

# **Community Impacts At the Crossroads of Nuclear and Climate Injustices In the U.S. South**

How climate change intersects with the nuclear energy and weapons industries, and the effect this nexus has on rural communities in the U.S. South

Written by

Becky Rafter, Georgia WAND Education Fund, Inc. Atlanta, GA

Mary Olson, Nuclear Information Resource Service, Asheville, NC

Jumana Master, Bevier Public Health Intern, Agnes Scott College, Decatur, GA

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**Georgia WAND Education Fund, Inc. (Georgia WAND)** is an independent, grassroots, women-led organization, deeply rooted in community and working toward systemic change. Georgia WAND's mission is to educate the public and opinion leaders about the need to reduce violence and militarism in society and redirect excessive military spending to unmet human and environmental needs. Georgia WAND works to bridge divides to build power and voice for community-led, peaceful, inclusive solutions to the South's most pressing issues.

**Nuclear Information and Resource Service (NIRS)** is a national non-profit organization devoted to a nuclear-free, carbon-free world. It has served as the information and networking hub for people and organizations concerned about nuclear power, radioactive waste, radiation, and sustainable energy issues since 1978. The organization was founded to be the national information and networking center for citizens and environmental activists concerned about nuclear power, radioactive waste, radiation, and sustainable energy issues.

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## Introduction

With a primary focus on the U.S. South, this report examines the intersection of climate change, the nuclear energy and weapons industries, and the subsequent effects on rural communities; it also provides recommendations for solutions. Consideration is given to water, air, safety, and health in discussing how and where nuclear energy and nuclear weapons industries intersect with the climate.

As the home to both commercial and military nuclear facilities, the U.S. South can be considered the nuclear hub of the United States. The South is the only region with new nuclear reactor construction underway, Plant Vogtle in Burke County, GA, and two reactors that recently ceased construction in South Carolina.<sup>1</sup> It is home to thirty-four operational nuclear reactors, two large nuclear weapons sites (Oak Ridge in TN and Savannah River Site in SC, bordering GA); all the nuclear fuel factories in the U.S., many radioactive waste processing sites, the “low-level” radioactive waste burial site at Barnwell SC, the two original uranium enrichment sites (Paducah, KY and Portsmouth in Appalachian OH - both now closed), and a closed and leaking nuclear waste burial site at Maxey Flats in Kentucky.<sup>2</sup>

Southern states have endured some of the costliest weather- and energy-related events in recent decades, including hurricanes (Katrina, Rita, Harvey, Andrew, Irma, Jose, and Maria), the Deepwater Horizon disaster, increased flooding, droughts, several freezes, and other severe storms. Super storms and other effects of climate change wreak havoc on the nuclear industry. In fact, nuclear energy generation actually derails climate efforts, described in Section I of this report. As climate-related issues change southern geologic, atmospheric, and hydrologic landscapes, the dangerous intersection with the nuclear industry, the south will face extreme challenges.

However, many southern communities are already in a state of emergency. In addition to billion dollar natural disasters repeatedly clobbering them, southerners work daily to overcome the disproportionate burden of living in a region beset with economic, racial, and environmental injustices. In a region overwhelmingly beset by a lack of adequate healthcare access, income, affordable housing, political representation, job training, high school diplomas, and more, it is difficult to handle additional emergencies. In general, southern communities lack adequate resources to handle widespread damage to personal and public infrastructure from storms, droughts, and freezes. Inadequate formal emergency response and preparedness abounds, and largely nothing is in place to deal with the clash of nuclear activity and the climate.

Families of color and rural families bear the brunt of the South’s high rates of toxic industry sites, high energy burdens, mass health issues, unrelenting racial profiling and incarceration, systemic detention and

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<sup>1</sup>See: <http://thegrio.com/2012/01/25/nuclear-plants-and-cancer-epidemics-in-a-poor-black-georgia-town-environmental-racism-in-the-21st-ce/> and <http://bettergeorgia.org/2016/04/12/shell-bluff-georgias-own-flint-water-crisis/> and <http://www.cleanenergy.org/2017/05/22/plant-vogtle-georgias-nuclear-renaissance-now-financial-quagmire/>

<sup>2</sup> Maxey Flats was operated as a commercial disposal site for so-called “low-level” radioactive waste from 1963 until it was closed in 1977 and came under the U.S. EPA Superfund program. See: <http://waste.ky.gov/sfb/pages/maxeyflatsproject.aspx>

deportation, discrimination in public life, work, and play, and other experiences of struggle. Yet it is hard for many to speak out against the injustices they face because the same industries that contaminate people are also employing them. And the South has such a high concentration of nuclear and other toxic-emitting industries.

This report offers solutions for communities to determine for themselves how to prepare for the ensuing disruptions from climate change, contamination from the nuclear industry, and the lethal clash of the climate and nuclear-related industries.

In the face of these troubling statistics and foreboding forecasts, local communities across the South are banding together and creating solutions. Local communities are building equity into public policy, regulatory, and budgetary systems. Southerners are finding ways to be participatory and collaborative, working across sector, geography, politics, and demographics to create action plans that address climate and environmental injustices, not just in the South, but globally. Climate and ecological justice leader Colette Pichon Battle, who helped anchor Gulf South Rising, a coordinated, regional movement to commemorate the 10<sup>th</sup> anniversary of Hurricane Katrina in New Orleans and across the Gulf in 2015, calls the U.S. South “a strategic region for shifting national systems.”<sup>3</sup>

Therefore, this report recommends building community-based emergency preparedness; developing blueprints for transitioning to a sustainable, peaceful economy; and increasing education, grassroots leadership, and civic engagement at all levels of public life. Indeed, the U.S. South can help lead the country toward a more participatory democracy.

## Why the South?

Despite billions of dollars flowing into the nuclear energy and weapons industries and military installations in the region, rural communities of color living in proximity to these sites, and the U.S. South in general, remain some of the most challenged in the country in terms equity. One media activist illustrates it in terms of statistics: “...if leaky civilian and military nukes really are the job-creating answers to poverty, shouldn’t Burke County, GA be one of the wealthiest, instead of the poorest places east of the Mississippi 25 years after its first civilian nukes, and six decades after neighboring towns, some of them all Black on the South Carolina side of the river, were bulldozed to create the Savannah River Nuclear Weapons facility?”<sup>4</sup>

A changing climate is already resulting in record-breaking<sup>5</sup> heat, precipitation and drought; more storms with increased intensity, hurricanes, flooding; and broader planetary-system changes, such as sea-level

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<sup>3</sup> <http://www.gulfsouthrising.org/final-report/>

<sup>4</sup> [http://www.huffingtonpost.com/bruce-dixon/siting-nukes-in-a-poor-bl\\_b\\_559103.html](http://www.huffingtonpost.com/bruce-dixon/siting-nukes-in-a-poor-bl_b_559103.html)

<sup>5</sup> One of the most outstanding educational resources on what is already happening to our weather and to climate is NASA, see: <https://climate.nasa.gov/>. We will provide additional resources, but this site is the most comprehensive and includes access to primary data.

rise.<sup>6</sup> Climate studies predict that these and other changes will increase and accelerate in coming years. How adverse the effects of these predictions are will depend on choices made today, in the early 21<sup>st</sup> century. These adverse effects are already disproportionately affecting vulnerable communities, making the urgency of addressing climate change also an issue of justice and equity.<sup>7</sup>

The U.S. South has increased chances of severe, long-term burdens from the energy sector being brought to a tipping point by climate change. While all areas of the country are affected, there are specific geographic areas of the U.S. that are dealing with compounded factors. The state of Georgia was recently designated as the 2<sup>nd</sup> most apocalyptic state.<sup>8</sup>

The Southeastern U.S. will be an epicenter of climate change impacts, according to Southface Policy and Community Sustainability Fellow Gabriela Atsepoyi. The issue is economic as well as environmental: Atsepoyi says that in already warm climates like Texas and Florida, there will be a decrease in GDP between 10-20% per year for each degree Fahrenheit that temperatures rise. Atsepoyi added that increased sea and land temperatures will affect the economies of the Southeast as flooding results in displacement and skyrocketing insurance premiums and extreme heat events raise energy costs.

Due to the South's natural climate vulnerabilities, such as the Gulf of Mexico, the long Atlantic coastline, and tropical temperatures, the effects of climate change could exacerbate the region's historic inequities.<sup>9</sup> The nexus between a changing climate and nuclear operations in the southern region of the U.S. must be addressed and explored. The South is currently the only region of the U.S. with a *growing* fleet of nuclear power reactors. Additionally, there are two major nuclear weapons production sites in the South, and the region is home to the nation's nuclear fuel factories (Roanoke VA, Erwin TN, Columbia SC, and Wilmington NC). The Savannah River Site (SRS) nuclear weapons and Superfund site will be referenced in our reporting due to its proximity to nuclear power Plant Vogtle and climate-affected southern waterways.

Though much of the literature on energy and climate focuses on how the use of fossil fuels harms the atmosphere by releasing Greenhouse Gas (GHG) emissions into the air, the harmful effects of extractive energy sources such as nuclear mining, oil drilling, mountaintop removal, and fracking must also be addressed. This report looks primarily at nuclear-related issues, including the impacts of nuclear energy,

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<sup>6</sup> Scavia, et al, 2002. Climate Change Impacts on U.S. Coastal and Marine Ecosystems in a Journal called Estuaries, posted: <http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1565&context=usdeptcommercepub> remains one of the most-often cited pieces of original research on sea-level impacts. Recent work on sealevels and warming along the Eastern Seaboard is summarized here: <http://www.climatecentral.org/news/sea-level-and-risk-of-flooding-rising-rapidly-in-mid-atlantic-16822>

<sup>7</sup> Climate and Justice resources include the NAACP <http://www.naacp.org/issues/environmental-justice/> and Indigenous Environmental Network <http://www.ienearth.org/> and WAND <http://gawand.org/category/our-issues/environmental-justice-our-issues/>

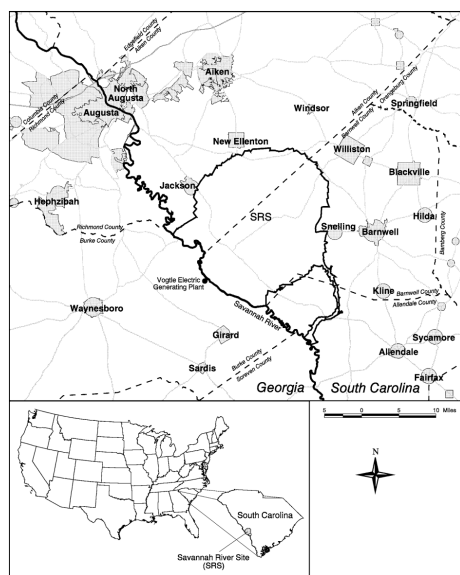
<sup>8</sup> <http://www.ajc.com/news/climate-disaster-map-shows-georgia-second-most-apocalyptic-state/15mW1oUxwKz72rrFanFkl/>

<sup>9</sup> Hsiang, et al, 2017. "Estimating economic damage from climate change in the United States" in Science Magazine, posted: <http://science.sciencemag.org/content/356/6345/1362.full>

rising sea levels, rising atmospheric and water temperatures, nuclear weapons, global tension, the “bathtub effect,” and the myth of nuclear waste “recycling.”

There is a growing body of literature, thought leadership, and strategic vision to which this report contributes. A collaborative of southern-based NGOs, Advancing Equity and Opportunity in the U.S. South (AEO),<sup>10</sup> has formed to address the compounding effects of extractive energy industries and climate change in the U.S. South, a region already hit hard by climate change damages and beleaguered by the siting of the U.S.’s largest power-generating carbon polluters, also located primarily in the South.

The extreme extraction practices of fossil fuel companies have degraded ecological resources in the South, destroying local economies with mountaintop removal in Appalachia and oil spills off the Gulf Coast.<sup>11</sup> There are constant attempts to drill more oil along the coast, with oil drilling off the Southern Atlantic seaboard states being back on the radar under the Trump administration.<sup>12</sup> Add to that the effects of climate change: three of the five worst storm-related climate disasters in recent years happened in the South’s Gulf Coast. It can be safely said that the damages of climate change have already cost communities in the South billions of dollars. Additionally, as the threat of flooding increases, there is growing concern that southern states such as South Carolina and North Carolina will have difficulty securing equitable access to FEMA resources for flood recovery in minority and low-income communities.



**Savannah River Site<sup>13</sup>**

<sup>10</sup> Georgia WAND Education Fund is a member of AEO

<sup>11</sup> Conceptualized by members of the AEO collaborative: <https://seandra-pope.squarespace.com/s/Advancing-Equity-and-Opportunity-through-work-on-Energy-Climate-and-Environmental-Justice-in-the-Sou-v5kz.pdf>

<sup>12</sup> See: <http://thehill.com/policy/energy-environment/336389-trump-proposes-seismic-tests-for-atlantic-oil-drilling>

<sup>13</sup> <http://www.srs.gov/general/pubs/ERsum/ersum04/srsmmap03.pdf>

In the spirit of Ms. Pichon Battle, this report's recommendations work from the premise that amid crises arise opportunity and resilience. There are very distinct choices facing the U.S. South. Will the region find ways to build its local economies through sustainable efforts to reduce climate change? How will local southern communities command respect for their leadership in successfully managing resources, disasters, and conflicts? This report calls for people to come together across sectors, organizational affiliation, agencies, and geography to conduct further research and create solutions and greater investment in sustainable energy, healthy and well-paying jobs, managed transitions, emergency preparedness, and reaping and sharing the fruits of health and cooperation throughout the U.S. South.

Climate justice regarding nuclear energy and nuclear weapons is only one front in a region beset by historic, systemic, environmental, and social injustices, all of which disproportionately affect rural areas, blue collar workers, communities of color, poor people, and, in the case of the radiological effects of climate change, women.

## **SECTION 1: Climate Change Negatively Impacts Nuclear Operations and Safety**

Eight years after beginning the construction of nuclear reactors at Plant Vogtle in Georgia (construction began in 2009), Georgia Power announced to the Georgia Public Service Commission its plan to continue the project, going on to expand and construct units 3 and 4, despite initial estimates of completion by 2017 and being over its budget by millions of dollars.<sup>14</sup> These are the only two reactors currently being built in the U.S. after the halting of the V.C. Summer project in South Carolina this July.<sup>15</sup> The South Carolina project was stopped after long delays and cost overruns.

Of the thirteen U.S. aging, nuclear plants at risk of being affected by a storm surge, seven of them are located below the Mason-Dixon line. And that number is growing. Currently the only U.S. nuclear plants under construction are sited in the U.S. South, and the U.S. Nuclear Regulatory has recently awarded additional Combined Operating Licenses (allowing construction in the future) of five more units, one in Virginia (North Anna 3); two in Florida (Levy County 1 & 2) and two additional (Lee 1 & 2) in South Carolina. Across the Gulf, two more units (South Texas 3 & 4) have recently been licensed for construction. After a nearly 45-year gap in new nuclear reactor plans, there are a total of 14 new reactors<sup>16</sup> named and licensed for sites in the South. Again, there are no new sites under construction in any other region of the U.S. The Combined Construction and Operating License (COL) is a new process in this century's round of reactor construction. Even though some people believe that most of these new licenses are not going to lead to immediate construction, the COL is valid for 20 years.

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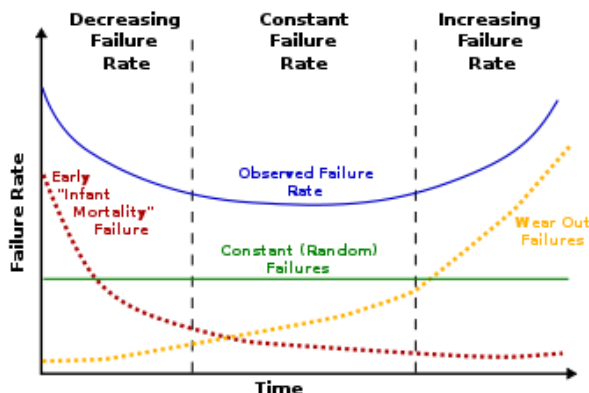
<sup>14</sup> <http://www.ajc.com/business/power-wants-keep-building-plant-vogtle-reactors/GHhhNy8YWT82PYbSsOdj3L/>

<sup>15</sup> <https://www.nytimes.com/2017/07/31/climate/nuclear-power-project-canceled-in-south-carolina.html?mcubz=1>

<sup>16</sup> The U.S. Nuclear Regulatory Commission is a quasi-independent federal regulator for commercial nuclear energy. The list of new reactor sites, some now suspended or canceled, as well as those listed here, is posted: <https://www.nrc.gov/reactors/new-reactors/col.html>



The operating commercial nuclear reactors in the South were generally built later than the rest of the U.S. fleet, and it is the only region where previously canceled reactor units have been resurrected for completion (TVA's Watts Bar 2).



### Bathtub Effect<sup>17</sup>

Because the Southeast is the only region of the country where new reactors are being built and brought on-line, it is the region most in jeopardy of accidents due to the front-end of what is known as the “bathtub curve” effect.<sup>18</sup> This documented effect shows that more accidents occur in the early stages of a reactor coming online, and, as reactors age, the rate of failure also increases, thus the curve. In Georgia, for example, Plant Vogtle Units 3 & 4 would be coming online around the same time as Units 1 & 2 move into end-of-life phase.

The following sections treat nuclear energy (civilian nuclear power) and the Department of Energy’s nuclear weapons infrastructure separately, though the interaction of these two and their joint impact on surrounding communities will be emphasized.

### Nuclear Energy

Scientists and engineers continue to produce studies proving that nuclear energy cannot solve the climate crisis. This report supports the case<sup>19</sup> that nuclear energy, particularly new reactor construction or costly

<sup>17</sup> [https://commons.wikimedia.org/wiki/File:Bathtub\\_curve.jpg](https://commons.wikimedia.org/wiki/File:Bathtub_curve.jpg)

<sup>18</sup> The bathtub curve is a basic mechanical engineering concept. It has been applied to nuclear reactors by the Union of Concerned Scientists Nuclear Engineer, David Lochbaum, and posted here: <http://allthingsnuclear.org/dlochbaum/nuclear-bathtub-safety>

<sup>19</sup> Tim Judson, 2014. “Killing the Competition” is a NIRS briefing paper on the false economics of supporting aging nuclear reactors over sustainable energy development. Posted: <https://www.nirs.org/wp-content/uploads/neconomics/killingthecompetition914.pdf> See also economist Mark Cooper’s analysis that new reactors are a climate problem not a solution, posted here: <https://www.nirs.org/wp-content/uploads/reactorwatch/newreactors/cooper-smrsaretheproblemnotthesolution.pdf>

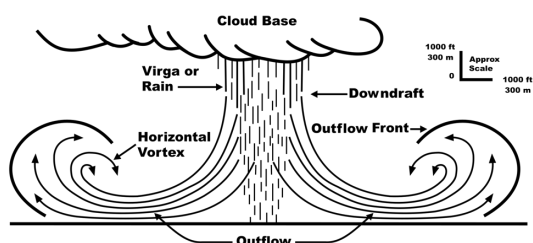
upgrades to aging reactors that should be scheduled for retirement, is not a cost-effective investment to prevent further climate change.<sup>20</sup> In fact, nuclear operations contribute to climate change.

A small number of well-funded advocates and a few scientists assert that nuclear energy is a requirement to successfully reduce carbon emissions; however, there is ample evidence to the contrary. Expanding and continuing to maintain the nuclear reactor fleet will derail our ability to meet vital goals for reductions in greenhouse gas emissions over the next few decades.

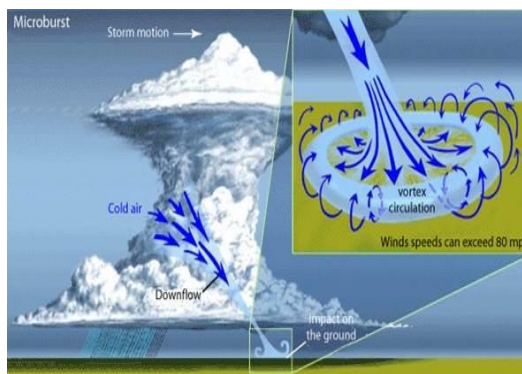
Weather and climate conditions affect both the near- and long-term operations of nuclear energy production plants, having multiple implications for both nuclear safety and electric power generation. The threats are imminent. "Warming seas and water shortages put nuclear and other electric power plants at risk. Power lines can be blown away by hurricanes and other extreme weather."<sup>21</sup>

### **Loss of power: A Problem for Nuclear, Unable to Be Solved by Nuclear**

Climate instability is increasing the incidence of many intense weather events including tornadoes and other wind events called 'microbursts' and 'derecho,' as well as extreme heat and ice storms, all of which can cause power outages and grid failures.



**Microburst<sup>22</sup>**



To operate, all U.S. nuclear power reactors require electric power from an external source. Chaotic weather is a contributor to electric power grids going offline. When local off-site power is disrupted, nuclear reactors linked to the grid lose electricity. Because power generation must stop when electric

<sup>20</sup> See 2015 analysis by NIRS on the prospect of reactor closure, thereby avoiding costly repairs, and the option to reinvest the savings in energy conservation, efficiency, renewables that produce a power surplus enabling additional closure of coal generation as well as the nuclear; sadly a plan dismissed by the Governor and regulators in New York; see: [https://www.nirs.org/wp-content/uploads/neconomics/replacement\\_analysis\\_press%20release.pdf](https://www.nirs.org/wp-content/uploads/neconomics/replacement_analysis_press%20release.pdf)

<sup>21</sup> 2017. "Climate Change: Energy Infrastructure Risks and Adaptation Efforts" U.S. GAO, Report # 660558, posted in full here: <http://www.gao.gov/assets/670/660558.pdf> Coverage of the report is: <http://www.climatecentral.org/news/gao-climate-change-major-threat-to-energy-infrastructure-17159>

<sup>22</sup> [http://commons.wikimedia.org/wiki/Category:Microburst#/media/File:Microburst\\_crossection\\_\(vectored\).svg](http://commons.wikimedia.org/wiki/Category:Microburst#/media/File:Microburst_crossection_(vectored).svg); <https://www.weather.gov/images/bmx/Daily/microbursts/microburst.jpg>

service is interrupted, nuclear reactors are designed to “scram”-- to shut down suddenly as soon as the grid is interrupted.

Components of nuclear power that depend on off-site power include the reactor itself, the control room, pumps, and other equipment vital to keeping the site safe. A reactor does not power its own circuits directly. Backup diesel generators on every site restore the most essential circuits; however, nuclear reactors that cease power generation cannot be brought back to generate power until the electric grid is back up and running. This means that nuclear power is dependent upon other types of generation that can provide immediate power without going through a grid, such as wind and coal.

An example of nuclear reactors going off-line but not coming back online quickly enough was the infamous Northeast Blackout of 2003.<sup>23</sup> A single cascade event in Ohio resulted in a loss of power in parts of eight states, idling 10 U.S. reactors in four states, and depriving power to another nuclear site in the process of refueling.<sup>24</sup> It took more than a week for the affected reactors to come back online. When the Canadian reactors are included in the count (18 nuclear power reactors and four research reactors in Ontario where power was also lost due to the outage),<sup>25</sup> the total number of nuclear units deprived of off-site power rises to 33.

Fortunately, this loss-of-offsite-power event did not result in a major nuclear accident, though one was possible. According to a 1999 NIRS study that assessed the performance of backup generators at reactor sites, site test records yielded a result of 80% reliability of the units studied. That means that 20% of the time, backup generators at nuclear reactor sites are unreliable, which could lead to disaster.

When an electrical grid goes offline, a nuclear reactor is halfway to “station blackout,” when there is no power on the site. Backup diesel generators for such emergencies have been known to fail completely. There are battery banks designed to buy a little time after that. While rare, station blackouts have occurred several times,<sup>26</sup> fortunately only for periods short enough to avert disaster. Notably, grid blackout was a contributing factor to the three meltdowns at Japan’s Fukushima Daiichi nuclear power plant in 2011.<sup>27</sup> In fact, the U.S. Nuclear Regulatory Commission attributes half the risk of a major reactor accident occurring to this one issue: no electric power at the site.<sup>28</sup>

Because climate chaos is increasing the number of times reactors must rely on backup power, there is a direct correlation between the chances of blackout and the chances backup generation could fail,

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<sup>23</sup> See: [http://www.nerc.com/docs/docs/blackout/NERC\\_Final\\_Blackout\\_Report\\_07\\_13\\_04.pdf](http://www.nerc.com/docs/docs/blackout/NERC_Final_Blackout_Report_07_13_04.pdf)

<sup>24</sup> <http://www.nytimes.com/2003/08/15/nyregion/blackout-2003-overview-power-surge-blacks-northeast-hitting-cities-8-states.html>

<sup>25</sup> [https://en.wikipedia.org/wiki/List\\_of\\_nuclear\\_reactors#Canada](https://en.wikipedia.org/wiki/List_of_nuclear_reactors#Canada)

<sup>26</sup> List of events between 1986-2004 that came close to station blackout are included in Appendix A, Table A-1 (nine pages long) is available here: <https://www.nrc.gov/docs/ML0602/ML060200477.pdf>

<sup>27</sup> David Lochbaum at Union of Concerned Scientists posted this item on station blackout within the first week of the nuclear disaster that is still unfolding in Fukushima Prefecture, Japan: <http://allthingsnuclear.org/dlochbaum/nuclear-station-blackout>

<sup>28</sup> See the NRC publication NUREG 1150: Severe Accident Risks, posted: <https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1150/>

resulting in a nuclear meltdown. A near miss for the South occurred when Hurricane Andrew hit south Florida in 1992. Andrew was rated the third strongest storm to hit the U.S. in the 20<sup>th</sup> century. Andrew took landfall directly on the Turkey Point reactor site in Homestead, Florida.<sup>29</sup> The grid went down, the reactors scrambled, and downed trees blocked traffic to and from the site.

The backup diesel generators had difficulty starting. Fortunately, a work crew, which gained hero status afterward, was able to work around the clock for a full week to keep the first and then the second back-up generator operating. Meanwhile, other crews worked for a week to restore power to the site. The scale of disaster in the wake of Andrew was unprecedented in this century. Thanks to the heroics of workers, Turkey Point never went into station blackout, and there was no nuclear disaster. Had it not been for those workers, the scale of nuclear disaster could have been immeasurable. Few people appreciate how close the Miami area came to experiencing a nuclear disaster.

The costs associated with devastating storms are enormous. Hurricane Andrew clocked in at about \$26 billion (in 1993 dollars) in cost to Florida alone. If Turkey Point had added radioactive contamination to the clean-up, the costs would have grown exponentially, and much of the infrastructure that was repaired after Andrew would have been unusable due to radiation contamination. In addition, as the history of the disasters at Chernobyl and Fukushima tell us, the land contaminated by a would-be accident, would have been permanently uninhabitable.<sup>30</sup>

All nuclear reactors are vulnerable to the type of hydrogen explosions that occurred at Fukushima Units 1, 2, and 4 due to the loss of electrical power to the cooling pumps. Hydrogen gas is constantly formed at nuclear sites as water molecules, which are present to cool the reaction, are split by neutron radiation into hydrogen and oxygen gases. The production of this gas is ongoing at nuclear reactors; since the circulation of coolant (primarily water) disperses the gas, it does not build up. However, when power is lost and the pumps stop, as in station blackout, production of the gas continues and it builds up to explosive levels, as seen in Japan in 2011.

One reactor design, called the “ice condenser,” has tons of ice to cool hot steam in the event of a reactor accident. This design also has a very thin steel nuclear core containment structure instead of the robust concrete of older reactor designs. Its fragility is illustrated by its nickname: “eggshell containment.” If coolant stops moving in ice-condenser reactors, the hydrogen gas builds up and is trapped in pockets in the ice. A spark can set off a hydrogen explosion more severe than with other designs. The explosion will destroy the mass of cold material designed to quell the heat of the nuclear core accident. Of the 10 “ice condenser” reactors in the U.S., eight are in the South: McQuire 1 & 2 and Catawba 1 & 2 (all Duke reactors) near Charlotte NC; Sequoyah 1 & 2 near Chattanooga, TN; and Watts Bar 1 & 2 (TVA) near Knoxville, TN. The sooner these aging, dangerous reactors are closed, the safer the region will be.

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<sup>29</sup> [http://www.huffingtonpost.com/2012/08/21/20-facts-hurricane-andrew-anniversary\\_n\\_1819405.html](http://www.huffingtonpost.com/2012/08/21/20-facts-hurricane-andrew-anniversary_n_1819405.html)

<sup>30</sup> Interdiction of land--the making of a place uninhabitable--is on a timescale that is unique to nuclear accidents. See: <http://neis.org/release-groups-public-petition-nrc-to-learn-the-lessons-of-fukushima/> and <https://www.nirs.org/wp-content/uploads/reactorwatch/emergency/epzpressrelease4914.pdf>

## Nuclear Energy Derails Climate Efforts

Because nuclear power reactor sites do not emit massive plumes of carbon dioxide (CO<sub>2</sub>), there is a misconception that nuclear energy is “carbon-free.” In reality, all power sources have a carbon footprint associated with the manufacture of the power generating equipment; even wind turbines require steel blades and concrete footings. However, nuclear’s carbon footprint is in particularly notable, due to being an extractive energy source.

Nuclear is an extractive energy source dependent on mining for fuel. Uranium mining uses fossil fuel; over time, as the richer deposits are used up, the amount of fossil fuel needed for mining will also increase. The purification and concentration of uranium also require massive energy inputs as well as transportation, all of which depend on CO<sub>2</sub>-generating coal and oil.<sup>31</sup> Sustainable energy pioneers such as former Tennessee Valley Authority (TVA) Director David Freeman,<sup>32</sup> Beyond Nuclear’s Paul and Linda Pentz Gunter,<sup>33</sup> Rocky Mountain Institute’s Amory Lovins,<sup>34</sup> Institute for Energy and Environmental Research’s Dr. Arjun Makhijani,<sup>35</sup> Benjamin Sovacool,<sup>36</sup> and others have created a body of literature establishing that investing more in nuclear is not a climate solution. These scholars present evidence that resource investment in nuclear will divert resources from actual solutions that are both cost-effective and performance-ready in the near timeframe, unlike nuclear.

Nuclear is more expensive. New nuclear kilowatts<sup>37</sup> sell for four times more than a kilowatt of energy from wind, and two and a half times more than a kilowatt from solar photovoltaic (PV) panels at solar farms.<sup>38</sup> The factors associated with rooftop solar make it a very complex equation to compare with nuclear; however, analysts agree that the price of power from new nuclear reactors and from retail-priced PV

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<sup>31</sup> See analysis of fossil fuels in the production of nuclear fuel and facilities by J.W. Storm van Leeuwen  
<https://www.stormsmith.nl/>

<sup>32</sup> Freeman, S. David, 2007. “Winning Our Energy Independence,” Gibbs Smith.

<sup>33</sup> <http://www.beyondnuclear.org/pandoras-false-promises>

<sup>34</sup> Amory Lovins has been a leader working with industry to unlock the profitability of preventing carbon emissions. His most recent work on why nuclear is not a climate solution is reported on here:  
<https://www.ecowatch.com/nuclear-climate-change-2462663343.html>

<sup>35</sup> The classic text: Carbon Free, Nuclear Free: A Roadmap for U.S. Energy Policy, 2010, written by Dr Arjun Makhijani of IEER, is available in full, at no charge, here: <https://ieer.org/resource/reports/carbon-free-and-nuclear-free/>

<sup>36</sup> Ben Sovacool is on the faculty of the Vermont Law School and has written extensively on both climate and appropriate energy systems. His 2008 classic: “Nuclear Nonsense; Why Nuclear is No Answer to Climate Change” is published here: <http://scholarship.law.wm.edu/cgi/viewcontent.cgi?article=1040&context=wmelpr>

<sup>37</sup> “New nuclear reactor construction and operating costs are very different than old reactors being run into the ground by mega corporations that bought them for pennies on the dollar after the major reactor accidents”-Mary Olson, NIRS. See: <http://www.ucsusa.org/nuclear-power/cost-nuclear-power#.WXQ6T4jyuds> see also:  
<https://earthtrack.net/document/do-coal-and-nuclear-generation-deserve-above-market-prices>

<sup>38</sup> <https://cleantechnica.com/2015/09/30/average-utility-scale-solar-price-in-u-s-falls-to-5%C2%A2kwh/>

panels installed on a home are now comparable because solar costs are falling, while nuclear costs are increasing.<sup>39</sup>

However, the Southeast remains a “regulated utility market” where nuclear energy is protected by state-set electric power rate. Here, customers do not have a choice of a restricted and constrained energy provider, meaning nuclear energy has a regulation-protected, consumer-paved, and consumer-paid path to growth in the Southeast, regardless of what consumers of energy prefer. This means that the Southeast, over time, will also be the area of the U.S. where reactors operate the longest, exposing the region to more years of reactor operation and, therefore, more risk of reactor failure.

A 2003 report from Massachusetts Institute of Technology (MIT)<sup>40</sup> intended to support nuclear as an option for climate change mitigation actually demonstrates that in real-world timelines, nuclear reactors cannot be delivered fast enough, or delivered at all. The report, co-authored by Dr. Ernest Moniz before he became Secretary of Energy under President Obama, concludes that 1,500 new reactors would be needed for even a partial climate mitigation, and these would have to come online before 2050. If this project had begun in 2003, that would mean a new nuclear power plant being built every two weeks. This is simply not possible—and now, 14 years after the report, it is impossible.

The reactor construction underway in Georgia (Vogtle 3 and 4) and, until July 2017, South Carolina (V.C. Summer 2 and 3) are examples of the impossibility of timely, affordable reactor construction. The construction of nuclear power Plant Vogtle’s expansion is set to exceed \$29 billion<sup>41</sup> and is years behind schedule. According to Southern Alliance for Nuclear Energy, “It is shocking that 8 years into the project construction is only 32% complete [as of June 2017].”<sup>42</sup>

The unprofitability of new nuclear reactors is underscored by the fact that Westinghouse, the former contractor of the Vogtle and Summer Units, filed for bankruptcy in 2017. Toshiba, the Japanese corporation that bought Westinghouse and was to be the supplier for Westinghouse reactor parts, had to write down more than \$9 billion due to the failure of the Westinghouse nuclear reactor market.<sup>43</sup>

We learned from Beyond Nuclear’s *Pandora’s False Promises*<sup>44</sup> that, in addition to insufficient money and time, several other factors make nuclear an unlikely component in healthy, safe, and sustainable U.S. energy future. Water is too scarce to withstand a mass nuclear cropping. Earth lacks sufficient water to hydrate humans and cool new nuclear reactors.

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<sup>39</sup> See for instance: <https://www.usnews.com/news/articles/2016-03-31/when-will-rooftop-solar-be-cheaper-than-the-grid> and <https://www.facingsouth.org/2010/07/solar-power-now-cheaper-than-nuclear-in-north-carolina.html>

<sup>40</sup> Deutsch and Moniz, 2003. “The Future of Nuclear Power” Updated 2009. MIT Energy Initiative. Posted: <http://web.mit.edu/nuclearpower/>

<sup>41</sup> <http://www.reuters.com/article/us-toshiba-accounting-westinghouse-bankr-idUSKBN1962YH>

<sup>42</sup> <http://blog.cleanenergy.org/2017/07/17/theater-of-the-absurd-underway-with-georgias-nuclear-power-expansion/>

<sup>43</sup> <http://www.denverpost.com/2017/03/29/westinghouse-troubles-loom-over-nuclear-projects/>

<sup>44</sup> <http://www.beyondnuclear.org/pandoras-false-promises>

In addition, the radioactive waste created by the generation of nuclear power and weapons is an ecological nightmare. Spent fuel storage pools are running out of room,<sup>45</sup> and there is no permanent geological repository. The MIT team projects in their report<sup>46</sup> the need for a new deep geologic repository to be constructed for highly radioactive waste every 5 years. Finally, the risk of disaster is too high, especially with the potentially lethal combination of a growing number of aging and new reactors coming online, the threat of a strike to both municipal grids and nuclear spent fuel pools, and the impact of climate change.

Despite nuclear energy having a smaller carbon footprint than other currently used CO<sub>2</sub>-emitting technologies, such as coal and oil, nuclear energy has the least effect on mitigating CO<sub>2</sub> emissions out of all the energy generation proposals suggested by the International Energy Agency (IEA).<sup>47</sup>

### **Rising Tides**

Rising sea levels are a cause for concern around the safety of and contamination from nuclear energy production and other functions that create radioactive releases associated with nuclear weapons production. As sea levels rise, tides and storm surges rise as well, posing threats to coastal reactors.

The physical barriers created to protect these vulnerable technologies are adversely affected by climate disruptions. Safety equipment and waste installations are placed in areas at risk of flooding, increasing the probability of a major reactor accident.<sup>48</sup> All reactors on the coastlines of the Pacific, the Atlantic, tidal rivers, and the Gulf are vulnerable, including sites that are not operating but still have waste onsite.

Inland flooding<sup>49</sup> is another threat to nuclear sites. In 2011, a Nebraska nuclear power reactor, Fort Calhoun, was surrounded by the floodwaters of the raging Missouri River for the second time in five years.<sup>50</sup> The site is now closed, but the combination of the electricity-dependent technology of the nuclear power reactors with the dangerous power of flooding was perhaps critical in the 2016 decision by the State of Nebraska to close the site. Although cost of power was the official explanation,<sup>51</sup> the risks presented by the danger and cost of a reactor breach in such a flood situation would prove to be incalculable. A similar concern arose during Hurricane Harvey in relation to the South Texas Project.<sup>52</sup>

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<sup>45</sup><http://www.ucsusa.org/publications/catalyst/su-13-the-growing-threat-of-nuclear-waste.html#.WW7jG4qQyD4>

<sup>46</sup> See note 34

<sup>47</sup> <http://www.iea.org/statistics/>

<sup>48</sup> See Union of Concerned Scientists: Flood Risk at Nuclear Power Plants: <http://www.ucsusa.org/nuclear-power/nuclear-power-accidents/flood-risk-at-nuclear-power-plants#.WXTE54jyuds>

<sup>49</sup> There is more information on flooding in the nuclear weapons section of the report

<sup>50</sup> The Nuclear Monitor, February 14, 2014: <https://www.nirs.org/wp-content/uploads/mononline/NM777.PDF>

<sup>51</sup> <http://www.npr.org/2016/10/24/498842677/waste-families-left-behind-as-nuclear-plants-close>

<sup>52</sup> <http://www.accuracy.org/release/nuclear-reactors-in-harveys-path/>





**Fort Calhoun Nuclear Reactor Site<sup>53</sup>**

As climate and energy reporter Christina Nunez wrote in National Geographic in December 2015, the United States has 100<sup>54</sup> nuclear reactors that are currently operational, and 17 that are being decommissioned. Historically, data on previous flooding and storms would determine a unit's licensing requirements, but present-day weather events show that relying on historical data isn't enough. "We generally thought that backward look was sufficient," said director of the Nuclear Safety Project at the Union of Concerned Scientists Dave Lochbaum. "That's a tenuous assumption at best," Lochbaum said, pointing to Fukushima and large storms, like 2012's [Superstorm] Sandy.<sup>55</sup>

### **Rising Temperature of Water**

Increased heat in our planetary system not only melts ice, contributing to a rise in sea level, but also causes the oceans to expand as the temperature of the water rises. Thus, water temperature contributes to increased seasonal storm surges, even higher tsunami levels, and the potential for greater devastation.

The relationship between increasing temperature and water is not limited to storm surges and rising sea levels. As global temperatures increase, the impact on rivers, lakes, and even the oceans reduces the viability of all thermal or "steam cycle" electricity generation, including nuclear. As temperatures rise, the amount of water available for cooling electric power generators—and thus electricity supply—decreases while consumer demand for electricity increases.<sup>56</sup> Nunez added that nuclear plants need "uninterrupted power and vast amounts of cool water, which is why they're often located near coastlines, rivers, and

<sup>53</sup> [https://commons.wikimedia.org/wiki/File:Calhoun-Corp\\_of\\_Eng.\\_6-16-11A\\_266.jpg](https://commons.wikimedia.org/wiki/File:Calhoun-Corp_of_Eng._6-16-11A_266.jpg)

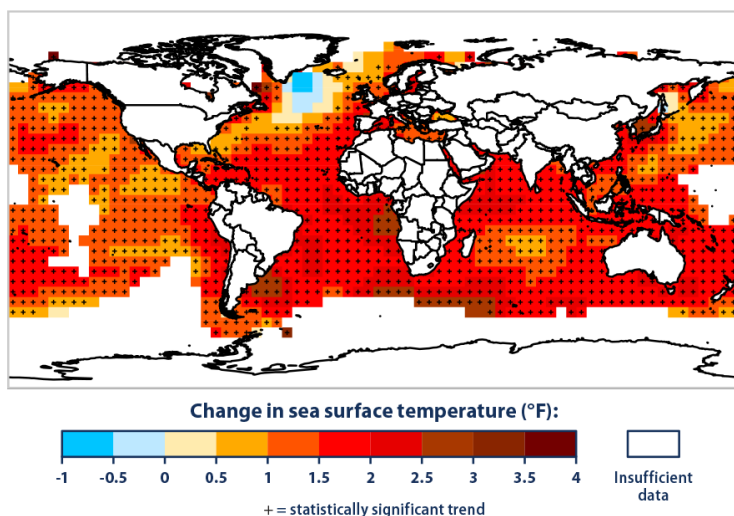
<sup>54</sup> As of 2017, there are 99 reactors operational in the U.S.A. <http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power.aspx>

<sup>55</sup> <http://news.nationalgeographic.com/energy/2015/12/151215-as-sea-levels-rise-are-coastal-nuclear-plants-ready/>

<sup>56</sup> <http://www.climatecentral.org/news/gao-climate-change-major-threat-to-energy-infrastructure-17159>



lakes. Even when a plant isn't running, its fuel continues to generate heat that needs to be controlled to prevent explosions or radioactive leaks.”<sup>57</sup>



### Rising Sea Temperature - Environmental Protection Agency<sup>58</sup>

Nuclear engineer David Lochbaum of the Union of Concerned Scientists explains that “as the climate heats up nuclear plants are less able to deliver,” adding that we must first “solve the climate-change problem if we want nuclear power; not the other way around.”<sup>59</sup>

Nuclear power reactors create a significant amount of thermal waste. Nuclear power reactors are thermal generators, meaning atoms are split to collect heat. The heat is used to boil water, and the resulting steam creates pressure to turn a turbine. The turbine spins a generator causing electrons to flow into power lines. This process is called the “steam cycle,” and in order to close the loop, steam must be condensed back into liquid water to be boiled again. Unfortunately steam cycles produce enormous waste. Only one-third of the fuel (whether coal, oil, gas, wood, uranium) contributes directly to the electricity generated. Two-thirds of the fuel is consumed in the conversion of water to steam. The steam, when cooled by the condenser, releases its heat back to the cooling water, which is then released to the environment without producing any electricity. Thermal energy uses fuel in a way that is too wasteful to be considered “green” energy. A rarely stated consequence of so-called “33% fuel efficiency” is that two-thirds of the energy becomes thermal waste.

Thermal power generation should not qualify as a “sustainable” energy source. The massive release of heat from thermal power generation has become a factor in the overall warming of rivers and oceans.<sup>60</sup> At nuclear sites that have cooling towers, some of the excess heat is returned to the water source, but

<sup>57</sup> <http://news.nationalgeographic.com/energy/2015/12/151215-as-sea-levels-rise-are-coastal-nuclear-plants-ready/>

<sup>58</sup> <https://www.epa.gov/sites/production/files/styles/large/public/2016-07/sea-surface-temp-figure2-2016.png>

<sup>59</sup> <http://www.nytimes.com/2007/05/20/health/20iht-nuke.1.5788480.html>

<sup>60</sup> See note 51

most of the heat and the 20,000—50,000 gallons per minute<sup>61</sup> (depending on reactor size and season) of used cooling water is released into the air as massive plumes of water vapor that may travel great distances and return to watersheds far from the original source.

Where cooling towers are not used, the “once-through” cooling system pulls even more water from the source: 300,000—950,000 gallons per minute<sup>62</sup> (depending on the reactor size) which changes as the level of heat generated changes. Since once-through systems return some water, less water leaves the watershed; however, the massive heat released directly into the lake, river, or ocean causes much greater local thermal impact. The once-through cooling method of reactors also has a greater impact on flora and fauna in the water source. As climate change progresses, the removal of cooling water from the source will impact the local ecology even more.

This atomic heat can become a feedback loop to the point that in a heat wave, reactors have to reduce power level or go offline completely because the cooling water is too warm to condense steam. An extreme case in Europe exemplifies this concept. An extended heat wave in the summer of 2003 forced a total of 17 reactors in France to idle to low- or no-power production<sup>63</sup> because the rivers were too hot, and in some cases, water levels were too low to provide cooling.<sup>64</sup> Storage of nuclear waste is also affected by changes in water temperature and availability. There needs to be a vast and continuous supply of cool water to cool fuel rods.<sup>65</sup> Water levels during the 2007 drought in the southeastern U.S. forced some power plants to shut down or reduce power production because water levels in nearby lakes, rivers, and reservoirs dropped below their intake valves,<sup>66</sup> which take in surface water to service the cooling system.

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<sup>61</sup> Lochbaum, Dave, 2007. Union of Concerned Scientists Brief: “Got Water?”  
[http://www.ucsusa.org/sites/default/files/legacy/assets/documents/nuclear\\_power/20071204-ucs-brief-got-water.pdf](http://www.ucsusa.org/sites/default/files/legacy/assets/documents/nuclear_power/20071204-ucs-brief-got-water.pdf)

<sup>62</sup> Same as above

<sup>63</sup> “Climate Change Puts Nuclear Energy in Hot Water” New York Times, May 20, 2007.  
<http://www.nytimes.com/2007/05/20/health/20iht-nuke.1.5788480.html>

<sup>64</sup> UNEP, March 2004 review of the Impacts of the Summer Heat Wave 2003, see page 3 for nuclear energy:  
[http://www.unisdr.org/files/1145\\_ewheatwave.en.pdf](http://www.unisdr.org/files/1145_ewheatwave.en.pdf)

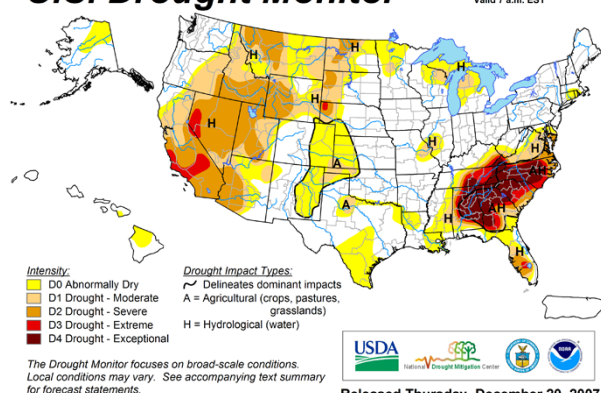
<sup>65</sup> <http://news.nationalgeographic.com/energy/2015/12/151215-as-sea-levels-rise-are-coastal-nuclear-plants-ready/>

<sup>66</sup> <http://www.climatecentral.org/news/gao-climate-change-major-threat-to-energy-infrastructure-17159>

## U.S. Drought Monitor

December 18, 2007

Valid 7 a.m. EST



### 2007 U.S. Drought Map<sup>67</sup>

In Georgia, nuclear power Plant Vogtle, with two reactor units, currently uses 75 million gallons of water per day, roughly equivalent to the water consumed daily by the City of Atlanta. The Southern Alliance for Clean Energy reported in 2008 that with the expansion of Plant Vogtle, “more water will be lost as steam from the two existing and two proposed reactors [combined] than is currently used by all residents of Atlanta, Augusta, and Savannah combined.”<sup>68</sup>

In Maryland, thermal power plants account for nearly 80% of water withdrawals from the Susquehanna River basin. Indian Point, in New York State, uses 2 billion gallons/day from the Hudson, returning all of the excess heat generated from fission back to the river. Nationwide, thermal power generation (all fuel-based) accounted for 41% of all freshwater withdrawals from the environment.<sup>69</sup> All of that water is returned hot, sometimes chemically contaminated, or released as water vapor that will most likely not return to the same basin.

In 2007 and 2010, the Browns Ferry reactors in Alabama were forced to reduce power production and, for part of the time, cease production due to elevated water temperature during a heatwave. This was, of course, when people in the region were demanding a lot of additional power to run their cooling systems.<sup>70</sup>

Interestingly, reactors outside the U.S. South, including Illinois, Massachusetts, Connecticut, New Jersey, and Pennsylvania, are also being idled due to rising water temperatures, with over 100 incidents associated with hot weather reported in the Federal Register between 1998 and 2015.<sup>71</sup>

<sup>67</sup> <http://www.noaa.gov/stories2007/images/usdm-071218300dpib.png>

<sup>68</sup> The Energy-Water Connection, 2008. Southern Alliance for Clean Energy, <http://www.cleanenergy.org/wp-content/uploads/F-SACE-GA-WaterEnergy-Legislative-info-071508.pdf>

<sup>69</sup> <http://www.ucsusa.org/clean-energy/energy-water-use/water-energy-electricity-overview#.WXNjGlijyuds>

<sup>70</sup> [http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean\\_energy/10-Things.pdf](http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/10-Things.pdf)

<sup>71</sup> See Hot Water Events published by the U.S. NRC, compiled by Dave Lochbaum.

In order for nuclear reactors to condense steam, there must be a temperature differential sufficient to balance the energy that created the steam. If the cooling water is too warm, the condenser will not work. It is ironic that an energy source promoted by some as a way to “solve” global warming is, itself, less reliable in a warming world.

### **Preparing for Emergency**

With climate change heralding increased safety risks at nuclear sites, emergency preparedness is a growing concern within communities. One such community is Shell Bluff, GA, in Burke County, home to Southern Company’s expanding nuclear power Plant Vogtle, and downstream and downwind from nuclear weapons complex and superfund site at the Savannah River Site (SRS).

Shell Bluff community members face a number of potentially life-threatening emergency preparedness issues: sirens that are not audible to everyone in the community; unpaved roads that are treacherous to navigate in adverse weather conditions; and some households, within the five-mile radius of Plant Vogtle, lack the shortwave radios and batteries provided by Southern Company. Many people lack access to the Internet. There are many elderly people and those who need assistance. The emergency call numbers on the calendar have been known to be out of date, sometimes all routing to the same, outdated message.

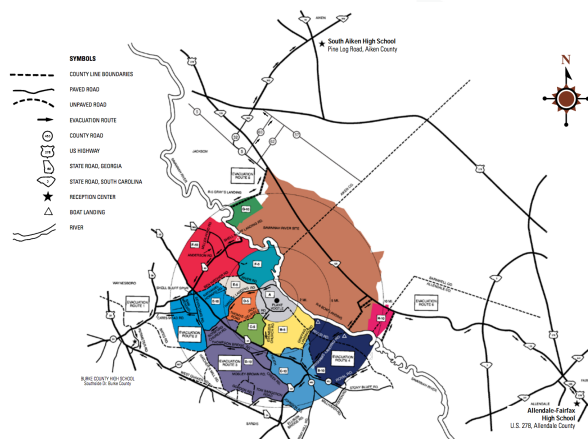
Emergency evacuation routes are not clear, the signs are far from the road, the text is small, and the message is only in English. With migrant workers and other immigrants living near the sites, it is important to explain evacuation routes in Spanish and other languages. Evacuation maps are small, distributed to the community on the back of calendars, and hard to read. The designated safe zone, the county high school, does not stock adequate supplies of water and medical supplies. Many houses in the community are not structurally sound enough to be sealed as a point of protection per the mandated 72-hour “shelter in place” instructions in case of an accident at the plant.



**One of many dirt roads in Shell Bluff, Burke County, GA**

ZONES	EVACUATION ROUTES	RECEPTION CENTERS
<b>A</b>	<b>Evacuation Route 2 or 3</b>	Burke County High School Southside Dr. Burke County
<b>B-5</b>	<b>Evacuation Route 3 or 4</b>	
<b>C-5</b>	<b>Evacuation Route 2 or 3</b>	Burke County High School Southside Dr. Burke County
<b>D-5</b>	<b>Evacuation Route 2</b>	
<b>E-5</b>	<b>Evacuation Route 1 or 2</b>	Burke County High School Southside Dr. Burke County
<b>F-5</b>	<b>Evacuation Route 1 or 2</b>	
<b>B-10</b>	<b>Evacuation Route 4</b>	Burke County High School Southside Dr. Burke County
<b>C-10</b>	<b>Evacuation Route 3 or 4</b>	

ZONES	EVACUATION ROUTES	RECEPTION CENTERS
<b>D-10</b>	<b>Evacuation Route 2, 3 or 4</b>	Burke County High School Southside Dr. Burke County
<b>E-10</b>	<b>Evacuation Route 1, 2 or 3</b>	Burke County High School Southside Dr. Burke County
<b>F-10</b>	<b>Evacuation Route 1</b>	
<b>G-10</b>	<b>Evacuation Route 5</b> Cowden Plantation	South Aiken High School Pine Log Road Aiken County
<b>H-10</b>	<b>Evacuation Route 6</b> Creek Plantation	Allendale-Fairfax High School U.S. 278 Allendale County
<b>SAVANNAH RIVER SITE</b>	<b>If directed north on South Carolina 125 to Highway 63, take Evacuation Route 5. If directed south on South Carolina 125, take Evacuation Route 6.</b>	South Aiken High School Pine Log Road Aiken County
		Allendale-Fairfax High School U.S. 278 Allendale County



Georgia Power Emergency Preparedness Calendar/Map (pg. 7-8)<sup>72</sup>

## SECTION 2: The Intersection of Nuclear Weapons and Climate Change

### Nuclear Weapons and Human Impact

The first site constructed exclusively for the development and production of nuclear weapons was the Oak Ridge National Lab in TN. Oak Ridge did not exist as a town prior to the arrival of the Manhattan Project's workers, initially a group of 3,000 that grew to a total of about 75,000 by 1945 when the first atomic bombs were dropped on Hiroshima and Nagasaki, Japan.

Oak Ridge had its own tragedy when Black workers' homes were clustered, due to Jim Crow-enforced segregation, in an area called Scarboro Community, located in the path of runoff from the nuclear

<sup>72</sup> [http://www.southerncompany.com/about-us/our-business/southern-nuclear/pdfs/Emergency\\_Info\\_Vogtle.pdf](http://www.southerncompany.com/about-us/our-business/southern-nuclear/pdfs/Emergency_Info_Vogtle.pdf)

materials processing at the Y-12 factory. Accounts from residents tell of subsistence gardens and fishing in catchment ponds without notification of contamination to the residents.<sup>73</sup> Steve Heiser of Scarboro was quoted by the Chicago Tribune when he took legal action against the University of Chicago for its role in Oak Ridge (2001): "They didn't only drop the atom bomb on Japan. It dropped here too, but it didn't explode--it just opened up."<sup>74</sup>

The siting of Oak Ridge in the Appalachian Mountains contributed to the nuclearization of the U.S. South, both with the embrace of nuclear power by the Tennessee Valley Authority, and the development of a nest of nuclear waste handlers and processors clustered in TN. A report by Nuclear Information and Resource Service, "Out of Control on Purpose," details this aspect of TN and Oak Ridge.<sup>75</sup>

However, this report focuses more on the second nuclear weapons production site in the region, Savannah River Site (SRS), originally called the Savannah River Plant, which was established in 1951 during the Cold War arms race. The SRS is a 310 square mile U.S. Department of Energy (DOE) nuclear weapons facility located in South Carolina, directly across the Savannah River from Burke County, GA, which borders the Savannah River for approximately 17 miles. The Middle Savannah River is the third most toxic stretch of river in the U.S.

SRS produced tritium and plutonium for nuclear weapons.<sup>76</sup> SRS demolished and displaced whole towns in order to create space for its vast needs. The traditional, primarily Black communities of Ellenton and Dunbarton, South Carolina, were completely erased by the building of the site. Today, New Ellenton, which replaced Ellenton, is just a couple miles from SRS's northeastern site boundary. In fact, the Savannah River Site Citizens Advisory Board (SRS CAB) holds a couple of its bimonthly meetings in their town civic building.

SRS workers who were exposed due to their employment and radiation victims in their families, tried to bring a class action suit against the Department of Energy and its contractors.<sup>77</sup> These cases were never certified as a "class" by the courts; so individuals were left to sink or swim alone, case by case.

Both of these nuclear weapons production sites employed tens of thousands of people during the peak of the Cold War, but these were not healthy jobs. Many workers, particularly Black men, were exposed to radiation on the job. During the early 2000's some of the legal actions contributed to revelation of human experimentation done by the Department of Energy.<sup>78</sup> A majority of those who suffered the often undisclosed, involuntary radiation exposure and administration of radioactivity were Black. The disclosure

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<sup>73</sup> "Our Story, Scarboro Community in Oak Ridge, Tennessee" by M. Jones

<sup>74</sup> [http://articles.chicagotribune.com/2001-02-18/news/0102180396\\_1\\_oak-ridge-nuclear-weapons-atomic](http://articles.chicagotribune.com/2001-02-18/news/0102180396_1_oak-ridge-nuclear-weapons-atomic)

<sup>75</sup> DArrigo, and Olson, 2007. "Out of Control on Purpose" Nuclear Information and Resource Service. See: <https://www.nirs.org/wp-content/uploads/radwaste/outofcontrol/outofcontrolreport.pdf>

<sup>76</sup> <http://www.srs.gov/general/about/history1.htm>

<sup>77</sup> [http://articles.chicagotribune.com/2001-02-18/news/0102180396\\_1\\_oak-ridge-nuclear-weapons-atomic](http://articles.chicagotribune.com/2001-02-18/news/0102180396_1_oak-ridge-nuclear-weapons-atomic) and [http://chronicle.augusta.com/stories/2000/04/27/met\\_289157.shtml# WXNv14jyuds](http://chronicle.augusta.com/stories/2000/04/27/met_289157.shtml# WXNv14jyuds) are examples available on-line. In 2000, the local papers (print edition) had many articles on these cases.

<sup>78</sup> <http://www.nytimes.com/1994/04/11/us/cold-war-radiation-test-on-humans-to-undergo-a-congressional-review.html?pagewanted=all>



of these racist acts led Sec. Bill Richardson, then Secretary of Energy, to declare for the first time (officially) that radiation is harmful.<sup>79</sup> He supported the passage of the Radiation Exposure Compensation Act,<sup>80</sup> which *The State* newspaper in Columbia, SC, reported had paid SRS workers \$800 million to date.<sup>81</sup> This compensation did not justify radiation nor make radiation harm appropriate. Civilian, non-military nuclear workers have also been exposed but have received no compensation, other than settlements won for egregious accidents and where the victim had the resources to pursue legal action.

In the Fall of 2017, tritium production at SRS has increased threefold. This roughly coincides with tensions between the U.S. and North Korea, two nuclearized nations with eradic leaders. By calling the expansion of Plant Vogtle a matter of national security, the Trump administration, the Department of Energy, and others are calling forth more loan guarantees and even market guarantees for Vogtle.

### **Savannah River Site - Tritium Contamination**

The nuclear weapons site of focus in this report is the Savannah River Site (SRS). Today, the Savannah River Site has two facets of work: Environmental Management (EM) of legacy waste and National Nuclear Security Administration (NNSA) missions, which mostly focus on tritium processing and atomic weapon reliability testing production to maintain the U.S. nuclear weapons stockpile.

Tritium, a key component in nuclear warheads, is essential to the main activation of the bomb, contributing to the fusion that gives an atomic bomb its high yield. Tritium has a short half-life of just 12.33 years; therefore, warheads must undergo constant testing and installation of tritium into deployed warheads (1,411) and hedge arsenal of some 2,800 non-deployed warheads. (The U.S. has a total of 6,800 nuclear weapons)<sup>82</sup>.

Further research is needed to more fully understand the harmful effects increased tritium would have on public health. As stated in the Registered Nurses' Association's Tritium Standard Review, tritium poses major risks to human health as it is known to be a teratogen (an agent that causes embryo malformation), mutagen (an agent that causes genetic mutation), and carcinogen when it emits ionizing radiation in the body. They go on to say that tritium can be ingested in food or water, inhaled, and absorbed through the skin. Once released as a contaminant from nuclear operations, it disperses quickly and cannot be cleaned out of drinking water.

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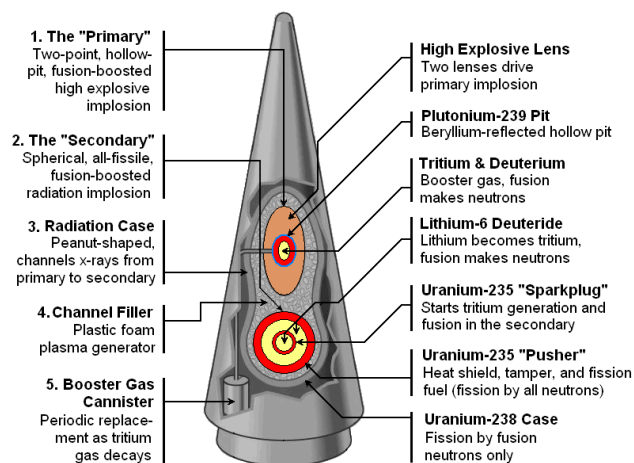
<sup>79</sup> <https://wiseinternational.org/nuclear-monitor/524/us-acknowledges-radiation-caused-cancers-n-weapon-industry> also: <http://www.nytimes.com/2000/01/29/us/us-acknowledges-radiation-killed-weapons-workers.html>

<sup>80</sup> <https://www.justice.gov/civil/common/reca>

<sup>81</sup> <http://www.thestate.com/news/politics-government/politics-columns-blogs/the-buzz/article13920077.html>

<sup>82</sup> <https://www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat>; part of the 6,800 U.S. warhead count are 2,800 retired warheads slated for dismantlement

### *W88 Warhead for Trident D-5 Ballistic Missile*



### **Warhead Image<sup>83</sup>**

The "Savannah River Tritium Enterprise" (SRTE), which refers to all tritium-related activities at SRS, houses five process facilities (two of which are left over from the Cold War) to fulfill four tritium missions: extracting and "recycling" tritium to be used in maintenance of the U.S. tritium supply of nuclear weapons; assembling and shipping out "gas transfer systems," which ensure the performance of nuclear weapons; testing of random current U.S. warheads' "gas transfer systems" since nuclear weapons testing is largely banned; and recovering and serving as a storehouse for helium-3, a byproduct of tritium decay and the element used to detect nuclear reactions across the world.<sup>84</sup>

Regular radioactive and chemical emissions stemming from NNSA's tritium missions at SRS are released into the environment through some of the 2,123 contamination emission points in H-Area, which is the designated zone at SRS that includes the tritium facilities.<sup>85</sup> This area of SRS is one of the more contaminated SRS contained facilities sites that have radioactive emissions. For 40 years, SRS was unregulated, and therefore radioactive contaminants, heavy metals, degreasers, and other emissions released into the environment, particularly into the adjacent streams--Upper Three Runs and Fourmile Branch--were not measured.<sup>86</sup> These streams feed into the Savannah River. While more recent tritium missions contribute mostly to air contamination, which is of grave concern to Georgia residents living downwind from the site,<sup>87</sup> historic missions during the Cold War by and large severely contaminated surface and groundwater.

<sup>83</sup> [https://commons.wikimedia.org/wiki/File:W-88\\_warhead\\_detail.png](https://commons.wikimedia.org/wiki/File:W-88_warhead_detail.png)

<sup>84</sup> [http://www.srs.gov/general/news/factsheets/tritium\\_esrs.pdf](http://www.srs.gov/general/news/factsheets/tritium_esrs.pdf)

<sup>85</sup> [https://www.cdc.gov/nceh/radiation/savannah/Chapter\\_15.pdf](https://www.cdc.gov/nceh/radiation/savannah/Chapter_15.pdf)

<sup>86</sup> [https://www.cdc.gov/nceh/radiation/savannah/Chapter\\_15.pdf](https://www.cdc.gov/nceh/radiation/savannah/Chapter_15.pdf)

<sup>87</sup> A SW wind blows over SRS for over half the year, toward Shell Bluff



Contributing to these high levels of legacy contamination are two chemical separation facilities, waste treatment, storage and disposal facilities, and various supporting facilities.<sup>88</sup> According to the Savannah River Remediation Closure and Waste Disposal Authority, SRS houses 35 million gallons of waste in 43 underground carbon-steel waste tanks.<sup>89</sup> Currently four of these massive underground high-level liquid waste tanks are fully submerged below the water table, and four are partially submerged and continuing to sink.<sup>90</sup> As mentioned, major streams run through SRS, contributing to movement of contamination beyond the site boundary, such as into the Savannah River.

As a result of past waste disposal practices, underlying groundwater systems are contaminated with tritium, other radionuclides, and volatile organic compounds (VOCs). According to SRS's 2014 Environmental Report, Fourmile Branch stream, which feeds into the Savannah River closely downstream from Plant Vogtle's intake valves, is the most contaminated stream on the site boundary. At its highest level, the tritium concentration in Fourmile Branch measured 35,700 pCi/L (picoCuries per Liter) and averaged 30,800 pCi/L. The federal EPA drinking water standard for tritium is 20,000 pCi/L; tritium concentrations measured in Fourmile Branch stream in 2014 were 78% above the designated safe drinking limit. Moreover,  $4.23 \times 10^{+14}$  pCi/L of  $6.57 \times 10^{+14}$  pCi/L of SRS radioactive effluent going into streams was found in Fourmile Branch,<sup>91</sup> or 64% of SRS's radioactive emissions.

There are also multiple groundwater plumes in the various aquifers below SRS's site boundary, which are miles-long in length, made of high-volume radiological and other chemically coagulated contaminants, that are slowly moving toward the Savannah River and surrounding area. Also, these plumes are gradually expanding. There is also evidence of low concentrations of both lead and mercury in the groundwater.

The groundwater from the southwest plume discharges tritium-contaminated water from surface springs and seeps into a small tributary that eventually flows into Fourmile Branch. The contamination of streams, the Savannah River, groundwater, and even precipitation is detrimental to local habitation, as explained by former Shell Bluff resident and GA WAND Field Coordinator, Bernice Johnson-Howard, at the Organization of American States Inter-American Commission on Human Rights, Right to Water and Sanitation hearing in April 2016:<sup>92</sup>

"Radiological poisons in our environments will stay in our environments for many thousands of years. Ungodly elements that strip health and livelihoods from thousands of generations. Women and girls are most particularly harmed. The National Academy of Sciences research shows that women have a 40-60% greater chance of getting cancer than men when exposed to the same

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<sup>88</sup> <https://energy.gov/em/savannah-river-site>

<sup>89</sup> [http://www.srs.gov/general/news/factsheets/srr\\_rlwf.pdf](http://www.srs.gov/general/news/factsheets/srr_rlwf.pdf)

<sup>90</sup> H-Area Tank Farm Performance Assessment Overview. [http://www.srs.gov/general/outreach/srs-cab/library/meetings/2011/wm/20110426\\_hfpa.pdf](http://www.srs.gov/general/outreach/srs-cab/library/meetings/2011/wm/20110426_hfpa.pdf).

<sup>91</sup> <https://www.srs.gov/general/pubs/ERsum/er14/er2014.htm>

<sup>92</sup> <https://www.ushrnetwork.org/events/human-rights-water-sanitation-growing-frontline-struggle-webinar>

radiation levels. Children's risks are greater; girls are six times more likely to develop cancer than boys receiving same dose [of] radiation."<sup>93</sup>

It is also important to note that "the strategic importance of groundwater for global water and food security will probably intensify under climate change as more frequent and intense climate extremes (droughts and floods) increase variability in precipitation, soil moisture and surface water."<sup>94</sup> With so much groundwater volume and bodies of water so close to the contaminant release points at SRS, climate change poses a significant threat.

### **Climate Change and Tritium**

A growing concern around nuclear energy generation and SRS's maintenance of nuclear weapons is the relationship between climate change and the increased efficacy of tritium traveling through the air and rain as pathways into communities' water, food, and ecological sources. Tritium abounds in Burke County, GA. Tritium is radioactive water: it is a hydrogen isotope, it reacts with oxygen, and it behaves like water. The more moisture present, the more likely tritium is to transition from a gaseous state to a liquid state.<sup>95</sup> "Studies indicate that continued Greenhouse Gas (GHG) emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century."<sup>96</sup>

As global temperatures rise, the ice caps melt, sea levels rise, and water temperature increases<sup>97</sup>, more moisture is held in the air. Therefore, present moisture effects tritium behavior, and any change in any present moisture, such as an increase in precipitation or in air or soil humidity will affect tritium behavior.<sup>98</sup> So as climate change increases ambient humidity and precipitation, tritium will disperse farther and faster.

Although we know that climate change does, in fact, effect tritium dispersion, no one knows how extensive it could get under changing climate conditions. SRS, due to its high level of tritium activity, closely monitors current changes and predicts long-term changes to humidity and precipitation levels at the site. Alarming, according to the Canadian Nuclear Safety Commission's 2009 report "Investigation of the Environmental Fate of Tritium in the Atmosphere:"

"...climate change modeling currently does not reliably predict effects on short-term (day-to-day) weather variance, which plays a significant role in tritium dispersion. Also, the resolution of current climate change models is regional, which is beyond the more localized effects of sub-

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<sup>93</sup> <https://www.youtube.com/watch?v=uNqNhuNnFWE> - coverage of Inter-American Commission on Human Rights (IACHR), special rapporteur on the human right to water testimony April 2016 (4:44-6:30)

<sup>94</sup> <http://www.nature.com/nclimate/journal/v3/n4/full/nclimate1744.html#access>

<sup>95</sup> <https://www.ccpa.net/DocumentCenter/Home/View/3173>

<sup>96</sup> 3.4 Impact of Climate Change on Tritium Dispersion <https://www.nrc.gov/docs/ML1029/ML102990100.pdf>.

<sup>97</sup> Even if aggressive global action to cut greenhouse gases is implemented, projections show that temperatures are going up, and likely will continue for some time, causing ongoing chaos in the weather of the South. Elevated water temperature contributes to the strength of tropical storms and hurricanes, a dominant feature in the lives of Southerners in coastal states.

<sup>98</sup> <https://www.nrc.gov/docs/ML1029/ML102990100.pdf>

regional features (shorelines, topography, etc.) that surround individual facilities. Thus, more detailed work on climate change downscaling techniques is needed to fully understand the influence of climate change on the atmospheric dispersion of tritium at nuclear facilities.”<sup>99</sup>

The Registered Nurses’ Association adheres to the sound reasoning that there is no safe level of ionizing radiation and that, as exposure to ionizing radiation increases, one’s cancer risk also increases. Therefore, the Registered Nurses’ Association believes that reducing and stopping the release of any amount of tritium into the environment plays an important role in protecting the health of the public.<sup>100</sup>

### **Burke County, GA and Contamination**

As a community affected by tritium in the atmosphere, Burke County, GA is an important case study. Like the Gulf Coast and Appalachian communities, Shell Bluff residents are employed by the same extractive and toxin-producing and -emitting industries that poison the environment.

Burke County lies directly downwind and downstream from SRS, which, despite being located in South Carolina, burdens Georgia outside of its site boundary. These burdens are due to wind patterns, streams flowing into the Savannah River, and groundwater flowing southeast, among other concerns. Burke County is also home to nuclear power Plant Vogtle, which is currently expanding from two to four operating reactors. Burke is one of Georgia’s largest and agriculturally productive counties. With a population of roughly 23,000 it is a tight-knit community dotted with churches about every 5 miles. There are strong family and community ties, long-standing generational and cultural knowledge, interconnected local and church communities, and a strong, shared faith.

During the post-enslavement time period, people of Shell Bluff worked hard on their land and built a thriving community-based economy in the East Burke hamlet of Shell Bluff, where Black people own large tracts of land. In a robust, self-sustaining agrarian community, people have farmed the land and fished the river. The county has longstanding roots in agriculture, with many of the residents having once been, or currently tending to farmland. In 2013, the median household income of Burke County residents was \$30,486. But because of lack of opportunity, many young people move away once they reach 18 years of age, making the median age for Burke County residents 36.2 years old and rising. The largest demographic population group is Black, followed closely in number by white people and Latino migrant workers. Burke County and surrounding areas suffer from high unemployment rates, yet the ability to build clean, green, and sustainable jobs in the area is very limited.

For 26 years, Georgia Department of Natural Resources Environmental Protection Division (EPD) conducted independent radiological environmental monitoring in Burke County and several other areas around Georgia. However, in 2002, this independent, non-industry, air, water, and land testing ceased. Data from the 2000-2002 monitoring samples showed “elevated concentrations of man-made

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<sup>99</sup> <https://www.nrc.gov/docs/ML1029/ML102990100.pdf>

<sup>100</sup> March 27, 2008. Tritium Standard Review. Registered Nurses’ Association of Ontario (RNAO).

radionuclides or radiation that are attributable to operations at a nuclear facility.”<sup>101</sup> Though none of these locations regularly exceeded the U.S. Nuclear Regulatory Commission reporting levels, there were some exceptions: panfish and catfish from Beaver Dam Creek and catfish from Fourmile Creek (Savannah River Area) exceed 10 millirem per year; leafy vegetation in two locations in southern Richmond County exceeded 15 millirem per year; direct radiation along two fence lines at the Georgia Tech research reactor, exceeding the Nuclear Regular Commission’s (NRC) reporting level but not to the annual dose limit of 100 millirem.”<sup>102</sup>

Burke County environmental samples contained tritium, cesium-137, strontium-90, plutonium, iodine-129, cobalt-60, with tritium being the element contributing the highest levels of contamination, showing up in air, rain, groundwater, river water, drinking water, fish, milk, crops, leafy vegetation, and deer. Current NNSA missions at SRS and routine radiological releases at Plant Vogtle result in continued tritium contamination in the air and water, in addition to EM legacy missions regarding contamination from Cold War era activities.

While today there is a very limited amount of environmental monitoring in Burke County by SRS and Plant Vogtle, there has been no independent (or non-industry related) air monitoring in this immediate downwind community since 2002.<sup>103</sup> Efforts are underway to re-establish a permanent SRS air monitoring station in Burke County. A 2004 report by the Georgia Department of Natural Resources Environmental Protection Division stated: “Elevated levels of tritium ( $\geq 5x$  background) were periodically detected at eight of 10 [air monitoring stations] within 30 miles of SRS with highest concentrations detected within SRS’s predominant downwind footprint.”<sup>104</sup>

Currently, Georgia WAND is collaborating with University of Georgia’s Savannah River Ecology Lab (SREL), on their Radionuclide Education, Monitoring, and Outreach Program (REMOP), which Georgia WAND brokered from 2015-2016 and which formally launched in July 2017. REMOP is a participatory sampling and education program for residents of Burke County. Given that SRS increased tritium extraction in 2017,<sup>105</sup> placing an air monitoring station in Burke County and educating residents about legacy contamination is both timely and critical. This work is collaborative in nature, and leaders are working together across sectors, cultures, beliefs, and histories in order to focus on community participation, needs, and ideas. But the legacy of fear runs deep in the community, and organizing people to come out remains a challenge.

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<sup>101</sup> Contact Georgia EPD’s Barty Simonton, 404.362.2755 to request a copy of the 2004 Report, entitles *Georgia Department of Natural Resources Environmental Protection Division Environmental Radiation Surveillance Report 2000-2002* (March 2004)

<sup>102</sup> Hardeman, Jim, “A Brief Look at Radiation Levels in Georgia”, *Radiation Monitoring in Georgia*, Georgia Department of Natural Resources Environmental Protection Division, March 2004

<sup>103</sup> Southern Nuclear / Plant Vogtle currently conducts limited air monitoring in the area.

<sup>104</sup> Hardeman, Jim, “A Brief Look at Radiation Levels in Georgia”, *Radiation Monitoring in Georgia*, Georgia Department of Natural Resources Environmental Protection Division, March 2004

<sup>105</sup> <https://nnsa.energy.gov/mediaroom/pressreleases/savannah-river-site-reaches-milestone-supplying-tritium-national-defense>

Annie Laura Howard Stephens is a Shell Bluff resident and community leader whose father worked at SRS (then known as “the Bomb Plant”) and whose brother retired from SRS. Both men, along with many other members of her family, died from cancer. Other people in the community are also employed by SRS. Annie Laura shared the following public comments at the July 25, 2017 SRS Citizens Advisory Board (SRS CAB) meeting:

“....The people of Burke County....come together [at REMOP monthly Community Talks] to meet...[and learn] the science part of it, the technical part of it, as well as the education part of it, and the spirit part of humanity so that we as a people can be safe. And I can understand the fear of the people of the community not wanting to be a part of [it] or come to the meetings because of fear... because they are uneducated people, they’re poor, [or] they work for SRS... and Georgia Power... we as humanity and human beings... what will affect one will affect all...”

It is possible that systemic racism, classism, and ruralism (the lack of respect and equal regard for people living in rural areas) contributed to the siting of these and other toxin-producing plants in such close proximity to the people living in this community. A lack of political representation and civic engagement around federal resource allocation also contributed to the development of the nuclear stronghold in the U.S. South. SRS was constructed under Jim Crow, when systemic racism was legal and very real. People were not made aware of the extreme and long-term dangers of nuclear weapons production and its radioactive and toxic related contaminants. Because the site was unregulated for 40 years; radioactive waste was dumped directly into creeks, which fed into the Savannah River, a food source for generations of people living in the surrounding communities. Today there are no fish advisories along the Savannah River despite high levels of radiological contamination found in some fish in the river. When Georgia Power, a Southern Company, conducted land-siting to construct Plant Vogtle, the Howard family, consisting of Black farmers who had owned their land for generations—an anomaly in the post-Reconstruction South—were cajoled out of their land.

### **Nuclear’s Vulnerability to Flooding**

Flooding of a nuclear facility would cause catastrophic effects and is increasingly likely in a world of extreme climate events. The most common natural disasters in South Carolina are thunderstorms and lightning, and flooding, occurring once every 3 days and once every 14.8 days, respectively.<sup>106</sup> South Carolina is home to several nuclear facilities, including the Barnwell Low-Level Radioactive Waste Disposal Facility, which has one of the highest amounts of radioactive waste storage in the country, and which has leaked tritium into the groundwater.<sup>107</sup> According to the South Carolina Department of Natural Resources, every town, city, and county in South Carolina has been identified as a flood-prone area.<sup>108</sup> According to a Climate Central<sup>109</sup> analysis of water levels in South Carolina, from 2017 to 2050, there is a 34% risk of at

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<sup>106</sup> [https://www.energy.gov/sites/prod/files/2015/06/f22/SC\\_Energy%20Sector%20Risk%20Profile.pdf](https://www.energy.gov/sites/prod/files/2015/06/f22/SC_Energy%20Sector%20Risk%20Profile.pdf)

<sup>107</sup> <http://www.thestate.com/news/local/article104316181.html>

<sup>108</sup> [http://dnr.sc.gov/water/flood/documents/SCQG\\_FloodplainManagement.pdf](http://dnr.sc.gov/water/flood/documents/SCQG_FloodplainManagement.pdf)

<sup>109</sup> “The Surging Seas model is based on projected sea level rise and historic storm data and doesn’t factor in larger, more powerful, and more frequent storms fueled by climate change which has been predicted by the 2013 National Climate Assessment. In other words, the chances of these devastating storm surges could be much worse

least one five-foot or higher flood occurring in South Carolina and an 86% risk of at least one four-foot or higher flood occurring in Georgia.<sup>110</sup> The state of South Carolina was so beleaguered by flooding in 2016 that, as soon as the University of South Carolina reopened its doors once the flooding receded, it put out a call for and subsequently funded over 30 research projects to look at flooding in South Carolina.<sup>111</sup>

Security has been increased at the major earthen dam that is up-river from a Duke Energy nuclear reactor site in South Carolina. Dam failure, for any reason, would result in three reactors melting down with a 100% probability, according to the NRC Nuclear Regulatory Commission (NRC).<sup>112</sup> This probability has been downgraded, but only marginally, due to Duke Energy adopting a flood-mitigation plan.<sup>113</sup> The Jocassee Dam is not unique; other reactors, including Watts Bar in TN are similarly threatened by catastrophic flooding if a dam, engineered for water volumes of the 20<sup>th</sup> century, were to break or be violently broken.

Given that SRS borders the Savannah River and the contaminated streams coming off the site, such as Fourmile Branch, feed into the river, it is concerning that a major nuclear complex is in a location particularly vulnerable to flooding (including flooding of already-contaminated streams) and severe thunderstorms. Climate change is bad for SRS, as storm surges and flooding could result in structural damage of the complex, environmental damage, loss of power to the site, and raising the risk of hazardous contamination that threatens both environmental and public health and safety.

Recent devastating hurricanes are affecting the South significantly. With Harvey in Texas, Irma in Florida, and Maria in Puerto Rico, records have been broken. Harvey marked the most extreme rainfall event in continental U.S. history and Irma is the most extreme storm recorded in the Atlantic. These extreme weather events align with climate scientists' projections that storms will become more severe as global temperatures rise.<sup>114</sup>

And as weather events get more extreme, concerns about nuclear facilities get more pressing. The South Texas Project, a nuclear power station, was called to attention for its potential to cause great harm in the face of Harvey, during which it continued to run at full capacity.<sup>115</sup> Its embankment wall, which protects its two nuclear reactors from the nearby 7,000-acre reactor cooling water reservoir, could be broken by Harvey's flood and rainwaters, according to watchdog groups the Sustainable Energy and Economic Development coalition, the South Texas Association for Responsible Energy, and Beyond Nuclear which

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than these tools show." - <http://www.motherjones.com/environment/2013/07/sea-level-rise-charts-climate-central/>

<sup>110</sup> [http://riskfinder.climatecentral.org/state/south-carolina.us?comparisonType=county&forecastType=NOAA2017\\_int\\_p50&impact=EPA\\_tris&impactGroup=Contamination+Risks&level=5&unit=ft#threat-forecast](http://riskfinder.climatecentral.org/state/south-carolina.us?comparisonType=county&forecastType=NOAA2017_int_p50&impact=EPA_tris&impactGroup=Contamination+Risks&level=5&unit=ft#threat-forecast)

<sup>111</sup> [https://sc.edu/about/offices\\_and\\_divisions/research/docs/sc\\_floods\\_project\\_summary\\_booklet.pdf](https://sc.edu/about/offices_and_divisions/research/docs/sc_floods_project_summary_booklet.pdf)

<sup>112</sup> Report from Union of Concerned Scientists, Greenpeace and Whistleblowers, in Huffington Post (2012). [http://www.huffingtonpost.com/2012/10/19/nuclear-plant-flood-threat-leak\\_n\\_1983005.html](http://www.huffingtonpost.com/2012/10/19/nuclear-plant-flood-threat-leak_n_1983005.html)

<sup>113</sup> Letter from Duke Energy to NRC, 2016. <https://www.nrc.gov/docs/ML1613/ML16131A671.pdf>

<sup>114</sup> <https://insideclimatenews.org/news/06092017/hurricane-irma-harvey-climate-change-warm-atlantic-ocean-question>

<sup>115</sup> [https://www.commondreams.org/news/2017/08/29/historic-flooding-grips-texas-groups-demand-nuclear-plant-be-shut-down?utm\\_campaign=shareaholic&utm\\_medium=email\\_this&utm\\_source=email](https://www.commondreams.org/news/2017/08/29/historic-flooding-grips-texas-groups-demand-nuclear-plant-be-shut-down?utm_campaign=shareaholic&utm_medium=email_this&utm_source=email)



called for its shutdown.<sup>116</sup> Potential dangers included electrical fires and meltdown, but the facility stayed open. In addition, flooding from the nearby Colorado River could have caused further dangers. This represents a disregard for the safety of the general public and the workers of the facility in the interest of productivity.

One doesn't have to live next door to these sites to experience the consequences of climate change and increased risks from the nuclear industry. Radiological contaminants from SRS can be found downstream in the Savannah River as it flows past Savannah, GA on its way to the Atlantic Ocean. The last bit of land the Savannah River passes on its way into the ocean is the northern point of Georgia's 100-mile coastline, Tybee Island. Cesium 137 has shown up in sediment (up to 540x background) not just at the SRS site boundary but also up to 100 miles downstream. The 2004 Georgia Department of Natural Resources Environmental Protection Division report found: "Elevated cesium-137 in sediment (from SRS creeks) is responsible for most of the cs-137 problem found in fish from [the Burke County area and] .... elevated levels of [Cobalt-60] (approximately 22x background) Cobalt-60 was also detected up to 100 miles downstream."<sup>117</sup> In short, radioactivity is found at the river's furthest downstream point, in Savannah, GA.

The city of Savannah and its environs are facing climate vulnerabilities as well. In 2015, Georgia's Tybee Island and the Savannah area experienced 23 "nuisance floods,"<sup>118</sup> the most in recorded history.<sup>119</sup> The October 2015 king tide flooding (the highest tide of the year), of Route 80 leading from Savannah, GA to Tybee Island was a wake-up call on coastal vulnerability—something Tybee residents and people who work in local governments in coastal communities had already been wrestling with.<sup>120</sup>

In 2016, Karen Graineey wrote in the Georgia Sierra Club's election issue of *Georgia Sierran*:

"National Oceanic and Atmospheric Administration (NOAA) has documented a long-term trend of increasing nuisance flooding on Tybee Island and the Savannah area as a clear consequence of rising seas. Compare the 4.8 average number of observed nuisance flood days in the four-year period 1956-60 to the 13.2 average number of such days during the period 2006-10."<sup>121</sup>

To connect the dots, radiological contamination is dispersed into the Savannah River and the Atlantic Ocean at the river's mouth near Savannah and Tybee Island, GA. Graineey continued: "In addition to flooding, the only road to Tybee, these floods back up through the storm water system, flooding city streets and yards with salt water—killing lawns and gardens."<sup>122</sup> When flooding is radioactive, much more than gardens will perish.

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<sup>116</sup> <https://www.reuters.com/article/us-storm-harvey-nuclearpower/south-texas-project-nuclear-plant-running-despite-harvey-idUSKCN1B92KG>

<sup>117</sup> Hardeman, Jim, "A Brief Look at Radiation Levels in Georgia", *Radiation Monitoring in Georgia*, Georgia Department of Natural Resources Environmental Protection Division, March 2004

<sup>118</sup> 5.2 feet above an established benchmark

<sup>119</sup> Graineey, Karen, "Sea-Level Rise: It's Long Past Time to Act", *Georgia Sierran*, Vol. 40, #4, Oct, Nov, Dec 2016

<sup>120</sup> Graineey, Karen, "Sea-Level Rise: It's Long Past Time to Act", *Georgia Sierran*, Vol. 40, #4, Oct, Nov, Dec 2016

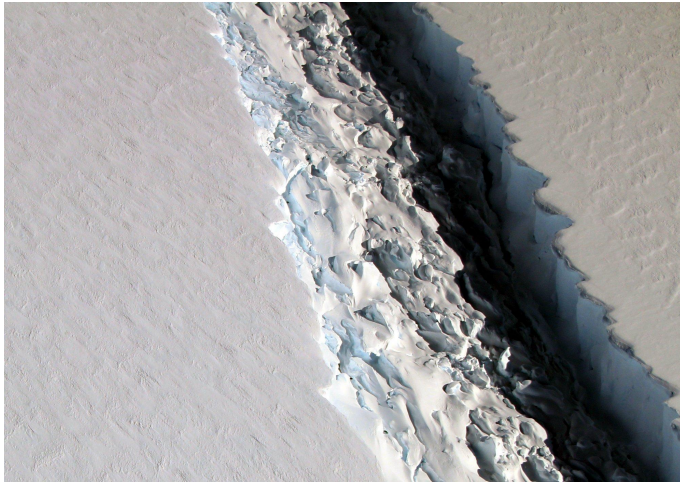
<sup>121</sup> Graineey, Karen, "Sea-Level Rise: It's Long Past Time to Act", *Georgia Sierran*, Vol. 40, #4, Oct, Nov, Dec 2016

<sup>122</sup> Graineey, Karen, "Sea-Level Rise: It's Long Past Time to Act", *Georgia Sierran*, Vol. 40, #4, Oct, Nov, Dec 2016

## Section 3: A Look Ahead at Nuclear Operations in a Changing World

### When Tides Have Risen

This report shows the interaction of nuclear power reactors, nuclear weapons complex missions, water, temperature, and changing weather. While power plants must be sited on water bodies for cooling purposes, this need makes reactors on the Gulf, Atlantic, and tidal rivers subject to the changes in our oceans. As the oceans change due to the melting of long-term icepack and the expansion of warmer oceans, coastlines will change. This directly impacts nuclear reactors, which are permanently fixed facilities that cannot move when water encroachment threatens their safety and function.



**Larsen C Shelf in 2016 before it broke apart in 2017 - NASA<sup>123</sup>**

Sea level rise is, at this point, inevitable, even if we participate in mitigating efforts. Benjamin Strauss of Climate Central published a 2013 article in the National Academy of Science Proceedings in which he stated, “...we have already committed to a long-term future sea level [more than] 1.3 or 1.9 [meters] higher than today and are adding about 0.32 [meters per] decade to the total: 10 times the rate of observed contemporary sea-level rise.”<sup>124</sup> Strauss goes on to show the forces that contribute to this rise of sea level:

“By mid century, the central estimate of commitment would rise to [more than] 3.1 [meters], assuming today’s trends continue or to 2.1 [meters] under an aggressive emissions-cutting and atmospheric carbon dioxide removal scenario. Both scenarios threaten the future viability of many hundreds of coastal municipalities in the United States alone, but the low emissions path would likely spare hundreds more, including many major cities.”<sup>125</sup>

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<sup>123</sup> <https://www.nasa.gov/image-feature/rift-in-antarcticas-larsen-c-ice-shelf>

<sup>124</sup> Strauss, B 2013. <http://www.pnas.org/content/110/34/13699.full>

<sup>125</sup> Strauss, B 2013. <http://www.pnas.org/content/110/34/13699.full>



Melting and warming will, in time, irreversibly produce a level of sea-rise, but it may take some years for that result to arrive. The numbers Strauss cited are conservative compared to catastrophic projections showing results from the cumulative effect of the entire Greenland ice-mass sliding into the ocean, which would potentially move coastlines far inland, worldwide. Hypothetical as these impacts seem, it is critical that the nuclear industry examine all options for preparing nuclear plants and radioactive waste sites for imminent disruption. Even minor changes in sea level place reactors in the U.S. South in jeopardy.

The National Oceanographic and Atmospheric Agency (NOAA) has created an online mapping tool to visualize the impact of sea-level rise on existing geography.<sup>126</sup> With the tool, the viewer can extend the projection up to a six-foot rise, less than Strauss's 2.1-meter scenario mentioned above. Several nuclear reactors where normal operations would be compromised by even a one-foot rise are in Florida: Turkey Point, where two new reactors are proposed to join two existing reactors; two reactors at St Lucie; and the shuttered Crystal River site.<sup>127</sup> Any rise in sea-level also changes storm surge levels, and all of the Atlantic and Gulf coast nuclear energy sites are already subject to storm-flooding. Since flooding can cause power outages and other accidents, the danger related to the nuclear industry is that much more imminent given the effect of climate change. It is feared that it will only get worse.

In addition to nuclear safety issues, the impact of significant changes in seacoasts will, as Strauss states, result in relocation of population and the abandonment of historic communities. Such transitions necessarily carry with them an enormous stress burden. Climate chaos is also projected to disrupt usual food production as well as diminish the availability of fresh drinking water.<sup>128</sup>

### **Nuclear Facilities and Conflict**

The existence of nuclear reactors and their waste products is deeply troubling in a world plagued by violence and conflict. Climate change is already leading to stress and conflict, and extremist violence in the U.S. and internationally has the potential to underpin new conflicts. Industry proposals to build new nuclear sites in a destabilized world must include credible analysis of the potential consequences of violent unrest and war on nuclear operations as potential targets of mass destruction. For example, even the use of conventional explosives that disrupt reactor cooling mechanisms, specifically the reactor core—could produce results very similar to the Fukushima Daiichi nuclear disaster.

Nuclear reactors and adjacent spent fuel pools can be seen as pre-deployed weapons of mass destruction. The September 11, 2001, attackers passed over the Indian Point nuclear power reactor site four air-minutes from the World Trade Center site. An NRC Commissioner doubted media reports from 15 years ago that Al Qaeda was planning to hit U.S. nuclear sites, stating that the NRC had asked for but had

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<sup>126</sup> <https://coast.noaa.gov/slr/#> - visit the viewer for more information about specific locations

<sup>127</sup> All operating nuclear power reactors in the U.S. are listed here: <https://www.nrc.gov/reactors/operating/list-power-reactor-units.html>

<sup>128</sup> See for instance the 2017 study by Arizona State University for the Southwestern U.S.: <https://asunow.asu.edu/20170327-arizona-impact-asu-study-shows-effect-climate-change-food-energy-and-water-across-southwest> and the monumental 2013, Island Press "Climate of the Southeastern U.S." <https://www.sercc.com/ClimateoftheSoutheastUnitedStates.pdf>

received no direct evidence from intelligence agencies of any plots to attack U.S. reactors.<sup>129</sup> These historical strokes of good fortune do not ensure that such luck will hold in the future.

No expert analysis of the consequences of using a nuclear weapon on a nuclear power reactor is available in the public press. This scenario is raised in this report because we are living in a time of greater nuclear threats of every kind. If climate policy leads to an ever-growing number of nuclear sites worldwide, then in the event that a nuclear weapon is used in war, the chances of it hitting a nuclear reactor, or alternatively, disrupting the electric and water delivery infrastructures needed for reactor safety systems to operate, disrupting all emergency services and other personnel, must be factored in to any analysis. Conversely, nuclear reactor cores, as well as the waste stored on the site, contain a great deal more persistent, long-term radioactivity than is released by a nuclear weapon, greatly increasing the radioactivity in the aftermath of such an event.<sup>130</sup> These considerations are partly why nations and non-government organizations have put a focus on the “humanitarian impacts” of nuclear weapons,<sup>131</sup> where a reality-based discussion of such outcomes is taken as the basis for saying that nuclear weapons are not a source of security, and like Weapons of Mass Destruction, should be eliminated.

### **Plutonium: A Danger in our Time**

The source of energy in nuclear waste is plutonium. Plutonium is the preferred “active ingredient” to fuel nuclear weapons; its fission is better suited to rapid explosion compared to highly enriched uranium, which traditionally fuels nuclear reactors. Reactors fueled with low-enriched uranium make plutonium as a by-product, so reactors that make electricity also makes nuclear weapons materials. Since the reactor waste is highly radioactive (the levels are lethal), there is a high barrier to its recovery. Nonetheless, some nations have become nuclearized by utilizing the plutonium in reactor waste for nuclear weapons production.

Often, if nuclear energy is promoted as a solution for climate change, a parallel proposal is made: waste from 20<sup>th</sup> century nuclear reactors should be “recycled” because, it is claimed, energy is present in the waste and can provide enormous amounts of additional electric power. These promises come primarily from new, startup companies proffering “Generation IV” reactors that are portrayed as “green and clean.”<sup>132</sup> Recently, the MIT graduate-founded energy startup Transatomic Power claimed to recycle nuclear waste. However, the company has been exposed for its inflated claims of 75 times more electricity produced from fuel than current reactors; these claims came from “serious errors in the company’s calculations,” detected by MIT faculty and reported in *MIT Technology Review*.<sup>133</sup>

The *MIT Technology Review* reports that Transatomic Power has since backpedaled on its main claims:

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<sup>129</sup> Edward McGaffigan, former NRC Commissioner, private communication with Mary Olson circa 2006.

<sup>130</sup> Alvarez, et al posted by the U.S. NRC: <https://www.nrc.gov/docs/ML1207/ML12073A432.pdf>

<sup>131</sup> See for instance, The Vienna Conference on the Humanitarian Consequences of Nuclear Weapons,” <https://www.bmeia.gv.at/en/european-foreign-policy/disarmament/weapons-of-mass-destruction/nuclear-weapons-and-nuclear-terrorism/vienna-conference-on-the-humanitarian-impact-of-nuclear-weapons/>

<sup>132</sup> An example of an article from 2013 trumpeting these concepts: <http://gizmodo.com/5990383/the-future-of-nuclear-power-runs-on-the-waste-of-our-nuclear-past>

<sup>133</sup> MIT, 2017. <https://www.technologyreview.com/s/603731/nuclear-energy-startup-transatomic-backtracks-on-key-promises/>

“...the company downgraded ‘75 times’ to ‘more than twice.’ In addition, it now specifies that the design ‘does not reduce existing stockpiles of spent nuclear fuel’ or use them as its fuel source. The promise of recycling nuclear waste, which poses tricky storage and proliferation challenges, was a key initial attraction of the company and captured considerable attention.”

Another security issue associated with using plutonium as fuel is that the fresh, unused fuel is an easy target for those seeking nuclear weapons-usable materials. Uranium fuel cannot be converted to nuclear weapons fuel without sophisticated enrichment technology to concentrate the fissile uranium because the fuel is composed of two isotopes of a single element that cannot be separated chemically. As pressures from climate grow, so does the potential for global conflict over scarce resources. Using a technology that increases the risks of nuclear weapons spreading increases our vulnerability to nuclear war and destruction.

### **The Dangers of Mixed-Oxide Fuel**

As a fuel, plutonium is twice as deadly as uranium. MOX fuel, or Mixed-Oxide fuel (mixed oxides of plutonium and uranium), is made by down-blending weapons-grade plutonium. It is harder to manage than uranium, and if control is lost, a major accident would take place that releases irradiated fuel, similar to Chernobyl and Fukushima. It would be twice as deadly in terms of long-term cancer deaths, according to Dr. Edwin Lyman,<sup>134</sup> who compared MOX to a uranium-only core.

Elected officials may want to dig deeply into these scenarios and findings when asked to endorse degraded plutonium, or any plutonium, as a fuel for civilian energy, particularly in light of the intersection between climate change and nuclear safety. No public servant should support a doubling in public harm from an already dangerous technology.

Starting in 1996, the U.S. and Russia were working to pursue the use of MOX fuel, under a different recycling model: the plutonium would come from dismantled nuclear weapons. The DOE began plans for a MOX fuel factory in 1996, to be sited in South Carolina at SRS.<sup>135</sup> A partnership of grassroots and national organizations, including Georgia WAND, challenged the license at the Nuclear Regulatory Commission.<sup>136</sup> This program was eventually derailed due to technical challenges, cost over-runs, and schedule delays. The program, or any parallel MOX fuel plan, should not be revived for environmental and worker exposure issues, let alone the other issues at hand.

Plutonium-239, if separated from the waste, is weapons-usable. If plutonium is used as a reactor fuel—such as in MOX—there is a catalogue of nuclear safety and security problems. Part of the delay in implementing MOX fuel production at SRS has been the unwillingness of commercial reactor owners to

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<sup>134</sup> Dr Edwin Lyman, 2000. <http://www.nci.org/pdf/lyman-mox-sgs.pdf>

<sup>135</sup> This project has now been more or less halted, and the suggestion has been made to use the facility to make new plutonium pits instead of MOX. concerns over potential pit production is deserving of a separate report

<sup>136</sup> Blue Ridge Environmental Defense League, Nuclear Watch South, Nuclear Information and Resource Service teamed up as intervenors on the MOX fuel factory license, securing Dr. Edwin Lyman of Union of Concerned Scientists as the qualified expert and Diane Curran as legal counsel.

use it. In other words, MOX fuel has no customers. The plan, which was hatched in 1996 and is still not implemented, would have put MOX fuel into the existing, aging reactor fleet. It cannot be overstated that plutonium is harder to control. Uranium fission can be stopped by dropping metal control rods into the reactor core; but control rods are virtually useless with a plutonium-powered reactor because of differences in the neutrons released by the two fuels. So the plan was tweaked to load only one-third MOX and two-thirds traditional uranium fuel into commercial reactors. However, this tweak caused the program, which was designed to degrade the weapons plutonium per the New START treaty, to last longer than the reactors themselves.

Similarly, use of plutonium in smaller facilities, as the promoters of Small Modular Reactor (SMR) and GEN IV envision, would greatly increase the potential for radioactive harm. The one site under consideration for a pilot SMR site is in TN, across the river from the Oak Ridge National Lab and nuclear weapons production site. Once again, it is the U.S. South that is placed at greater risk. One model for SMRs is to cluster them together on a single site. If this plan is implemented and plutonium is used, more heat would be generated with each fission. In a steam cycle, that means even greater release of waste heat. Heated water and steam, already an issue from uranium fuel, under plutonium fueling, therefore would be even worse.

The new treaty negotiated at the United Nations in Spring 2017 to ban nuclear weapons may help slow down the nuclear industry's clash with the climate. On July 7, 2017, of the 124 nations that participated in the negotiation of the language of the new treaty, 122 voted to move ahead, 1 opposed, and 1 abstained. The U.S., along with the other eight countries that own nuclear weapons, did not participate in the negotiations or the vote.<sup>137</sup> The diplomacy, practicality, and open-mindedness demonstrated by the nations negotiating in the UN are concepts rooted in an approach to working across differences toward shared goals. These values also embodied in many organizations coalescing in the U.S. South around climate change, energy justice, and sustainable economies.<sup>138</sup>

Given what UN nations have modeled, there is hope for change.

## Recommendations

With this report, Georgia WAND and Nuclear Information Resource Service amplify education about the effects of climate change on nuclear energy generation and nuclear waste storage in communities across the southern region. Information provided in this report will help build the case for sustainable, green, clean, healthy jobs for all, and the argument that a sustainable economy is the future. Therefore, key recommendations include centering workers and affected communities in the conversation. The Gulf South Rising (GSR)'s 2015 report said:

“‘Just transition’ [is] tailored to acknowledge a Southern reality. Within the GSR initiative, the demand was a just transition away from extractive industries, discriminatory policies and unjust

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<sup>137</sup> <https://www.pri.org/stories/2017-07-11/un-adopted-treaty-banning-nuclear-weapons-no-nuclear-armed-nations-are-board>

<sup>138</sup> See recommendations section for more information.

practices that hinder equitable recovery from disaster and impedes the development of sustainable communities.”<sup>139</sup>

There is a dire need for sustainable, safe, and healthy jobs in the U.S. South. It is especially concerning in places like Burke County where communities are simultaneously employed by and supported by the same industries that contribute to environmental contamination that could be causing adverse health issues. There is a lack of job training in many southern communities, and often, family members have to jeopardize their health in order to provide for their families. The need to build partnerships with organized labor and industry is imperative to help communities arrive at the capacity to thrive and withstand major shocks, such as climate change.

By building awareness about energy justice across the South, this report leverages science and shared community expertise to drive new economic solutions and displace fossil fuels. This report references the need for community-led, robust emergency preparedness and planning, as well as the need for renewable, sustainable energy sources. Wind and solar are readily available, renewable solutions that can be implemented in a timeline that will decrease the rapidly increasing rate of atmospheric CO<sub>2</sub> production.<sup>140</sup>

Further inquiry and research will be critical not only to inform policy, industry, and regulatory decisions, but also to adequately prepare communities for proper hazard mitigation, disaster preparedness, emergency evacuation, and preparedness planning. Because there are compound effects of other fossil fuel-based energy infrastructure and natural disaster-related occurrences, the authors recommend future studies around energy-related climate issues, nuclear-related environmental and health issues, and a continued analysis of the U.S. South’s vulnerability to future climate shocks.

All of the recommendations below are rooted in principles of justice and equity. When the following recommendations are accomplished, life-threatening dangers to communities from the intersection of climate change and nuclear energy / nuclear weapons industries in the U.S. South will be greatly reduced:

1. Create just, participatory economic inclusion and sustainability policies for communities dependent on nuclear reactors, with priority on the oldest reactors, reactors under construction, and the eight “ice-condenser” units in the region at Watts Bar and Sequoyah (TN), McGuire (NC), Catawba (SC), and GE MARK reactors. GE MARK Units: Browns Ferry (AL), Grand Gulf (MS), Brunswick (NC), Hatch and Baxley (GA), River Bend (LA) as these reactors reach the end of their life cycles.

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<sup>139</sup> <http://www.gulfsouthrising.org/final-report/>

<sup>140</sup> This report does not detail the economics of fossil and nuclear fuels in relation to the mandate to reduce greenhouse gas emissions; however, when older reactors are closed, money is saved by avoiding costly repairs. These resources can be used to phase-in energy conservation and efficiency, solar and wind energy generation, and other sustainable energy technologies and practices.<sup>140</sup> In fact, according to *Lazard’s Levelized Cost of Energy Analysis-Version 9.0*, solar and wind energy would be 80% less expensive than the construction of new nuclear reactors, yet would produce the same amount of peak energy  
output <https://www.lazard.com/media/2390/lazards-levelized-cost-of-energy-analysis-90.pdf>

2. Develop Nuclear Harm Reduction measures and protocols at nuclear weapons production sites, waste sites, and labs; and nuclear energy generations plants, uranium mining, fuel fabrication, uranium milling, and nuclear waste management sites, for example, the nuclear industry should share with the public when there are scheduled releases of radiological effluent into the air and water, without creating new nuclear missions.
3. Fund and conduct community-led, quantitative, qualitative, and emergent participatory health research about nuclear radiation exposure and human health within communities living in the shadow of nuclear energy and weapons plants.
4. Terminate public funding, including federally administered accident liability caps, subsidies, and Construction Work in Progress, for the two new nuclear reactors under construction at Plant Vogtle and any reactors in the future; and create participatory policymaking circles in affected communities consisting of elected officials, residents, workers, and other affected groups to help guide policy and affect decision-making at the Public Service Commission, state legislature, and Congress.
5. Educate the public and decision makers about the need for energy efficiency, decreasing demand for energy,<sup>141</sup> and energy equity, which draws connections between energy and racial equity, economic justice, gender and reproductive justice, disability justice, environmental and climate justice, health, ruralism, distribution of public resources, and state violence.
6. Replace the South's current vertically integrated energy generation and distribution system, where power is centralized and owned mainly by one company, with a new system consisting of decentralized, coordinated clean and local power, where there is more local ownership of electrical generation, such as solarized homes and businesses, and the company is serving a coordination role in the transmission of the energy.<sup>142</sup>
7. Center, prioritize, and involve unionized, non-union, and undocumented workers from the nuclear industry in creating economic development and inclusion policies, such as funding for job training in emerging sustainable economies in communities dependent on nuclear reactor sites, that ensures well-paying, safe, and healthy jobs.
8. Co-create community-led, participatory emergency preparedness plans, being inclusive of the language and population needs of the communities directly affected, with input and support from the nuclear industry and local, state, and federal emergency management agencies.

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<sup>141</sup> For instance, in North Carolina the proposal for <http://ncsavesenergy.org/> is not yet implemented, but has been introduced in the state legislature.

<sup>142</sup> <http://www.nytimes.com/2006/10/21/business/21solar.html>

9. Increase civic engagement and education of the public about issues related to the nuclear industry, such as the importance and urgency of the U.S. to sign and ratify the United Nations Treaty on the Prohibition of Nuclear Weapons.
10. Fund and further develop coalitions and partnerships that can advance climate, environmental, economic, reproductive, and energy justice collaboratively, such as Advancing Equity in the U.S. South, Partnership for Southern Equity's Just Energy Circle; U.S. Human Rights Network; Project South and the Southern Movement Alliance; the Georgia Water Coalition; the Alliance for Nuclear Accountability; SisterSong Women of Color Reproductive Justice Collective; Atlanta Jobs with Justice; and others.
11. Bring together communities that face multiple environmental, social, and economic insults across the region and other parts of the U.S.; and connect globally with communities facing similar climate injustices in order to facilitate the development of community-led solutions.
12. End production of nuclear weapons materials, including production of tritium at the Savannah River Site, and re-invest the billions of dollars from SRS's tritium missions into environmental clean up, management, and isolation of radioactivity from life sustaining ecosystems.
13. Educate the public and opinion leaders about the need to invest in diplomacy, conflict resolution, cultural competency, and participatory democracy.
14. Improve nuclear safety at all nuclear related sites, for example, Immediately close reactors downstream of dams where dam failure would result in a high likelihood of a major reactor accident. Reduce waste stored in reactor fuel pools and choose better storage containers.<sup>143</sup>
15. Conduct further studies about Savannah River Site Tank Farms since some tanks have sunken and others are continually sinking below the water table; at least one has leaked in the past.
16. Conduct further studies about the effects of climate change on the Y-12 nuclear weapons complex and Oak Ridge National Laboratory in Tennessee.

Most importantly, it is critical to engage a variety of voices. We recommend resourcing cross-sector, trans-partisan, multiracial, inter-generational, multilingual, cross-geographic participatory efforts, approaches, and solutions to address the climate and energy crises facing the region, taking into consideration information and recommendations in this report to progress toward a healthy, safe, sustainable future for all.

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<sup>143</sup> See: <http://www.psr.org/resources/principles-for-safeguarding.pdf> with endorsement for safer and more secure storage from community groups, and better storage containers: <https://sanonofresafety.org/>