Why Kentucky Legislators should not repeal current waste disposal requirements for nuclear power plants in the Commonwealth, 2017.

The 2017 Kentucky legislature finds itself without the historical checks on the construction and consideration of statute. Senator Carrol has introduced SB11 in the Senate and Representatives Watkins and Richards introduced HB90 in the House. These short bills would repeal the extant policy in the Commonwealth to require a means of disposing of waste ere one makes it. The bills change the statutory requirement that a nuclear power plant have a plan and a means to dispose of the spent fuel rods it generates. The bills would permit a nuclear power plant to store spent fuel on site indefinitely.

Unlike any other bill offered in this session, the term of consequence and the scale of liability entailed by the House and Senate's simple revision of nuclear waste management statutes are measured, at least, in centuries and may encumber unhealthy fractions of the state's economy. The current bills lack measures of cost and benefit, limits to the scale and style of "nuclear fission thermal power plants", guidance about risk management and mitigation, or any commitment to ever remove Spent Nuclear Fuel (SNF) from the Nuclear Power Plant (NPP) site. It may unnecessarily predispose the state to reprocess waste without consideration of cheaper disposal methods or the lack of market for reprocessed NPP fuels (MOX, Mixed Oxides fuel). These issues deserve more consideration than a rubber stamp, and will certainly be reviewed in future legislative sessions. Please make choices that the next generation can abide.

Two events in the Commonwealth have framed the discussion of nuclear waste in the last year: the illegal TENORM dumping in Estill County, and the announcement of Hitachi/GE's SILEX (Separation of Isotopes by Laser Excitation) process being applied to waste tailings at Paducah. Both highlight some special aspects of nuclear waste and the large costs of managing it properly. Neither event advocates for the Commonwealth to relax radioactive waste standards.

Paducah's recently announced plan[1] to re-refine some onsite UF6 "tailings" using the Australian technology SILEX licensed by Hitachi/GE seems unlikely to actually happen, but it may. SILEX had been promoted for more than a decade, with only a couple of demonstration sites taking shape[2], then basically mothballed[3]. The world market for SILEX services appears small (and flooded). There are concerns that promoting SILEX has some security concerns, as the technology has attributes that make it hard to detect bad actors[4]. Rather than make Low Enriched Uranium fuel (LEU) at Paducah, some tailings will be refined and then re-diluted into other tailings to make a "natural ore equivalent" (an equal concentration of U235 as found in natural Uranium ore) with the hope of then marketing as ore what is now a nuclear waste. However, the UF6 waste is already being addressed[5]. Also adding to the doubt, in April 2016 Hitachi/GE decided to withdraw their 3/4 share from the Global Laser Enrichment consortium[6]. As well, the west has abundant ore, Yellowcake and LEU production. The market for ore is not expected to improve[7].

The national and international nuclear power markets remain mixed but have improved slightly in the last year. In the US, the Waste Isolation Plant (WIPP) just reopened[8] and will

again take some nuclear wastes. Russia has opened a similar facility[9]. Japan has restarted some reactors while closing three permanently. China, India, Pakistan, and other nations have added NPP base production. Nations that have been using NPPs longer continue to encounter economic disincentives and have closed some licensed plants. Japan recently abandoned it's 22 year long and nine billion dollar investment in fast breeder Plutonium production[10], and TEPCO's ice wall at Fukushima is a failure[11] Nations that have reprocessed fuels continue to find their Plutonium inventoried on shelves, without market[12] (except North Korea[13]). Malware[14] was found at a nuclear power plant.

The remainder of this document is the same argument and citations as offered in the 2016 session, for some this may be a second reading.

> Documented below is a international track record of financial failure in both free market unsubsidized Nuclear Power Plants (NPP), and Spent Nuclear Fuel (SNF) reprocessing facilities. Also detailed are insights into risks, penalties and the very large costs of nuclear waste management and disposal.[15] Of particular note, in addition to the reactor vessel decommissioning costs, a reactor's hot SNF will long remain on site in cooling pools and dry casks after the reactor is dismantled,[16] requiring significant long term oversight and security. This document offers supporters of HB90 and SB11 the evidence that most SNF in the US is not reprocessed, nor is it likely that it will be, absent inflated investments of federal tax dollars[17]. MOX and it's production are riskier and the market for reprocessed fuel is flooded[18].
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> Please note that the preceding legislative sessions (2014, 2016) that saw similar bills and a healthier international nuclear industry[19] chose to not pass any bills to remove the extant nuclear waste management standards.

- Weak economics: Licensed NPPs are closing in the US as they prove uneconomic to operate[20]. The IEEE's review of the economic history of Small Modular Reactors (SMR) shows SMRs to be an even worse financial choice than NPPs[21]. Germany and Japan's private NPP operators are seeking to put their costs and risks on their nation's public after their private earnings went negative[22]. It is likely that taxpayers in the Commonwealth would be challenged to bear closure and remediation costs in the same fashion. Like Germany's private NPP operators, TEPCO (Fukushima) is seeking to place their risks and costs of NPPs on the public[23].

- There are few suitable sites for a nuclear power plant in the Commonwealth. The Paducah community cannot, nor can any other community at the Western end of the Commonwealth, safely host a nuclear power plant: the New Madrid Fault is too close. Reliable coolant water supplies, freedom from earthquakes, avoidance of population centers, and access to electrical reticulation narrow the possibilities significantly. Placing them on the Ohio River risks the water supply to many downstream communities- that will invite many other states to take issue, and may lead to a new generation of Paddlewheelers (Louisville's Paddlewheel Alliance organized to oppose the Marble Hill, Indiana nuclear power plants). Reticulated sites on larger interior rivers, like East Kentucky Power Co-Op at Trapp, in Clark County, are typically in direct competition with the public for fresh water.

- *With an emphasis on nuclear waste management issues, this section is a brief abstract of risk related events in the international nuclear industry over the last two years.* There have been economic failures in major NPP markets. Areva (87% owned by the nation of France) is in trouble[24]. In the red for 5+ years, they've laid off c.5k employees and recently lost $6B, costing France $4B in one year alone. Their partner, EDF, is also in dire financial straits, bringing uncertainty to Britain's nuclear plans[25]. Britain's nuclear reservation, Sellafield, had to cancel a $30B cleanup because the cost was escalating beyond their means[26]. Toshiba/Westinghouse are looking to sell their NPP interests[27]. Germany is facing an $80 billion cost for decommissioning NPPs[28], and the private interests holding their NPPs want the public to foot the cleanup bill[29]. The Czech Republic has put their long term waste repository plans on hold[30]. Waste disposal has also regressed in the USA, as issues with the basic storage technologies rise[31], with fugitive Plutonium contamination trouble at WIPP[32] that exposed 17 worker to Plutonium waste (probably due to a one misheard word: "inorganic" heard as "an organic"), and with Hanford's cleanup, which remains 25 years behind schedule[33]. The USA is at odds with most of the 77 members of the Convention on Nuclear Safety, and may need to raise it's standards, with the incumbent costs falling on the taxpayer[34]. In the US, reactor construction is over budget and behind schedule[35]. The EU advanced reactors are also many years behind schedule and 3x over budget[36]. Belgium has reported cracks in two NPP pressure vessels, while France has found dangerous flaws in their new designs[37]. The USA has found deliberate falsification of NPP operator records[38]. South Korea closed an NPP after the operator controls were hacked[39]. Watchdogs think there will be more cyber assaults[40] like the US's Stuxnet. To date, most efforts to slow the fugitive nucliides egress to the sea at Fukushima has failed[41], and they have rolled back the SNF removal by 3 years[42]. Post Fukushima, TEPCO has been a drag on Japan's economy[43], with more than $100B in debts, only $15B in assets, and c. $1.2B annual net income[44]. The world's stockpile of Pu and SNF has grown and has proven to have a significant negative value[45]. The down blending of HEU has hit a rough patch[46]. Russia, Pakistan, India, China, North Korea, and others are building or improving ballistic/drone first strike nuclear weapons[47]. China and Russia are publicly expecting new nuclear facilities to operate for 100[48] years. Here in the US, at 40 (+40[49]) years, we encounter obsolescence and degradation issues so profound that even permitted NPPs are closing[50]. Past NRC board chairman Jaczko has told a nuclear safety conference: "I think it's time that we need to reconsider prolonging the lifetime of many of these reactors." [51] There is a tritium leak 45 miles upstream of Manhattan[52].

  On the bright side, Australia expects to sell more yellow cake to China[53]. Iran has accommodated international concerns, and will no longer enrich beyond LEU[54].

- Nuclear Waste management is a long term problem. The Commonwealth's efforts to fully fund long term obligations like pensions and schools, are models for how difficult it will be for the state to fully afford the complete life cycle of nuclear power generation. While the current Kentucky government is the "future generation" now for inbuilt pension and education costs, this Kentucky legislature is being asked to pass a bill to let nuclear power plants avoid the real cost of waste management and to defer these extensive costs to later generations and legislatures. As a broad fact, most nations that remain ambitious to implement NPPs for base load utility within their national borders are relative newcomers to the industry and have not been in the business long enough to have the issues of age, obsolescence, or large volumes of SNF come to roost as they have for all the early adopters, like the US, Britain, France, or Russia. Just as Kentucky faces the belated cost of under funding the state pension system, so too, will NPP operators and MOX producers that try to

ignore the cost of waste disposal and decommissioning. Those agents will ultimately face very large unfunded obligations. Failing to plan and budget for the full cost of the life cycle of the facility assures that future generations will see a large cost for the benefits their parent's enjoyed.

- The nuclear power industry has unique and prolonged waste disposal issues that demand very large long term investments to address[55]. Ignoring those can only be done in the short term, like one fuel cycle, or about 1-4 years for most facilities.[56] Relative to other power generation utilities, there are large closure costs for shut down plants that no longer generate electricity or revenue. Albeit, not a nuclear power plant, one in-state example of long term radionuclide cleanup costs is Paducah (the home district of two of the bills sponsors). In 2013, the year after stopping gaseous diffusion enrichment, the site took a small hit from a tornado,[57]Paducah's operator, USEC, declared bankruptcy,[58] the GAO reported federal hi-jinx in the title and valuation of the remaining inventories at Paducah (see above), and Kentucky is threatening to sue the federal government over Paducah's cleanup[59]. Legislators should note that the Federal Government has had trouble finding the money to properly close Paducah. The Commonwealth has much smaller pockets. Another Kentucky example is the low level waste disposal site at Maxie Flats: after leaking for years, it became a Superfund site, and will require maintenance for lifetimes.
- As public leadership, it's important to observe and consider the intrinsic risk that the public will further abandon the industry after the next big failure or significant technical advance in competing energy technologies. Fukushima has precipitated large cuts in the planned numbers of new plants in Russia, China, and India, the international growth leaders. Japan closed all nuclear power plants, and has only restarted two in the last five years, and many nations have paused for review. World production of energy from nuclear power has fallen post-Fukushima.[60] Should Kentuckians be persuaded to cancel a nuclear power plant under construction, we will then have to solve the energy production problem again, while paying off the mothballed nuclear plants. This has happened before in the USA: Washington state and New Hampshire are examples.[61] No other source of electrical power has this 'sudden death of public support' feature.
- The political argument to repeal our longstanding safe-guards has many vulnerabilities. The state of Kentucky has gone on record opposing such facilities and joined in lawsuits opposing nuclear power plants, citing health and safety concerns.[62] As senior members of the state's legislature are aware, Kentucky had long suffered from inadequate solid waste disposal standards that led to hard won improvements in waste management-this proposal is a contradiction to that trend and will certainly draw out the same community of voters that brought better protections to the Commonwealth. It won't help Kentucky's beleaguered coal industry to have the public realize that coal includes Naturally Occurring Radioactive Materials (NORMs)[63] and those already pose problems as fugitive aerosols and fly ash.
- Repealing the current standards gains the Commonwealth little: nuclear power generation is not cheap. Federal construction subsidies[64], regulatory relief, and subsidized insurance notwithstanding, nuclear power generation still costs more than other methods of providing electrical power infrastructure[65], and those costs are rising. Excelon, one of the nation's largest civilian nuclear operators now says that even wind power can be cheaper.[66] Taxpayer subsidized insurance plus fuel price manipulations[67] skews cost comparisons between nuclear power and other means of producing electricity, hiding part of the cost of nuclear power. Nuclear power plants are uninsurable in a free market. Further, the federal government's coverage (the Price-Anderson Act[68]) puts an artificially low cap on damages: in the event of a significant failure, the citizens of the Commonwealth will simply lose. The

plants themselves are relatively harder to finance (the industry's default rate on government-backed loans has been over 50 percent, according to the Government Accountability Office.).[69] Kentucky has no experience operating NPPs or reprocessing fuel, both have little to do with diffusion driven U235 LEU isolation, our obsolete forte'. The state's experienced nuclear technical resources have worked on nuclear fuel production and medical isotopes, not civilian power plant operation.

- As HB90 suggests, nuclear power plants inspire facilities that reprocess spent fuel. Such facilities are proving to be far more expensive than first thought, while failing to deliver their product. Although the alternative, 'Once-through' fuel use and dry cask storage of spent fuel rods is not cheap, the British, French and Japanese experience with reprocessing has proven a huge financial and fuel stock failure [70]. They have encountered massive costs, low production, and low thermal and radiological waste reductions. Those nations have mostly put the fissile product on the shelf because it is more costly than ore based LEU or down blended HEU, because it makes a riskier MOX fuel rod, and because it is a bomb proliferation risk. China may follow them.[71] Those concerned with dirty or nuclear bomb proliferation should reflect on the national security risks associated with making the requisite materials and technology common. Genuine proliferation issues have become more evident in recent years[72]. Pakistan, North Korea[73], and Israel continue to escalate uncontrolled, non IAEA managed bomb production.[74] Theft of nuclear materials has remained a threat.[75]
- The future for high level waste disposal in the US remains murky[76] The US is decommissioning more reactors than it is building, while the decommissioning costs remain uncertain.[77] Former Nuclear Regulatory Commission chairman Jaczko expects nuclear power to wind down[78], calling some US reactors “unsafe”.[79] US high-level radioactive waste continues to accumulate in pools at power stations across the nation.[80] US long term high-level radioactive waste disposal planning took a legal and funding hit in 2013 from the Federal Courts and industry.[81] The WIPP Plutonium containment failure mentioned earlier has closed that facility since the Pu containment barrels began bursting, with a tentative reopening scheduled for December 2016. The Goshute Indians' site, one of the few alternatives to Yucca Mountain, quit seeking a NRC license for their proposed high level waste disposal service.[82]

- Internationally, high level waste management also remains unsettled: the Czech SNF repository study has had a Yucca Mountain moment.[83] Britain again studies High Level Waste Management but still has no waste disposal site.[84] South Korea has not yet found a way to dispose of its nuclear waste.[85] China's nuclear program, often held up as an example to follow, has made no better progress than the US on high-level nuclear waste management, both rely upon in-situ pool storage and short term cask storage. Public opposition to nuclear power is on the rise in China.[86] Their long-term storage site for high level waste may be on line in 2050.[87] Their intended reliance on reprocessing remains fiscally unproven.[88]

- Fukushima made little progress, making far more waste than it has managed and TEPCO made some Fukushima cleanup a public cost.[89] Non-toxic TEPCO assets are being resold.[90] Few residents have returned to the region: the Japanese government has declared a Dead Zone[91] and a local fish was measured 7,400x over the legal radiation limits.[92] The power plant has encountered real issues with fugitive primary coolant management[93], core and SNF cleanup.[94] Although TEPCO built a subsoil wall[95], perimeter radiation levels spiked to a two year high[96] with fugitive releases.[97] TEPCO has shuttered the remaining reactors.[98]

There are reports of high level radiation exposure risk[99] to contractors used in Fukushima cleanup as well.[100]

- *With an emphasis on nuclear waste management issues over the period 2012-2014, this section is a brief abstract of risk related events in the international nuclear industry of those two years.* Notable "Nuclear Energy is Clean,[101] Safe,[102]and Cheap[103]" cautions from 2012 to 2014 (not all are entirely related to nuclear power plants): US National electricity usage in 2013 was down to 2001 levels.[104] US Federal Courts have decided that states legislatures are "pre-empted " from regulating nuclear power plant safety[105]. New and operating licensed US nuclear power plants have shut down[106], too expensive to competitively operate[107]. Maintenance costs on US reactors are also rising[108], while obsolete General Electric Boiling Water Reactors, like Fukushima's, remain in service here.[109] Thorium was found to not be as proliferation resistant as previously thought.[110] A SNF cask was undamaged in a low speed derailment 10km from Paris, France.[111] Reports surfaced of ocean dumping of post-WW2 radioactive waste off the US East Coast[112], in the English Channel[113], and of Soviet era ocean dumping in Arctic.[114] Available fresh coolant water is becoming more scarce for thermal power production.[115] A large Swedish reactor scrammed from coolant loss caused by jellyfish.[116] A US nuclear power plant staffer was arrested for fake backup generator fuel records.[117] Hanford, Washington's Plutonium waste systems, leaking[118] and at risk for explosion,[119] face staff layoffs[120]. Chernobyl containment remains underfunded and unfinished.[121] Megatons to Megawatts, A US/Russian disarmament scheme down blending bomb grade U235 to reactor fuel, ended with Russia complaining that the US was not doing its part[122] France is planning a nuclear exit. Britain canceled four nuclear power plants[123] then returned with a plan to subsidize a new plant at twice the cost of alternatives.[124] Meanwhile, Britain's excessive Sellafield cleanup costs face review.[125] South Korea has shuttered several nuclear power plants built with bogus components[126] and faces nuclear scandal[127], leading lawmakers to brawl over nuclear power.[128] All but two Japanese nuclear power plants remain offline.[129] Small modular reactors get mixed press.[130] Small under-capitalized reactors are more likely to become an orphaned public burden without adequate waste management regulation. Only one safety switch away from ignition, a US nuclear warhead in a 1961 Broken Arrow event nearly detonated in North Carolina,[131] and a peer reviewed report suggests some small nuclear exchanges are likely to cause mass famine.[132]
- In May of 2014, the GAO released an audit of Paducah's inventory transactions[133]: "GAO identified legal concerns with all four of DOE's uranium transactions." In a nutshell, GAO took issue with the values assigned to Paducah's UF6 tailings and questioned whether USEC and DOE broke federal law or accounting standards.

- There remains a culture of deception that pervades aspects of the nuclear industry, some rooted in national security, some from industry. For a Kentucky example: "Unbeknownst to some at the time, workers were exposed to dangerous radioactive elements at the Paducah Gaseous Diffusion Plant, the government would [years] later admit..."[134]. Other examples: the Fukushima cleanup.[135] Chernobyl went unreported for two days until neighboring countries detected the radiation.[136] In Japan, there are more examples: "A nuclear power plant operator, the Hokuriku Electric Power Company, shut down a reactor in central Ishikawa Prefecture for inspection after it admitted that it had covered up a 15-minute uncontrollable nuclear chain reaction in 1999.[137]" The full extent of damage to Three Mile Island was not even measured until years after the meltdown event[138]. Many other examples can be found in the literature.

- Nuclear power plants fail[139], sometimes catastrophically[140]. Three important trends deserve consideration: the national trend towards short term cost savings leading to fewer inspections and reduced maintenance, retaining in service the known flawed GE power plant designs (like Fukushima's), and that power plants are being run well beyond their design life. In recent years, a primary coolant loss was narrowly avoided in Indiana, where the containment vessel had corroded down to ¼ inch of stainless steel, and that had already buckled from strain.[141]

In closing, the collection of facts above give cause to reflect on the unusual nature of HB90 and SB11: mistakes are going to cost a lot for a long time. The benefits to the Commonwealth are at best small, and unlikely. Please do not vote to repeal the current nuclear waste management statutes.

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