8 for a summary by each benefit category). EPA provides a summary description of its benefits in Table 2-1 of the *Benefit-Cost Analysis*.[75]

Under Option 4, 49 percent of all monetized benefits (including air-related benefits) are derived from reduced impoundment failures, 28 percent from reduced air pollution, and 19 percent from improved ecological conditions. The remaining benefits—human health, groundwater quality, and reduced water withdrawals—are assigned just 4 percent of the total monetized benefits of the proposed ELGs. EPA calculated the benefit of reduced air pollution due to the proposed steam electric ELGs only for Options 3 and 4, and, from this, imputed this benefit for Options 3a, 3b, and 4a.

Here we review the benefits for the proposed steam electric ELGs that EPA identifies as underestimates.

[75] Benefit-Cost Analysis, p.2-13.

Table 7. Proposed steam electric ELG benefits (as discussed in EPA *Benefit-Cost Analysis*)

Benefit	Inclusion	Quantification	Monetization
Reduced incidence of cancer from reduced exposure to arsenic from fish consumption	Included	Quantified (Low)	Monetized (Low)
Reduced IQ losses to infants from reduced in-utero mercury exposure from maternal fish consumption	Included	Quantified (Low)	Monetized (Low)
Reduced IQ losses to children ages 0 to 7 from reduced childhood exposure to lead from fish consumption	Included	Quantified (Low)	Monetized (Low)
Reduced need for specialized education from reduced childhood exposure to lead from fish consumption	Included	Quantified (Low)	Monetized (Low)
Reduced mortality from exposure to NOx, SO_2 and particulate matter (PM2.5)	Included	Quantified (Low)	Monetized (Low)
Improved aquatic and wildlife habitat from improved ambient water quality in receiving reaches	Included	Quantified (Low)	Monetized (Low)
Enhanced swimming, fishing, boating, and near-water activities from improved water quality	Included	Quantified (Low)	Monetized (Low)
Increased aesthetics from improved water clarity, color, odor, including nearby site amenities (residing, working, traveling)	Included	Quantified (Low)	Monetized (Low)
Enhanced existence, option, and bequest values from improved ecosystem health.	Included	Quantified (Low)	Monetized (Low)
Reduced risks to aquatic life from exposure to steam electric pollutants	Included	Quantified (Low)	Monetized (Low)
Improved T&E habitat and thus potential increase in T&E population	Included	Quantified (Low)	Monetized (Low)
Reduced air emissions of CO_2 resulting in avoided climate change /global warming impacts	Included	Quantified (Low)	Monetized (Low)
Increased availability of groundwater resources from reduced groundwater withdrawals	Included	Quantified (Low)	Monetization (Uncertain)
Reduced groundwater contamination	Included	Quantified (Low)	Monetized (High)
Reduced risk of impoundment failures due to changes in the use of impoundments	Included	Quantified (Low)	Monetization (Uncertain)

Source: Benefit-Cost Analysis, pp.2-12 and 2-13, Table 2-1; authors' analysis

Table 8. Annualized monetized benefits of steam electric ELGs (millions of 2010$)

Monitized Value of Benefits in Million 2010$, all Values at Mean Benefit Estimates and 3 Percent Discount Rate					
Benefit Category	Option 1	Option 2	Option 3	Option 4	Option 5
Reduced Impoundment Failures	$62.1	$62.1	$114.8	$295.1	$295.1
Reduced Air Pollution	omitted	omitted	$127.6	$170.5	omitted
Improved Ecological Conditions and Recreational Uses	$15.3	$45.0	$59.9	$116.1	$115.2
Human Health Benefits	$3.9	$4.0	$7.7	$17.2	$17.2
Groundwater Quality Benefits	$0.7	$0.7	$1.6	$6.5	$6.5
Reduced Water Withdrawals	$0.0	$0.0	<0.1	$0.1	$0.1
Total benefits, Excluding Air-Related Benefits	**$82.0**	**$111.7**	**$184.1**	**$435.0**	**$434.1**
Total Benefits (Including Air-related Benefits)	**n/a**	**n/a**	**$311.7**	**$605.5**	**n/a**

Note: All values at mean benefit estimates and 3-percent discount rate

Source: 78 Fed. Reg. at 34,518, Table XIV-8

Reduced risk of impoundment failures due to changes in the use of impoundments: Benefits to the proposed steam electric ELGs are dominated by the benefit for reduced impoundment failures—this single benefit accounts for nearly half of the value of benefits monetized for Option 4. EPA's estimate of the value of avoided failures is based on a national average probability of impoundment failures (a 0.58 percent chance of failure in each year) applied to all impoundments. EPA also presents, but does not include in its final valuation, an alternative methodology that takes account of specific differences in impoundment characteristics. (The *Benefit-Cost Analysis* notes that, "because of the limited data available to develop and validate the statistical model, EPA did not use the model in the primary benefit estimates presented in this chapter but instead relied on historical failure rates."[76]) This method raises the benefit of avoided impoundment failures by a factor of 2.7 to 3.2 depending on the regulatory option, such that for Options 4 and 5 this benefit rises from $295 million to $918 million.[77] Using this alternative method, total Option 4 benefits rise to $1,228 million, and EPA's benefit-cost ratio for this Option rises from 0.44 to 0.89.

EPA's method also fails to account for two other important, closely related categories of benefits associated with the rule. First, EPA expressly notes in the *Benefit-Cost Analysis* that its analysis "does not account for the effect of best management practices (BMPs)—including integrity inspections and preventive maintenance—that would help reduce the probability of impoundment failures."[78] Second, EPA's method does not account for the costs of any litigation that may occur around the cleanup of an impoundment failure that would be avoided as a result of the rule. EPA does not attempt to quantify, let alone monetize, either of these two categories of benefits, both of which would also result from the rule's reduction in impoundment failures.

Reduced mortality from exposure to NO_x, SO_2 and particulate matter and reduced CO_2 emissions resulting in avoided climate change impacts: EPA also underestimates the benefits associated with reduced mortality from exposure to NO_x, SO_2 and particulate matter (PM2.5) as well as from avoided climate-change-related impacts. EPA uses IPM modeling to determine air emissions reductions from the steam electric ELGs. The IPM analysis includes emission factors known to be highly variable and sometimes incomplete.[79] In addition, EPA assumes a linear relationship between CO_2 emissions and benefits, which may underestimate the value of large changes in emissions.[80] EPA also uses the 2010—now outdated—per ton estimates of the social cost of carbon. In the latest estimates released by the Interagency Working Group, the 2020 social cost of carbon at the 3-percent discount rate has risen from

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76 Benefit-Cost Analysis, p.7-2.

77 Benefit-Cost Analysis, Appendix G.

78 Id. at 7-2.

79 EPA Office of Inspector General Report No. 2006-P-00017, "EPA Can Improve Emissions Factors Development and Management." March 22, 2006. And EPA Office of Inspector General Report No. 13-P-0161, "EPA Needs to Improve Air Emissions Data for Oil and Natural Gas Production Sector." February 20, 2013.

80 Benefit-Cost Analysis, p.8-9, Table 8-9.

$27 to $45 (by 65 percent);[81] benefits of reduced CO_2 emissions due to the proposed ELGs would, therefore, be 65 percent higher.

EPA points to several other deficiencies in their air quality analysis: "This analysis does not include all of the human health benefits associated with air pollution reductions because the benefits per ton estimates that were used are based only on mortality, and not morbidity endpoints. Thus the quantified human health benefits included in this analysis represent only a subset of the total potential health benefits expected to result from the proposed ELGs."[82] Correction of these assumptions would increase the expected benefits from reduced air emissions associated with this rulemaking. Assuming that Option 5 would have, at a minimum, the same air-benefits as Option 4, raises the Option 5 benefits by 39 percent to $605 million. This single change raises the Option 5 benefit-cost ratio from 0.19 to 0.26.

Improved aquatic and wildlife habitat from improved ambient water quality in receiving reaches; enhanced swimming, fishing, boating, and near-water activities from improved water quality; increased aesthetics from improved water clarity, color, odor, including nearby site amenities (residing, working, traveling); enhanced existence, option, and bequest values from improved ecosystem health; reduced risks to aquatic life from exposure to steam electric pollutants; and improved threatened and endangered habitat and thus potential increase in threatened and endangered population: Several assumptions made by EPA regarding the value of water quality result in an underestimation of the value of improved ambient water quality in receiving reaches. The value of these benefits depends on how much water quality is expected to improve under each regulatory option. EPA notes that their measure of water quality accounts for metal and nutrient concentrations but does "not include improvements in water quality indicators associated with other pollutant loadings (e.g., BOD, dissolved oxygen), nor does it consider improvements in other water quality variables such as TSS. Omitting some water quality parameters from the analysis is likely to result in underestimation of the expected water quality changes."[83]

EPA's quantification of improved ecosystem health; reduced risks to aquatic life from exposure to steam electric pollutants; and improved threatened and endangered species habitat and thus potential increase in threatened and endangered population is based on a series of assumptions that ultimately result in an underestimation. First, EPA notes, "[t]he databases used to estimate benefits to [threatened and endangered] species exclude all species considered threatened or endangered by scientific organizations but not protected by the [Endangered Species Act]. The magnitude of the underestimate

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[81] 2010 Interagency Working Group 2020 social cost of carbon (in 2010$) is $28 (see Benefit-Cost Analysis, p.8-7, Table 8-6. 2013 Interagency Working Group 2020 social cost of carbon (in 2011$) is $46 (see http://www.epa.gov/climatechange/EPAactivities/economics/scc.html); converted to 2010$ using the CPI-U (see ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt).

[82] Benefit-Cost Analysis, p.8-9, Table 8-9.

[83] Benefit-Cost Analysis, p.4-20, Table 4-14.

is likely to be significant."[84] Moreover, "EPA excluded all species with low and moderate vulnerability potentials based upon life history traits. For all species with high potential vulnerability, EPA conducted further analyses to identify those species likely to be affected by the proposed ELGs, rather than all species whose life histories make them vulnerable."[85] EPA further reduces the pool of threatened and endangered species included in its benefits calculations. EPA's meta-regression analysis includes only benefits of threatened and endangered freshwater fish; other types of animals are either valued at zero dollars or excluded from any mention.[86] EPA illustrates the scale of the impact of its incomplete analysis using the example of one species of insect, the Hine's Emerald Dragonfly:

> It is likely that population increases in [the Hine's Emerald Dragonfly] have value to the public. In addition to bequest, altruistic, and existence values, dragonflies may have aesthetic or cultural values. Dragonflies also provide beneficial ecological services. They are voracious insectivores that prey on mosquitoes, flies, and other small insects. The estimated annual benefits of pest control attributable to insects are $4.5 billion in the United States…[87]

While the EPA is able to estimate a monetary value for the benefits of endangered species, they do so by limiting their analysis to a sub-set of the affected species. Some of these species have an obvious value to the public, including the Hine's Emerald Dragonfly, which contributes to the $4.5 billion of annual benefits associated with pest control in the United States. EPA's methodology omits this value.

Reduced incidence of cancer due to less exposure to arsenic from fish consumption; reduced IQ losses to infants due to less in-utero mercury exposure from maternal fish consumption; reduced IQ losses to children ages 0 to 7 due to less childhood exposure to lead from fish consumption; reduced need for specialized education due to less childhood exposure to lead from fish consumption; and reduced other adverse health effects (cancer and non-cancer) due to less exposure to other pollutants (arsenic, lead, etc.) from fish consumption: The proposed ELGs are expected to reduce the number incidences of cancer from consumption of fish containing arsenic. EPA first determines how many fewer people will be exposed to arsenic, and from this values the benefits of reduced cancers. EPA fails, however, to value risks to recreational anglers and subsistence fishers downstream of receiving reaches: "By omitting downstream effects, this analysis potentially understates baseline risks that could be reduced by the proposed ELGs, and therefore underestimates the benefits."[88] A cancer slope factor—taken from toxicology studies—is then applied this underestimated exposure rate. A cancer slope factor is the number of cases of cancer expected based on a population's exposure to a given carcinogen.

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[84] Benefit-Cost Analysis, p.5-11 Table 5-7.

[85] Benefit-Cost Analysis, p.5-11, Table 5-7.

[86] Benefit-Cost Analysis, p.5-6, Table 5-4.

[87] Benefit-Cost Analysis, p.5-11, Table 5-7.

[88] Benefit-Cost Analysis, p.3-17, Table 3-9.

EPA uses an arsenic cancer slope factor that is significantly smaller than the value that it has proposed as an updated arsenic cancer slope factor. As the benefit-cost analysis for the proposed steam electric ELGs explains, "EPA is currently revising its cancer assessment of arsenic to reflect new data on internal cancers. It is possible that the revised combined (lung and bladder cancer) [cancer slope factor] would be higher (draft value is 25.7 per mg/kg_{BW}/day), suggesting that the use of the current [1.5 cases per mg/kg_{BW}/day] value may result in an underestimate of benefits."[89] Inclusion of downstream reaches and more up-to-date cancer parameters would dramatically increase the expected reduction in cancer cases from lower exposure to arsenic from fish consumption, and would increase the total monetized benefit of the regulatory options. The new, draft, value for the cancer slop factor is over 17 times higher than the slope factor currently used by EPA. Had EPA used the updated value (albeit a draft value) they would have calculated 17 avoided cancer cases for every one cancer case currently reported as avoided. That multiplier would carry over through the rest of EPA's calculation and would result in value of reduced cancer cases 17 times higher than the currently reported value.

For mercury- and lead-related benefits, EPA used IQ losses as the measured effect, or "endpoint," for quantifying adverse resulting from childhood or in-utero exposure to these toxins. EPA points out that:

> IQ may not be the most sensitive endpoint. Additionally, there are deficits in cognitive abilities that are not reflected in IQ scores, including acquisition and retention of information presented verbally and many motor skills. To the extent that these impacts create disadvantages for children exposed to mercury at current exposure levels or result in the absence of (or independent from) measurable IQ losses, this analysis may underestimate the benefits of the proposed ELG of reduced lead and mercury exposure.[90]

EPA's assumptions result in an undervaluation of the benefits associated with (1) reduced IQ losses to infants from reduced in-utero mercury exposure from maternal fish consumption, (2) reduced IQ losses to children ages 0 to 7 from reduced childhood exposure to lead from fish consumption, and (3) reduced need for specialized education from reduced childhood exposure to lead from fish consumption. Using a more holistic method, beyond IQ point loss, would result in an increase in benefits associated with childhood development. (Below we discuss additional concerns with EPA's methodology for monetizing IQ losses avoided by the proposed ELGs.)

Methodological and ethical issues with monetizing benefits

Of sixteen benefits quantified by EPA, fifteen are assigned monetary values and included in the total monetized benefits of the regulatory options. While the benefit from "reduced other adverse health

[89] Benefit-Cost Analysis, p.3-17, Table 3-9. Mg/kg_{BW}/day is milligrams of toxin per kilogram of body weight per day exposed. This means that 1.5 cases of cancer are observed for every milligram of arsenic per kilogram of body weight per day exposed.

[90] Benefit-Cost Analysis, p.3-17, Table 3-9.

effects (cancer and non-cancer) from reduced exposure to other pollutants (arsenic, lead, etc.) via fish consumption" is quantified (albeit a low estimation), EPA was unable to complete the monetization step; as a result, this benefit is effectively assigned a zero dollar value in the total monetized benefit of the regulatory options.

It is important to note that for all of the benefits, the monetization step extends any underestimation from the quantification step. As a result, a low estimation during quantification results in an undervaluation of the final monetized benefit even when the monetization method is based on the most accurate assumptions and techniques possible.

In the monetization of the benefits from the proposed ELGs EPA employs several controversial valuation techniques, discussed below: restricting willingness-to-pay to local impacts; the use of diverging state income in valuing a statistical life; and including lower educational expenses as a value to society. Variations on these tools are commonly used in EPA benefit-cost analyses, but are subject to well-known critiques for undervaluing ecosystems, and human health and well-being.[91]

Willingness to pay for improved water quality

EPA uses a willingness-to-pay methodology to monetize the value that society places on water quality, other than for its direct use: for example, the value of the existence of good water quality (even if the water is not used by society); the value of having the option to use that clean water in the future; and the value of being able to pass clean water down to future generations. EPA's non-use value for improved water quality is derived from "willingness-to-pay" surveys that ask respondents to assign a value to a social or environmental good.

EPA concludes that their attempt to determine society's willingness-to-pay for improved water quality in the proposed steam electric ELGs is likely an underestimation and that "[t]he estimation of [willingness-to-pay] may be sensitive to differences in the environmental water quality measures across studies in the meta data."[92]

Once determined from survey results, individual willingness to pay is extrapolated to the affected population. EPA assumes that households will only value improvements of nearby water bodies, further underestimating the value of increased water quality. "Residents of other states may hold values for water resources outside of their home state, in particular if such resources have personal, regional, or national significance. Even if per household [willingness-to-pay] for out-of-state residents are small they can be very large in the aggregate if these values are held by a substantial fraction of the population."[93] Correcting these assumptions would increase the water quality benefits from the proposed ELGs.

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[91] Ackerman, F and L Heinzerling, *Priceless: On Knowing the Price of Everything and the Value of Nothing* (New York: New Press, 2004).

92 Benefit-Cost Analysis, p.4-19, Table 4-14.

93 Benefit-Cost Analysis, p.4-19, Table 4-14.

Use of (diverging state) income in valuing human life

In one section of the proposed steam electric ELGs benefits analysis, EPA suggests, with little explanation, the ethically troubling and politically controversial notion that the lives of richer people are worth more than the lives of their fellow citizens with lower incomes. This judgment is never stated explicitly, but is implied by the following technical paragraph from the benefit-cost analysis (sentences in the quoted paragraph are separated here to facilitate discussion):

> The value of cancer risk reduction is a "normal good," and thus is expected to grow over time as real income grows.
>
> EPA used historic state-specific median household income data … for the years 1984 to 2009, and applied a stepwise autoregressive forecasting method to estimate future annual state level median household income through 2040.
>
> For each year in the analysis, EPA adjusted the VSL to account for income growth projections and the mid-range income elasticity assumptions...[94]

VSL is an abbreviation for "value of a statistical life," a standard monetization of the benefits of avoided premature deaths; it is the basis for the valuation of cancer risk reduction in the proposed steam electric ELGs. A "normal good," in economics, is one for which the demand grows as income rises. Thus the first quoted sentence asserts that the value of lives saved by cancer risk reduction is expected to grow as the income of the general population grows.

Earlier on the same page, EPA notes that the current default VSL is $8.0 million (in 2010 dollars) per life saved; that value is typically applied to people throughout the country, independent of income.[95] In order to apply it to future cancer risk reduction, however, EPA felt it necessary to calculate state median incomes; the second sentence quoted above describes a statistical procedure EPA used to forecast state median incomes through 2040.

It is unclear, from the limited explanation provided by EPA in the documentation to the proposed steam electric ELGs, which of two procedures was then followed. On the one hand, EPA could merely be engaging in an unusually complex method of projecting the national average growth of incomes, and hence the growth of the national VSL; indeed, through personal correspondence with EPA and its consultants, we were assured that this first explanation accurately describes the use of median income in the proposed steam electric ELGs.[96] On the other hand, EPA's methodology as described in the

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94 Benefit-Cost Analysis, p.3-5

95 See http://yosemite.epa.gov/ee/epa/eed.nsf/pages/MortalityRiskValuation.html#whatisvsl for a discussion of the history and original of the "value of a statistical life" measure.

96 Abt Associates, Memorandum to the Steam Electric ELG Record, "Responses to Questions regarding EPA's Analysis of Benefits of the Proposed Steam Electric ELGs, received from Liz Stanton on August 13, 2013," August 26, 2013. Apt explains that state income was used only to predict an average national income. In this memo, Abt compares the elasticity-adjusted income growth factor based on state average income, as used in the proposed steam electric ELGs, and the same factor based on national income. The gap between these two factors grows over time. The former is 1.04 in 2024, while the latter is 1.12. Abt

Benefit-Cost Analysis could easily be interpreted as projecting state-specific values of the VSL, based on future interstate differences in income. Under the former interpretation, there are no new problems raised here, other than the use of a nonstandard and needlessly circuitous method of forecasting the growth of national average incomes. Under the latter interpretation, however, EPA would be breaking new ground in a disturbing direction.

The third sentence quoted above could be read—and introduced as precedent into future rulemakings—as saying that EPA adjusted the VSL for future years based on state income growth. While presumably starting at a single national value for the recent past, the value of life would then diverge along with state income growth rates in the future. The "mid-range income elasticity assumptions," referred to at the end of the quote, determine the pace at which the value of life changes with income. EPA's assumption of an elasticity of 0.4 (in footnote 27, on the same page of the benefits analysis) means that every 1 percent increase in income is associated with a 0.4 percent increase in the value of human life.

In the absence of EPA's (unpublished) state median income projections, it would not be possible to determine exactly how unequal the projected values of lives would become by 2040. From 1984 to 2009, the average annual growth in real median household income ranged from 1.1 percent in the District of Columbia to -0.3 percent in Kansas.[97] If these growth rates continued for another 30 years, from 2010 through 2040, and EPA's elasticity assumption applied to income growth by state, then by 2040, a human life would be worth 18 percent more in DC than in Kansas.[98] In short, this unconventional method would assign higher values to some future human lives than to others. It appears that this usage is not intended by EPA, but the ambiguous language in the *Benefit-Cost Analysis* nonetheless opens the door to future uses of differentiated incomes in VSL calculations.

The application of income elasticity to VSL estimation is unorthodox and, if its use took place in a less obscure EPA publication, would almost certainly be controversial. In addition, this departure from the EPA's more traditional monetization procedures raises a question regarding the use of income-dependent VSLs in other analyses: If the "income elasticity assumption" is applicable to the future growth of income, does it apply to base-year differences in income as well? There is no obvious logical difference between past and future income inequality, when it comes to valuing human lives. In 2011 the richest state, Maryland, had median household income 1.9 times as large as the poorest state,

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does not present a national-income-based factor for 2025 through 2040, but does indicate that an linear extrapolation would be used for years after 2024. Using this methodology, the state-based factor would be 1.09 in 2040, while the national-based factor would be 1.26.

97 From U.S. Census Bureau, Current Population Survey, Annual Social and Economic Supplements, "Table H-8 Median Household Income by State: 1984 to 2011", http://www.census.gov/hhes/www/income/data/statemedian/

98 Under these assumptions, median income would grow by a ratio of $(1.011)^{30}$ in DC, and $(0.997)^{30}$ in Kansas; the VSL would grow by $[(1.011)^{30}]^{0.4}$ and $[(0.997)^{30}]^{0.4}$, respectively. The ratio of these VSL values is 1.18.

Mississippi.[99] Under EPA's assumption that avoiding death from carcinogenic pollutants is a "normal good" whose value is higher at higher income levels, one could argue that life is worth 30 percent more today in Maryland than in Mississippi.[100]

This approach to benefit-cost analysis, extended more broadly, could lend support to numerous morally repugnant conclusions: It would, for example, reliably demonstrate the greater monetized benefit of protecting human health in richer communities, seemingly providing "objective" economic grounds for concentrating hazardous facilities in poor neighborhoods. Valuing human lives based on their income is at variance with a legal system premised on equal protection for all and clashes with widely held ethical, philosophical, and religious beliefs that assign an equal worth to every human being.

As noted above, it seems that EPA did not intend to introduce state-specific VSL calculations. For the reasons explained here, we hope that the ambiguity in EPA methodological description is resolved and EPA's position on using different VSLs for different populations made clear.

Valuing children's IQ loss: Is lower educational expenditure a benefit of pollution?

To monetize reductions in childhood ingestion of lead, EPA estimates the economic losses that result from lower IQs, a well-documented consequence of lead exposure.[101] The principal economic effect of a lower IQ is a reduction in the present value of lifetime earnings (since, on average, people with higher IQs have higher incomes). Depending primarily on the chosen discount rate, EPA estimates that incomes are $2,429 to $14,631 lower for each lost IQ point.

EPA then reduces this income loss to take account of an offsetting factor: Students with lower IQs spend fewer years in school, reducing society's educational costs. This calculation is troubling in at least three respects: It raises philosophical questions about the treatment of reduced education as a benefit; it miscalculates the true marginal cost of reduced education; and it entirely omits discounting of these changes in costs, which often occur more than a decade after exposure.

If lead poisoning results in children leaving school at a younger age, is the reduced cost of education a benefit to society, or a measure of what has been lost through environmental harm to the next generation? EPA's numerical tally of reduced school costs opts for the former answer: the less schooling, the more society saves. This is numerically accurate in a short-run, tunnel vision of the bottom line, but substantively absurd in a broader, long-run view of social value, responsibility to the nation's children, and the human and economic benefits of education. Viewing these lost years of education instead as a loss to society would increase the monetized benefits of the lead poisoning avoided by implementing more stringent ELGs.

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99 Calculated from U.S. Census Bureau, 2011 American Community Survey, Table S1903, "Median Income in the Past 12 Months," http://factfinder2.census.gov/

100 Because $(1.90)^{0.4} = 1.293$.

101 Benefit-Cost Analysis, p.3-6 to 3-11

Setting aside such broad framing questions, EPA uncritically adopts a simple estimate of cost savings due to slightly reduced years of schooling. The cost used by EPA, $9,724 (in 2010 dollars) per pupil-year of school, comes from a document that calculates the average cost of K-12 education.[102] Elementary and secondary education systems, however, have substantial fixed costs in facilities and tenured faculty and staff; thus the marginal cost of a small change in the number of pupils is likely to be much smaller than the average cost. It is, of course, only the marginal cost that is avoidable by a small change in the number of pupils, and the lead-induced change in numbers at any one school system will be quite small. Again, using the small marginal cost of reduced education costs instead of the inflated average cost would increase the monetized benefits of ELGs.

Moreover, a significant fraction of children will go on to post-secondary education, which is frequently financed as an investment by the student or the student's family. A lead-related reduction in the years of post-secondary education—assuming the same calculation remains applicable at this level—has different consequences and cost implications than a reduction in public K-12 education. Reduced investment in a student's future, by the student or family, is again a sad indicator of what has been lost; it is not in any sense a social benefit.

Finally, EPA neglects to discount the estimated "savings" from reduced education expenditure, but simply subtracts the current estimate of savings from the present value of lost earnings. If children are impaired by lead exposure in early childhood, while the slight resulting reduction in years of schooling occurs in high school, then the "savings" occurs many years after the exposure. Suppose, for example, that the reduced school attendance occurs 12 years after lead exposure; standard practice in EPA cost calculations would then call for discounting the "savings" over 12 years, to calculate its present value. At a 3 percent discount rate, the present value is 70 percent of the reported value; at a 7 percent discount rate, the present value is 44 percent of the reported value. Using this approach to discounting—a well-established practice in EPA analyses, used in other aspects of the ELG analysis—would lower the value of these lost years of education and raise the monetized benefits of the proposed steam electric ELGs.

EPA reports that the (undiscounted) savings for avoided cost of education is $979 in one study, and $1,274 in another, and then subtracts these from the present value of earnings, ignoring the discount rate.[103] In fact, assuming that those savings were correctly calculated but occur 12 years after exposure, EPA should have used present values of $685 at 3 percent or $431 at 7 percent for the first study, and $892 at 3 percent or $561 at 7 percent for the second study. In quantitative terms, this would cause a large percentage increase in the overall valuation of lead exposure at a 7 percent discount rate and a smaller increase at the 3 percent rate.

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[102] Chambers, J.G., T.B. Parrish, and J.J. Harr, "What Are We Spending on Special Education Services in the United States, 1999-2000?" (Special Education Expenditure Project, report to U.S. Department of Education, 2004, http://www.csef-air.org/publications/seep/national/advrpt1.pdf).

[103] Benefit-Cost Analysis, p.3-9

5. Options 4 and 5 Were Eliminated Inappropriately

The Clean Water Act establishes a simple, clear standard for the choice of pollution control technologies to be enforced by EPA: For each industry, the most stringent, but still technologically achievable, control measures are identified. These are the measures to be enforced, unless there is evidence that a particular technology will place a prohibitive burden on the industry as a whole. In the proposed steam-electric ELGs, this standard has been ignored. Control technologies were identified, sorted into eight regulatory options, and ordered in terms of their relative impact on controlling the discharge of pollutants. Regrettably, the two most stringent of these options were then eliminated from further consideration—that is, not designated as "preferred"—without EPA presenting evidence demonstrating that they were either technologically or economically unachievable.

EPA's eight regulatory options for its effluent limitations guidelines and standards for steam electric power generators are shown above in Table 2.[104] Options 1, 2, 3, 4, and 5 were introduced in EPA's original proposal;[105] Options 3a, 3b, and 4a were introduced by the Office of Management and Budget (OMB) in its review of the proposal.[106] Options described in bold text below are those designated by OMB as preferred, and, therefore, presented in more detail in the Federal Register (see also Table 2 above).

Option 1 differs from current EPA regulations by requiring chemical precipitation for FGD wastewater, but it would allow status quo practices (such as use of unlined impoundments) to continue for fly ash and bottom ash transport water. As with all eight proposed versions of the regulation, Option 1 also requires vapor-compression evaporation for gasification wastewater and chemical precipitation for nonchemical metal cleaning wastewater.

Option 2 is identical to Option 1, with a single exception: Option 2 requires biological treatment, in addition to chemical precipitation, for FGD wastewater.

Option 3 adds zero-discharge dry handling for fly ash transport water and flue gas mercury control wastewater to Option 2's chemical precipitation and biological treatment for FGD wastewater.

Option 3a (introduced by OMB) is a weakened version of Option 3: controls for FGD wastewater would be determined on a case by case basis by permitting authorities using "best professional judgment."

104 Benefit-Cost Analysis, p.3-9

105 U.S. Environmental Protection Agency, *Proposed Rule: Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category*, as submitted to the Office of Budget and Management in accordance with Executive Order 12866

106 Office of Budget and Management, *Revisions to: Proposed Rule: Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category*

Option 3b (introduced by OMB) is an alternative weakening of Option 3: for FGD wastewater, the requirement of chemical precipitation is consistent with Option 3, but biological treatment is required only for plants with capacity equal to or greater than 2,000 MW; biological treatment at smaller plants would be determined on a case by case basis by permitting authorities using "best professional judgment."

Option 4 improves on Option 3's chemical precipitation and biological treatment for FGD wastewater, and zero-discharge dry handling for fly ash transport water and flue gas mercury control wastewater with two additions: zero-discharge dry handling for bottom ash transport water and chemical precipitation of coal combustion residual leachate.

Option 4a (introduced by OMB) is a weakened version of Option 4: surface impoundments are permitted for bottom ash transport water at plants with capacity equal to or less than 400 MW, and the removal of suspended solids is permitted for combustion residual leachate.

Option 5 strengthens Option 4's control requirements by replacing biological treatment of FGD wastewater with vapor-compression evaporation systems.

5.1. The BAT standard for the Clean Water Act

To control the direct discharge of effluents into U.S. surface waters, the Clean Water Act requires use of the Best Available Technology Economically Achievable (BAT):

> [E]ffluent limitations for categories and classes of point sources, other than publicly owned treatment works…shall require application of the best available technology economically achievable for such category or class, which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants… [S]uch effluent limitations shall require the elimination of discharges of all pollutants if the Administrator finds, on the basis of information available…that such elimination is technologically and economically achievable for category or class of point sources as determined in accordance with regulations issued by the Administrator…[107]

The critical elements of the BAT standard, then, are: (1) the best possible effort at eliminating the discharge of pollutants into surface waters given, (2) technological achievability, and (3) economic achievability.

Achieving BAT

In supporting documents to the proposed steam electric ELGs, EPA explains that it:

> …determines economic achievability based on the effect of the cost of compliance with BAT limitations on overall industry and subcategory financial conditions. BAT may reflect

[107] 33 U.S.C. 1311(b)(2)(A)

> the highest performance in the industry and may reflect a higher level of performance than is currently being achieved based on technology transferred from a different subcategory or category, bench scale or pilot plant studies, or foreign plants…BAT may be based upon process changes or internal controls, even when these technologies are not common industry practice.[108]

Achieving BAT for Clean Water Act compliance clearly requires that:

- At a minimum, limitations must be based on the control technologies used at "the single best-performing plant in an industrial field",[109] and may even call for limitations based on more effective technologies used in other industries or other countries.
- A superior control technology must be rejected only when it can be demonstrated to have a cost of compliance that cannot be "reasonably borne by the industry."[110] To be clear, this restriction is based on the determination that costs are prohibitive "on a class or category basis, rather than on a plant-by-plant basis."[111]

Elimination from consideration for BAT may not be made based on the burden that a control technology places on individual plants, nor may it be made based on the requirement that easily quantified costs be outweighed by far more difficult to substantiate economic benefits.

Subcategorization of the steam electric industry

EPA may consider other "statutory factors" in determining whether or not a control technology is technologically and economically achievable:

> Factors relating to the assessment of best available technology shall take into account the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, the cost of achieving such effluent reduction, non-water quality environmental impact (including energy requirements), and such other factors as the Administrator deems appropriate;[112]

An ERG memorandum analyzes the applicability of these factors to the proposed steam electric ELGs, explaining that: "One way EPA may take these factors into account is by dividing a point source category into groupings called 'subcategories.' Regulating a category by subcategory, where warranted, ensures

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[108] Technical Development Document, pp.1-3 to 1-4

[109] *Chem. Mfrs. Ass'n v. EPA*, 870 F.2d 177, 226 (5th Cir. 1989). See also, *Kennecott v. U.S. EPA*, 780 F.2d 445, 448 (4th Cir. 1985): "In setting BAT, EPA uses not the average plant, but the optimally operating plant, the pilot plant which acts as a beacon to show what is possible."

[110] Waterkeeper Alliance v. U.S. EPA, 399 F.3d 486, 516 (2nd Cir. 2005); see also Rybachek v. U.S. EPA, 904 F.2d 1276, 1290-91 (9th Cir. 1990).

[111] Am. Iron & Steel Institute v. EPA, 526 F.2d at 1051.

[112] Clean Water Act section 304(b)(2)(B) and 33 U.S.C. 1314(b)(2)(B).

that each subcategory has a uniform set of effluent limitations that take into account technology availability and economic achievability and other relevant factors unique to that subcategory."[113] Based on ERG's analysis, EPA determined that: There was no basis for subcategorization of the steam electric industry by age of plant or generating unit, or geographic location; and that oil-fired generating units and generating units with capacities 50 MW and smaller warrant subcategorization.[114] EPA proposed to maintain effluent limits for oil-fired generating units and generating units with capacities 50 MW or smaller at existing ELG standards.[115] This subcategorization is supported by the underlying ERG memorandum.

Two additional subcategorizations were, however, introduced in OMB's review of the proposed steam electric ELGs that are not supported by the ERG memorandum. First, in its review, OMB introduced Option 4a—a watered-down version of EPA's proposed Option 4. While Option 4 requires dry handling of bottom ash transport water (for all plants other than oil-fired generating units and generating units with capacities 50 MW or smaller), Option 4a permits units with capacities of 400 MW or less to continue with the current practice of storing untreated bottom ash transport water in surface impoundments. We are not aware of any document in the 40 CFR Part 423 docket that supports subcategorization of plants 400 MW and smaller. The ERG memo only presents analysis related to potential subcategorization of plants with capacities equal to or smaller than 50 MW, 100 MW, 150 MW, and 200 MW.

In the Federal Register, EPA states that this 400 MW subcategorization is based on greater risk of retirement:

> [W]hile all plants, regardless of size, are capable of installing and operating dry handling or closed-loop systems for bottom ash transport water, and the costs would be affordable for most plants, EPA believes that companies may choose to shut down 400 MW and smaller units instead of making new investments to comply with proposed zero discharge bottom ash requirements. EPA is basing this belief on its review of units that facilities have announced will be retired or converted to non-coal based fuel sources. Of those units that plants have announced for retirement, and that also generate bottom ash transport water, over 90 percent are 400 MW or less.[116]

This risk analysis, however, is based on plants that have already announced their retirements and would therefore not incur costs under the final steam electric ELGs.[117] Plants already slated for retirement will

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[113] Elizabeth Sabol and Thomas Finseth, April 19, 2013, "Steam Electric Effluent Guidelines—Evaluation of Potential Subcategorization Approaches," ERG Memorandum to the steam Electric Rulemaking Record.

[114] 78 Fed. Reg. at 34,446-34,447.

[115] 78 Fed. Reg. at 34,469.

[116] 78 Fed. Reg. at 34,471-34,472.

[117] ERG, Memorandum to the Steam Electric Rulemaking Record, "Methodologies for Estimating Costs and Pollutant Removals for Steam Electric ELG Regulatory Option 4a," April 15, 2013.

not incur costs under these ELGs: It is difficult to fathom how perceived risks to such plants merit their subcategorization and special regulatory treatment.

A second unsupported subcategorization occurs in one of the weakened versions of Option 3 introduced by OMB. Option 3 requires chemical precipitation followed by biological treatment for FGD wastewater. OMB's Option 3a allows for FGD wastewater effluent limitations to be determined on a site-specific "best professional judgment" basis explaining only that:

> [T]here is a wide range of technologies currently in use for reducing pollutant discharges associated with FGD wastewater, and research continues in the development of additional technologies to treat FGD wastewater…The more advanced technologies (those that reduce the most pollutants) reflect recent innovations in the area of treatment of FGD wastewater. EPA expects this trend to continue and, therefore,…effluent limitations representing BAT for discharges of FGD wastewater would be determined on a site-specific [best professional judgment] basis.[118]

Option 3b introduces the unsupported subcategorization, requiring chemical precipitation followed by biological treatment for FGD wastewater only for steam electric plants with wet-scrubber capacity (that is, the capacity of all units at a plant using wet scrubbers) equal to or greater than 2,000 MW.[119] We are not aware of any document in the 40 CFR Part 423 docket that supports subcategorization of plants with equal to or greater than 2,000 MW wet-scrubber capacity.

Out of 401 U.S. coal plants in that year, 117 discharged FGD wastewater.[120] According to EIA and EPA data, only 5 percent of coal plants (representing 17 percent of total coal capacity) both have wet FGD scrubbers and have a capacity equal to or greater than 2,000 MW.[121] Option 3b would eliminate, without justification, at least 95 percent of coal plants with wet FGDs from the requirement to perform biological treatment on FGD wastewaters.

5.2. EPA's "preferred alternatives" for steam electric ELGs

Well-supported subcategorization of an industry is permitted. Aside from this subcategorization process, however, Congress' mandate to EPA in the Clean Water Act requires that pollution control technologies be eliminated from consideration for BAT only on grounds of:

4. ***Stringency:*** There are other more effective technologies for controlling the discharge of pollutants from a particular effluent stream.

[118] 78 Fed. Reg. at 34,460.

[119] 78 Fed. Reg. at 34,460.

[120] 78 Fed. Reg. at 34,451.

[121] EIA Form 860 2011 and EPA Air Markets Dataset 2012.

5. ***Technological achievability:*** The proposed technology is not achievable (i.e. cannot be purchased or installed).
6. ***Economic achievability:*** The cost of proposed technology is, in EPA's determination, an unreasonable burden to the industrial category as a whole (here, all steam electric generators other than oil-fired generating units and generating units with capacities 50 MW or smaller).

EPA's original proposal recommended Options 3 and 4 as preferred,[122] and only performed its full economic analysis using the IPM model on those two options. The EPA proposal found Options 1 and 2 to be too lax—"neither option would represent the best available technology level for steam electric power plant discharges"[123]—and rejected Option 5 even though "without question, Option 5 would remove the most pollutants from steam electric power plant discharges."[124] EPA's elimination of Option 5 from consideration for this rulemaking was made on economic grounds: "EPA did not select Option 5 as its preferred option for BAT because of the high total industry cost for the option…and because of preliminary indications that Option 5 may not be economically achievable."[125]

OMB's review required EPA to instead recommend Options 3, 3a, 3b, and 4a, and introduced the following language to EPA's proposed guidelines to explain the rejection of Option 4 (discussed above).

EPA does not include Options 1 and 2 among its "preferred alternatives" on the basis that there are other more effective technologies than those that would be required under these regulatory options.[126]

The grounds for EPA's decision to exclude Options 4 and 5 from its preferred alternatives are not well established. EPA's failure to include Options 4 and 5 results in the elimination of the following control technologies from BAT consideration:

- Dry handling of bottom ash transport water for units with capacities 400 MW or smaller
- Chemical precipitation of combustion residual leachate
- Vapor-compression evaporation of FGD wastewater (Option 5 only)

All three of these technologies are more effective than those included in among EPA's preferred alternatives and are technologically achievable (see Table 9).

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[122] U.S. Environmental Protection Agency, Proposed Rule: Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category, as submitted to the Office of Budget and Management in accordance with Executive Order 12866.

[123] 78 Fed. Reg. at 34,472.

[124] 78 Fed. Reg. at 34,473.

[125] 78 Fed. Reg. at 34,473.

[126] 78 Fed. Reg. at 34,472-34,473.

The following sub-sections demonstrate that the control technologies removed from consideration when Options 4 and 5 were not designated as "preferred"—dry handling of bottom ash transport water for units with capacities 400 MW or smaller, chemical precipitation of combustion residual leachate, and vapor-compression evaporation for FGD wastewater—meet the criteria set out in the Clean Water Act for BAT. That is, these control technologies are: 1) more stringent than the technologies required in EPA's preferred options; 2) technologically achievable in the United States today; and 3) economically achievable for the steam electric industry as a whole.

Table 9. Eliminated control technologies

Eliminated Technology	Comparative Stringency	Use in the Steam Electric Industry
Dry handling of bottom ash transport water for units with capacities 400 MW or smaller	"Under Options 1, 3a, 2, 3b, 3, and 4a (for units less than or equal to 400 MW), effluent limitations and standards for bottom ash transport water would be set equal to the current BPT effluent limitations,based on the technology of gravity settling in surface impoundments to remove suspended solids... Although surface impoundments can be effective at removing particulate forms of metals and other pollutants, they are not designed for nor are they effective at removing other pollutants of concern such as dissolved metals and nutrients. The concentrations of pollutants that remain in the wastestream at the ash impoundment effluent, in combination with the large volumes of bottom ash transport water discharged to surface waters, results in a large mass loading of pollutants of concern being discharged from surface impoundments. Effluent limitations and standards based on the technologies used as the basis for Options 4a (for units more than 400 MW), 4, and 5 would completely eliminate the discharge of pollutants in bottom ash transport water."(pp.34,461-34,462)	283 steam electric units in the United States employ dry handing systems for bottom ash transport water. (p.34,454)
Chemical precipitation of combustion residual leachate	"Under Options 1, 3a, 2, 3b, 3, and 4a, effluent limitations and standards for leachate from surface impoundments and landfills containing combustion residuals would be set equal to the current BPT effluent limitations, based on the technology of gravity settling in surface impoundments to removesuspended solids...[S]ince surface impoundments are not designed for, nor are they effective at, removing other pollutants of concern such as dissolved metals, EPA used chemical precipitation/coprecipitation as the technology basis for Options 4 and 5. Physical/chemical treatment systems are capable of achieving low effluent concentrations of various metals and are effective at removing many of the pollutants of concern present in leachate discharges to surface waters."(pp.34462-34,463)	"The pollutants of concern in leachate are the same pollutants that are present in, and in many cases are also pollutants of concern for, FGD wastewater, fly ash transport wastewater, bottom ash transport water, and other combustion residuals...Given the similarities present among the different types of wastewaters associated with combustion residuals, combustion residual leachate will be similarly amenable to chemical precipitation treatment. The treatability of pollutants such as arsenic and mercury using chemical precipitation technology is also demonstrated by technical information compiled for ELGs promulgated for other industry sectors."(p.34,454)
Vapor-compression evaporation of flue gas desulfurization wastewater (Option 5 only)	"Although EPA did not select Option 5 as the preferred BAT option, without question, Option 5 would remove the most pollutants from steam electric power plant discharges."(p.34,473)	"Two U.S. plants and four Italian plants are operating this technology to treat FGD wastewater from their coal-fired generating units."(p.34,460)

Source: 78 Fed. Reg.

5.3. Relative stringency of regulatory options

EPA promulgates national ELGs for three types of pollutants: (1) conventional pollutants (i.e., total suspended solids, oil and grease, biochemical oxygen demand, fecal coliform, and substances that affect the acidity (pH) of water); (2) toxic pollutants (e.g., toxic metals such as arsenic, mercury, selenium, and chromium; toxic organic pollutants such as benzene, benzo-a-pyrene, phenol, and naphthalene); and (3) non-conventional pollutants, which are those pollutants that are not categorized as conventional or toxic (e.g., ammonia-N, phosphorus, and total dissolved solids).[127]

EPA's preferred regulatory options—3, 3a, 3b, and 4a—are expected to prevent the release of 2,488 to 6,665 million lb-eq of toxic-weighted pollutants into surface waters (see Table 10). Rejected Options 4 and 5 would prevent the release of 7,831 to 8,201 million lb-eq of pollutants.

Table 10. Steam electric pollutant removals

Pollution Streams and Controls	Option 1	Option 3a	Option 2	Option 3b	Option 3	Option 4a	Option 4	Option 5
Total Annual Pollutant Removals* (millions lb-eq)	1,531	2,488	2,604	3,397	5,092	6,665	7,831	8,201
Estimated Annual Pollutant Loading Reduction (million lb)								
Conventional Pollutants (i.e., total suspended solids, oil and grease, biochemical oxygen demand, fecal coliform, and pH)	2.8	16	2.8	17.1	19	28	35	36
Priority/Toxic Pollutants (e.g., toxic metals such as arsenic, mercury, selenium, and chromium; toxic organic pollutants such as benzene, benzo-a-pyrene, phenol and naphthalene)	0.5	0.4	0.7	0.6	1.1	1.4	1.7	1.7
Nonconventional Pollutants (e.g., ammonia-N, phosphorus, and total dissolved solids)	-418	468	1,155	914	1,623	2,612	3,328	5,287
Pollutant Long-Term Averages with Flue Gas Desulfurization								
Arsenic (ug/L)	4.48		4.48	4.48	4.48	4.48	4.48	4.00
Mercury (ng/L)	75.40		75.40	75.40	75.40	75.40	75.40	17.79
Nitrate-nitrite (mg/L)			0.11	0.11	0.11	0.11	0.11	
Selenium (ug/L)			7.46	7.46	7.46	7.46	7.46	5.00
Total Disolved Solids (mg/L)								14.88

Source: 78 Fed. Reg. at 34,485, Table IX-4; 34,490, Table X-1; and 34,504, Table XII-1

*Note: * Toxic-weighted pollutant removals for direct (to surface waters) dischargers*

Dry handling of bottom ash transport water for units with capacities 400 MW or smaller, and chemical precipitation of combustion residual leachate

The selection of Option 4, as compared to Option 4a, would require plants with capacities equal to or less than 400 MW to implement zero-discharge dry handling for bottom ash transport water. This one

[127] Technical Development Document, p.1-2

additional requirement impacts on conventional, toxic, and nonconventional pollutants (see Table 10). Option 4 also includes the addition (as compared to Option 4a) of chemical precipitation of combustion residual leachate. The greater stringency of Option 4, as compared to EPA's preferred options, is demonstrated by its additional removal of pollutants over and above Option 4a. Option 4 removes 6,665 million lb-eq whereas Option 4a removes only 5,092 million lb-eq.

Vapor-compression evaporation systems in Option 5

The selection of Option 5 would require an additional improvement to controls: a vapor-compression evaporation system for FGD wastewater:

> This type of system uses a falling-film evaporator (or brine concentrator) to produce a concentrated wastewater stream and a distillate stream. With pretreatment, such as chemical precipitation and softening, brine concentrators can reduce wastewater volumes by 80 to 90 percent. Plants can further process the concentrated wastewater stream in a crystallizer or spray dryer, which evaporates the remaining water to generate a solid waste product and potentially a condensate stream. The distillate and condensate streams may be reused within the plant or discharged to surface waters. EPA identified two U.S. plants and four Italian plants that treat FGD wastewater using vapor-compression evaporation. A third U.S. plant is currently installing a vapor-compression evaporation treatment system; it is scheduled to be operational by the end of 2013.[128]

As shown in Table 10, this single change limits the release of arsenic, mercury and selenium into public waterways. EPA explains that:

> Physical/chemical treatment systems can achieve low effluent concentrations for a number of pollutants, and reduce concentrations even further when combined with biological treatments systems…However, these technologies have not been effective at removing substantial amounts of boron and pollutants that contribute to high concentrations of [Total Dissolved Solids]. [Vapor-compression evaporation] can address these recalcitrant pollutants…[129]

The requirement of vapor-compression evaporation for biological treatment of FGD wastewater represents the only difference between Options 4 and 5. Option 5's additional pollutant removals, therefore, are the result of vapor-compression evaporation and result in greater stringency than any of the other regulatory options. Option 5 removes far more pollutants than Option 4—8,201 million versus 7,831 million lb-eq per year, respectively (see Table 10 above). Option 5's total monetized benefits (excluding air-related benefits), however, are slightly lower than those of Option 4—$434.1 million

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[128] Id. at 34,452.

[129] 78 Fed. Reg. at 34,460.

annualized versus $435.0 million in annualized terms (see Table 8). EPA offers an explanation for this result, stating:

> [U]nder Option 4, EPA assumes that plants with both leachate and FGD waste streams implement chemical precipitation and biological treatment for the combined streams. Under Option 5, EPA assumes that plants treat the two streams separately: FGD wastewater by evaporation and leachate using chemical precipitation (which removes less pollutant load than biological treatment).[130]

This methodological quirk does not, however, explain away the mismatch between toxic-weighted pollutants and monetized benefits; rather, it illustrates a deep flaw in EPA methodology. While the additional pollutants removed in Option 5 have a higher toxic weight, they are not readily quantified or monetized. EPA's erroneously values the removal of those toxic pollutants at zero dollars.

Listed as the major capital cost components of vapor-compression evaporation systems are water softeners, brine concentrators, and forced-circulation crystallizers.[131] The brine concentrator (sometimes called a falling-film evaporator) and forced-circulation crystallizer are used in sequence: The brine concentrator separates FGD wastewater—which has already completed a chemical precipitation process—in brine and distillate; a forced-circulation crystallizer (or other similar process, e.g., a spray dryer) then separates the brine concentrator distillate then passes into solid waste and a liquid condensate.[132]

The distillate and condensate may either be reused within the plant—in which case, the vapor-compression evaporation system results in "zero liquid discharge" from the FGD scrubber—or may be released into surface waters or public water treatment works. Option 5 would regulate the latter; curiously, the former treatment of FGD wastewaters, zero liquid discharge, is not included among the regulatory options presented by EPA.

Effluent limitations for Option 5 are set based on a weighted average of brine concentrator distillate and crystallizer condensate measurements sampled from a single Italian plant that appears to follow a zero liquid discharge protocol:

> For the treatment of FGD wastewater using chemical precipitation followed by a vapor-compression evaporation system, hereafter referred to as a "vapor-compression evaporation" system (which is the technology serving as the basis for Regulatory Option 5), EPA evaluated three systems as part of the EPA sampling program. One plant operates a system that is similar to the technology basis for the FGD wastewater limitations in the proposed rule: a one-stage chemical precipitation system followed by

[130] 78 Fed. Reg. at 34,518, Table XIV-8

[131] Id. at 34,482.

[132] Technical Development Document, pp.3-13 and 3-14

softening and a vapor-compression evaporation system. EPA used the data from this plant to develop the limitations based on the vapor-compression evaporation technology for the treatment of the FGD wastewater. That plant is Enel's Federico II Power Plant, located in Brindisi, Italy (hereafter referred to as Brindisi). EPA used data from a second plant for characterization purposes and not for limitations development because it only collected effluent data for one day from the plant. The third system does not represent the technology serving as the basis for the vapor-compression evaporation option, and was not used for the limitations development. This plant operates a solids removal process prior to the vapor-compression evaporation system but includes neither a full chemical precipitation system nor a softening step. Furthermore, this plant also operates a one-stage evaporation system and instead of employing a second stage of evaporation to crystallize and remove salts and other pollutants from the concentration brine, mixes the brine with fly ash and sends it to the landfill for disposal.[133]

5.4. Technological achievability of eliminated control technologies

The environmental controls eliminated with the exclusion of Options 4 and 5 are all technologically achievable.

Dry handling of bottom ash transport water for units with capacities 400 MW or smaller

The Federal Register directly states that dry handling of bottom ash transport water is technologically achievable for plants of any size:

> [A]ll plants, regardless of size, are capable of installing and operating dry handling or closed-loop systems for bottom ash transport water, and the costs would be affordable for most plants...[134]

Chemical precipitation of combustion residual leachate

The Federal Register also states that chemical precipitation has been shown to be technologically achievable for the pollutants in combustion residual leachate, and for other industries with similar pollutants:

> Physical/chemical treatment systems are capable of achieving low effluent concentrations of various metals and are effective at removing many of the pollutants of concern present in leachate discharges to surface waters. The pollutants of concern in leachate have also been identified as pollutants of concern for FGD wastewater, fly ash

[133] Technical Development Document, p.13-5; see also 78 Fed. Reg. at 34,490, Table X-1; Technical Development Document Section 3.4.1; and DCN SE02002 sampling data for limits.xlsx.

[134] 78 Fed. Reg. at 34,471-34,472.

> transport wastewater, bottom ash transport water, and other combustion residuals. This is to be expected since the leachate itself comes from landfills and surface impoundments containing the combustion residuals and those wastes are the source for the pollutants entrained in the leachate. Given the similarities present among the different types of wastewaters associated with combustion residuals, combustion residual leachate will be similarly amenable to chemical precipitation treatment. The treatability of pollutants such as arsenic and mercury using chemical precipitation technology is also demonstrated by technical information compiled for ELGs promulgated for other industry sectors.[135]

Vapor-compression evaporation systems in Option 5

Vapor-compression evaporation and other zero liquid discharge systems are technologically achievable. These systems are used in a variety of industrial applications, including electric generation, throughout the United States and around the world. In background documents to the proposed steam-electric ELGs, EPA notes that:

> Mechanical evaporators in combination with a final drying process can significantly reduce the quantity of wastewater pollutants and volume discharged from certain process operations at various types of industrial plants, including steam electric power plants, oil refineries, and chemical plants.[136]

Southwest states including Colorado, Arizona and California require some industrial facility's waste streams to achieve zero liquid discharge.[137] In most industrial settings this typically requires a combination of technologies, commonly evaporation and crystallization units, but may also include thermal/evaporative processes, membrane processes, and spray driers.

The largest manufacturers of zero liquid discharge systems are Veolia, Aquatech, and GE Power and Water.[138] Other vendors of zero liquid discharge technology include Siemens Water Technologies, 212 Resources, AGV Technologies, Aqua-Pure, INTERVAS, and Total Separation Solutions.[139] Veolia has installed zero liquid discharge in over 700 facilities worldwide across a large range of industries including: power generation, oil and gas, pulp and paper, metals and mining, ethanol/agricultural products/biofuel production, chemical processing, fertilizer manufacturing, salt production, chlor-alkali

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135 78 Fed. Reg. at 34,454.

136 Technical Development Document, p.7-3.

137 Global Water Intelligence. (2009, December). From zero to hero – the rise of ZLD. Global Water Intelligence, 10(12). http://www.globalwaterintel.com/archive/10/12/market-insight/from-zero-to-hero-the-rise-of-zld.html.

138 Global Water Intelligence. (2009, December). From zero to hero – the rise of ZLD. Global Water Intelligence, 10(12). http://www.globalwaterintel.com/archive/10/12/market-insight/from-zero-to-hero-the-rise-of-zld.html.

139 Colorado School of Mines. (2009). An Integrated Framework for Treatment and Management of Produced Water. RPSEA Project 07122-12. p. 1 http://aqwatec.mines.edu/produced_water/treat/docs/Tech_Assessment_PW_Treatment_Tech.pdf.

production, and soda ash production.[140] Aquatech—whose representatives were interviewed by EPA staff during the rulemaking process—has installed over 160 zero liquid discharge systems in of the same industries as Veolia as well as in a few additional industries including petrochemicals and pharmaceuticals.

According to Veolia Water Solutions & Technologies, electric generators have successfully applied evaporation and crystallization to achieve zero liquid discharge on "natural-gas combined cycle cooling water, gasification wastewater, and FGD wastewater, and for integrated water and wastewater facilities and [nuclear wastewater] evaporation crystallization."[141]

There are zero liquid discharge in use at power plants in at least three states, Arizona, Missouri, and Illinois. Three Arizona natural-gas combined cycle (NGCC) plants use evaporation and crystallization units to achieve zero liquid discharge for their cooling water blowdown and wastewater systems: APS Redhawk Power Station in Arlington, Arizona (two NGCC units operating 1,060 MW total);[142] Harquahala Generating Project in Tonopah, Arizona (totaling 1,000 MW);[143] and Duke Energy's Arlington Valley Power station (570 MW), also in Arlington, Arizona.[144] More recently, it was announced that two 758 MW NGCC plants in Texas—the Temple Power Plant in Bell County and the German Power Plant in Grayson County—would be retrofitted to achieve zero liquid discharge by 2014.[145]

All eight regulatory options of the proposed steam electric ELGs, required vapor-compression evaporation systems for IGCC plants. As stated in the proposed ELGs, "EPA is aware of two plants that currently operated [IGCC] units in the United States, and a third plant is scheduled to begin operating an IGCC this year. All three of these plants currently treat or plan to treat the IGCC wastewaters with vapor-compression evaporation systems."[146] Overseas, zero liquid discharge technology is applied at a number of power plants including at IGCC and coal-fired power plants. The ELCOGAS IGCC power plant in

[140] Veolia Water. (2013). HPD Evaporation and Crystalization. Capabilities Report, Veolia Water Solutions & Technologies. http://www.veoliawaterst.com/vwst-northamerica/ressources/documents/1/32351,HPD-EVAP-6-3.pdf.

[141] Veolia Water. (2013). HPD Evaporation and Crystalization. Capabilities Report, Veolia Water Solutions & Technologies. http://www.veoliawaterst.com/vwst-northamerica/ressources/documents/1/32351,HPD-EVAP-6-3.pdf.

[142] Veolia Water. (n.d.). APS Redhawk Power Station Case Study, Veolia Water Solutions & Technologies. http://www.veolianorthamerica.com/info/redhawk.htm

[143] Veolia Water. (n.d.). Power Generation Industry Project Profile: Harquahala Generating Project, LCC. Case Study, HPD. http://www.veoliawaterst.com/hpdsystems/ressources/documents/1/2201,HPD-HAR-CS-9-3.pdf.

[144] Aquatech. (n.d.). Duke Energy Selects HERO Membrane Process for ZLD Application. Case Study. http://www.aquatech.com/Portals/0/ProjectProfiles/02Arlington_HERO.pdf.

[145] General Electric. (2013). GE to Provide Water Recycling Technology for Two Texas Power Plants. Press Release, GE Water & Process, Trevose. http://www.genewscenter.com/Press-Releases/GE-to-Provide-Water-Recycling-Technology-for-Two-Texas-Power-Plants-3d66.aspx.

[146] 78 Fed. Reg. at 34454.

Puerollano, Spain (a 335 MW coal and petcoke facility) uses a number of process units, including evaporation and crystallization technologies, to achieve zero liquid discharge.[147]

In 2009, two U.S. coal-fired electric generation units—Iatan Station 1 (670 MW) and Iatan Station 2 (850 MW) in Weston, Missouri—began treating FGD wastewater with a vapor-compression evaporation system.[148] According to a case study released by a zero liquid discharge manufacturer, the Springfield, Illinois Dallman Power Station's four coal-fired units require the use of a falling film evaporator, vapor compressor, and spray dryer to meet Boron permit specifications for their FGD wastewater, resulting in achieving zero liquid discharge.[149] As discussed by EPA, several coal-fired power facilities in Italy have eliminated discharge of FGD wastewater using evaporation and crystallization units.[150]

5.5. Economic achievability of eliminated options

With regards to the question of whether or not these technologies represent an unreasonable burden to the category as a whole (all steam electric generators other than oil-fired generating units and generating units with capacities 50 MW or smaller), EPA notes that it "retains considerable discretion in assigning the weight to be accorded these factors."[151] In the Federal Register, EPA explains that Option 4 and 5 have not been selected as preferred options on economic grounds:

> EPA did not select Option 4 as its preferred regulatory option because of concerns expressed above associated with the projected compliance costs associated with zero discharge requirements for bottom ash for units equal to or below 400 MW.[152]
>
> EPA did not select Option 5 as its preferred option for BAT because of the high total industry cost for the option ($2.3 billion/year annualized social cost) and because of preliminary indications that Option 5 may not be economically achievable.[153]

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[147] Veolia Water. (n.d.). ELCOGAS Chooses HPD's CoLD™ Process for Spain's First IGCC Power Plant to Attain Zero Liquid Discharge. Press Release, Veolia Water Solutions & Technologies, http://www.veoliawaterstna.com/news-resources/press-releases/2011-08-24,elcogashpdigcc.htm.

[148] Aquatech. (n.d.). Aquatech Supplies Zero Liquid Discharge Treatment for FGD System at the Iatan Generating Station. Case Study. http://www.wateronline.com/doc/aquatech-supplies-zero-liquid-discharge-0001.

[149] Aquatech. (n.d.). Coal Fired Power Plant Achieves ZLD for FGD Wastewater. Case Study. http://www.environmental-expert.com/articles/coal-fired-power-plant-achieves-zld-for-fgd-wastewater-194733.

[150] Global Water Intelligence. (2009, December). From zero to hero – the rise of ZLD. Global Water Intelligence, 10(12). http://www.globalwaterintel.com/archive/10/12/market-insight/from-zero-to-hero-the-rise-of-zld.html. Veolia Water. (2013). FGD Scrubber Effluent Treatment - ItalyZero Liquid Discharge (ZLD) System. Power Industry Case Study, Veolia Water Solutions & Technologies. http://www.veoliawaterst.com/vwst-northamerica/ressources/documents/1/32351,HPD-EVAP-6-3.pdf.

[151] Technical Development Document, pp.1-4 and 1-5; EPA cites Weyerhaeuser Co. v. Costle, 590 F.2d 1011, 1045 (D.C. Cir. 1978) in support of this statement.

[152] 78 Fed. Reg. at 34,473.

As evidence of this judgment, EPA provides the results of several economic screening tests, notably: total annualized compliance and social costs, plant and firm cost-to-revenue ratios, cost-effectiveness, plant closures, costs to households, and job effects (see Table 11).

The results of EPA's screening tests, however, do not support a determination that Options 4 and 5 are not economically achievable. On the contrary, Options 4 and 5 appear to be economically achievable both in the context of the steam electric industry and in comparison to other industries.

EPA's screening methods for economic achievability

- *Total annualized compliance and social costs:* EPA's assertion that the cost to industry of requiring Option 5 is too high is presented without explanation or justification. Dollar-figure costs can only be understood in the context of the scale of an industry. Costs that would be far too high for a small industry to bear may be indiscernible to a larger industry such as steam-electric power generation. In addition, EPA's cost analysis is inflated by the inclusion of some plants that have since retired. Cost-to-revenue analysis (discussed below) is a more appropriate way for EPA to present evidence of high costs.

  In addition, EPA's measure of compliance cost (and, therefore, the use of this measure in cost-to-revenue ratios and cost-effectiveness tests) is based on a strong and—by EPA's own admission—inaccurate assumption. EPA assumes that all of the compliance costs associated with the proposed steam electric ELGs will be borne by the owners of the power plants and not, as is undeniably the common practice in the industry, passed on in some part to consumers in higher utility rates.[154]

[153] 78 Fed. Reg. at 34,473.

[154] 78 Fed. Reg. at 34,495.

Table 11. Summary of steam electric ELG screening test results

ELG Screening Tests	Option 1	Option 3a	Option 2	Option 3b	Option 3	Option 4a	Option 4	Option 5
Total annualized compliance costs (millions $2010)								
7-percent discount rate, pre-tax	266	168	393	265	561	948	1,373	2,277
7-percent discount rate, after-tax	191	108	281	182	389	636	917	1,547
Total annualized social costs (millions $2010)								
3-percent discount rate	268	185	387	281	472	954	1,381	2,329
7-percent discount rate	259	165	381	257	545	915	1,323	2,209
Plant after-tax compliance cost-to-revenue ratio								
Share of plants with no compliance costs	88.9%	93.4%	88.9%	92.1%	85.3%	81.1%	74.0%	74.0%
Share of plants with 0-1 percent	8.6%	4.0%	8.0%	5.0%	9.5%	10.6%	10.3%	8.2%
Share of plants with 1-3 percent	1.6%	2.0%	1.7%	2.2%	3.5%	6.0%	10.8%	10.7%
Share of plants with >3 percent	0.5%	0.1%	1.0%	0.2%	1.3%	1.9%	4.4%	6.7%
Firm after-tax compliance cost-to-revenue ratio								
Share of plants with no compliance costs	71.2-83%	84.4-89.3%	71.2-83%	82.7-88.6%	69.1-82.1%	64.6-79.9%	56.4-75.9%	56.4-75.9%
Share of plants with 0-1 percent	10.1-21%	4.3-9.1%	9.1-18.9%	5.1-10.7%	9.7-20.2%	10.8-22.6%	12.6-26.3%	11.2-23.5%
Share of plants with 1-3 percent	0.2-0.4%	0.4-0.8%	1.2-2.5%	0.4-0.8%	1.4-2.9%	2.2-4.5%	4.1-8.6%	3.9-8.2%
Share of plants with >3 percent	0.8-1.6%	0-0%	0.8-1.6%	0-0%	1-2.1%	1.2-2.5%	1.4-2.9%	3-6.2%
Cost-effectiveness: direct discharge (1981$/lb-eq)	69	27	60	31	44	57	70	111
Plant closures in 2030 (MW)					-102		317	
Average annual cost to households in 2014 (2010$)	0.75	0.48	1.12	0.75	1.59	2.69	3.89	6.46
Average annual employment increase (jobs)	243	168	548	255	519	865	1,253	2,112

Source: 78 Fed. Reg. at 34,492, Table XI-1; 34,493, Table XI-2; 34,494, Tables XI-3 and XI-4; 34,504, Table XII-1; 34,498, Table XI-6; 34,501, Table XI-9; and 34,503, Table XI-11.

- *Cost-to-revenue ratios*: This screening test compares EPA's measure of compliance costs to revenues on a plant and firm basis. In Options 4 and 5, 74.0 percent of plants have no compliance costs whatsoever. Just 4.4 and 6.7 percent of plants, respectively, have costs greater than 3 percent of revenues; while most of the EPA rulemakings that presented a cost-to-revenue measure showed smaller shares of entities with cost-to-revenue ratios greater than 3 percent, at least one ELG category was approved at the same approximate level.[155]

  EPA's assumption of zero cost pass-through is a key determining factor in estimating the share of plants with costs greater than 3 percent of revenues. An assumption of 50-percent pass-through of compliance costs would lower the Option 4 and 5 shares substantially: EPA performed this sensitivity for Option 4 and found that the share of

[155] Concentrated Aquatic Animal Production at 5.7 percent; see 69 Fed. Reg. at 51,892 (August 23, 2004).

plants with costs greater than 3 percent fell from 4.4 percent to 0.9 percent.[156] An assumption of 100-percent pass-through (as is used in EPA's household cost and jobs analyses) would bring these shares down to zero. EPA's explanation that the zero cost pass-through assumption was chosen to provide a worst case outcome is accurate, but unhelpful:

> This assumption is used for analytic convenience and provides a *worst-case* scenario of regulatory impacts to steam electric plants. Even though the majority of steam electric plants *may be* able to pass increases in production costs to consumers through increased electricity prices, it is difficult to determine exactly which plants would be able to do so. Consequently, EPA judges that assuming zero cost pass-through is appropriate as a screening-level, upper bound estimate of the potential cost impact from the proposed ELGs to steam electric plants and their parent entities. To the extent that some steam electric plants are able to recover some of the increased production costs in increased prices, this analysis overstates plant-level impacts.49 The analysis, while helpful to understand potential cost impact, does not generally indicate whether profitability is jeopardized, cash flow is affected, or risk of financial distress is increased.[157]

Surely, a screening measure that "does not generally indicate whether profitability is jeopardized, cash flow is affected, or risk of financial distress is increased" cannot be a reliable measure of the economic achievability of ELGs.

- *Cost-effectiveness:* EPA presents "cost-effectiveness" for direct and indirect dischargers (although the vast majority of discharges are direct); this measure is the ratio of compliance costs to toxic-weighted pollutants. Options 4 and 5 receive $70 and $111 per lb-eq cost-effectiveness estimates, respectively. EPA's comparison to cost-effectiveness in other ELG categories showed a range of dollar to lb-eq measures from less than $1 for inorganic chemicals to $404 electrical and electronic components.[158] Like cost-to-revenue ratios, cost-effectiveness depends on EPA measure of compliance costs, and suffers from the same biases. EPA uses compliance costs to industry—and not total costs to society—to measure cost-effectiveness; cost pass-through assumptions are, therefore, critical in estimating values for these regulatory options. An assumption of greater pass-through of costs to ratepayers would have the effect of lowering cost-effectiveness ratios. Again, EPA's own assessment that the zero pass-through assumption is not useful in determining profitability, effects to cash flow, or risk of financial distress would tend to preclude the use of cost-effectiveness in assessing economic achievability for BAT.

- *Plant closures:* EPA used IPM analysis to estimate plant closures from Options 3 and 4 only. Modeling of Option 4 resulted in a net increase in capacity of 317 MW (less than

[156] Regulatory Impact Analysis, p.B-2.

[157] Regulatory Impact Analysis, p.4-2.

[158] Regulatory Impact Analysis, p.D-8.

0.1 percent of baseline U.S. capacity), which included small net decreases in the NPCC and SPP regions:[159] "As a result, for Option 4, the IPM analysis projects total net closure of nine generating units…The results support EPA's conclusion that Option 4 is economically achievable."[160] EPA uses the analysis of plant closures as evidence of the economic achievability of Option 4 and fails to complete plant closure analysis for Option 5.

- *Costs to U.S. households:* Using the worst-case assumption (from rate-payers perspective) of 100-percent cost pass-through to customers, average annual costs to U.S. households are far from onerous: $3.89 for Option 4 and $6.46 for Option 5. The highest regional costs were found for the ECAR region: $10.08 and $16.86 per year respectively. The average U.S. household spends about $2,000 each year on electricity, heating and cooking fuels combined.[161]

- *Job effects:* EPA estimates average annual employment increases from all eight regulatory options. Employment increases from Options 4 and 5 are 1,253 and 2,112 job-years, respectively.

EPA fails to make a case that Options 4 and 5 are not economically achievable. Indeed, EPA states outright that Option 4 is economically achievable. Similarly, EPA notes that its analysis of Option 5 "shows that the entity-level compliance costs are low in comparison to the entity-level revenues; very few entities are likely to face economic impacts at any level."[162] Given reasonable assumptions regarding cost pass-through in the steam-electric industry, it seems likely that economic screening measures for Options 4 and 5 would fall within the bounds of those presented in approved ELGs. Plant closures—EPA's ostensible reason for not selecting Option 4—and costs to households are negligible. Jobs are expected to increase as a result of all of the proposed steam electric regulatory options, including Options 4 and 5.

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[159] 78 Fed. Reg. at 34,498, Table XI-6.

[160] 78 Fed. Reg. at 34,472.

[161] EIA, 2009 Residential Energy Consumption Survey, Table CE1.1, http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption.

[162] RIA at 4-9.

6. CONCLUSION

Implementation of EPA's proposed ELGs for the steam electric industry would result in cleaner water, more sustainable natural ecosystems, and better human health. Keeping arsenic, mercury, nitrate-nitrite, selenium, and total dissolved solids from power generation out of U.S. waters would reduce incidence of cancer and other health effects from fish consumption; improve water quality for recreational uses and aesthetic enjoyment, as well as improved protection of threatened and endangered species and other ecological benefits; reduce groundwater contamination and associated health risks; lower costs from combustion residual impoundment failures and water treatment, and reduced damages to commercial fisheries, tourism, and property values; reduce air emissions as a result of curtailed generation at high-emission power plants; and reduce water use for power generation.

The goal of the Clean Water Act is to eliminate all pollution in U.S. surface waters. The most stringent of the regulatory options proposed by EPA do much more to eliminate more water pollution from power plants, do more to protect the environment, and save more human lives than would their less stringent "preferred" counterparts. Options 4 and 5—the most pollutant-reducing regulatory options presented by EPA—have been eliminated from consideration as steam-electric ELGs inappropriately. Elimination from BAT consideration under the Clean Water Act requires one of the following:

1. ***Insufficient stringency:*** There are other more effective technologies for controlling the discharge of pollutants from a particular effluent stream.
2. ***Lack of technological achievability:*** The proposed technology is not achievable (i.e. cannot be purchased or installed).
3. ***Lack of economic achievability:*** The cost of proposed technology is, in EPA's determination, an unreasonable burden to the industrial category as a whole (here, all steam electric generators other than oil-fired generating units and generating units with capacities 50 MW or smaller).

Benefit-cost analysis is not a permissible criterion for determining BAT under the Clean Water Act. Regulatory benefit-cost analyses notoriously overestimate costs and underestimate benefits, and the benefit-cost analysis for the proposed steam electric ELGs is no exception.

Option 4 is less stringent only than Option 5, and is both technologically and economically achievable. Option 5 passes all three tests.

Option 4 should be among EPA's preferred options

Control technologies for Option 4—dry handling of bottom ash transport water for units with capacities 400 MW or smaller, and chemical precipitation of combustion residual leachate—are more effective at controlling the discharge of pollutants than are the Options selected by EPA as "preferred." These control technologies are also—as documented by EPA in this rulemaking—technologically achievable. Furthermore, EPA itself describes Option 4 for as "economically achievable" and fails to make a case that it would be a burden to industry. EPA's rationale for eliminating Option 4 from consideration is based entirely on a subcategorization of the steam-electric industry that has not been appropriately justified in this docket.

Option 5 is BAT for the steam-electric industry

The sole additional control technology found in Option 5 but not in Option 4—vapor-compression evaporation—makes Option 5 the most effective of all the proposed steam-electric regulatory options at controlling the discharge of pollutants. Option 5 is technologically achievable; zero-liquid discharge technologies are used to control similar pollutants in many other industries, in several steam-electric plants in the United States, and in several more abroad.

Option 5 is also economically achievable. EPA has not demonstrated that Option 5 would be a burden to the steam electric industry. The measures of economic achievability presented by EPA are deeply flawed; EPA itself states that the metric for which it presents an adverse result for Option 5—the cost-to-revenue ratio—"does not generally indicate whether profitability is jeopardized, cash flow is affected, or risk of financial distress is increased."[163] Option 5's cost-effectiveness is within the bounds of those of approved ELGs (and is biased upward by the same faulty assumption used in the cost-to-revenue ratio), EPA presents no evidence of its plant closures, its household costs are negligible, and it results in an average annual increase of 2,112 jobs.

In addition, as the vapor-compression evaporation industry has developed, new designs and operation methods have become available. For example, Veolia's press materials claim that the CoLD™ technology has the lowest capital and operating costs of all zero liquid discharge processes; CoLD has been successfully implemented at facilities in multiple industries.[164] More generally, zero liquid discharge capital costs have dropped precipitously over the past decade. According to Bill Heins, general manager of thermal products and zero liquid discharge for GE Water and Process Technologies, total capital costs for installation dropped as much as 65 percent over the past seven years.[165]

Option 5 is BAT for the steam-electric ELGs.

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[163] Regulatory Impact Analysis, p.4-2.

[164] Veolia Water. (2013). The CoLD Process: ZLD Wastewater Treatment for Coal-fired Generation. Case Study, Veolia Water Solutions & Technologies. http://www.veoliawaterstna.com/vwst-northamerica/ressources/documents/1/30047,CoLD-Coal-TDS-1-22.pdf.

[165] Global Water Intelligence. (2009, December). From zero to hero – the rise of ZLD. Global Water Intelligence, 10(12). http://www.globalwaterintel.com/archive/10/12/market-insight/from-zero-to-hero-the-rise-of-zld.html.