



Report on the

# ANALYSIS OF THE ADVANCED RECYCLING FACILITY INDUSTRY & ENVIRONMENTAL IMPACTS

January 2024

Prepared for **Gov. Henry McMaster**  
and the **Members of the S.C. Legislature**



Prepared by the S.C. Department of Health and Environmental Control's  
Division of Mining and Solid Waste Management

*Edward Simmer, MD, MPH, DFAPA, Director*

# Introduction

Plastic remains a significant and rapidly growing segment of the nation’s municipal solid waste (MSW) stream.

New technologies are being developed to improve plastic recovery. These emerging technologies include advanced recycling. Also known as chemical recycling, it is a process that uses heat or chemical solvents to break down plastic into liquid and gas to produce an oil-like mixture that can be turned into plastic pellets to make new products.

Advanced recycling has its supporters and critics. Supporters say it will allow more types of used plastic to be recovered and remanufactured into new products. Critics argue that this type of recovery can create toxic waste and emissions that are a potential risk to human health, and that the facilities are prone to fires and explosions.

In 2022, the S.C. General Assembly required the S.C. Department of Health and Environmental Control (DHEC) to complete an analysis of the advanced recycling industry and recommend if a cash trust fund or surety bond should be required of a facility. In addition, DHEC’s analysis should incorporate the industry’s record in South Carolina or elsewhere and include potential environmental and human health impacts.

The report is due to the General Assembly by January 27, 2024.

## Commonly Used Acronyms & Abbreviations

- **Act** – Act 119, South Carolina Solid Waste Policy and Management Act
- **ACC** – American Chemistry Council
- **BAQ** – Bureau of Air Quality
- **BOW** – Bureau of Water
- **BLWM** – Bureau of Land and Waste Management
- **CAA** – Clean Air Act
- **DHEC** – The S.C. Department of Health and Environmental Control
- **EPA** – U.S. Environmental Protection Agency
- **Industry** – Representatives from the advanced recycling companies
- **ND** – No Discharge Land Application
- **NPDES** – National Pollutant Discharge Eliminations System
- **NGO** – Non-Governmental Organization
- **NRDC** - National Resources Defense Council
- **PIA** - Plastics Industry Association
- **State** – South Carolina
- **SWPMA** – S.C. Solid Waste Policy and Management Act of 1991

## Table of Contents

<b>Executive Summary</b> .....	<b>3</b>	<b>Findings</b> .....	<b>7</b>
Recommendations .....	3	Environmental Concerns .....	7
Next Steps .....	3	Firefighting, Displacement & Relocation of Affected Persons .....	7
<b>Advanced Recycling Legislation</b> .....	<b>4</b>	Foreseeable Costs of Advanced Recycling: Operation, Management & Abandonment .....	8
Advanced Recycling .....	4	Public Health Impacts .....	9
Advanced Recycling Facility .....	5	Groundwater, Surface Water & Private-Property Contamination .....	10
Financial Responsibility Mechanism .....	5	Regulation of Advanced Recycling Outputs .....	11
Post-Use Polymer .....	5	Cost of Cleanup & Environmental Remediation .....	12
Recovered Feedstock .....	5	<b>References</b> .....	<b>12</b>
<b>Advanced Recycling at a Glance</b> .....	<b>6</b>		
National Overview .....	6		
EPA Region 4 States .....	6		
South Carolina .....	7		

## About this report ...

“Report on the Analysis of the Advanced Recycling Facility Industry and Environmental Impacts 2024” is submitted by DHEC in compliance with the Act – Section § 44-96-140 (C) – and is published by DHEC’s Bureau of Land and Waste Management’s (BLWM) Division of Mining and Solid Waste Management (DMSWM). In addition, Act 119 of 2005 mandates that agencies provide all reports to the General Assembly in an electronic format. ***This report was published on January 25, 2024.***

**BLWM Assistant Bureau Chief:** Juli Blalock • **Editor:** Brian Norman • **Layout/Artwork:** Gregg Glymph  
**DMSWM Director:** Marty Lindler • **Contributors:** Richard Chesley, Kyle Clark, Adah Gorton and Sallie Williams

# Executive Summary

The S.C. General Assembly directed DHEC to research and analyze advanced recycling – an emerging technology focused on recovering plastic waste – and in turn make recommendations on addressing potential human health and environmental impacts as well as the necessity of financial assurance for facilities. Multiple viewpoints were collected in the research of this report. Members of non-governmental organizations highlight potential environmental, public health, and financial risk impacts. Conversely, reports and research from members of the advanced recycling industry promote advanced recycling as the safe future of recycling plastic and other material.

Here are the key findings:

- It is a new, emerging technology. As of the publication of this report, there are eight advanced recycling facilities nationwide. South Carolina does not have a facility, however, there is a company that has received a permit for construction from DHEC’s Bureau of Air Quality (BAQ).
- While South Carolina does not have advanced recycling regulations, DHEC has oversight in other regulatory aspects. BAQ, as mentioned above, requires permits on any plans to construct, alter, or add to a source of air pollution including the installation of any air pollution control device. The Bureau of Water (BOW) requires National Pollutant Discharge Elimination System permits to discharge any organic or inorganic matter into the environment. The Bureau of Land and Waste Management (BLWM) has authority over any applicable solid waste management that is entitled to compliance checks.
- More research is required to understand the effectiveness of advanced recycling as well as potential safety and financial risks.
- Perceptions of the advanced recycling industry are polarized, therefore information that is currently available is prone to bias.
- As of publication, 24 states have passed legislation saying advanced recycling is manufacturing and not waste management. The distinction is important because waste management facilities are subject to more stringent environmental regulations. Supporters say this lowers the barrier for a new technology and better fits the description of the processes happening in the facilities. Detractors oppose the classification and prefer such facilities to have to prove themselves to higher environmental standards.

- EPA is analyzing the advanced recycling industry to redefine its current definition. Comments submitted in 2021 and other studies are being considered for this ruling.

## Recommendations

- DHEC supports the continued development of advanced recycling facilities with appropriate safeguards to protect the public.
- As required by Act 119, DHEC supports the requirement for advanced recycling facilities to provide financial assurance prior to being placed into operation. Financial assurance mechanisms are warranted for facilities that store large amounts of plastic, similar to solid waste facilities. To demonstrate financial responsibility, the advanced recycling facility must establish a cash trust fund under the control of DHEC or obtain a surety bond for which DHEC is the sole beneficiary, sufficient in form and amount to meet all reasonably foreseeable costs of clean up, environmental remediation, firefighting, ground water, or surface water contamination, private-property contamination, public health impacts, and displacement and relocation of affected persons, and any other reasonably foreseeable costs associated with the operation, management, or abandonment of any pyrolysis and gasification facilities including, but not limited to, the operation and storage of postuse polymer, plastic polymer, or incidental contaminants or impurities; provided, however, that no cash-trust fund or surety bond shall be required if the advanced recycling facility establishes to DHEC that such costs are not reasonably foreseeable.

## Next Steps

- DHEC will continue to monitor nationwide actions, research and studies to better understand the overall process, effectiveness, and potential risks.
- Although there currently are not any advanced recycling facilities in the state, DHEC will continue to monitor for any potential new operations as well as the company with a BAQ construction permit.
- In an effort to further embrace innovative technologies while protecting the state and environment, DHEC will continue to research and maintain information of advanced recycling efforts.

# Advanced Recycling Legislation

The 2022 Act Number 119 pursuant to the S.C. Solid Waste Policy and Management Act of 1991 (SWPMA) was ratified by the Governor on January 27, 2022. In the amendments to the Act, necessary terms were defined to advanced recycling and advanced recycling facilities. Visit [scstatehouse.gov/sess124\\_2021-2022/bills/525.htm](https://scstatehouse.gov/sess124_2021-2022/bills/525.htm) for those definitions. Also, the amendment included language regarding permitting advanced recycling facilities and financial responsibility mechanisms.

Prior to being issued a permit for advanced recycling facilities or the advanced recycling facility being placed in operation, financial responsibility must be demonstrated. To demonstrate financial responsibility, the advanced recycling facility must establish a cash trust fund under the control of DHEC or obtain a surety bond for which DHEC is the sole beneficiary, sufficient in form and amount to meet all reasonably foreseeable costs of clean-up.

This fund will cover the costs for:

- **Environmental remediation;**
- **Firefighting;**
- **Groundwater or surface water contamination;**
- **Private property contamination;**
- **Public health impacts;**
- **Displacement and relocation of affected persons; and**
- **Any other reasonably foreseeable costs associated with the operation, management, or**

abandonment of any pyrolysis and gasification facilities including, but not limited to, the operation and storage of post-use polymer, plastic polymer, or incidental contaminants or impurities.

No cash trust fund or surety bond shall be required, however, if the advanced recycling facility establishes to DHEC that such costs are not reasonably foreseeable.

The following subsections provide definitions regarding advanced recycling language in the Act.

## Advanced Recycling

Advanced recycling is a group of manufacturing processes that convert post-use polymers and recovered feedstocks into basic hydrocarbon raw materials, feedstocks, chemicals, waxes, lubricants, and other products through processes that include pyrolysis, gasification, depolymerization, solvolysis, catalytic cracking, reforming, hydrogenation, and other similar technologies.

The recycled products produced from advanced recycling include monomers, oligomers, plastics, plastics and chemical feedstocks, basic and unfinished chemicals, crude oil, naphtha, waxes, lubricants, coatings, and other basic hydrocarbons. Advanced recycling is not incineration, combustion, energy recovery, material recovery, or treatment.



## Advanced Recycling Facility

In South Carolina, advanced recycling facility means a manufacturing facility that receives, separates, stores, and converts the post-use polymers and recovered feedstocks it receives using advanced recycling. An advanced recycling facility is not a solid waste processing facility, solid waste management facility, materials recovery facility, waste-to-energy facility, or incinerator, but the facility is subject to DHEC inspections to ensure compliance.

Solid waste generated by an advanced recycling facility is subject to all applicable laws and regulations for manufacturers relating to storage and disposal of solid waste. Post-use polymers and recovered feedstock may not be mixed with solid waste or hazardous waste on-site or during processing at an advanced recycling facility.

At least 75 percent of the weight or volume of recovered feedstocks or post-use polymers received during the previous calendar year must be processed at an advanced recycling facility or transferred to a different site for processing in order for a facility to qualify as an advanced recycling facility.

If an advanced recycling facility does not comply with the requirements of this definition, then it is not an advanced recycling facility and is subject to all applicable solid waste laws and regulations as determined by DHEC.

Within 60 days of the termination of operations at an advanced recycling facility, all unused pre-converted and post-converted post-use polymers or recovered feedstock must be sold or disposed of by the advanced recycling facility in compliance with applicable laws.

## Financial Responsibility Mechanism

Financial responsibility mechanism means a mechanism designed to demonstrate that sufficient funds will be available to meet specific environmental protection needs of solid waste management facilities and advanced recycling facilities. Available financial responsibility mechanisms include, but are not limited to, insurance, trust funds, surety bonds, letters of credit, personal bonds, certificates of deposit, financial tests, and corporate guarantees as determined by DHEC by regulation.

## Post-Use Polymer

Post-Use Polymer means a plastic polymer that is not solid waste when:

- **It is derived from** any industrial, commercial, agricultural, or domestic activities;
- **Its use or intended use is** to manufacture crude oil, fuels, feedstocks, blend-stocks, raw materials, or other intermediate products or final products using advanced recycling;
- **It may contain** incidental contaminants or impurities (e.g., paper labels, metal rings); and
- **It is processed at** an advanced recycling facility or held at an advanced recycling facility prior to processing.

## Recovered Feedstock

Recovered feedstock means one or more of the following materials that has been processed so that it may be used as feedstock in an advanced recycling facility:

- **Post-use polymers;**
- **Materials** for which EPA has made a non-waste determination under 40 C.F.R. 241.3(c); and
- **Materials** that EPA has otherwise determined are feedstocks and not solid waste or recovered feedstock that does not include unprocessed MSW.

2022
The Act becomes effective January 27, 2022.
2022-23
Analysis of the Advanced Recycling Industry inside and outside of South Carolina.
2024
The report is due to the General Assembly two years after the effective date (January 27, 2024).

# Advanced Recycling at a Glance

## National Overview

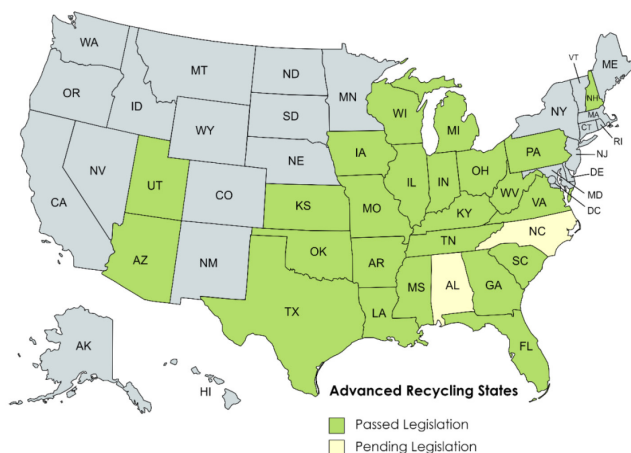
As of October 2023, 24 states currently have legislation addressing advanced recycling according to the American Chemistry Council (ACC).<sup>1</sup> As of February 2022, there are eight advanced recycling facilities identified in the United States by the National Resources Defense Council (NRDC).<sup>2</sup>

See Tables 2.1 and 2.2 and Map 2.3 for more information.

Arizona	Kentucky	Pennsylvania
Arkansas	Louisiana	South Carolina
Florida	Michigan	Tennessee
Georgia	Mississippi	Texas
Illinois	Missouri	Utah
Indiana	New Hampshire	Virginia
Iowa	Ohio	West Virginia
Kansas	Oklahoma	Wisconsin

Alabama	North Carolina
---------	----------------

**MAP 2.3: Advanced Recycling States with Passed & Pending Legislation**



## EPA Region 4 States

Region 4 consists of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. Of these eight states in Region 4, six have legislation addressing advanced recycling. They include Florida, Georgia, Kentucky, Mississippi, South Carolina, and Tennessee. See Map 2.7 for details.

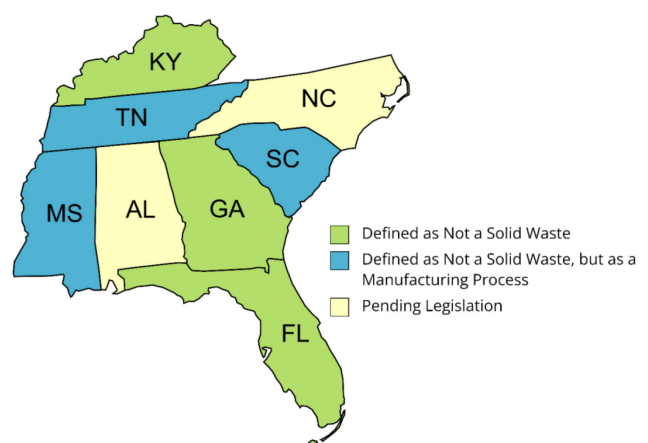
The remaining states of Alabama and North Carolina have recently shown momentum to address advanced recycling as well. In 2023, bills were introduced in both states to define advanced recycling as a manufacturing process.

Georgia	Florida	Kentucky
---------	---------	----------

Mississippi	South Carolina	Tennessee
-------------	----------------	-----------

Alabama	North Carolina
---------	----------------

**MAP 2.7: Advanced Recycling State Status in EPA Region 4**



## South Carolina

Currently, there are no regulations in place in South Carolina specifically for advanced recycling facilities. Therefore, there are no permitted advanced recycling facilities in the state. DHEC, however, is closely monitoring an advanced recycling company, Enerra, that purchased land in Dillon County. The facility is currently permitted for construction by DHEC's BAQ and has one pyrolysis machine to recycle plastics and other materials, but it is not currently operational. DHEC is committed to further research and development of advanced recycling in the future.

While there are no advanced recycling regulations in South Carolina, the state does have regulations

regarding pyrolysis facilities. In June 2016, Regulation 61-107.12 Solid Waste Incineration and Solid Waste Pyrolysis Facilities was published in the state register. This regulation's definition of pyrolysis "means the chemical decomposition of a material by heat in the absence of oxygen."

Regulation 61-107.12 requires facilities using incineration technologies, including pyrolysis, to obtain a permit from DHEC pursuant to the regulation prior to the construction, modification, or operation of a solid waste incineration facility. The permit application must be signed by an engineer duly licensed and registered under the laws of the State. Permit application, design, operations criteria, monitoring and reporting, and general requirements are pursuant to Regulation 61-107.12.

---

## Findings

Advanced recycling is an emerging industry in the United States with less than a dozen operating facilities as of 2022. Despite the limited facilities to analyze in the United States, the topic of advanced recycling is becoming popular nationally and globally. Legislation is sweeping the nation and will continue to provide more opportunity for advanced recycling facilities to operate and be studied.

Environmental effects of advanced recycling will continue to be closely analyzed by the nation in the coming years as the effects are more widely known.

### Environmental Concerns

In the past several years the solid waste industry has been challenged, specifically in relation to advanced recycling. Policy restrictions are hindering global solid waste operations. Locally, states face issues with fires, costs to cleanup, and public health impacts.

Globally, the solid waste industry is affected by foreign policy impacts. For instance, China announced a policy in July 2017 called "Operation National Sword" or "National Sword" for short.<sup>3</sup> China's National Sword policy banned and implemented restrictions on certain recyclable materials imported to China. Restricted materials include low-quality recyclables like greasy paper goods, plastic, and scrap metals. This is a major issue for countries like the United States that have exported for decades, since China was previously one of the largest importers.

Locally, the United States has experienced challenges managing solid wastes that had been exported in

previous years. The policy has directly affected solid waste recycling facilities in the United States that has causing larger accumulations of low-quality recycling material.

However, there are reasons to believe that China's policy may be a large reason why Municipal Recycling Facilities (MRFs) investments have fired up.<sup>4</sup> The challenge of China's import ban on plastics has a possibility of being a proponent of technology and continual funding to advance domestically.<sup>5</sup>

### Firefighting, Displacement, & Relocation of Affected Persons

Considering the novelty of advanced recycling, there are few instances of large, advanced recycling operations to be studied. However, available studies show that advanced recycling methods such as pyrolysis and gasification may cause fires due to high heat.

While pyrolysis and gasification are more likely to cause fires, advanced recycling methods such as chemical depolymerization and solvent-based processes are less likely to create plant fires.<sup>6</sup>

In 2021, a Richmond, Indiana plastics recycling facility experienced a fire caused by pyrolysis. This advanced recycler's method to recycle is to store plastic, shred it, compress it into pellets, and then feed the pellets into pyrolysis chambers that produce a synthetic gas and pyrolysis oil. Following the implementation of National Sword, the business prospects in China were no longer feasible. Although this market disappeared, the company continued to

buy plastics, which piled up on site. Plastic waste can be highly flammable and requires proper health and safety management. Facilities such as these may be experiencing challenges with the influx of waste and lack of methods for disposal.

The Richmond, Indiana fire began with 700-degree vapors releasing from a valve on a pump at the plant. These highly flammable vapors ignited in the facility. Once ignited, the pump was shut off and then released via flare to prevent dangerous vapor and pressure build-up. The event forced the evacuation of nearly 2,000 nearby residents. Local health officials stated that the biggest threat concern is breathing in particulates in the smoke.<sup>7</sup> The county worked multiple hours to put out the fire at the facility. The fire produced large, dark clouds of smoke. Details of the property damage are not known to DHEC.<sup>8</sup>

## Foreseeable Costs of Advanced Recycling: Operation, Management & Abandonment

One major foreseeable cost of advanced recycling may be the commute to these facilities from pick-up locations. Many communities may travel great distances to reach advanced recycling facilities, which inherently increases expenses to recycle. For example, residents of Boise, Idaho adopted an advanced recycling program to transform hard-to-recycle plastic waste into low-polluting fuel.<sup>9</sup> These plastic wastes were then shipped more than 300 miles from Boise, ID to Salt Lake City, UT. A single one-way trip takes approximately 5 hours for a truck to deliver these plastics. Locations can be limited in the United States due to state legislation but may continue to increase with more states approving legislation.

One significant conversation concerning the advanced recycling industry is the commercial viability of the industry. Reuters claims that in the

past two years there are three separate projects that were backed by major companies that have been dropped or indefinitely delayed due to this issue. These company-backed projects were pronged to be in the Netherlands, Indonesia, and the United States. The advanced recycling location in Richmond, Indiana has experienced operational issues that have pushed back full capacity for two years.

Most of these projects are agreements between smaller advanced recycling firms and major corporations like ExxonMobil, Royal Dutch Shell Plc, and Procter & Gamble Company. Reuters also claims they have interviewed more than 40 people who are directly tied to the advanced recycling industry. The interviewees consist of plastic industry officials, recycling executives, scientists, and others who come from 30 different advanced recycling projects. Many of these firms are operating on a modest scale or in some cases have closed.

The Plastics Industry Association (PIA) claims that Reuters is painting a poor image of the industry by pulling information that isn't a fair description.<sup>10</sup> Disregarding the opportunities of advanced recycling may be considered the wrong way to address plastic waste in the eyes of the industry. Proper management of plastics can yield environmental benefits and help reach climate and sustainability goals.

PIA focuses on the challenge of increasing consumer education about the process of recycling. Effective education increases the amount of viable material in the waste stream.

Projects that are supposedly behind schedule in the United States as well as abroad could be attributed to the global pandemic, labor shortages, and lockdowns, according to PIA. The organization emphasizes that both mechanical and advanced recycling are valuable to our modernization process to ensure that all plastics stay in the economy. The industry encourages government support on these





ongoing efforts instead of passing legislation to place outright bans on advanced recycling innovations. While it may take fewer resources to produce plastics, making the production advantageous, environmental waste challenges come with it.

With fewer than a dozen advanced recycling facilities in the United States, it may be too early to provide viable analysis of potential abandonment risks locally. Facilities that abandon their sites may be addressed like solid waste facilities with decommissioning plans and financial assurance. Although advanced recycling is not defined as a solid waste in South Carolina, the Act requires solid waste financial assurance mechanisms for solid waste facilities and advanced recycling facilities. This will ensure funds are available for clean-up of facilities at the time of closure and to cover any post-closure care that may be required.<sup>11</sup> Financial assurance will also ensure proper long-term planning by owners to protect human health and the environment.

## Public Health Impacts

Advanced recycling is particularly associated with hard-to-recycle plastics. Advocates of the industry state that it will keep plastic out of the environment and waste streams that may potentially mingle into the water and air. The same parties argue that advanced recycling is a viable way to prevent contamination of marine life, keeping toxic materials from leaching in landfills, incinerators, and waterways.

The ACC states that advanced recycling reduces greenhouse gas emissions 43 percent relative to waste-to-energy incineration of plastic films made from virgin resources. High-quality plastics that may be used in medical and pharmaceutical fields are capable of being manufactured in advanced recycling processes.

Plastics that are hard to be recycled can also be processed by this technology. In a pyrolysis vessel, there is no oxygen and therefore no combustion. The

vessel itself does not emit anything other than heat from fossil fuels.

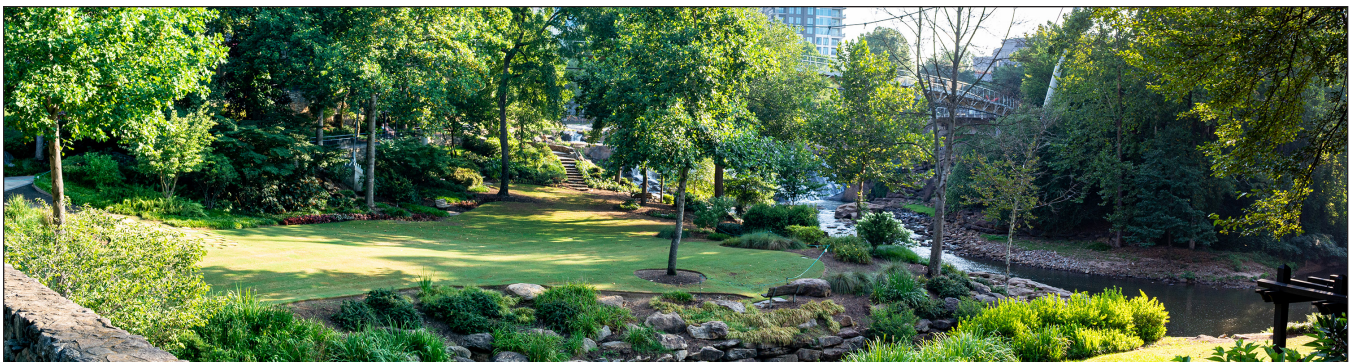
Bob Powell, the founder of the advanced recycling company Brightmark in the United States stated that his aim is 100 percent circularity, plastic to plastic. Currently, the company is at an “interim step” while the market matures and price of recycled plastic drops. During this step, pyrolysis oil could be sold as fuel. This company believes that turning plastics into fuel is a better environmental outcome than having “rivers of plastics flowing”<sup>12</sup> as seen in pictures online.

Environmentalists, on the other hand, insist that the industry is not entirely forthcoming about the implications of advanced recycling. NRDC senior scientist Veena Singla states that what pyrolysis does is create fuel to be sold from refined oil, adding that the process may be profitable, but it is not recycling.

In summary, Singla insists that recycling is returning materials to the production cycle, which reduces the demand for virgin resources. Plastics made from mechanically recycled content or traditional methods generate 30 to 40 percent fewer greenhouse gas emissions than materials made from virgin resources. Singla claims that burning plastic as fuel is not aiding plastic production, therefore there is continued extraction of fossil fuel.

According to the Australian-based philanthropic organization Minderoo Foundation, advanced recycling capacity will increase 2 million tons in the next five years. Of these 2 million tons, half a million tons of this material will be recycled back into plastic goods. The remaining material will be used in the “interim step” to power airplanes, trucks, and other heavy transportation.<sup>13</sup>

This may explain why advanced recycling is not defined as a solid waste in many states but as a manufacturing process. The Policy Director of the Global Alliance for Incinerator Alternatives stated advanced recycling is a high-energy process with



high-carbon emissions that releases hazardous air pollutants.<sup>14</sup>

As mentioned previously regarding Richmond, Indiana, one major public health concern is the risk of fire in facilities that store large amounts of plastics. The respective Health Department, Wayne County, revealed that particulates in the smoke are the biggest concern. Air monitoring was continued by EPA for particulates and several types of chemicals, such as volatile organic compounds, benzene, chlorine, and hydrogen cyanide. To DHEC's knowledge, a report on these findings has not been released by EPA.<sup>15</sup>

Under standard operating procedures, advanced recycling facilities may be subject to air regulations on both federal and state levels. The ACC Advanced Recycling fact sheet claims that, while scale is a factor, facilities have relatively low emissions. Small to medium operations tend to be minor source facilities and have different requirements than major facilities.<sup>16</sup>

Requirements for both major and minor facilities emissions root from the federal Clean Air Act (CAA) implemented by EPA. CAA is the authority of EPA to regulate and limit the concentration of pollutants in the air we breathe. BAQ is authorized by EPA to implement and enforce these federal air quality standards. These standards are issued and enforced under permits of the CAA, S.C. Pollution Control Act, and S.C. Regulation 61-62 Air Pollution Control Regulations and Standards. The entire state of South Carolina is currently attaining all of EPA's health-based national air quality standards. South Carolina's air toxics list includes the federal hazardous air pollutants (HAPs) along with 71 additional HAPs.

In 2020, EPA proposed to remove pyrolysis from the definition of "other solid waste incineration" while reviewing the CAA. In 2021, EPA requested comments to assist in the potential development of regulations for advanced recycling.<sup>17</sup> According to the results, pyrolysis and gasification processes are widely used to convert waste into useful products or energy. In June of 2023, EPA decided to stop the proposal due to the complexity of the process and varied industries of advanced recycling. The agency stated that it will leave the existing regulations in place while it continues to analyze the industry.<sup>18</sup>

As mentioned in the ACC Fact Sheet, the State enforces a construction permit for any person who plans to construct, alter, or add to a source of air pollution, including the installation of any air pollution control device. The construction permit must be issued before any construction-related activities occur at the site. These activities include,

but are not limited to, an increase in production, change in raw materials, or modification to existing equipment. The construction permit allows for the construction and start of operation of equipment.

Any source requiring a construction permit must obtain an operating permit when the new or altered source is placed into operation. DHEC's BAQ requires certification that the construction covered by the application has been completed in accordance with the specifications in the operating permit. Facilities in the state must demonstrate that emissions coming from their source will not cause or contribute to a violation of any applicable state or federal ambient air quality standards. As mentioned, the advanced recycling company located in Dillon, SC currently has their construction permit with BAQ.<sup>19</sup>

## Groundwater, Surface Water, & Private Property Contamination

Surface water consists of bodies of water that are above ground like lakes and rivers. Groundwater is fresh water that soaks into the soil and is stored in pores between rocks and particles of soil. Water that seeps deep into the ground that can be found in aquifers is called groundwater.<sup>20</sup>

A range of contaminants can be found in these waters from both natural and human-induced chemicals, according to the United States Geological Survey. Leakage from waste-disposal sites can introduce bacteria to the water that can eventually end up in water drawn from a well.

Examples of contaminants found in waters specifically from plastic include cadmium, cyanide, volatile organic compounds, plasticizers, chlorinated solvents, benzopyrene, and dioxin. Many of these contaminants have adverse effects that can cause cancer and damage vital organs.<sup>21</sup>

In advanced recycling's manufacturing process, water is likely to be treated, recirculated, and periodically purged depending on the technology.<sup>22</sup> On a federal level, the Clean Water Act requires permits to discharge process water to waters of the United States. DHEC is required by law to proactively maintain the quality of surface and groundwater per South Carolina Code of Laws: Pollution Control Act. It is DHEC's goal to maintain or restore groundwater quality in South Carolina to be suitable as a drinking water source without any treatment.

DHEC's Groundwater Protection Program is part of the Division of Monitoring, Assessment, and Protection in the Bureau of Water (BOW). This program is responsible for groundwater monitoring

and risk assessment. In South Carolina, it is unlawful for any person, directly or indirectly, to throw, drain, run, allow to seep, or otherwise discharge into the environment any organic or inorganic matter, including sewage, industrial wastes, and other wastes, except as in compliance with a permit issued by DHEC.

NPDES permits and No Discharge Land Application (ND) permits can be obtained by required facilities via the Groundwater Protection Program. NPDES and ND permits are issued by the Water Pollution Control Division for compliance with discharging organic or inorganic matter into the environment. The NPDES Program issues NPDES permits as outlined in R.61-9 Water Pollution Control Permits.

Permits to apply wastewater effluent or sludge to land are issued by the Land Application Program (No Discharge Program) as outlined in Regulation 61-9. Facilities to be constructed require both a construction permit (Regulation 61-67) and an operational permit.<sup>23</sup>

## Regulation of Advanced Recycling Outputs

Advanced recycling may produce outputs like oil, plastics, carbon black, salts, and feedstocks that do not meet specifications required to comply with regulations. Oil outputs and plastic products

require operators to comply with EPA's Toxic Substances Control Act (TSCA) Pre-Manufacturing Notice and Spill Prevention Control and Countermeasure (SPCC).

Carbon black, also known as char, is an advanced recycling byproduct that can be in the form of solid residue. This solid residue may be used in tire manufacturing, ink production, or as an asphalt modifier if it meets downstream offtake requirements. Waste generators are required to test if it should be managed as a solid waste or hazardous waste. Most small to medium advanced recycling methods are non-hazardous. Under EPA's Resource Conservation and Recovery Act (RCRA), advanced recycling, like other common manufacturing and industrial processes, may be subject to RCRA regulations if generating hazardous waste. DHEC is authorized to implement RCRA for properly managing hazardous waste.

Plastic resins containing chlorine or fluorine are removed from advanced recycling processes whenever possible. If they are found in the processes, these resins may contaminate the saleable products. Chlorine can cause corrosion of equipment, so it is often converted into salts that can be disposed of as non-hazardous waste.

Pre-processed plastic products are typically relied on and used as feedstock for advanced recycling

CONTAMINANT	SOURCE	HUMAN IMPACT
<b>Cadmium</b>	Found in low concentrations in rocks, coal, and petroleum and enters the groundwater and surface water when dissolved by acidic waters. May enter the environment from industrial discharge, mining waste, metal plating, water pipes, batteries, paints and pigments, plastic stabilizers, and landfill leachate.	Replaces zinc biochemically in the body and causes high blood pressure, liver and kidney damage, and anemia. Destroys testicular tissue and red blood cells. Toxic to aquatic biota.
<b>Cyanide</b>	Often used in electroplating, steel processing, plastics, synthetic fabrics, and fertilizer production; also from improper waste disposal.	Poisoning is the result of damage to spleen, brain, and liver.
<b>Volatile Organic Compounds</b>	Enter environment when used to make plastics, dyes, rubbers, polishes, solvents, crude oil, insecticides, inks, varnishes, paints, disinfectants, gasoline products, pharmaceuticals, preservatives, spot removers, paint removers, degreasers, and many more items.	Can cause cancer and liver damage, anemia, gastrointestinal disorder, skin irritation, blurred vision, exhaustion, weight loss, damage to the nervous system, and respiratory tract irritation.

CONTAMINANT	SOURCE	HUMAN IMPACT
<b>Plasticizers, Chlorinated Solvents, Benzo[a]pyrene, and Dioxin</b>	Used as sealants, linings, solvents, pesticides, plasticizers, components of gasoline, disinfectant, and wood preservative. Enter the environment from improper waste disposal, leaching runoff, leaking storage tanks, and industrial runoff.	Cause cancer. Damage nervous and reproductive systems, kidney, stomach, and liver.

SOURCE: [usgs.gov/special-topics/water-science-school/science/contamination-groundwater](https://usgs.gov/special-topics/water-science-school/science/contamination-groundwater)

activities. These plastic products are intentionally separated into material used to manufacture marketable products. Although these products are separated, small unidentified material may make it through the screening process. Handling of these non-plastic materials would be governed by applicable solid waste laws. Further information may be found on DHEC and EPA's websites.<sup>24</sup>

## Cost of Cleanup & Environmental Remediation

In the United States, there are only eight advanced recycling facilities. DHEC doesn't believe enough information is available to accurately estimate the cost of clean-up and environmental remediation for advanced recycling facilities. DHEC will continue to monitor for reports released on the advanced recycling facility fire in Richmond, IN.

Since the establishment of China's National Sword, exporters of solid waste may be seeing excess plastic coming to their facilities. Depending on the facility, this may alter typical costs of cleanup and environmental remediation. Although advanced recycling is not considered solid waste in the state, DHEC requires a financial responsibility mechanism to demonstrate that sufficient funds are available to meet specific environmental protection needs.

The amount of financial assurance required is based on the current DHEC-approved closure and/or post-closure cost estimate for a facility. Owners/operators can select from a list of approved financial mechanisms that include, but are not limited to, insurance, trust funds, surety bonds, letters of credit, personal bonds, certificates of deposit, financial tests, and corporate guarantees as determined by DHEC by regulation.<sup>25</sup>

---

## References

- 1 ACC. (2023a, April 20). Indiana Lawmakers Overwhelmingly Pass Advanced Recycling Legislation to Boost Economy, Help End Plastic Waste. [www.americanchemistry.com/chemistry-in-america/news-trends/press-release/2023/indiana-lawmakers-overwhelmingly-pass-advanced-recycling-legislation-to-boost-economy-help-end-plastic-waste](http://www.americanchemistry.com/chemistry-in-america/news-trends/press-release/2023/indiana-lawmakers-overwhelmingly-pass-advanced-recycling-legislation-to-boost-economy-help-end-plastic-waste)
- 2 NRDC: Recycling Lies - "Chemical Recycling" of Plastic Is Just Greenwashing Incineration. (2022). In National Resource Defense Council. [www.nrdc.org/sites/default/files/chemical-recycling-greenwashing-incineration-ib.pdf](http://www.nrdc.org/sites/default/files/chemical-recycling-greenwashing-incineration-ib.pdf)
- 3 Center for EcoTechnology. (2018, May 9). What is the National Sword? [www.centerforecotchnology.org/what-is-the-national-sword/](http://www.centerforecotchnology.org/what-is-the-national-sword/)
- 4 Quinn, M. (2022, September 14). National Sword kicked off a wave of MRF investments. 5 years later, tech and funding continue to advance. Waste Dive. [www.wastedive.com/news/national-sword-five-years-mrf-robotics-recycling-investment/630731/](http://www.wastedive.com/news/national-sword-five-years-mrf-robotics-recycling-investment/630731/)
- 5 Pyzyk, K. (2022, August 22). Domestic destinations for recycled paper and plastic are growing. Is National Sword the reason? Waste Dive. [www.wastedive.com/news/domestic-paper-plastic-recycling-us-china-national-sword/628062/](http://www.wastedive.com/news/domestic-paper-plastic-recycling-us-china-national-sword/628062/)
- 6 NRDC: Recycling Lies - "Chemical Recycling" of Plastic Is Just Greenwashing Incineration.
- 7 Bruggers, J. (2023, April 12). Where There's Plastic, There's Fire. Indiana Blaze Highlights Concerns Over Expanding Plastic Recycling. Inside Climate News. <https://insideclimatenews.org/news/12042023/plastics-fire-richmond-indiana/>
- 8 WANE 15. (2021, May 14). Steuben County fire crews battle fire at plastic renewal company for multiple hours. [www.wane.com/news/local-news/steuben-county-fire-crews-battle-fire-at-plastic-renewal-company/?source=email](http://www.wane.com/news/local-news/steuben-county-fire-crews-battle-fire-at-plastic-renewal-company/?source=email)
- 9 Brock, J., Volcovici, V., & Geddie, J. (2021, April 29). The recycling myth: A plastic waste solution littered with failure. Reuters. [www.reuters.com/investigates/special-report/environment-plastic-oil-recycling](http://www.reuters.com/investigates/special-report/environment-plastic-oil-recycling)
- 10 PIA. (2021, August 2). Recycling isn't a myth—and we need more of it. <https://thisisplastics.com/innovation/recycling-isnt-a-myth-and-we-need-more-of-it/>
- 11 DHEC. (n.d.). Solid Waste Financial Assurance | DHEC. Retrieved October 27, 2023, from [scdhec.gov/environment/land-management/solid-waste/solid-waste-financial-assurance](http://scdhec.gov/environment/land-management/solid-waste/solid-waste-financial-assurance)
- 12 Mernit, J. L. (2023, June 1). As Plastics Keep Piling Up, Can "Advanced" Recycling Cut the Waste? Yale E360. <https://e360.yale.edu/features/advanced-plastics-recycling-pyrolysis>
- 13 Minderoo Foundation. (2023). Plastic Waste Makers Index 2023. <https://cdn.minderoo.org/content/uploads/2023/02/04205527/Plastic-Waste-Makers-Index-2023.pdf>
- 14 McDermott, J. (2022, October 21). Advanced recycling: Plastic crisis solution or distraction? AP NEWS. <https://apnews.com/article/science-united-states-providence-business-climate-and-environment-b9f202a703ea7fa4231053d544b3266e>
- 15 Fast Company. (2023, April 21). "They are sketchy operators": Massive Indiana fire exposes the issues with plastic recycling. <https://www.fastcompany.com/90884551/they-are-skechy-operators-massive-indiana-fire-exposes-the-issues-with-plastic-recycling>
- 16 ACC. (2023). Advanced Recycling Facilities Regulation Requirements Fact Sheet. [www.americanchemistry.com/content/download/13615/file/Advanced-Recycling-Facilities-Regulation-Requirements-Fact-Sheet.pdf](http://www.americanchemistry.com/content/download/13615/file/Advanced-Recycling-Facilities-Regulation-Requirements-Fact-Sheet.pdf)
- 17 EPA. (2021, September 8). Potential Future Regulation Addressing Pyrolysis and Gasification Units. Federal Register. [www.federalregister.gov/documents/2021/09/08/2021-19390/potential-future-regulation-addressing-pyrolysis-and-gasification-units](http://www.federalregister.gov/documents/2021/09/08/2021-19390/potential-future-regulation-addressing-pyrolysis-and-gasification-units)
- 18 Paben, J. (2023, June 6). EPA opts to maintain existing pyrolysis air rules. Plastics Recycling Update. <https://resource-recycling.com/plastics/2023/06/06/epa-opts-to-maintain-existing-pyrolysis-air-rules/>
- 19 DHEC. (n.d.-a). Bureau of Air Quality Permitting Information | DHEC. [scdhec.gov/environment/air-quality/bureau-air-quality-permitting-information](http://scdhec.gov/environment/air-quality/bureau-air-quality-permitting-information). Retrieved October 27, 2023, from [scdhec.gov/environment/air-quality/bureau-air-quality-permitting-information](http://scdhec.gov/environment/air-quality/bureau-air-quality-permitting-information)
- 20 EPA. Surface Water Quality Standards and Procedures - Sub-chapter 6, from <https://www.epa.gov/sites/default/files/2014-12/documents/mt-subchapter6.pdf>
- 21 U.S. Geological Survey. (2018, June 6). Contamination of Groundwater | U.S. Geological Survey. [www.usgs.gov/special-topics/water-science-school/science/contamination-groundwater](http://www.usgs.gov/special-topics/water-science-school/science/contamination-groundwater). Table cells provided from [www.usgs.gov/special-topics/water-science-school/science/contamination-groundwater](http://www.usgs.gov/special-topics/water-science-school/science/contamination-groundwater)
- 22 ACC. Advanced Recycling Facilities Regulation Requirements Fact Sheet.
- 23 DHEC. (n.d.-c). Water Regulations & Standards: Water Pollution Control Permits | SCDHEC. [scdhec.gov](http://scdhec.gov). Retrieved October 27, 2023, from [scdhec.gov/BOW/water-regulations-standards/water-regulations-standards-water-pollution-control](http://scdhec.gov/BOW/water-regulations-standards/water-regulations-standards-water-pollution-control)
- 24 ACC. Advanced Recycling Facilities Regulation Requirements Fact Sheet.
- 25 S.C. State House. (n.d.). Code of Laws - Title 44 - Chapter 96 - South Carolina Solid Waste Policy And Management Act. [www.scstatehouse.gov](http://www.scstatehouse.gov). Retrieved October 27, 2023, from [www.scstatehouse.gov/code/t44c096.php](http://www.scstatehouse.gov/code/t44c096.php)