ATTACHMENT 10

Nuclear power debate

From Wikipedia, the free encyclopedia
(Redirected from Nuclear debate)

The **nuclear power debate** is about the controversy[1][2][3] which has surrounded the deployment and use of nuclear fission reactors to generate electricity from nuclear fuel for civilian purposes. The debate about nuclear power peaked during the 1970s and 1980s, when it "reached an intensity unprecedented in the history of technology controversies", in some countries.[4][5]

Proponents of nuclear energy contend that nuclear power is a sustainable energy source that reduces carbon emissions and increases energy security by decreasing dependence on foreign oil.[6] Proponents advance the notion that nuclear power produces virtually no air pollution, in contrast to the chief viable alternative of fossil fuel. Proponents also point out that nuclear power is the only viable course to achieve energy independence for most Western countries. Proponents also emphasize that the risks of storing waste are small and can be further reduced by using the latest technology in newer reactors, and the operational safety record in the Western world is excellent when compared to the other major kinds of power plants.[7]

Opponents believe that nuclear power poses many threats to people and the environment. These threats include health risks and environmental damage from uranium mining, processing and transport, the risk of nuclear weapons proliferation or sabotage, and the unsolved problem of radioactive nuclear waste.[8][9] They also contend that reactors themselves are enormously complex machines where many things can and do go wrong, and there have been many serious nuclear accidents.[10][11] Critics do not believe that these risks can be reduced through new technology [*citation needed*]. They also argue that when all the energy-intensive stages of the nuclear fuel chain are considered, from uranium mining to nuclear decommissioning, nuclear power is not a low-carbon electricity source.[12][13][14]

Arguments of economics and safety are used by both sides of the debate.

Contents

Energy security

Main article: Energy security

For some countries, nuclear power affords energy independence. Nuclear power has been relatively unaffected by embargoes, and uranium is mined in "reliable" countries, including Australia and Canada.[15][16]

The neutron-poisoning element boron, necessary for the operation of pressurized water reactors, is found primarily in two countries (Turkey and the United States) (see Boron).

According to a Stanford study, fast breeder reactors have the potential to provide power for humans on earth for billions of years, making this source sustainable.[17]

Reliability

See also: Intermittent power sources

Nuclear power plants are some of the more complex mechanical systems ever devised, although much of that complexity is due to redundancy of systems and the defense in depth strategy of the designs. New reactors, though, will incorporate passive safety features to reduce the need for redundancy.[18]

In 2005, out of all nuclear power plants in the world, the average capacity factor was 86.8%, the number of SCRAMs per 7,000 hours critical was 0.6, and the unplanned capacity loss factor was 1.6%.[19] Capacity factor is the net power produced divided by the maximum amount possible running at 100% all the time, thus this includes all scheduled maintenance/refueling outages as well as unplanned losses. The 7,000 hours is roughly representative of how long any given reactor will remain critical in a year, meaning that the scram rates translates into a sudden and unplanned shutdown about 0.6 times per year for any given reactor in the world. The unplanned capacity loss factor represents amount of power not produced due to unplanned scrams and postponed restarts.

The World Nuclear Association states that "Sun, wind, tides and waves cannot be controlled to provide directly either continuous base load power, or peak-load power when it is needed. In practical terms they are therefore limited to some 10–20% of the capacity of an electricity grid, and cannot directly be applied as economic substitutes for coal or nuclear power, however important they may become in particular areas with favourable conditions." "The fundamental problem, especially for electricity supply, is their variable and diffuse nature. This means either that there must be reliable duplicate sources of electricity, or some means of electricity storage on a large scale. Apart from pumped-storage hydro systems, no such means exist at present and nor are any in sight." "Relatively few places have scope for pumped storage dams close to where the power is needed, and overall efficiency is low. Means of storing large amounts of electricity as such in giant batteries or by other means have not been developed."[20] See also energy storage.

Nuclear power has much different characteristics. As is the case for coal, its capital costs are higher than for gas-fired turbines but its operating costs are lower. Economics therefore favors running nuclear plants at full power as much as possible for baseload power.[21] If nuclear energy is used only for the base load, utilities also need other energy sources most of the time, when power demand is above the minimum. Alternatively, advanced-design nuclear plants could be sized for peak demand and produce hydrogen thermochemically during off-peak hours as feedstock for synthetic liquid fuels.[22]

Reduced operation during very hot weather

Since nuclear power plants are fundamentally heat engines, waste heat disposal becomes an issue at high ambient temperature. In such very hot weather a power reactor (just as a coal-fired or solar-thermal power plant will) may have to operate at a reduced power level or even shut down.[23] In the 2006 European heat wave, a number of nuclear plants had to secure exemptions from regulations in order to discharge overheated water into the environment; several European nations were forced to reduce operations at some plants and take others offline and France, normally an electricity exporter, had to buy electricity on European spot market to meet demand.[24] Overheated discharge water has resulted in significant fish kills in the past, impacting livelihood and raising public concern. Fish kills remain a problem for plants which use water for cooling, due to high volumes which pull fish into intake systems. Plants with cooling towers are more expensive, but allow for alleviating temperature effects.

Economics

See also: Relative cost of electricity generated by different sources

See also: Negawatt power

Nuclear plants generally have very high capital costs, with operating costs just under those of coal-fired generation.[25] Fuel costs, on the other hand, are very low. According to Christopher Crane, Senior Vice President of Exelon, representing the World Nuclear Association in an April 2007 speech to members of the U.S. Congress, "Nuclear energy is, in many places, competitive with fossil fuel for electricity generation, despite relatively high capital costs and the need to internalize all waste disposal and decommissioning costs. If the social, health and environmental costs of fossil fuels are also taken into account (for example, if a carbon tax is implemented), nuclear is outstanding."[26]

Opponents of nuclear energy argue that utilities contemplating the construction of reactors demand support from the government in the form of loan guarantees, which implies that reactors are a high-risk investment. In his 2007 speech to members of congress, Cristopher Crane said that these loan guarantees must cover 100 percent of project debt, otherwise financing of new powerplants would be extremely difficult.[27] Supporters of nuclear power point out that the guarantees would only apply to the first few reactors, as an assurance that the licensing requirements would not be changed during construction, as has happened in the past. Similar loan guarantees are provided for renewable-energy and carbon-sequestration projects.[28]

Anti-nuclear organisations consider the economics of new nuclear power plants to be unfavourable because of the initial costs of constructing a nuclear plant (see Darlington Nuclear Generating Station), the public subsidies and tax expenditures involved in research and security, the cost of decommissioning nuclear facilities, and the undetermined costs of storing nuclear waste.[29][30]

In a study conducted for the SER, an economic advisory council of the Dutch government, the Energy Research Centre of the Netherlands (ECN) expressed concern that the expansion of nuclear energy might reduce investment in renewable energy technologies through lock-in effects.[31]

Cost of new plants

Main article: Economics of new nuclear power plants

Urgency in the face of possible fossil fuel shortages and climate change can be seen both as an advantage *and* a disadvantage of nuclear fission. If, for example, the goal is to cover 80% of the world's (present) energy demand with fission, then thousands of new plants would have to be built,[citation needed] at a price of several billion US$ each,[32] which would mean an investment of tens of trillions of US$, although this general scale of investment is required no matter which approach to carbon reduction is taken. Also, permitting and building a nuclear plant can take about 10 years.[32] This allows speculation on where other alternatives would stand by then if that money were invested in making them cheaper and more efficient. It is possible that that route would in the long run be more economical, but that depends on how big the improvements would be. Solar energy, for example, which has received relatively little development investments, and is therefore still in early development stages, is still making progress on efficiency levels.[citation needed]

Cost of decommissioning nuclear plants

Shutting down a nuclear plant is cited as an extremely expensive process by nuclear power critics, although the costs are usually covered by a component of price charged for electricity during operation. In the UK the Nuclear Decommissioning Authority has increased the overall cost for decommissioning nuclear plants from £57 billion in 2005 to £73 billion in 2008, according to the BBC, although this is heavily influenced by cleaning up the weapons development at Sellafield. However, the Parliamentary Public Accounts Committee was told in July 2008 that this cost could rise further and that it is almost impossible to come up with an accurate figure. Stabilising a plant and ensuring that it is safe is cited as an unknown cost by critics, claiming that decommissioning costs can massively increase the overall cost of nuclear energy.

Subsidies

Critics of nuclear power claim that it is the beneficiary of inappropriately large economic subsidies — mainly taking the forms of research and development, and financing support for new build — and that these subsidies are often overlooked when comparing the economics of nuclear against other forms of power generation.

Nuclear industry proponents argue that competing energy sources also receive subsidies. Fossil fuels receive large direct and indirect subsidies, such as tax benefits and not having to pay for the greenhouse gases they emit[citation needed]. Renewables receive proportionately large direct production subsidies and tax breaks in many nations, although in absolute terms they are often less than subsidies received by other sources.[33]

Energy research and development (R&D) for nuclear power continues to receive large state subsidies. In the United States, nuclear receives more Federal R&D support than the renewables industry[citation needed], however the impact of favorable tax incentives drives the total Federal support of the renewables industry to a level almost four times as high as that of the nuclear industry, despite all renewables (excluding hydroelectric, which receives no R&D funding) producing only 1/8th as much power as nuclear.[34] In Europe, the FP7 research program has more subsidies for nuclear than for renewable and energy efficiency together, although over 70% of this is directed at the ITER fusion project.[35][36] In the US, public research money for nuclear fission declined from 2,179 to 35 million dollars between 1980 and 2000.[33] However, in order to restart the industry, the next few US reactors will receive subsidies equal to those of renewables and, in the event of cost overruns due to litigation or regulatory delays, at least partial compensation (see Nuclear Power 2010 Program).[citation needed]

A May 12, 2008 editorial in the Wall St. Journal stated, "For electricity generation, the EIA concludes that solar energy is subsidized to the tune of $24.34 per megawatt hour, wind $23.37 and 'clean coal' $29.81. By contrast, normal coal receives 44 cents, natural gas a mere quarter, hydroelectric about 67 cents and nuclear power $1.59."[37] The impacts of prior subsidies, some of which may no longer be in effect, are not measured in the previous analysis. However, the Renewable Energy Policy Project[38] stated that from 1947 to 1999, nuclear power was subsidized $145.4 billion, wind power $1.2 billion and solar $4.4 billion[39]. From a megawatt hour basis, this translate into $12.45 per MWh produced for nuclear power, $36.47 for wind power and $511.63 for solar (1999 dollars)[39].

In the United States, nuclear power plant liability insurance coverage is provided through the Price-Anderson Act. Besides commercial insurance of US$200 million per reactor, plant owners maintain a self-insurance pool of over US$11 billion. As a point of comparison, the total payout for the Three Mile Island accident was US$151 million.

Costs of disposing of high-level waste

See also: Nuclear fuel cycle#Waste disposal

See also: Nuclear reprocessing#Economics of reprocessing nuclear fuel

See also: Yucca Mountain nuclear waste repository

The cost of disposing of high-level waste is poorly known due to uncertainties of the length of time the waste must be stored, the final method to be used, how payment will be structured, and other reasons.

Nuclear opponents claim that the costs of handling spent fuel will be expensive. Advocates of nuclear energy argue that spent fuel has a high enough value to offset all or nearly all of the processing cost. However by 2003, Sellafield's Thermal Oxide Reprocessing Plant had made losses of over £1bn in the first 9 years of operation.[40]

Though it is not a viewpoint that figures prominently in the debate, some individuals suggest the value of spent fuel would be enhanced by using it as a heat source. According to a U.S. Department of Energy report,[41] the initial heat produced by U.S. nuclear waste will be on the order of 30 to 50 times the heat flux in the Geysers geothermal reservoir in California. According to The California Energy Commission,[42] Geothermal Energy in California website, in 2007 California produced 13,000 gigawatt-hours of geothermal energy. Assuming the conservative estimate of 30 times this amount of heat flux for U.S. nuclear waste, 390,000 gigawatt-hours of energy is produced annually by U.S. waste. This is close to half of the power output by America's operational reactors (806.5 billion kilowatt-hours (bkWh in 2007).[43]

390,000 gigawatt-hours is the equivalent of 219,956,237.507 barrels of fuel oil (US). The energy return on investment for SAGD is 5.2/1 [44]. Therefore, the heat flux of America's nuclear waste has the potential to produce over a billion barrels of synthetic oil annually.

The U.S. has approximately a quarter of the global inventory of spent nuclear fuel; therefore the potential exists for the development of significantly more unconventional deposits with imported spent fuel. Essentially America's total oil demand could be met from the output from the global spent fuel inventory. But that would require converting all energy use to electricity, for one thing. So this statement is rather hopeful, if not bizarre.

The Henry Hub pricing point for natural gas futures contracts traded on the New York Mercantile Exchange for the week ended July 30, 2008 was $9.01 per MMBtu. 390,000 gigawatt-hours is the equivalent 1,330,735,236.9199 MMBtu so the waste heat of America's spent nuclear fuel has the annual potential of $12 billion worth of Natural Gas. Burning a clean fuel [natural gas] to make a dirty fuel [from oil sands] has been characterized as a form of reverse alchemy. A far better use for natural gas is making electricity, home heating or as Boone Pickens advocates, transportation.

The Nuclear Assisted Hydrocarbon Production Method,[45] Canadian patent application 2,638,179, is a method for the temporary or permanent storage of nuclear waste materials comprising the placing of waste materials into one or more repositories or boreholes constructed into an unconventional oil formation. The thermal flux of the waste materials fracture the formation, alters the chemical and/or physical properties of hydrocarbon material within the subterranean formation to allow removal of the altered material. A mixture of hydrocarbons, hydrogen, and/or other formation fluids are produced from the formation. The radioactivity of high-level radioactive waste affords proliferation resistance to plutonium placed in the periphery of the repository or the deepest portion of a borehole.

Environmental effects

Main article: Environmental effects of nuclear power

The primary environmental impacts of nuclear power come from uranium mining, radioactive effluent emissions, and waste heat, as under normal generating conditions nuclear power does not produce greenhouse gas emissions [CO_2, NO_2] directly (although the nuclear fuel cycle produces them indirectly, though at much smaller rates than fossil fuels).[46] Nuclear generation does not directly produce sulfur dioxide, nitrogen oxides, mercury or other pollutants associated with the combustion of fossil fuels. In 2008, *The Economist* stated that "nuclear reactors are the one proven way to make carbon-dioxide-free electricity in large and reliable quantities that does not depend (as hydroelectric and geothermal energy do) on the luck of the geographical draw."[47] Many experts, some of whom consider themselves environmentalists, now believe that expanded nuclear generation is the only way to reduce green house gas emissions while providing for current and future electricity needs.[*citation needed*] However, this is disputed by some on the basis of thermodynamic limits to nuclear energy deployment.[48]

While nuclear power does not directly emit greenhouse gasses, over a facility's life cycle, emissions occur through plant construction, operation, uranium mining and milling, and plant decommissioning. A longtime opponent of nuclear energy collected 103 life cycle studies of greenhouse gas-equivalent emissions for nuclear power plants[49] from various sources, most of them other anti-nuclear activists. The calculated emissions over the lifetime of a nuclear power plant ranged from 1.4 to 288 g/kWh and averaged out to 66 g/kWh. This figure is 50 percent greater than that of biomass (41 g/kWh), more than five times that of solar (13 g/kWh), and more than seven times as much as wind and hydroelectric (9-10 g/kWh); these other emission rates come from a single reference and aren't averaged from multiple references. The article never figured importantly in the nuclear power debate. A study done at the University of Wisconsin has had influence on the debate; it showed all non-fossil sources are roughly equal in reducing greenhouse-gas emissions.[50]

Nuclear plants require more, but not significantly more, cooling water than fossil-fuel power plants due to their slightly lower generation efficiencies. Uranium mining can use large amounts of water - for example, the Roxby Downs mine in South Australia uses 35 million litres of water each day and plans to increase this to 150 million litres per day.[51]

Waste

There are a number of different kinds of nuclear waste: low-level waste (LLW), intermediate-level waste and high-level waste (HLW). LLW is defined as any radioactive waste that isn't categorized as HLW or ILW. It accounts for the majority of nuclear waste produced from power and weapons generation.[52] LLW includes materials that have been exposed or contaminated with dangerous levels of radiation, like protective clothing (such as radiation shoe coverings and clothing), wiping rags, mops, syringes, lab animal carcasses and reactor residue.

Intermediate-level waste consists primarily of materials from plants that have been decommissioned. ILW contains lower levels of radioactivity than high-level waste but is still radioactive enough not to be incorporated into the exclusionary category or LLW.

High-level waste is the most dangerous type of radioactive waste. Spent nuclear fuel and transuranic waste are considered HLW. HLW contains the fission products and transuranic elements generated in the reactor core. Although over 90% of radioactive waste is LLW, HLW still accounts for over 90% of the radioactivity produced from power plants.[52]. HLW consists of waste products that can be considered concentrated biological hazards. HLW can, depending on type, remain radioactive for millions of years. The reason the waste stays dangerous for so long is that, when, for example, plutonium-239 decays, it becomes uranium-235. The former remains dangerous for approximately 250,000 years, but the latter can remain dangerous for over 7 million years.[53] Therefore, HLW must be stored in a facility that can quarantine the waste from the ecosystem essentially forever if we do not consider any other solution than geological repositery. Indeed, the long-term radioactivity of nuclear waste (HLW) can be reduced, from ~10 million years to 200 or 300 years[54][55], with nuclear transmutation, although this technology have yet to be proven[54].

Low-level waste is disposed of in two ways. Under the first method, the waste is stored in a secure facility on the generator until it is no longer dangerously radioactive. When radiation levels have dropped to those found normally in nature, the waste is disposed of as regular trash. The second method of disposing of LLW is to transport it in secure containers approved by the U.S. Department of Transportation to a facility that is equipped to safely contain it. Three of these sites exist in the USA. The waste at these sites comes from plant operations and the chemical processing system.[56]

The disposal of high-level waste is more difficult and has been the source of political debates every since waste disposal became an issue in the 1970s. HLW is first stored in on-site tanks of cooling liquid. Immersed in this liquid, the HLW (such as spent fuel rods) cools in temperature and becomes less radioactive over time. In the 1970s, however, these on-site cooling facilities began to run out of room for new waste. Therefore, an alternative means of storage was devised and is currently used today. Waste that has been cooled for at least one year in tanks are moved to dry cask storage containers, which are large, silo-shaped receptacles with numerous protective layers that shield workers and the public from radiation. The United States Nuclear Regulatory Commission (NRC) has determined that these containers are a form of "leak-tight containment" due to the numerous redundant measures to keep the radiation inside the receptacles.[57] The rods themselves are surrounded by inert gas which is within a steel cylinders that are welded or bolted closed. Each cylinder is further surrounded by additional steel and/or concrete that provides further radiation shielding.

Most countries with nuclear power agree that storing spent fuel in deep geological repositories is the best option for waste disposal, but no such long-term waste repositories have yet been constructed.[58][59] In nature, sixteen repositories were discovered at the Oklo mine in Gabon where natural nuclear fission reactions took place 1.7 billion years ago.[60] The fission products in these natural formations were found to have moved less than 10 ft over this time period,[61] thus since its discovery in 1972 this site has provided an important part of the basis for evaluating the geology and design of potential man-made repositories, including the proposed US repository at Yucca Mountain.[62]

The argument has been made that the problems of nuclear waste do not come anywhere close to approaching the problems of fossil fuel waste.[63][64] A 2004 article from the BBC states: "The World Health Organization (WHO) says 3 million people are killed worldwide by outdoor air pollution annually from vehicles and industrial emissions, and 1.6 million indoors through using solid fuel."[65] In the U.S. alone, fossil fuel waste kills 20,000 people each year.[66] These statistics reinforce the scientific consensus that man-made fossil fuel waste has caused global warming.

However, nuclear power isn't just less problematic with regards to emissions. It also releases less radiation into world than other forms of energy generation. For instance, a coal power plant releases 100 times as much radiation as a nuclear power plant of the same wattage.[67] It is estimated that during 1982, US coal burning released 155 times as much radioactivity into the atmosphere as the Three Mile Island incident.[68]

Nuclear power has also caused less death from accidents than other forms of energy production. The World Nuclear Association provides a comparison of deaths from accidents in course of different forms of energy production. In their comparison, deaths per TW-yr of electricity produced from 1970 to 1992 are quoted as 885 for hydropower, 342 for coal, 85 for natural gas, and 8 for nuclear.[69]

Safety concerns

Main article: Nuclear safety

See also: State-of-the-Art Reactor Consequence Analyses

Safety of nuclear power centers around two issues; risk to workers and public due to low-level radiation from the plant, and health risk to the public when and if an accident happens at various stages of the fuel and maintenance cycle. While there have been some disastrous accidents in the past, the reactor design was typically at fault, and modern reactors are significantly less prone to such accidents.[70] Actually, human error was the significant factor in the Chernobyl accident, as well as most others. Regardless, the catastrophic aftermath of past accidents presents a strong justification for such safety concerns. In addition, the effects of the everyday activity is also a prominent concern. A recent example was unsecured interstate transport of contaminated cleaning equipment from the Prairie Island plant in Minnesota.

Health effects on population near nuclear power plants and workers

A major concern in the nuclear debate is the long-term effects of living near or working in a nuclear power station. These concerns typically center around the potential for increased risks of cancer. However, studies conducted by non-profit, neutral agencies have found no compelling evidence of correlation between nuclear power and risk of cancer.[71][72]

Fishermen near the now-dismantled Trojan Nuclear Power Plant in Oregon. The reactor dome is visible on the left, and the cooling tower on the right.

There has been considerable research done on the effect of low-level radiation on humans. Debate on the applicability of Linear no-threshold model versus Radiation hormesis and other competing models continues, however, the predicted low rate of cancer with low dose means that large sample sizes are required in order to make meaningful conclusions. A study conducted by the National Academy of Science found that carcinogenic effects of radiation does increase with dose.[73] The largest study on nuclear industry workers in history involved nearly a half-million individuals and concluded that a 1–2% of cancer deaths were likely due to occupational dose. This was on the high range of what theory predicted by LNT, but was "statistically compatible".[74]

The Nuclear Regulatory Commission (NRC) has a factsheet that outlines 6 different studies. In 1990 the United States Congress requested the National Cancer Institute to conduct a study of cancer mortality rates around nuclear plants and other facilities covering 1950 to 1984 focusing on the change after operation started of the respective facilities. They concluded in no link. In 2000 the University of Pittsburgh found no link to heightened cancer deaths in people living within 5 miles of plant at the time of the Three Mile Island accident. The same year, the Illinois Public Health Department found no statistical abnormality of childhood cancers in counties with nuclear plants. In 2001 the Connecticut Academy of Sciences and Engineering confirmed that radiation emissions were negligibly low at the Connecticut Yankee Nuclear Power Plant. Also that year, the American Cancer Society investigated cancer clusters around nuclear plants and concluded no link to radiation noting that cancer clusters occur regularly due to unrelated reasons. Again in 2001, the Florida Bureau of Environmental Epidemiology reviewed claims of increased cancer rates in counties with nuclear plants, however, using the same data as the claimants, they observed no abnormalities.[75]

Scientists learned about exposure to high level radiation from studies of the effects of bombing populations at Hiroshima and Nagasaki. However, it is difficult to trace the relationship of low level radiation exposure to resulting cancers and mutations. This is because the latency period between exposure and effect can be 25 years or more for cancer and a generation or more for genetic damage. Since nuclear generating plants have a brief history, it is early to judge the effects.

Most human exposure to radiation comes from natural background radiation. Natural sources of radiation amount to an average annual radiation dose of 295 mrem. The average person receives about 53 mrem from medical procedures and 10 mrem from consumer products.[76] According to the National Safety Council, people living within 50 miles of a nuclear power plant receive an additional 0.01 mrem per year. Living within 50 miles of a coal plant adds 0.03 mrem per year.[77] These numbers are negligible compared with the average annual dose of 358 mrem per year.

Current guidelines established by the NRC, require extensive emergency planning, between nuclear power plants, Federal Emergency Management Agency (FEMA), and the local governments. Plans call for different zones, defined by distance from the plant and prevailing weather conditions and protective actions. In the reference cited, the plans detail different categories of emergencies and the protective actions including possible evacuation.[78]

Nuclear proliferation and terrorism concerns

For more details on this topic, see Nuclear proliferation.

Nuclear proliferation is the spread of nuclear weapons and related technology to nations not recognized as "Nuclear Weapon States" by the Nuclear Nonproliferation Treaty (NNPT). Since the days of the Manhattan Project it has been known that reactors could be used for weapons-development purposes—the first nuclear reactors were developed for exactly this reason—as the operation of a nuclear reactor converts U-238 into plutonium. As a consequence, since the 1950s there have been concerns about the possibility of using reactors as a dual-use technology, whereby apparently peaceful technological development could serve as an approach to nuclear weapons capability.[79] Part of the radioactive material produced in some types of nuclear reactors has the potential to be used to make nuclear weapons by countries equipped with the capability of chemical and isotope separation.[80] For that reason, the United Nation's International Atomic Energy Agency (IAEA) closely monitors all reactors of nations who have joined.

Vulnerability of plants to attack

According to a 2004 report by the U.S. Congressional Budget Office, "The human, environmental, and economic costs from a successful attack on a nuclear power plant that results in the release of substantial quantities of radioactive material to the environment could be great."[81] Such an attack would, however, be difficult to mount. U.S. reactors are surrounded by a double row of electronically monitored tall fences, and patrolled by a sizable force of armed guards. Modern nuclear reactor containment buildings are designed to be impervious to a September 11-style attack.[82].[83] If terrorists were able to gain access to a nuclear reactor, they could do little more than vandalize the equipment. The National Reconnaissance Office's "Design Basis Threat" criteria for nuclear plant security is classified; what size attacking force the plants are able to protect against is unclear. It should be noted that scramming a plant takes less than 5 seconds, while unimpeded restart takes several hours, severely hampering any efforts to release radioactivity into the atmosphere. Attacks on chemical industry or petroleum industry plants, which are much more vulnerable to terrorism, would result in similarly dangerous outcomes, sometimes more lethal than an attack on the nuclear power industry.[84]

Use of waste byproduct as a weapon

An additional concern with nuclear power plants is that if the by-products of nuclear fission (the nuclear waste generated by the plant) were to be left unprotected it could be stolen and used as a radiological weapon, colloquially known as a "dirty bomb". There were incidents in post-Soviet Russia of nuclear plant workers attempting to sell nuclear materials for this purpose (for example, there was such an incident in Russia in 1999 where plant workers attempted to sell 5 grams of radioactive material on the open market,[85] and an incident in 1993 where Russian workers were caught attempting to sell 4.5 kilograms of enriched uranium.[86][87][88]), and there are additional concerns that the transportation of nuclear waste along roadways or railways opens it up for potential theft. The United Nations has since called upon world leaders to improve security in order to prevent radioactive material falling into the hands of terrorists,[89] and such fears have been used as justifications for centralized, permanent, and secure waste repositories and increased security along transportation routes.[90]

Public confidence

Polls consistently show that populations continue to oppose nuclear energy, but desire the energy security.[citation needed] A comprehensive public opinion survey, performed in May and June 2006 in the European Union member countries, concluded that EU citizens perceive great future promise in the use of renewable energies, but despite majority opposition, believe nuclear energy will have its place in the future energy mix.[91]

Safety culture in host nations

The safety of nuclear power depends strongly on building, maintaining and operating the reactors as designed. While the U.S. nuclear industry has an excellent safety culture, derived from standards established by Admiral Hyman G. Rickover for the U.S. Navy's Nuclear Propulsion Program, other nuclear industries and countries seeking nuclear power do not. Some developing countries which plan to go nuclear have very poor industrial safety records and problems with political corruption.[92] The Chernobyl disaster in Ukraine, during the time of the former Soviet Union, occurred due to the poor soviet safety culture. The Chernobyl reactor was badly designed, had no containment building, and was located near a large population, which proved catastrophic when an uncontrolled power increase occurred in the reactor. Large areas of Europe were affected by moderate radioactive contamination, and parts of Ukraine and one fifth of Belarus continue to be affected by radioactive fallout as of 2008.[93]

Plants in adjacent nations

The limited liability for the owner of a nuclear power plant in case of a nuclear accident differs per nation while nuclear installations are sometimes built close to national borders.[94] The Vienna Convention on Civil Liability for Nuclear Damage is intended to address this concern.

See also

- Anti-nuclear movement
- Atomic Age
- Energy development
- Leuren Moret
- Linear no-threshold model
- List of anti-nuclear protests in the United States
- List of books about nuclear issues
- List of canceled nuclear plants in the United States
- List of nuclear whistleblowers
- Lists of nuclear disasters and radioactive incidents
- Loss of coolant accident
- Nuclear contamination
- Nuclear fuel cycle
- Nuclear Liabilities Fund
- Nuclear optimism
- Nuclear power in the United States
- Nuclear terrorism
- Passive nuclear safety
- Radiophobia
- Relative cost of electricity generated by different sources
- Uranium mining

Footnotes

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Current Status

Today, the TMI-2 reactor is permanently shut down and defueled, with the reactor coolant system drained, the radioactive water decontaminated and evaporated, radioactive waste shipped off-site to an appropriate disposal site, reactor fuel and core debris shipped off-site to a Department of Energy facility, and the remainder of the site being monitored. In 2001, FirstEnergy acquired TMI-2 from GPU. FirstEnergy has contracted the monitoring of TMI-2 to Exelon, the current owner and operator of TMI-1. The companies plan to keep the TMI-2 facility in long-term, monitored storage until the operating license for the TMI-1 plant expires, at which time both plants will be decommissioned.

Below is a chronology of highlights of the TMI-2 cleanup from 1980 through 1993.

Date	**Event**
July 1980	Approximately 43,000 curies of krypton were vented from the reactor building.
July 1980	The first manned entry into the reactor building took place.
Nov. 1980	An Advisory Panel for the Decontamination of TMI-2, composed of citizens, scientists, and State and local officials, held its first meeting in Harrisburg, PA.
July 1984	The reactor vessel head (top) was removed.
Oct. 1985	Defueling began.
July 1986	The off-site shipment of reactor core debris began.
Aug. 1988	GPU submitted a request for a proposal to amend the TMI-2 license to a "possession-only" license and to allow the facility to enter long-term monitoring storage.
Jan. 1990	Defueling was completed.
July 1990	GPU submitted its funding plan for placing $229 million in escrow for radiological decommissioning of the plant.
Jan. 1991	The evaporation of accident-generated water began.

April 1991	NRC published a notice of opportunity for a hearing on GPU's request for a license amendment.
Feb. 1992	NRC issued a safety evaluation report and granted the license amendment.
Aug. 1993	The processing of 2.23 million gallons accident-generated water was completed.
Sept. 1993	NRC issued a possession-only license.
Sept. 1993	The Advisory Panel for Decontamination of TMI-2 held its last meeting.
Dec. 1993	Post-Defueling Monitoring Storage began.

Environmental effects of coal

From Wikipedia, the free encyclopedia

There are a number of adverse **environmental effects of coal** mining and burning.

Contents

Effects of mining

- Release of carbon dioxide and methane, both of which are greenhouse gases causing climate change and global warming . Coal is the largest contributor to the human-made increase of CO_2 in the atmosphere.[1]
- Waste products including uranium, thorium, and other radioactive and heavy metal contaminants
- Acid rain
- Acid mine drainage (AMD)
- Interference with groundwater and water table levels
- Impact of water use on flows of rivers and consequential impact on other land-uses
- Dust nuisance

tunnels, sometimes damaging infrastructure

- Rendering land unfit for the other uses

Coal mining causes a number of harmful effects. When coal surfaces are exposed, pyrite (iron sulfide), also known as "fool's gold", comes in contact with water and air and forms sulfuric acid. As water drains from the mine, the acid moves into the waterways, and as long as rain falls on the mine tailings the sulfuric acid production continues, whether the mine is still operating or not. This process is known as acid rock drainage (ARD) or acid mine drainage (AMD). If the coal is strip mined, the entire exposed seam leaches sulfuric acid, leaving the subsoil infertile on the surface and begins to pollute streams by acidifying and killing fish, plants, and aquatic animals which are sensitive to drastic pH shifts.

Coal mining produces methane, a potent greenhouse gas. Methane is the naturally occurring product of the decay of organic matter as coal deposits are formed with increasing depths of burial, rising temperatures, and rising pressures over geological time. A portion of the methane produced is absorbed by the coal and later released from the coal seam and surrounding disturbed strata during the mining process.[2] Methane accounts for 10.5% of greenhouse gas emission created through human activity.[3]

According to the Intergovernmental Panel on Climate Change, methane has a global warming potential 21 times greater than that of carbon dioxide on a 100 year time line. While burning coal in power plants is most harmful to air quality, due to the emission of dangerous gases, the process of mining can release pockets of hazardous gases. These gases may pose a threat to coal miners as well as a source of air pollution. This is due to the relaxation of pressure and fracturing o the strata during mining activity, which gives rise to serious safety concerns for the coal miners if not managed properly. The buildup of pressure in the strata can lead to explosions during or after the mining process if prevention methods, such as "methane draining", are not taken.[2]

Wherever it occurs in the world, strip mining severely alters the landscape, which damages the values of the natural environment in the surrounding land.[4] Strip mining, or surface mining of coal completely eliminates existing vegetation, destroys the genetic soil profile, displaces or destroys wildlife and habitat, degrades air quality, alters curren land uses, and to some extent permanently changes the general topography of the area mined.[5] The community of micro organisms and nutrient cycling processes are upset by movement, storage, and redistribution of soil.

Generally, soil disturbance and associated compaction result in conditions conducive to erosion. Soil removal from the area to be surface mined alters or destroys many natural soil characteristics, and may reduce its productivity for agriculture or biodiversity. Soil structure may be disturbed by pulverization or aggregate breakdown.

Removal of vegetative cover and activities associated with construction of haul roads, stockpiling of topsoil, displacement of overburden and hauling of spoil and coal increase the quantity of dust around mining operations. Dust degrades air quality in the immediate area, can have adverse impacts on vegetative life, and may constitute a health and safety hazard for mine workers and nearby residents. The land surface, often hundreds of acres, is dedicated to mining activities until it can be reshaped and reclaimed. If mining is allowed, resident human populations must be resettled off the mine site, and economic activities such as agriculture or hunting and gathering food or medicinal plants are displaced, at least temporarily. What becomes of the land surface after mining is determined by the manner in which mining is conducted.

Surface mining can adversely impact the hydrology of a region. Deterioration of stream quality can result from acid mine drainage, toxic trace elements, high content of dissolved solids in mine drainage water, and increased sediment loads discharged to streams. Waste piles and coal storage piles can yield sediment to streams, and leached water from these piles can be acid and contain toxic trace elements. Surface waters may be rendered unfit for agriculture, human consumption, bathing, or other household uses. Controlling these impacts requires careful management of surface water flows into and out of mining operations.

Effects on water

Flood events can cause severe damage to improperly constructed or located coal haul roads, housing, coal crushing and washing plant facilities, waste and coal storage piles, settling basin dams, surface water diversion structures, and the mine itself. Besides the danger to life and property, large amounts of sediment and poor quality water may have detrimental effects many miles downstream from a mine site after a flood.

Ground water supplies may be adversely affected by surface mining. These impacts include drainage of usable water from shallow aquifers; lowering of water levels in adjacent areas and changes in flow directions within aquifers; contamination of usable aquifers below mining operations due to infiltration or percolation of poor quality mine water;

and increased infiltration of precipitation on spoil piles. Where coal or carbonaceous shales are present, increased infiltration may result in increased runoff of poor quality water and erosion from spoil piles; recharge of poor quality water to shallow groundwater aquifers; or poor quality water flow to nearby streams. This may contaminate both ground water and nearby streams for long periods. Lakes formed in abandoned surface mining operations are more likely to be acid if there is coal or carbonaceous shale present in spoil piles, especially if these materials are near the surface and contain pyrites.

Sulphuric acid is formed when minerals containing sulphide are oxidised through air contact, which could lead to acid rain. Leftover chemicals deposits from explosives are usually toxic and increase the salt quantity of mine water and even contaminating it.

Effects on wildlife

Surface mining of coal causes direct and indirect damage to wildlife. The impact on wildlife stems primarily from disturbing, removing, and redistributing the land surface. Some impacts are short-term and confined to the mine site; others may have far reaching, long term effects. The most direct effect on wildlife is destruction or displacement of species in areas of excavation and spoil piling. Mobile wildlife species like game animals, birds, and predators leave these areas. More sedentary animals like invertebrates, many reptiles, burrowing rodents and small mammals may be directly destroyed.

If streams, lakes, ponds or marshes are filled or drained, fish, aquatic invertebrates, and amphibians are destroyed. Food supplies for predators are reduced by destruction of these land and water species. Animal populations displaced or destroyed can eventually be replaced from populations in surrounding ranges, provided the habitat is eventually restored. An exception could be extinction of a resident endangered species.

Many wildlife species are highly dependent on vegetation growing in natural drainages. This vegetation provides essential food, nesting sites and cover for escape from predators. Any activity that destroys this vegetation near ponds, reservoirs, marshes, and wetlands reduces the quality and quantity of habitat essential for waterfowl, shore birds, and many terrestrial species. The commonly used head of hollow fill method for disposing of excess overburden is of particular significance to wildlife habitat in some locations. Narrow, steep sided, V shaped hollows near ridge tops are frequently inhabited by rare or endangered animal and plant species. Extensive placement of spoil in these narrow valleys eliminates important habitat for a wide variety of species, some of which may be rendered extinct.

Broad and long lasting impacts on wildlife are caused by habitat impairment. The habitat requirements of many animal species do not permit them to adjust to changes created by land disturbance. These changes reduce living space. The degree to which a species or an individual animal tolerates human competition for space varies. Some species tolerate very little disturbance. In instances where a particularly critical habitat is restricted, such as a lake, pond, or primary breeding area, a species could be eliminated. The wide range of damage that could be done is severe.

Large mammals and other animals displaced from their home ranges may be forced to use adjacent areas already stocked to carrying capacity. This overcrowding usually results in degradation of remaining habitat, lowered carrying capacity, reduced reproductive success, increased interspecies and intraspecies competition, and potentially greater losses to wildlife populations than the number of originally displaced animals.

Degradation of aquatic habitats has often been a major impact from surface mining and may be apparent to some degree many miles from a mining site. Sediment contamination of surface water is common with surface mining. Sediment yields may increase 1000 times over their former level as a direct result of strip mining. In some circumstances, especially those involving disturbance of unconsolidated soils, approximately one acre foot of sediment may be produced annually for every 80 acres (320,000 m^2) of disturbed land.[5]

In some situations, surface mining may have beneficial impacts on some wildlife. Where large, continuous tracts of forest, bush land, sagebrush, or grasslands are broken up during mining, increased edges and openings are created. Preferred food and cover plants can be established in these openings to benefit a wide variety of wildlife. Under certain conditions, creation of small lakes in the mined area may also be beneficial. These lakes and ponds may become important water sources for a variety of wildlife inhabiting adjacent areas. Many lakes formed in mine pits are initially of poor quality as aquatic habitat after mining, due to lack of structure, aquatic vegetation, and food species. They may require habitat enhancement and management to be of significant wildlife value.[citation needed]

Loss of topsoil

Removal of soil and rock overburden covering the coal resource, if improperly done, causes burial and loss of top soil, exposes parent material, and creates vast infertile wastelands. Pit and spoil areas are not capable of providing food and cover for most species of wildlife. Without rehabilitation, these areas must go through a weathering period, which may take a few years or many decades, before vegetation is established and they become suitable habitat. With rehabilitation impacts on some species are less severe. Humans cannot immediately restore natural biotic communities. We can, however, assist nature through reclamation of land and rehabilitation efforts geared to wildlife needs. Rehabilitation not geared to the needs of wildlife species, or improper management of other land uses after reclamation, can preclude reestablishment of many members of the original fauna.

Surface mining operations and coal transportation facilities are fully dedicated to coal production for the life of a mine. Mining activities incorporating little or no planning to establish postmining land use objectives usually result in reclamation of disturbed lands to a land use condition not equal to the original use. Existing land uses such as livestock grazing, crop and timber production are temporarily eliminated from the mining area. High value, intensive land use areas like urban and transportation systems are not usually affected by mining operations. If mineral values are sufficient, these improvements may be removed to an adjacent area.

Coal seam fires

Main article: Coal seam fire

Fires sometimes occur in coal beds underground. When coal beds are exposed, the fire risk is increased. Weathered coal can also increase ground temperatures if it is left on the surface. Almost all fires in solid coal are ignited by surface fires caused by people or lightning. Spontaneous combustion is caused when coal oxidizes and air flow is insufficient to dissipate heat, but this occurs only in stockpiles and waste piles, not in bedded coals underground. Where coal fires occur, there is attendant air pollution from emission of smoke and noxious fumes into the atmosphere. Coal seam fires may burn underground for decades, threatening destruction of forests, homes, schools, churches, roadways and other valuable infrastructure. Spontaneous combustion is common in coal stockpiles and refuse piles at mine sites.

Fly ash spills

The burning of coal leads to substantial fly ash sludge storage ponds. These can give way as one did at Kingston Fossil Plant

Historic resources

Adverse impacts on geological features of human interest may occur in a surface mine area. Geomorphic and geophysical features and outstanding scenic resources may be sacrificed by indiscriminate mining. Paleontological, cultural, and other historic values may be endangered due to disruptive activities of blasting, ripping, and excavating coal. Stripping of overburden eliminates and destroys all archeological and historic features unless they are removed beforehand.also is really bad for health.

Aesthetic effects

Extraction of coal by surface mining disrupts virtually all aesthetic elements of the landscape, in some cases only temporarily. Alteration of land forms often imposes unfamiliar and discontinuous configurations. New linear patterns appear as material is extracted and waste piles are developed. Different colors and textures are exposed as vegetative cover is removed and overburden dumped to the side. Dust, vibration, and diesel exhaust odors are created, affecting sight, sound, and smell. Some members of local communities may find such impacts disturbing or unpleasant.

Aerial photograph of Kingston Fossil Plant coal fly ash slurry spill site taken the day after the event

Socioeconomic effects

Due to intensive mechanization, surface mines may require fewer workers than underground mines with equivalent production. The influence on human populations from surface mining is therefore not generally as significant as with underground mines. In low population areas, however, local populations cannot provide needed labor so there is migration to the area because new jobs are available at a mine. Unless adequate advance planning is done by government and mine operators, new populations may cause overcrowded schools, hospitals and demands on public services that cannot easily be met. Some social instability may be created in nearby communities by surface coal mining.

Many impacts can be minimized but may not be eliminated entirely by use of best mining practices either voluntarily or to comply with government regulatory programs. Financial incentives to minimize costs of production may minimize use of best mining practices in the absence of effective regulation. Some temporary destruction of the land surface is an environmental price we pay for utilization of coal resources. The scale of disturbance, its duration, and the quality of reclamation are largely determined by management of the operation during mining.

Mountaintop removal to remove coal is a large-scale negative change to the environment. Tops are removed from mountains or hills to expose thick coal seams underneath, and the soil and rock removed is deposited in nearby valleys, hollows and depressions, resulting in blocked and sometimes contaminated waterways. In some areas of the world, remediation is often delayed for decades.

One of the legacies of coal mining is the low coal content waste forming slag heaps. In addition, all forms of mining are likely to generate areas where coal is stacked and where the coal has significant sulfur content, such coal heaps generate highly acidic, metal-laden drainage when exposed to rainfall. These liquors can cause severe environmental damage to receiving water-courses.[6] Coal mining releases approximately twenty toxic release chemicals, of which 85% is said to be managed on site.[*citation needed*]

Mine collapses

Mine collapses, or mine subsidences, have a potential for major effects aboveground, which are especially devastating in built-up areas. German underground coal-mining, especially in North Rhine-Westphalia, has damaged thousands of houses, and the coal mining industries have set aside many millions in funding for future subsidence damages as part of their insurance and state subsidy schemes.[*citation needed*]

In a particularly spectacular case in the German Saar region, another historical coal mining area, a suspected mine collapse in 2008 created an earthquake of force 4.0 on the Richter magnitude scale, causing some limited damage to houses. Previous smaller earthquakes had been increasingly common. Coal mining was temporarily suspended in the area.[7]

Burning

Combustion of coal, like any other fossil fuel, occurs due to an exothermic reaction between the components of the fuel source and the components of the air surrounding it. Coal is made primarily of carbon, but also contains sulfur, oxygen and hydrogen. The reaction between coal and the air surrounding it produces oxides of carbon, usually carbon dioxide (CO_2 - an important greenhouse gas) in a complete combustion, along with oxides of sulfur, mainly sulfur dioxide (SO_2), and various oxides of nitrogen (NO_x). Because of the hydrogen and nitrogen components of air, hydrides and nitrides of carbon and sulfur are also produced during the combustion of coal in air. These could include hydrogen cyanide (HCN), sulfur nitrate (SNO_3) and many other toxic substances.

Further, acid rain may occur when the sulfur dioxide produced in the combustion of coal, reacts with oxygen to form sulfur trioxide (SO_3), which then reacts with water molecules in the atmosphere to form sulfuric acid (see Acid anhydride for more information). The sulfuric acid (H_2SO_4) is returned to the Earth as acid rain. Flue gas desulfurization scrubbing systems, which use lime to remove the sulfur dioxide can reduce or eliminate the likelihood o acid rain.

However, another form of acid rain is due to the carbon dioxide emissions of a coal plant. When released into the atmosphere, the carbon dioxide molecules react with water molecules, to produce carbonic acid (H_2CO_3). This, in turn, returns to the earth as a corrosive substance. This cannot be prevented as easily as sulfur dioxide emissions.

Coal and coal waste products, including fly ash, bottom ash, and boiler slag, contain many heavy metals, including arsenic, lead, mercury, nickel, vanadium, beryllium, cadmium, barium, chromium, copper, molybdenum, zinc, selenium and radium, which are dangerous if released into the environment. Coal also contains low levels of uranium, thorium, and other naturally occurring radioactive isotopes whose release into the environment may lead to radioactive contamination.[8][9] While these substances are trace impurities, enough coal is burned that significant amounts of these substances are released.[8] However, John Gofman, M.D., Ph.D, (Professor Emeritus of Medical Physics at the University of California, Berkeley, and the co-discoverer of Uranium-233) compared the radiation dose per megawatt-year from operation of a nuclear generating unit to the radiation dose from operation of a coal fired unit and found that the dose from natural nuclides associated with nuclear power would be 35-81 times higher than the dose from coal.[10]

Studies about coal phase out and climate change

Main article: Fossil fuel phase out

In 2008 James E. Hansen and eight other scientists published "Target Atmospheric CO_2: Where Should Humanity Aim?"[11] calling for phasing out coal power completely by the year 2030.

In 2008 Pushker Kharecha and James E. Hansen published a peer-reviewed scientific study analyzing the effect of a coal phase-out on atmospheric CO_2 levels.[12] Their baseline mitigation scenario was a phaseout of global coal emissions by 2050. The authors describe the scenario as follows:

> The second scenario, labeled Coal Phase-out, is meant to approximate a situation in which developed countries freeze their CO_2 emissions from coal by 2012 and a decade later developing countries similarly halt increases in coal emissions. Between 2025 and 2050 it is assumed that both developed and developing countries will linearly phase out emissions of CO_2 from coal usage. Thus in Coal Phase-out we have global CO_2 emissions from coal increasing 2% per year until 2012, 1% per year growth of coal emissions between 2013 and 2022, flat coal emissions for 2023–2025, and finally a linear decrease to zero CO_2 emissions from coal in 2050. These rates refe to emissions to the atmosphere and do not constrain consumption of coal, provided the CO2 is captured and sequestered. Oil and gas emissions are assumed to be the same as in the BAU [Business as Usual] scenario.

Kharecha and Hansen also consider three other mitigation scenarios, all with the same coal phase-out schedule but each making different assumptions about the size of oil and gas reserves and the speed at which they are depleted. Under the Business as Usual scenario, atmospheric CO_2 peaks at 563 parts per million (ppm) in the year 2100. Under the four coal phase-out scenarios, atmospheric CO_2 peaks at 422–446 ppm between 2045 and 2060 and declines thereafter. The key implications of the study are as follows: a phase-out of coal emissions is the most important remedy for mitigating human-induced global warming; actions should be taken toward limiting or stretching out the use of conventional oil and gas; and strict emissions-based constraints are needed for future use of unconventional fossil fuels such as methane hydrates and tar sands.

In the Greenpeace and EREC's Energy (R)evolution scenario,[13] the world could eliminate all fossil fuel use by 2090 [14][15][16]

Mercury Emissions

Mercury emissions from coal burning are concentrated as they work their way up the food chain and converted into methylmercury, a toxic compound[17] that harms people who consume freshwater fish. In New York State, winds bring mercury from the coal-fired power plants of the Midwest, contaminating the waters of the Catskill Mountains. The mercury is consumed by worms, who are eaten by fish, and then by birds, including bald eagles. As of 2008, mercury contamination of bald eagles in the Catskills had reached new heights.[18] Ocean fish account for the majority of human exposure to methylmercury; the sources of ocean fish methylmercury are not well understood.[19]

Coal-fired power plants shorten nearly 24,000 lives a year in the United States, including 2,800 from lung cancer.[20]

By country

United States

Main article: Coal power in the United States

By the late 1930s, it was estimated that American coal mines produced about 2.3 million tons of sulfuric acid annually. In the Ohio River Basin, where twelve hundred operating coal mines drained an estimated annual 1.4 million tonnes of sulfuric acid into the waters in the 1960s and thousands of abandoned coal mines leached acid as well. In Pennsylvania alone, mine drainage had blighted 2,000 stream miles by 1967.

In response to negative land effects of coal mining and the abundance of abandoned mines in the USA, the federal government enacted the Surface Mining Control and Reclamation Act of 1977, which requires reclamation plans for future coal mining sites. Reclamation plans must be approved and permitted by federal or state authorities before mining begins.[5] As of 2003, over 2 million acres (8,000 km²) of previously mined lands have been reclaimed in the United States.

Emissions from coal-fired power plants represents one of the two largest sources of carbon dioxide emissions, which ar the main cause of global warming. Coal mining and abandoned mines also emit methane, another cause of global warming. Since the carbon content of coal is higher than oil, burning coal is a serious threat to the stability of the global climate, as this carbon forms CO_2 when burned. Many other pollutants are present in coal power station emissions, as solid coal is more difficult to clean than oil, which is refined before use. A study commissioned by environmental groups claims that coal power plant emissions are responsible for tens of thousands of premature deaths annually in the United States alone.[citation needed] Modern power plants utilize a variety of techniques to limit the harmfulness of their waste products and improve the efficiency of burning, though these techniques are not subject to standard testing or regulation in the U.S. and are not widely implemented in some countries, as they add to the capital cost of the power plant.[citation needed] To eliminate CO_2 emissions from coal plants, carbon capture and storage has been proposed but ha yet to be commercially used.

The effects of sediment on aquatic wildlife vary with the species and amount of contamination. High sediment loads ca kill fish directly, bury spawning beds, reduce light transmission, alter temperature gradients, fill in pools, spread stream flows over wider, shallower areas, and reduce production of aquatic organisms used as food by other species. These changes destroy the habitat of some valued species and may enhance habitat for less desirable species. Existing conditions are already marginal for some freshwater fish in the United States. Sedimentation of these waters can result in their elimination. The heaviest sediment pollution of a drainage normally comes within five to 25 years after mining. In some areas, unrevegetated spoil piles continue to erode even 50 to 65 years after mining.[5]

The presence of acid forming materials exposed as a result of surface mining can affect wildlife by eliminating habitat and by causing direct destruction of some species. Lesser concentrations can suppress productivity, growth rate, and reproduction of many aquatic species. Acids, dilute concentrations of heavy metals, and high alkalinity can cause sever wildlife damage in some areas. The duration of acidic waste pollution can be long term. Estimates of the time required to leach exposed acidic materials in the Eastern United States range from 800 to 3000 years.[5]

Surface mining operations have produced cliff-like highwalls as high as 200 feet (61 m) in the United States. Such highwalls may be created at the end of a surface mining operation where stripping becomes uneconomic, or where a mine reaches the boundary of a current lease or mineral ownership. These highwalls are hazards to people, wildlife, and domestic livestock. They may impede normal wildlife migration routes. Steep slopes also merit special attention because of the significance of impacts associated with them when mined. While impacts from contour mining on steep slopes are of the same type as all mining, the severity of these impacts increase as the degree of slope increases. This is due to increased difficulties in dealing with problems of erosion and land stability on steeper slopes.

Mining operations in the United States must, under federal and state law, meet standards for protecting surface and ground waters from contamination, including AMD. To mitigate these problems, water is continuously monitored at coal mines. The five principal technologies used to control water flow at mine sites are:

- diversion systems,
- containment ponds,
- groundwater pumping systems,
- subsurface drainage systems,
- subsurface barriers.

In the case of AMD, contaminated water is generally pumped to a treatment facility that neutralizes the contaminants.

The Environmental Protection Agency classified the 44 sites as potential hazards to communities, which means the waste sites could cause death and significant property damage if an event such as a storm, a terrorist attack or a structural failure caused a spill. They estimate that about 300 dry landfills and wet storage ponds are used around the country to store ash from coal-fired power plants. The storage facilities hold the noncombustible ingredients of coal and the ash trapped by equipment designed to reduce air pollution.[21]

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Coal Mining by the Numbers:

90 million Gallons of waste slurry produced every year while preparing coal to be burned.

1,200+ Miles of streams that have been buried or polluted in Appalachia because of mountaintop removal mining.

260 million Gallons of water used for coal mining in the U.S. every day.

12,000 Miners who died from black lung disease between 1992 and 2002.

55 Percent decrease in number of coal miners employed from 1985-2000.

22 Percent increase in coal mining production from 1985-2005.

ATTACHMENT 14

IN BRIEF SPRING 2010

Former coal miner Chuck Nelson at the edge of the huge Hobet mountaintop removal mining operation in Lincoln County, West Virginia

The True Story of Coal in America—and Our Fight To Write a New Chapter

BY LIZ JUDGE AND JARED SAYLOR

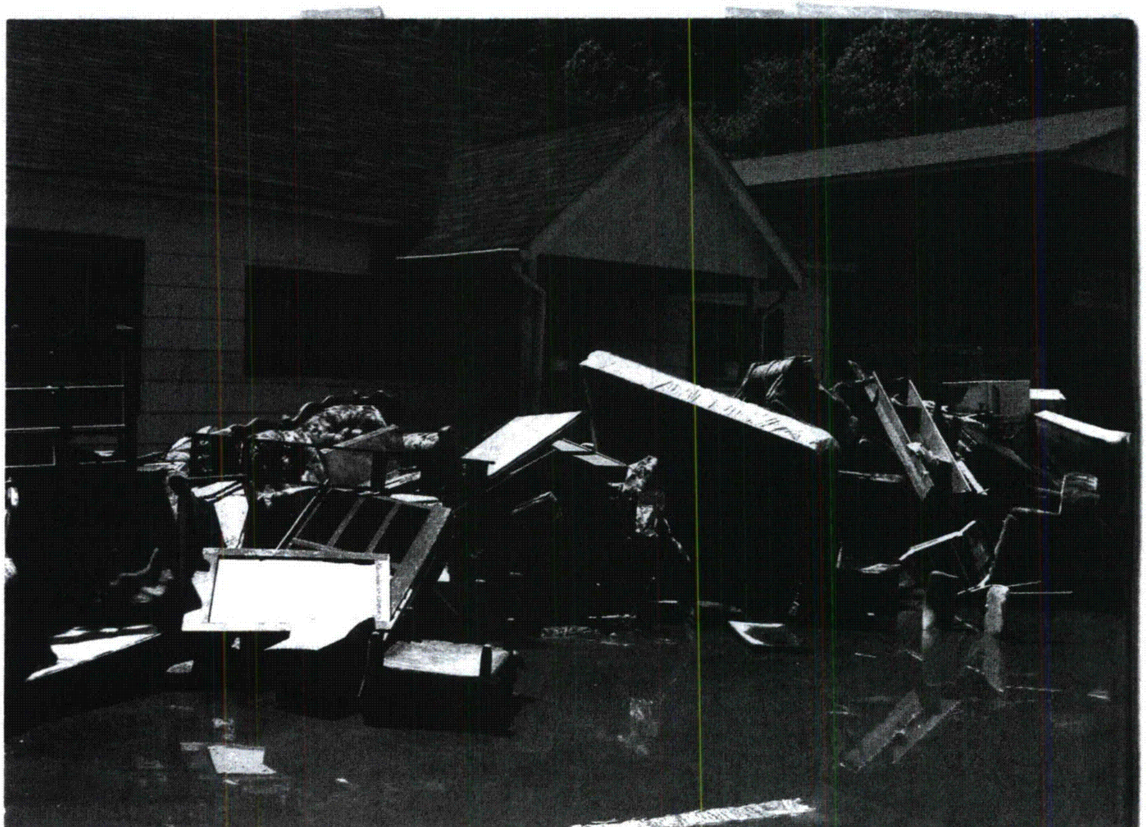
THE MORNING WEST VIRGINIA NATIVE CHUCK NELSON woke up to discover a quarter-inch of black coal dust coating his living room furniture was the day he knew something must be done.

Fellow West Virginian Judy Bonds knew she needed to act when she stood with her 6-year-old grandson in a stream near her home and watched a school of dead fish float by—the first of many fish kills caused by toxic mountaintop removal mining waste dumped in her area's streams and creeks.

Sarah McCoin's moment was even more dramatic: a billion gallons of toxic coal sludge burst through a dam in Kingston, Tennessee, near her home, destroying everything and transforming her into an activist.

continued on page 10

EARTHJUSTICE



Flooding in communities near mountaintop removal sites is becoming more common and more deadly. As mountains are cleared of trees, shrubs and other plants, rainwater that usually would be caught in these natural filters is running unabated into oversaturated streams.

These are the stories of coal in America—from coast to coast attacking communities. Cancer and asthma rates are on the rise. Arsenic, selenium, cadmium and lead pollute mountain streams and drinking water supplies. Mercury from smokestacks contaminates fish, while particulate pollution damages lungs. The life cycle of coal holds a tight grip on our health, environment and ability to thrive. But, with the

MINING COAL: WHERE IT ALL STARTS

For years, a mountain ridge stood between Chuck and the smokestacks of Massey Energy's coal preparation plant—until Massey blasted the mountain top off to get at the coal, exposing Chuck's neighborhood to the smokestacks and a toxic wind. Laden with chemical coal cleaners and clouds of black dust, it blew straight into Chuck's home.

"You could see whole clouds of coal dust blowing over the town. We shut our doors and windows, but that didn't stop the coal dust. We knew breathing coal dust laced with all those chemicals had to be terrible, and felt terrible."

Chuck, a third-generation coal miner, watched his wife develop severe asthma, saw neighbors fall ill, looked on as an unlined earthen dam filled with 9 billion gallons of coal waste two miles upstream from his town, and watched the elementary school down the street close after many of his neighbors vacated the town.

Judy's young grandson began to develop asthma shortly after Massey began mountaintop-removal mining in her home area of Marfork Hollow. "About every child in Marsh Fork Elementary had an asthma inhaler, the same with my grandson's Little League team." After Judy became the last person to leave her hollow, Massey put up a gate closing off the area from the public, and has since torn down the homes, hers included.

BURNING COAL: INTO THE AIR, INTO THEIR LUNGS

GILES ASHFORD

After coal is mined, taking its toll on nearby families and communities, then coal is burned—pumping toxins and pollution into the air of communities surrounding more than 600 coal-fired power plants nationwide, among them Washington's last coal-fired power plant, TransAlta.

TransAlta is the state's largest producer of global warming and other air pollutants, spewing hundreds of thousands of pounds of nitrogen oxide, hydrochloric acid, arsenic, mercury and lead into the air and water, polluting Puget Sound and high mountain lakes. Its polluted haze obscures nearby national parks and wilderness areas, even views of majestic Mount Rainier.

"There are a lot of people here in Washington, especially in the religious community, who believe that burning coal runs counter to religious values of caring for creation and the suffering, stewardship, and protecting the common good," says LeeAnne Beres, executive director of Earth Ministry/Washington Interfaith Power & Light

Her group is a partner of Earthjustice in the legal fight to convert the plant to cleaner fuels by 2015. Also joined in that struggle are the Sierra Club, the National Parks Conservation Association, Physicians for Social Responsibility and Northwest Environmental Defense Center.

As one of the state's 488,000 asthma sufferers, LeeAnne knows firsthand how burning coal causes wheezing, coughing and asthma attacks. Each year, according to the American Lung Association, particle pollution is responsible for 24,000 early deaths, and ozone pollution is linked to tens of thousands of emergency room visits, hospitalizations, and lost work days.

"We have an obligation to protect creation and the people who are part of creation, especially the least among us who will suffer the most from air pollution and climate change."

DUMPING COAL'S WASTE: AND THEN CAME THE FLOOD

The coal ash landfill filled with toxic remains of burning coal at the nearby Tennessee Valley Authority power plant burst through a dam and spilled dangerously high levels of arsenic, selenium, lead and other toxic pollutants, across 300 acres, damaging nearly two dozen homes.

Sarah McCoin says the first news reports were about a mudslide, not the billion gallons of coal ash that were actually flowing just a few miles from her home."I'm thinking,'Mudslide? What do they mean, a mudslide?'"

Hours later, she learned that a coal ash landfill filled with the toxic remains of burning coal at the nearby Tennessee Valley Authority power plant had burst through a dam and spilled across 300 acres. Laden with dangerously high levels of arsenic, selenium, lead and other toxic pollutants, the spill damaged nearly two dozen homes.

"The lake we used to fish in, it's gone. My farmer friends, their fields are covered in this stuff. There were huge ashbergs, telephone poles just snapped. People were parked with a shocked look on their face, and their house was gone, the road was just gone."

A ninth-generation Tennessean, Sarah never considered herself much of an activist. The spill near her home turned her and her community into affected citizens, victims of one of the greatest environmental disasters in our nation's history.

The EPA estimates that at least 47 other coal ash dumps pose a threat to human life if a catastrophic spill were to occur. Sarah realizes that coal is an inevitable part of our lives today, as we transition toward a clean break from this destructive energy source."Coal ash is a hazardous material, a waste that needs to be regulated," she said, "and though we can't stop producing coal-fired energy overnight, we cannot afford to have a community or the environment devastated the way we are."

All three people have also learned just how hard it can be to stand up to the powerful coal industry in the heart of coal country. But evi-

dence of coal's pollution and destruction go far beyond the anecdotal. A growing body of scientific studies shows that coal pollution is devastating communities, harming and sickening people, and destroying the ecosystems and natural resources in our country.

Green living tips

Effects of oil spills

By Green Living Tips | Published 06/12/2010

Originally published November 2007, last updated June 2010

Oil slicks do so much more damage than just the initial havoc we see on the news - the effects can be very long lasting.

Since first publishing this article in 2007 and even though oil has become even more precious in a world now coming to terms with the fact peak oil is a reality rather than possibility, we've continued to see significant oil leaks and spills occurring on a fairly regular basis.

The Deepwater Horizon BP oil leak disaster currently occurring in the Gulf of Mexico has well and truly eclipsed the Exxon Valdez oil spill of 1989.

Estimates for the average flow rate of the spill prior to the fitting of a Lower Marine Riser Package (LMRP) Cap Containment System in early June run between 20,000 barrels (840,000 US gallons or 3,200,000 litres) per day and 40,000 barrels (1,700,000 US gallons or 6,400,000 litres) per day.

While the capping and associated pumping is capturing oil, it is not capturing all of it and oil is continuing to spew into the Gulf of Mexico.

Effects of oil spills

When oil is spilled or leaked into in waterways and the ocean, it spreads very quickly with the help of wind and currents. A single gallon of oil can create an oil slick up to a couple of acres in size! The BP oil slick had spread over 580 square miles in just three days.

When oil starts mixing in water, it can change composition and becomes what's known as "mousse". This is a sticky substance that clings even more to whatever it comes in contact with. Many marine animals don't know to avoid a slick and some fish may even be attracted to it as it can resemble food.

Some of the many effects on animals coming into contact with crude oil include:

- hypothermia and drowning of birds as the oil breaks down the insulating capabilities of feathers, makes them heavier and compromises flying ability

- hypothermia in some seal pups as the oil destroys insulating fur

- if oil is ingested, it can either poison the animal outright, make them extremely sick or create a level of toxins in their system that then causes poisoning further up the food chain. Birds and other animals often ingest oil when trying to clean themselves. Shellfish and corals are particularly at risk in these scenarios as they cannot escape from an oil slick.

- damage to the airways of birds and animals.

- damage to animal immune systems

- interruption of breeding and fouling of breeding grounds

- thinner bird and turtle egg shells and also damage to fish larvae, causing deformities

- damage to sea grass beds and other shelter/feeding areas

- tainting of algae, which perform a vital role in waterway ecosystems

Even once the oil appears to have dissipated, it can still lurk beneath the surface of beaches and the sea bed, severely affecting marine organisms that burrow, such as crabs, for literally decades. These burrowing creatures are also food for other animals, so the cycle of poisoning continues for many years.

There's really no aspect of a marine and coastal environment that is not in some way adversely affected by an oil spill. The closer the spill occurs to the shoreline, the more pronounced the damage will be due to coastal zones being home to more concentrated and diverse populations of marine, bird and animal life than far out to sea.

World's biggest oil spills.

Here's four of the biggest marine spills in history.

Persian Gulf - January 23, 1991 - up to 1,500,000 tonnes
Gulf of Mexico - June 3, 1979 - 454,000 - 480,000 tonnes
Trinidad and Tobago - July 19, 1979 - 287,000 tonnes
Fergana Valley Uzbekistan - March 2, 1992 - 285,000 tonnes

There have been a total of 14 known marine oil spills consisting of over 100,000 tonnes. One tonne of crude oil is roughly equal to 308 US gallons; so in the Persian Gulf incident, approximately 462 million barrels were spilled - 20 times more than the USA consumes in a day, over a year's worth of consumption for Australia and enough to supply the entire world's crude oil needs for around 5 days.

It's interesting to note that the Exxon Valdez disaster, isn't among the "100,000" club - it wasn't even close at approximately 35,000 tonnes - but it was the largest spill in U.S. history and given where it occurred, one of the biggest ecological disasters the nation has experienced. That spill killed hundreds of thousands of sea birds, thousands of otters, hundreds of seals as well as killer whales, bald eagles and fish. It's not just how much oil is spilled that plays a role in the devastation that occurs, but where it is spilled.

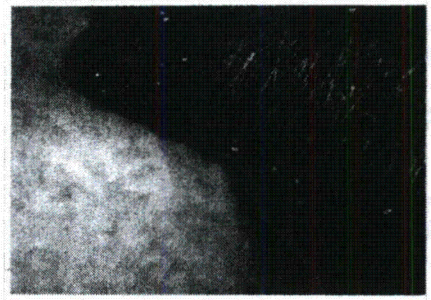
Oil leaks and spills don't just affect marine life - they have a direct impact on humans too long after the initial media frenzy has died down. Some Alaskan communities were affected by the Exxon Valdez disaster as important commercial fishing and hunting grounds were contaminated for an extended period. Tourism was also affected.

Unfortunately the people, creatures and ecosystems of Louisiana and other states are now experiencing the same..

GREEN LIVING

Effects of Oil Spills

The effects of oil spills reach far beyond the location of the original spill. Within a short period of time even a small spill can impact miles of habitat.



Oil, just one water pollution cause

Oil in Ocean and Other Waterways

Oil is spilled into the oceans and waterways through a variety of circumstances. About half of the 706 million gallons of oil that are estimated to enter the ocean every year are from run-off. Improper handling of used motor oil is a big part of this percentage. Although offshore drilling gets a lot of publicity when there is a spill, it actually accounts for less than eight percent of the annual total of oil spilled in the ocean. The rest of the oil comes from the following:

- Routine maintenance on ships: 20 percent
- Air pollution settling on the water: 13 percent
- Natural leaks in the ocean floor: estimated between 8 and 10 percent

It doesn't take much oil to spread over a large area. In the right conditions, a gallon of oil can create an oil slick as large as two acres wide.

Effects of Oil Spills on Habitats

One of the areas that is most obviously affected after an oil spill is the shoreline. The oil washes up on the beaches coating the sand, rocks, and plants with oily residue. When the sand is covered with oil it can't support the vegetation that normally would grow there. Wildlife may eat the contaminated vegetation and become sick or die.

Tidal pools and other small ecosystems can't support life when they become contaminated. The creatures in a tidal pool are part of the food chain so predators may either get sick from eating toxins in their prey or can starve from a lack of food.

Coral Reefs are destroyed by many factors, including oil spills. These reefs provide a habitat for aquatic life as well as being beautiful to look at.

Economic Effects

The local economy is affected by an oil spill. Recreational areas that are covered with oil are not appealing to tourists and towns that depend on tourism can find themselves in a difficult financial situation.

Property values may drop drastically after an oil spill. Investors may not want to invest in the area because of concern over a long-term drop in tourism. Restaurants, hotels, and retail establishments can be seriously compromised if the cleanup is not efficient, fast, and complete. After a spill it can take months or years to win tourists back to an area that has been affected by a spill.

Fishermen may not be able to fish because the sea is contaminated. Over a long period of time, the population of fish and shellfish in an area can be greatly reduced or totally lost from an oil spill. Boats and machinery can be damaged by the oil that floats on the surface of the water and nets and traps can be ruined. Cleanup crews can disrupt fishing schedules and there may even be a temporary ban placed on fishing as a precaution against contaminated fish becoming part of someone's dinner.

Besides the obvious economic effects of an oil spill there can be serious threats to the well being of residents. A power plant that has intakes that draw in seawater may need to close until cleanup can be completed. The machinery can be ruined by the oil that could come in with the water.

Effects of Spills on Wildlife

Probably one of the areas of greatest concern is the effect of the oil spill on wildlife. From the smallest plankton to the largest whale, all marine life is impacted by an oil spill.

Plankton

Plankton is not only a habitat for fish eggs and larvae, but is also the main diet of many ocean creatures. Without this basic organism, the entire ecosystem can be thrown off. Scientists know that toxins affect the number of plankton in an area, but the ocean is so large, it is difficult to come to any solid conclusions about percentages .

Seabirds

Many seabirds dive for their food. Often, they must dive through a layer of oil to get to the fish they eat. This leaves the oil residue on their feathers, which can cause numerous problems. When the birds attempt to preen, or clean themselves, they ingest the oil, which is toxic. However, the most common cause of death for these birds is from drowning, loss of body heat, or starvation because of the oil on their feathers. The eggs that the birds lay often have weak shells that break easily.

Entire colonies of birds can be wiped out by a single, serious oil spill, whether from illness, plumage contamination, or habitat loss.

Mammals

Seals, otters, and other marine mammals that breed on the shoreline are particularly at risk for problems after an oil spill. If oil gets on their fur they can no longer regulate their body temperatures and can die of hypothermia or even overheating. If the fish population has been affected, then the mammals can starve from lack of food. When oil washes up onto the shore and affects breeding areas, the birth rate may drop rapidly.

Fish, Turtles, and Other Life

Like other marine life fish and turtles, shellfish, and other organisms can be seriously compromised by an oil spill. Common problems include:

- Behavioral changes
- Blindness
- Damage to internal organs
- Spread to other habitats
- Sores
- Stress

Oil spills from oceans can be washed into inland wetlands and marshes, affecting the plant and animal life in these areas. Plants in wetland areas will die when they are covered with oil. Animals, birds, and other inland creatures may suffer from a variety of illnesses as the oil contaminates their habitat.

Far Reaching Effects

The effects of oil spills reach much farther than the ocean, and it is more than just the animals that are affected. From the economy to the ecosystem, oil spills disrupt lives.

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