AN ECONOMIC AND ENVIRONMENTAL IMPACT ASSESSMENT OF RECYCLING IN VIRGINIA

A Report to the Virginia General Assembly

Virginia Department of Environmental Quality

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EXECUTIVE SUMMARY

The Department of Environmental Quality (DEQ) was tasked with conducting a recycling economic and environmental impact assessment pursuant to Item 377 C in the Commonwealth's 2022-2024 Biennium Budget, House Bill 30 (herein referred to as HB30). HB30 outlined that the assessment must consider the total lifecycle of human and environmental benefits and impacts of recycling pursuant to generally accepted frameworks and standards.

Solid waste planning units in Virginia are currently required to meet or exceed a mandated recycling rate of 15% for planning units with populations less than 100,000 and 25% for planning units with populations of 100,000 or greater. From 1991 to 2021, the recycling rate for Virginia has risen from 19.7% to 43.3% statewide, marking a significant increase in the recycling efficiency in the state. This is due to the efforts of locality-based recycling programs and state-funded programs that help supplement these programs.

In developing this assessment, DEQ engaged in outreach with localities, solid waste planning units, solid waste facilities, and other stakeholders, including recycling facilities in the Commonwealth. DEQ staff researched various economic and environmental impact assessment methodologies and utilized economic and environmental models using in-house and publicly available data to ascertain Virginia's current recycling impact.

DEQ conducted a survey of recycling facilities in Virginia to gather more recent data from businesses engaged in recycling activities. According to the respondents, the average hourly wage was $23.57 with an average of 59 full-time employees for 2022. This equated to $171 million in wages paid to employees at recycling-related facilities.

Based on the analysis, the total economic impact of the recycling industry is estimated to be around $1.9 billion in revenue, with annual wages for 7,070 employees totaling $327 million. Economic data has shown a slight decrease in the total employment and number of establishments in recycling related businesses from 2012 to 2021, however, there was an increase in the total wages paid within that timeframe.

The environmental impact was based on the amount of total greenhouse emissions and energy saved. The total amount of greenhouse gas emissions saved by recycling instead of landfilling was estimated to be 6.6 million metric tons of carbon dioxide equivalent. The total energy saved by recycling instead of landfilling was assessed as 70,000,000 MBTUs.

INTRODUCTION

This assessment is being submitted pursuant to HB30, which provides:

> The Department of Environmental Quality shall conduct a recycling economic and environmental impact assessment in accordance with the Administrative Process Act including public participation and comment. The assessment shall consider the total lifecycle of human and environmental benefits and impacts of recycling pursuant to generally accepted frameworks and standards. The Department shall report its findings to the Governor and Chairs of the House and Senate Agriculture, Conservation and Natural Resources Committees by October 1, 2023.

In response to HB30, the DEQ conducted a literature search, analyzed industry and recycling data, surveyed Virginia facilities, met with stakeholders, and held a public meeting.

Virginia has multiple programs dedicated to increasing recycling across the state. Litter prevention and recycling grants provide funds from the state to localities, while recycling tax credits support businesses with investing in recycling machinery and equipment. DEQ also provides assistance for recycling programs beyond regulatory compliance, while mandatory state agency programs have worked to increase recycling within the state government.

DEQ performed a literature review of state, regional, and national recycling economic and environmental impact reports to understand the existing methodologies for preparing this assessment. DEQ contacted various organizations, including state and federal agencies, to discuss impact assessment methodologies and to obtain an available list of recycling facilities in Virginia. DEQ also conducted a survey of Virginia recycling facilities. The survey focused on obtaining the revenue, employment, wages, and tonnages of recycled materials data.

DEQ conducted an economic impact analysis based on the methodology utilized in *The Economic Benefits of Recycling in Virginia* and data from the U.S. Economic Census. The analysis provided an estimate of the recycling industry's total economic impact based on the total employment, wages, and revenue. DEQ analyzed the total environmental impact of recycling by utilizing recent recycling data reported to DEQ by all solid waste planning units and an environmental impact model available from the U.S. Environmental Protection Agency (EPA)[1]. The environmental impact was measured by the amount of greenhouse gas emissions reduced and energy savings based on the amount of principal recyclable materials (PRMs)[2] recycled.

[1] EPA's Waste Reduction Model (WARM), https://www.epa.gov/warm/versions-waste-reduction-model-warm#15

[2] 9VAC20-130-10, *"Principal recyclable materials" or "PRMs" means paper, metal, plastic, glass, commingled, yard waste, wood, textiles, tires, used oil, used oil filters, used antifreeze, batteries, electronics, or material as may be approved by the director. Commingled materials refers to single stream collections of recyclables where sorting is done at a materials recovery facility.*

RECYCLING IN VIRGINIA

Recycling programs in Virginia are managed by localities and/or solid waste planning units. There are currently 71 solid waste planning units (SWPUs) in Virginia that consist of individual or a combination of counties, cities, and towns. In larger or urban areas, these entities typically offer curbside and/or drop-off recycling programs. On the other hand, smaller or rural SWPUs and localities tend to rely on drop-off programs. Recycling in all regions may be supplemented by recycling conducted by private businesses.

The Virginia General Assembly adopted legislation that established a 25% recycling rate target for communities in 1989, which was then modified by the General Assembly in 2006 to establish a two-tiered recycling mandate of 15% and 25% of the municipal solid waste generated annually. SWPUs with population densities of less than 100 people per square mile, or with unemployment rates 50% above the state's average unemployment rate, must meet or exceed the 15% mandated recycling rate, while all others must meet or exceed the 25% mandated recycling rate.

In addition, the legislation adopted in 2012 eliminated the annual reporting requirement for SWPUs with populations of 100,000 or less after calendar year (CY) 2012. Instead, those SWPUs are required to report every four years beginning CY2016. Even though they are required to report to DEQ every four years, they are still required to track and maintain their mandated recycling rates. All SWPUs with populations greater than 100,000 are required to report on an annual basis. Up to CY2021, 17 planning units were required to report annually. Once the final 2020 Census data was published by the US Census Bureau, the population and population densities were recalculated for each planning unit. Subsequently, for CY2022 onward, 19 planning units fall under the annual reporting category. DEQ encourages voluntary reporting by all SWPUs not required to report annually.

If a SWPU is unable to meet the mandated rate of 15% or 25%, they are required to have a Recycling Action Plan (RAP), which may be added to the SWPU's solid waste management plan via a major plan amendment. DEQ also receives voluntary recycling information from major private businesses such as Walmart & Sam's Club, Weis Markets, Target, Kohl's, Save-A-Lot, and Best Buy. This information is posted on the DEQ website for SWPUs to include in their recycling rate reports.[3]

In 2021, the 17 SWPUs required to report annually contributed to a state calculated recycling rate of 43.3%, with several planning units achieving rates over 25%. Virginia's calculated recycling rate for CY2021 is 43.3% compared to 19.7% in 1991, which indicates a significant increase in recycling initiatives statewide. This calculated rate was derived from recycling rate data submitted by 17 Virginia SWPUs to DEQ in CY2021 as required by solid waste planning regulations (9VAC20-130-125).[4] In 2020, all 71 SWPUs were required to report and achieved a statewide recycling rate of 45.5%.

[3] Business recycling reports published on DEQ website, https://www.deq.virginia.gov/our-programs/land-waste/recycling/recycling-data/recycling-rate-report

[4] Recycling Requirements, 9VAC20-130-125, https://law.lis.virginia.gov/admincode/title9/agency20/chapter130/section125/

The recycling rate calculation is based on the amount of principle recyclable materials (PRM) recycled versus the amount of municipal solid waste (MSW) disposed per planning unit. It also allows for credits for solid waste reused, non-municipal solid waste recycled, recycling residues and source reduction programs. The final recycling rate is adjusted so that the aggregate of all credits does not exceed five percentage points of the base recycling rate.

The recycling rate is calculated using the following formula:

$$\left(\frac{\text{PRM + Credits}}{\text{PRM + Credits + MSW Disposed}}\right) \text{x } 100 + \text{Source Reduction Credit} = \text{Final Recycle Rate}$$

Looking at a five-year trend in Chart 1, the recycling rate has fluctuated from approximately 42% to 46%. The increase and decrease from year to year can be attributed to the number of planning units required to submit in a particular year, China's implementation of National Sword (China's ban on importing certain recyclables), the COVID-19 pandemic challenges, the lack of recycling markets in certain regions, and difficulty in obtaining recycling information from private businesses. In CY2017, CY2018, CY2019 and CY2021, only 17 planning units were required to report. For CY2020, all 71 planning units were required to report their recycling rates.

Chart 1 - Virginia's MSW, Recycling Tonnage and Recycling Rate from 2017 to 2021

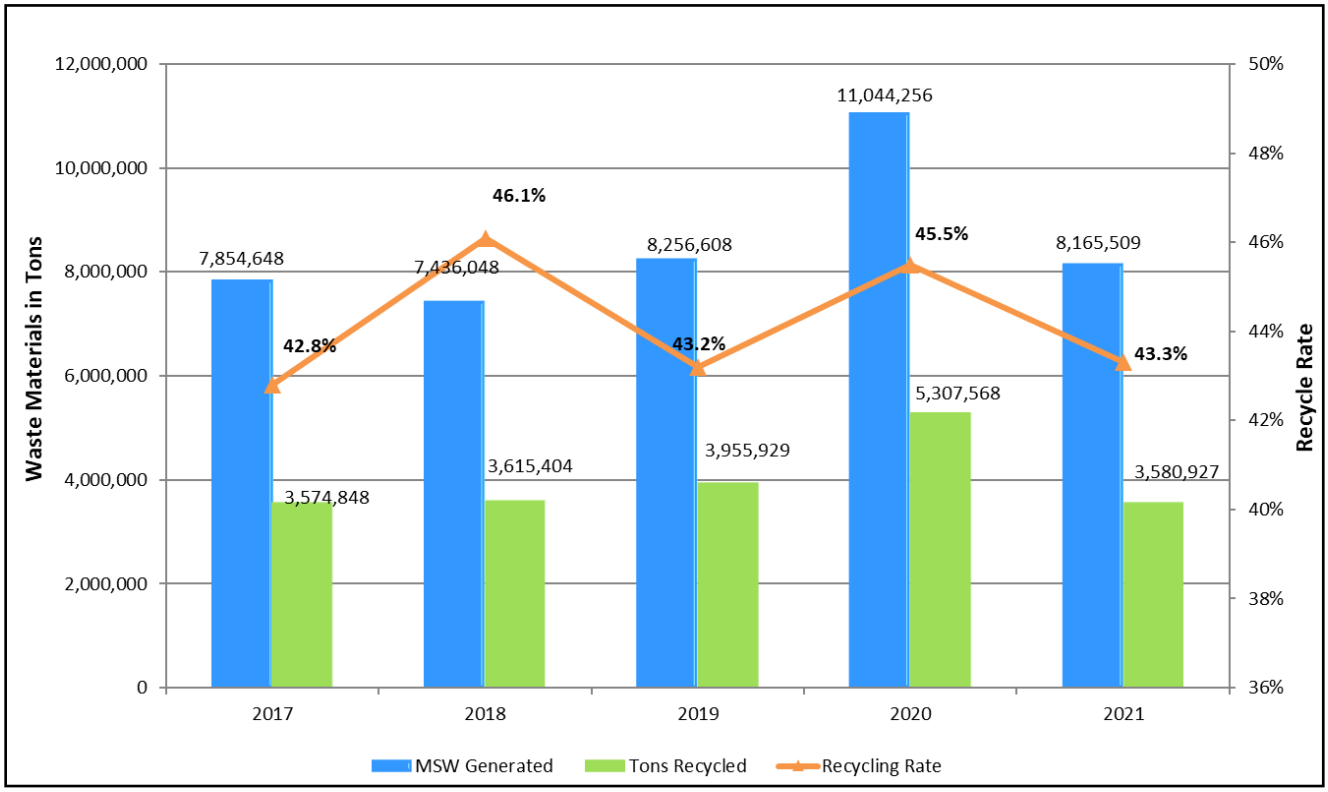
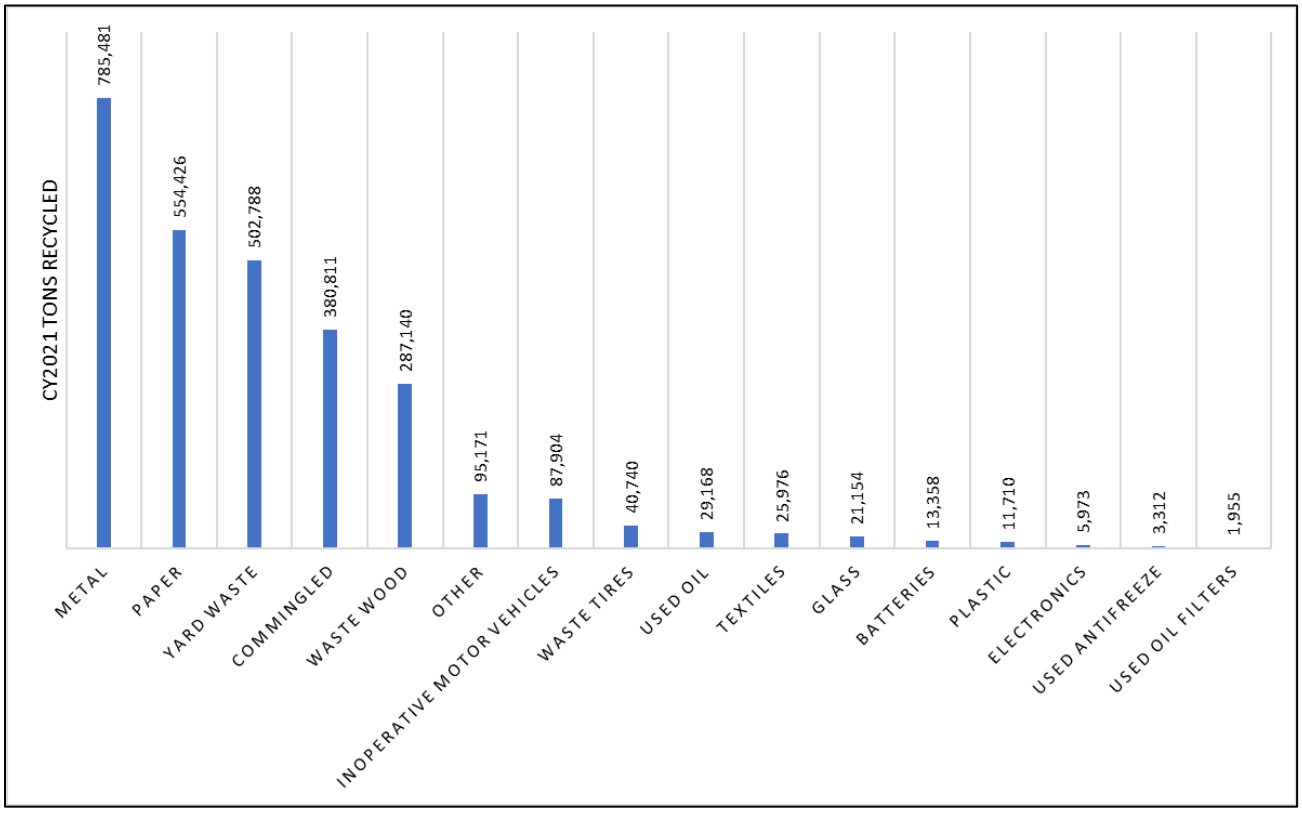


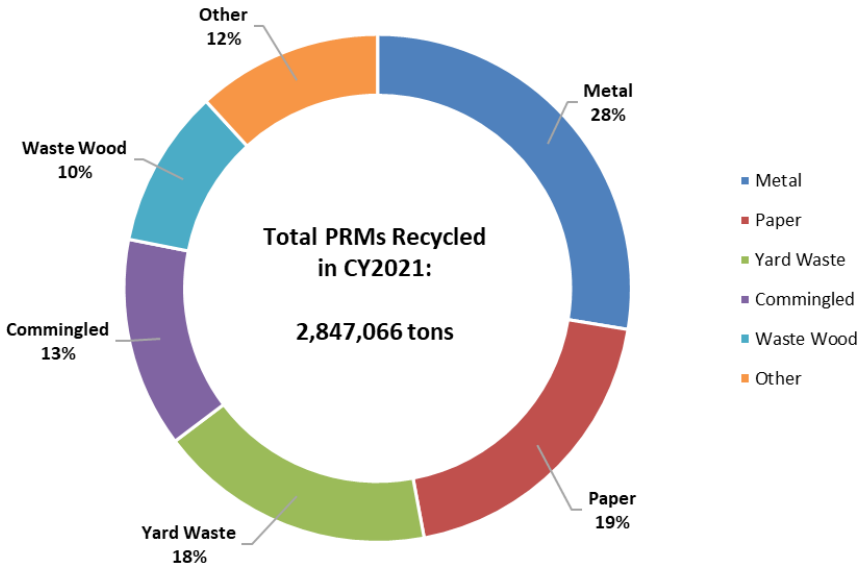
Chart 2 below shows the amount of principle recyclable materials recycled from the MSW stream as reported by Virginia planning units for CY2021. As seen in the chart below, the number of plastics recycled in relation to metals, paper, yard and wood waste, and commingled is significantly low. The commingled waste stream may account for some plastic waste recycled.

Chart 2 – CY2021 Principle Recyclable Materials Recycled in Tons



The materials with the highest recycled rates in Virginia are metal, paper, yard waste, commingled (single stream collected recyclables), and waste wood. Chart 3 shows the percentage of the top recycled streams of municipal solid waste.

Chart 3 – CY2021 – CY2021 Principle Recyclable Materials Recycled in Tons



Based on existing resources, DEQ's recycling program primarily provides program coordination, data analysis and reporting, guidance on recycling requirements, solid waste management plans, assistance to SWPUs on regulatory requirements, and grant application submittals. DEQ's recycling program also engages in outreach with localities, SWPUs, and solid waste/recycling associations. Other state-wide recycling initiatives and activities include recycling equipment and machinery tax credits, waste tire end-user reimbursements, non-competitive and competitive litter grants for localities, and activities undertaken by the DEQ Office of Pollution Prevention. Overall, state funding has a consistent positive impact on recycling efforts in the Commonwealth.

Litter Prevention & Recycling Grants

DEQ provides funds for litter prevention and recycling grants to localities under a non-competitive grant program based on population and road miles. Since 1980, these grants have been awarded annually to localities for local litter prevention and recycling program implementation, continuation, and/or expansion. The amount of funds available for this grant program is approximately 85% of the net resources allocated for the Litter Control and Recycling Fund (Litter Fund). In fiscal year (FY) 2022, $2.4 million was awarded to localities in non-competitive litter grants. Localities reported that 43% of funds were used for recycling program activities, while 57% of funds went towards litter prevention program activities. For FY2023, $2.9 million was awarded to localities.

Beginning in FY2018, competitive grants have been made available to eligible localities for the implementation of statewide and regional litter prevention and recycling educational programs and pilot projects. All localities currently receiving the DEQ litter prevention and recycling non-competitive grant are eligible to apply for the competitive grant. The amount of funds available for this grant program is approximately 5% of the net resources allocated for the Litter Fund. In FY2023, approximately $168,000 was awarded to 13 competitive grant applicants for litter prevention and recycling initiatives.

The 2021 General Assembly allocated up to 5% of the net resources allocated for the Litter Fund for the operation of public information campaigns to discourage the sale and use of expanded polystyrene products and to promote alternatives to expanded polystyrene (EPS) in the Commonwealth. Localities applying for the non-competitive litter grant can opt to receive additional funding to implement this campaign. In FY2023, an additional $153,000 was awarded to 67 applicants representing 107 localities, who opted into receiving funds for the implementation of the EPS campaign.

Recycling Tax Credits

A state income tax credit is available for the purchase of machinery and equipment for processing recyclable materials. The credit may be claimed for machinery and equipment used predominantly in or on the premises of manufacturing facilities, advanced recycling facilities or plant units which manufacture, process, compound or produce items of tangible personal property from recyclable materials within the Commonwealth for sale. The credit is equal to 20% of the original total capitalized cost of the purchase price for machinery and equipment for processing recyclable materials, and the total credit allowed cannot exceed 40% of the Virginia income tax liability in any taxable year. The unused amount of the credit can be carried over for the next ten years. There is also a $2 million cap on the tax credit per fiscal year. Before an entity is entitled to the tax credit, DEQ certifies that such machinery and equipment is integral to the recycling process. For 2022, 38 applications were received from manufacturing and recycling facilities to obtain DEQ certification for the state tax credit. A majority of these applicants were involved in either metals or construction demolition debris (CDD) waste recycling, while some were also involved in cardboard, wood, pallet, battery, and/or plastics recycling. Historically, the recycling equipment tax credit has been a good incentive for scrap metal processors, CDD processors, and other facilities investing in recycling equipment.

DEQ's Office of Pollution Prevention

The Office of Pollution Prevention within DEQ hosts several programs and initiatives that serve as a conduit for non-regulatory assistance to businesses, institutions, and communities. These efforts are targeted towards motivating Virginia facilities to minimize their environmental footprint though actions that often exceed regulatory requirements while enhancing their bottom line. Since 2000, DEQ has promoted the non-regulatory Virginia Environmental Excellence Program (VEEP) as a mechanism to encourage environmental results beyond compliance. VEEP encourages facilities to implement programs to reduce their environmental impacts, including programs that reduce waste generation and increase recycling. VEEP members report annually to DEQ on programs they have implemented.

Virginia Green is the Commonwealth's voluntary initiative to promote pollution prevention (P2) practices across all sectors for the tourism industry. Participating tourism businesses and organizations voluntarily commit to engage in P2 practices in the areas of waste reduction, water, and energy conservation, and in the support of green events and meetings. Virginia Green partners join through a checklist process that also serves as a learning tool for additional green practices and resources. DEQ's Office of Pollution Prevention oversees development of all programmatic guidance and requirements for the application, while DEQ's partners, the Virginia Green Travel Alliance, the Virginia Tourism Corporation, and the Virginia Restaurant, Lodging and Travel Association, coordinate the application review process, marketing, and

promotion. Virginia Green takes a double-sided approach to support recycling. It requires all members to have an active recycling program that allows customers access to recycling. In addition, members are required to minimize the impact of disposable food service items by reducing their usage and encouraging the usage of products that are recyclable.

DEQ has also implemented its own environmental management system (EMS) with the goal of reducing DEQ's environmental footprint. Regional EMS Teams coordinate events for Earth Day and America Recycles Day each year that often focus on recycling and contamination.

State Agency Recycling and Procurement

Since 1989, mandatory state agency recycling programs have grown from programs recycling primarily aluminum cans and office paper to programs utilizing assistance through the Department of General Services (DGS) and individual collection contracts to recycle items such as all paper grades, magazines and books, plastic beverage containers, toner cartridges, and metal. DEQ and DGS work together to provide recycling and surplus property guidance information to state agencies including market and recycling content information, resource information or referrals, program development and implementation assistance, and related state policies and procedures. All state agencies must revise their procurement procedures and specifications on a continuing basis to encourage the use of goods and products with recycled content and increase the awareness of the benefits of using such products per the Code of Virginia. Information on the DGS Recycling Assistance Program can be found at https://dgs.virginia.gov/office-of-surplus-property-management/government-entities/recycling-assistance-program/

REPORTS AND METHODOLOGIES FROM STATES AND OTHERS

Several states and organizations have conducted and published recycling economic and environmental impact reports. Summaries of some key reports reviewed by DEQ are provided below.

Alabama

The Alabama Department of Environmental Management published a report, *Economic Impact of Recycling in Alabama and Opportunities for Growth* in 2012. This report primarily focused on the net value loss from disposing recyclable materials in MSW landfills. Alabama surveyed solid waste disposal facilities to estimate an average "tipping" or gate fee as a base level cost of disposal for MSW. The study then calculated the value of the potential recyclable materials being landfilled by multiplying the tonnages of recyclable materials by the commodity pricing. The base gate fee added to the material value lost was considered to be the net value lost. The methodology used in this study measured the lost value from the recycling industry.[5]

[5] Alabama Department of Environmental Management, Economic Impact of Recycling in Alabama and Opportunities for Growth, June 2012, https://adem.alabama.gov/programs/land/landforms/CompleteEconomicsOfRecyclingAlabamaReport.pdf

Michigan

The *Michigan Recycling Economic Impact & Recycled Commodities Market Assessment* report included the impacts of both supply and demand side activities of the recycling industries in the state. This report used the IMPLAN model to determine the employment, labor income, value added, and output in relation to the recycling industry. The report also included economic impact projections for a potential scenario of increased recycling. This increase in the recycling rate showed a percent increase of approximately 50% for all parameters previously mentioned.[6]

North Carolina

North Carolina's Department of Environmental Quality published the *Employment Trends in North Carolina's Recycling Industry – 2020* report which calculated the direct, private-sector material flows and jobs generated within the state. Facility contact information was collected from the North Carolina Recycling Markets Directory as well as from the North Carolina Department of Commerce. This report identified 612 recycling facilities, to which North Carolina sent a survey, to collect data on recycling facilities' employee working hours, recycling activities, future business expansion, and recycled materials tonnages.[7]

South Carolina

South Carolina's report *The Economic Impact of the Recycling Industry in South Carolina* estimated the total economic impact of recycling through its direct, indirect, and induced effects in the state for CY2013. A survey was conducted of recycling facilities to get a baseline for their direct effects. The state then used the input-output model IMPLAN to estimate the indirect and induced effects of recycling. South Carolina also compared the outputs of the IMPLAN model, such as the jobs, labor income, and revenue, with those of its 2006 report to show that the recycling industry had grown by 44 percent and by more than 22,000 direct jobs.[8]

Tennessee

The *Economic Impact of the Recycling Industry in Tennessee* report was prepared by the Southeast Recycling Development Council (SERDC). For this study, a survey was sent to recycling facilities operating within the state to estimate the direct economic impacts of recycling in the state. This direct impact was entered into the IMPLAN model to find the ripple-effect of the indirect and induced impacts of recycling. The direct, indirect, and induced effects were summed to find the total economic impact of recycling in the state based on employment, labor income, revenue, and state and local taxes.[9]

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[6] Michigan Department of Environment, Great Lakes, and Energy, Michigan Recycling Economic Impact & Recycled Commodities Market Assessment, December 18, 2019, https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Programs/MMD/Recycling/Michigan-Market-Development-Report.pdf

[7] North Carolina Department of Environmental Quality, Employment Trends in North Carolina's Recycling Industry, 2020, https://www.deq.nc.gov/energy-mineral-and-land-resources/land-resources/publications/2020-recycling-employment-study-final/download

[8] Frank Hefner, The Economic Impact of the Recycling Industry in South Carolina, April 22, 2014, https://scdhec.gov/sites/default/files/Library/CR-011380.pdf

[9] Frank Hefner, The Economic Impact of the Recycling Industry in Tennessee, May 31, 2017, https://www.serdc.org/resources/Documents/Tenn%20Economic%20Impact%20Report%20Final.pdf

Texas

In the report, *Study on the Economic Impacts of Recycling*, Texas estimated the statewide economic, employment, and fiscal impacts derived from recycling MSW. Using data from recycling industries, Texas utilized the IMPLAN model to find the direct, indirect, induced, and total impacts measured through employment, labor income, value added, and output. These model outputs were further broken down to assess the impacts created by the processing of specific materials and by industry sector.[10]

Environmental Protection Agency (EPA)

The *Recycling Economic Information (REI) Report - November 2020* by the EPA analyzed the state of recycling nationwide. EPA used an analytical framework and a Waste Input-Output (WIO) model which focused on the lifecycle of materials. Using this model coupled with data from the Bureau of Economic Analysis, EPA was able to estimate the total direct and indirect economic impacts of recycling. The report showed that the recycling of materials creates jobs while generating local and state tax revenues. Based on 2012 data, recycling and reuse activities in the United States accounted for 681,000 jobs, $37.8 billion in wages, and $5.5 billion in tax revenue. This equates to 1.17 jobs for every 1000 tons of material recycled.[11]

DEQ initially considered the possibility of using EPA's WIO model for estimating the direct and indirect economic impacts of recycling. However, after reviewing the inputs necessary for running the model, DEQ considered an alternate option of using EPA's economic impact results as a multiplier for estimating Virginia's economic impact based on the recycling tonnages. After discussions with EPA and other organizations, it was determined that this multiplier approach would not be adequate for the purpose of this assessment due to limitations in the applicability of these results with Virginia data.

Institute of Scrap Recycling Industries, Inc. (ISRI)

In this report, *2021 Economic Impact Study, U.S. Based Recycling Industry*, the economic impact of recycling was calculated for the United States at the national, state, congressional district, state house, and city levels. The methodology for this report involved using IMPLAN, an econometric, input-output model that can be used to find the direct, indirect, and induced economic effects of an industry in a given geographic area. Using this model, ISRI found that in 2020, the total economic impact of the recycling industry in Virginia specifically was $1.66 billion, with 7,352 jobs created and accounting for $452 million in wages.[12]

Northeast Resource Recovery Association (NRRA)

NRRA used the Waste Reduction Model (WARM), a model developed by EPA, to create a comprehensive environmental impact report highlighting effects of recycling. The model provided high-level estimates of potential greenhouse gas (GHG) emissions reductions, energy savings, and economic impacts from several

[10] Texas Commission on Environmental Quality, Study on the Economic Impacts of Recycling, July 2017, https://www.tceq.texas.gov/p2/recycle/study-on-the-economic-impacts-of-recycling

[11] EPA Recycling Economic Information (REI) Report, November 2020, https://www.epa.gov/sites/default/files/2020-11/documents/rei_report_508_compliant.pdf

[12] Institute of Scrap Recycling Industries 2021 Economic Impact of the Recycling Industry in the United States, https://www.isri.org/economic-impact

different waste management practices – source reduction, anaerobic digestions, combustion, composing, and landfilling.[13] Using WARM, NRRA found the energy savings and GHG emissions reductions for several materials, including aluminum, steel, paper, tires, and glass. NRRA was also able to find the total GHG emissions reductions due to recycling efforts in their region.[14]

DETERMINATION OF METHODOLOGY

Upon reviewing existing methodologies, DEQ considered utilizing the methodology presented in *The Economic Benefits of Recycling in Virginia* report published in 2007 for the economic impact assessment and utilizing EPA's WARM model for the environmental impact assessment.

Economic Impact Methodology

The U.S. Economic Census dataset included NAICS codes for each business listing. Since there is no general classification code for the recycling industry, the determination was made to use classification codes used by various recycling-related sectors for the purpose of this report. The NAICS codes used in the study included: 42393 (Recyclable Material Merchant Wholesalers), 56292 (Materials Recovery Facilities), 236210 (Industrial Building Construction), 32192 (Wood Container and Pallet Manufacturing), 3221 (Pulp, Paper, and Paperboard Mills), 562111 (Solid Waste Collection), 562212 (Solid Waste Landfill), and 4842303 (Other Specialized Trucking, Long-Distance). The eight chosen recycling-related industry sectors were then sorted into three industry groups: core, manufacturing, and solid waste as shown in Table 1 below. The core industry group consists of businesses conducting recycling activities directly. The manufacturing industry group consists of businesses involved in recycling indirectly by producing finished goods from recycled materials. The solid waste industry group consists of businesses involved in recycling indirectly by the transportation or processing of recycled materials.

Table 1 – Recycling-Related Industries by Industry Category

Industry Group	NAICS Code	NAICS Code Description
Core	42393	Recyclable material merchant wholesalers
	56292	Materials recovery facilities
Manufacturing	236210	Industrial building construction
	32192	Wood container and pallet manufacturing
	3221	Pulp, paper, and paperboard mills
Solid Waste	4842303	Other specialized trucking, long-distance
	562111	Solid waste collection
	562212	Solid waste landfill

[13] EPA, Waste Reduction Model (WARM), https://www.epa.gov/warm

[14] Northeast Resource Recovery Association, Environmental Impact Report, 2022, https://www.nrrarecycles.org/environmental-impact-report

The most recent complete dataset available from the U.S. Economic Census data for the number of establishments, revenue, employees, and wages was for calendar year 2012. Using the 2007 report as a basis, two simplifying assumptions were made in order to calculate the recycling-related economic impact using employment, revenue, and wages. Simplifying assumptions of 50% and 41.5%[15] were used for the manufacturing and solid waste industries respectively. These assumptions were used to qualify the true amount of recycling-related revenue, employment, and wages within their respective industry groups.

Environmental Impact Methodology

EPA's Waste Reduction Model (WARM) provides high-level estimates of potential greenhouse gas (GHG) emissions reductions, energy savings, and economic impacts from several different waste management practices. WARM estimates these impacts from baseline and alternative waste management practices such as source reduction, recycling, anaerobic digestion, combustion, composting and landfilling.[16]

WARM calculates emissions, energy units, and economic factors across a wide range of material types of solid waste. GHG emissions and energy units are calculated by comparing the baseline scenario versus an alternate scenario. The WARM model recognizes 60 different material types[17], with detailed chapters outlining the development of the GHG emissions, energy, and economic factors used in the model[18].

Using the recycling data reported to DEQ by SWPUs, seven PRMs were entered into the model to calculate the greenhouse gas emissions reductions and energy savings provided by recycling in the Commonwealth. The PRMs entered into the model were: paper (mixed paper), metal (mixed metal), plastic (mixed plastic), glass, commingled (mixed recyclables), waste tires (tires), and electronics (mixed electronics). The reported PRM tonnages were entered into WARM to estimate the GHG emissions and energy savings for recycling (baseline) and landfilling (alternate) scenarios. This enabled DEQ to assess the environmental benefits of recycling versus landfilling in the state.

[15] Simplifying assumption of 41.5% is derived from the 2012 recycling rate as reported to DEQ
[16] EPA, Waste Reduction Model (WARM), https://www.epa.gov/warm
[17] EPA, Basic Information about the Waste Reduction Model (WARM), https://www.epa.gov/warm/basic-information-about-waste-reduction-model-warm
[18] EPA, Documentation for the Waste Reduction Model (WARM), https://www.epa.gov/warm/documentation-waste-reduction-model-warm

ECONOMIC IMPACT ANALYSIS

Recycling plays an important role in the U.S. economy by contributing to employment, wages, and revenue. In order to measure the economic impact of recycling, DEQ analyzed these three parameters for industries directly and indirectly tied to recycling. Some notable limitations to this analysis are the availability of recycling data pertaining to all waste types instead of only MSW, voluntary participation in the U.S. Economic Census data, the current available data for a full calendar year, and the simplifying assumptions used in the calculations. Therefore, the actual amount of recycling occurring in the state may be greater than what is actually being reported.

An overall summary of the economic impact analysis in the Commonwealth based on the most recently available U.S. Economic Census data from CY2012 is provided in Table 2 below. Based on the analysis conducted, 607 recycling-related establishments employed 7,070 full-time equivalent employees, who were paid about $327 million in wages. The total economic direct and indirect recycling-related revenue was approximately $1.9 billion in CY2012.

Table 2 – Summary of Recycling-Related Economic Impacts for CY2012

Industry Group	Number of Establishments	Recycling-Related Employees	Recycling-Related Wages	Recycling-Related Revenue
Core	155	2,345	$ 86,064,000	$ 1,279,219,000
Manufacturing	121	2,297	$ 138,167,500	$ 199,935,000
Solid Waste	331	2,428	$ 102,695,485	$ 432,670,000
Total	**607**	**7,070**	**$ 326,926,985**	**$ 1,911,824,000**

Source: CY2012 U.S. Economic Census Tables

From the most recent U.S Economic Census data from 2012, the total number of recycling-related establishments was 607 across the state. 155 establishments were part of the core industry group, which directly engaged in recycling. 452 establishments were part of the manufacturing and solid waste industry, which were both indirectly tied to recycling.

Employment

Since the recycling industry generates jobs, the direct and indirect impacts on the economy are significant. The amount of recycling-related employment from the three industry groups was estimated by multiplying the total employment for each industry by their respective simplifying assumptions as shown in Table 3 below. The total impact of each industry group was calculated by summing the recycling-related employment numbers.

Solid waste is one of the largest waste sectors and comprises of various waste management activities, including collection, transportation, processing, treatment, and disposal. All these various activities are in some way or another indirectly involved in recycling activities and therefore, it was the largest industry that employed recycling-related workers. Manufacturing is one of the largest industry groups. The industries in this sector are mainly focused on manufacturing goods from raw materials. Some manufacturing facilities incorporate recycling within their processes as a way to conserve resources or divert waste material, while others incorporate recycled materials in their influent material streams. The

amount of recycling-related employment was 2,297 employees, which was the lowest of the industry groups for this analysis. The core sector is entirely made of industries that are directly engaged in recycling. This sector provided 2,345 jobs directly related to recycling.

Table 3 – Recycling-Related Employment in Recycling Industry Sectors for CY2012

Industry Group	Industry Sector	Total Employment	Multiplier	Recycling-Related Employment
Core	Recyclable material merchant wholesalers	2,005	100%	2,005
	Materials recovery facilities	340	100%	340
	Total	**2,345**		**2,345**
Manufacturing	Industrial building construction	1,058	50%	529
	Wood container and pallet manufacturing	1,019	50%	510
	Pulp, paper, and paperboard mills	2,517	50%	1,259
	Total	**4,594**		**2,297**
Solid Waste	Other specialized trucking, long-distance	1,183	41.50%	491
	Solid waste collection	4,139	41.50%	1,718
	Solid waste landfill	528	41.50%	219
	Total	**5,850**		**2,428**
All Groups	**Total**	**12,789**		**7,070**

Source: CY 2012 U.S. Economic Census Data Tables

Wages

Businesses, along with their employees, play a role in the statewide and nationwide economic growth due to their spending power and contribution to tax revenue. As recycling related employees pay for goods and services using their wages, a ripple-effect is also created in the economy for industries outside of recycling. The amount of recycling-related wages from the each of the industry groups was estimated by multiplying the total wages for each industry by their respective simplifying assumptions as shown in Table 4 below. Since the solid waste and manufacturing sectors are quite large compared to recycling, the total amount of wages paid was significantly larger. The indirect recycling-related wages from these two industries totaled to approximately $241 million. The core sector, which is directly engaged in recycling, contributed to $86 million in wages.

Table 4 – Recycling-Related Wages in Recycling Industry Sectors for CY2012

Industry Group	Industry Sector	Total Wages	Multiplier	Recycling-Related Wages
Core	Recyclable material merchant wholesalers	$ 73,583,000	100%	$ 73,583,000
	Materials recovery facilities	$ 12,481,000	100%	$ 12,481,000
	Total	**$ 86,064,000**		**$ 86,064,000**
Manufacturing	Industrial building construction	$ 60,654,000	50%	$ 30,327,000
	Wood container and pallet manufacturing	$ 29,161,000	50%	$ 14,580,500
	Pulp, paper, and paperboard mills	$ 186,520,000	50%	$ 93,260,000
	Total	**$ 276,335,000**		**$ 138,167,500**
Solid Waste	Other specialized trucking, long-distance	$ 46,942,000	41.50%	$ 19,480,930
	Solid waste collection	$ 173,266,000	41.50%	$ 71,905,390
	Solid waste landfill	$ 27,251,000	41.50%	$ 11,309,165
	Total	**$ 247,459,000**		**$ 102,695,485**
All Groups	**Total**	**$ 609,858,000**		**$ 326,926,985**

Source: CY2012 U.S. Economic Census Data Tables

In order to estimate the average annual wages in each industry sector displayed in Table 5 below, the following formula was used:

$$\text{Average Annual Wage} = \frac{\text{Annual Wages}}{\text{Number of Employees}}$$

Table 5 – Average Annual Wages for Recycling Industry Sectors for CY2012

Industry Group	Industry Sector	Average Annual Wages
Core	Recyclable material merchant wholesalers	$ 36,700
	Materials recovery facilities	$ 36,709
Manufacturing	Industrial building construction	$ 57,329
	Wood container and pallet manufacturing	$ 28,617
	Pulp, paper, and paperboard mills	$ 74,104
Solid Waste	Other specialized trucking, long-distance	$ 39,680
	Solid waste collection	$ 41,862
	Solid waste landfill	$ 51,612

Source: CY2012 U.S. Economic Census Data Tables

The average annual wage gave an estimate of the wages earned by an individual employee within a recycling-related industry sector in CY2012. Since this was an average, the individual wages could have ranged from high-earning to low-earning employees. Based on the analysis, employees of industries directly engaged in recycling earned lower wages versus those working in the indirect industry groups.

Revenue

The impact of the total direct and indirect recycling-related revenue on the Virginia economy exceeded $1.9 billion in CY2012, the most recent year for which the data from the U.S. Economic Census required for this analysis is available. Recyclable material merchant wholesalers and materials recovery facilities generated the largest recycling revenue totaling $1.3 billion. The solid waste and manufacturing industries generated $433 million and $200 million in indirect recycling-related revenue respectively.

The amount of recycling-related revenue from the three industry groups was estimated by multiplying the total revenue for each industry by their respective simplifying assumptions as shown in Table 6 below. It should be noted that the recycling-related revenue for the Pulp, Paper and Paperboard Mills industry sector was unavailable from the U.S. Economic Census data required for this analysis.

Table 6 – Recycling-Related Revenue for Recycling Industry Sectors for CY2012

Industry Group	Industry Sector	Total Revenue	Multiplier	Recycling-Related Revenue
Core	Recyclable material merchant wholesalers	$ 1,195,686,000	100%	$ 1,195,686,000
	Materials recovery facilities	$ 83,533,000	100%	$ 83,533,000
	Total	**$ 1,279,219,000**		**$ 1,279,219,000**
Manufacturing	Industrial building construction	$ 280,272,000	50%	$ 140,136,000
	Wood container and pallet manufacturing	$ 119,598,000	50%	$ 59,799,000
	Pulp, paper, and paperboard mills	N/A	50%	N/A
	Total	**$ 399,870,000**		**$ 199,935,000**
Solid Waste	Other specialized trucking, long-distance	$ 180,788,000	41.50%	$ 75,027,000
	Solid waste collection	$ 729,628,000	41.50%	$ 302,796,000
	Solid waste landfill	$ 132,162,000	41.50%	$ 54,847,000
	Total	**$ 1,042,578,000**		**$ 432,670,000**
All Groups	**Total**	**$ 2,721,667,000**		**$ 1,911,824,000**

Source: CY2012 U.S. Economic Census Data Tables

Employment Data Trends

DEQ performed analysis on data received from the Virginia Employment Commission (VEC) in addition to the U.S. Economic Census data. This data enabled DEQ to compare the number of establishments, employment, and wages, from 2012 to 2021 for the selected recycling-related industries in Virginia. These trends indicated that recycling-related industries remained relatively steady over the nine-year period. During this timeframe, the total number of establishments and employment decreased by 3%. In contrast, wages increased by 27%, which goes hand-in-hand with inflation in the economy.

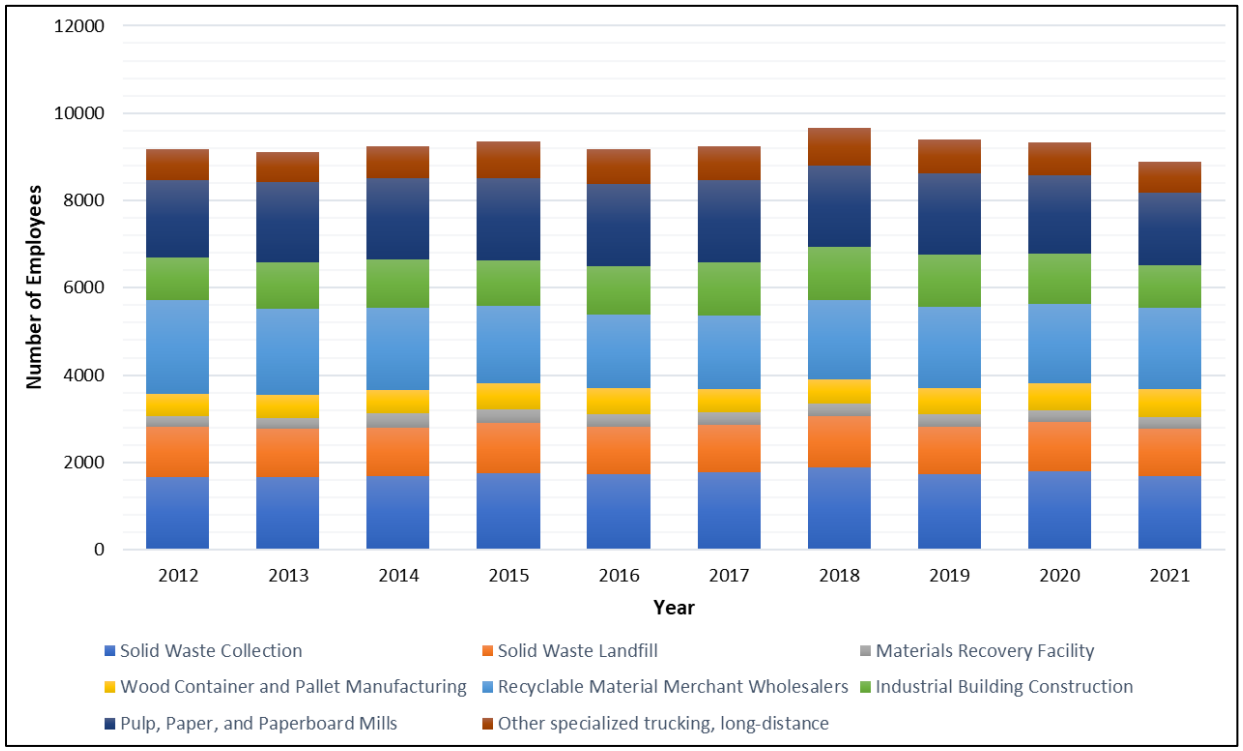
In order to accurately account for the portion of recycling activities in each industry sector, the simplifying assumptions were used as a basis. For the core and the manufacturing industry group, 100% and 50%

simplifying assumptions were used respectively. However, for the solid waste industry group, the simplifying assumption varied based on the recycling rate for each year.

Based on the economic trends, core recycling industries showed mixed results. Materials recovery facilities had an increase of 8% for the number of establishments, 10% for employment and 53% for wages. On the other hand, recyclable materials merchant wholesalers had a decrease of 3% for the number of establishments and 14% for employment. However, following the general trend of an increase in wages, there was a 20% increase for this industry sector.

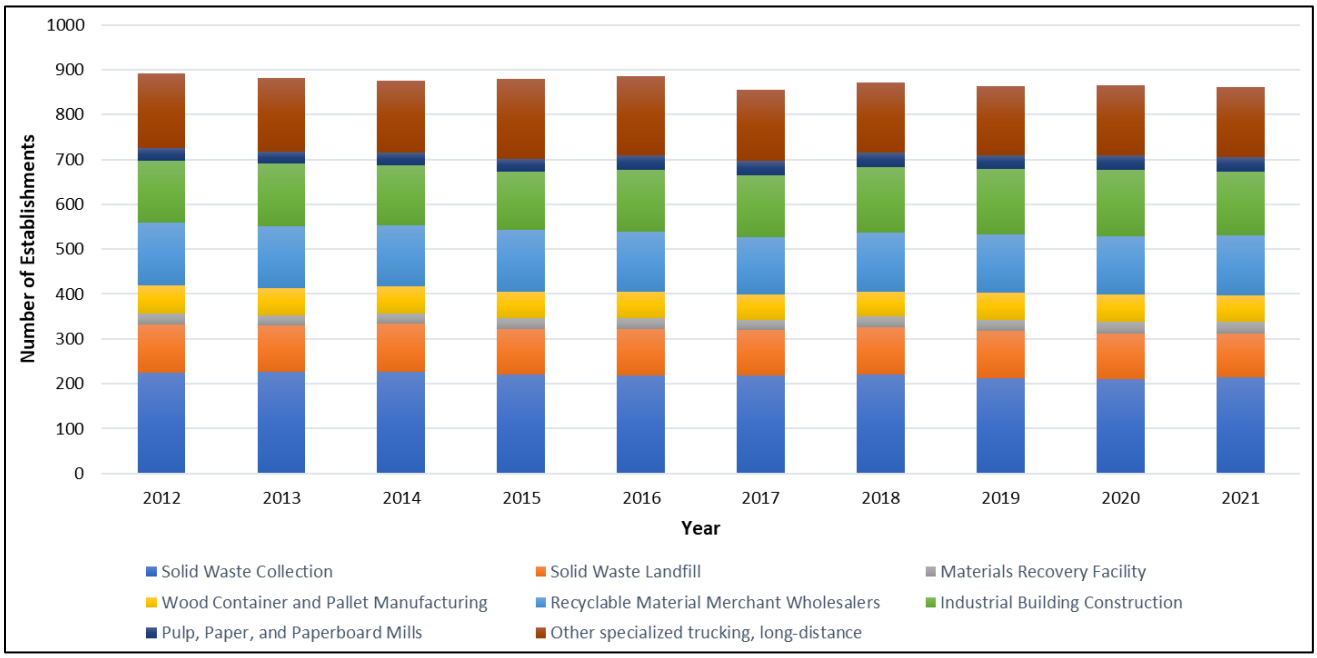
The same pattern holds true for the manufacturing and solid waste industry sectors, which saw relative increases for employment in some industries (solid waste collection, wood container and pallet manufacturing, industrial building construction, and other specialized trucking, long-distance) but decreased employment for other industries (solid waste landfill and pulp, paper, and paperboard mills). Subsequently, all industry sectors showed increases in overall wages, with the lowest wage increase of 8% from pulp, paper, and paperboard mills and the largest wage increase of 87% from wood container and pallet manufacturing over the 9-year period. Charts 4 through 6 present the trends for all three parameters.

Chart 4 – Recycling-Related Employment from Selected Recycling-Related Industries



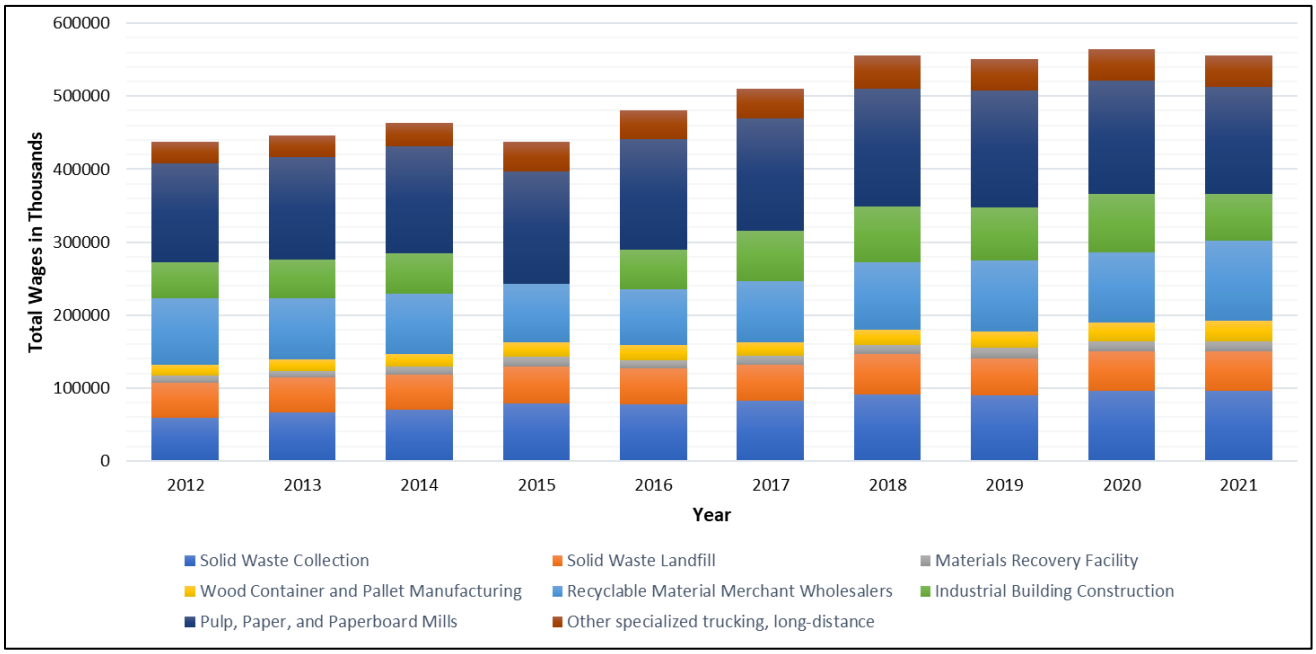
Source: Virginia Employment Commission

Chart 5 – Total Establishments in Selected Recycling-Related Industries



Source: Virginia Employment Commission

Chart 6 - Recycling-Related Wages from Selected Recycling-Related Industries



Source: Virginia Employment Commission

ENVIRONMENTAL IMPACT ANALYSIS

DEQ measured the environmental impact of recycling through the amount of waste diversion, reduction in greenhouse gas emissions, and energy savings. The amount of waste diverted was calculated from the recycling tonnages reported to DEQ, while the greenhouse gas emissions and energy savings related to recycling were calculated using EPA's WARM model.[19] For the purpose of this report, the GHG equivalent emissions and energy usage outputs from WARM were analyzed for the environmental impact. In order to obtain the above outputs, the CY2021 Recycling Rate Report data was used for the inputs in WARM. The materials that were inputted into WARM were as follows: paper (mixed paper), metal (mixed metal), plastic (mixed plastic), glass, commingled (mixed recyclables), waste tires (tires), and electronics (mixed electronics).

Waste Diversion

Every year, DEQ publishes an annual Recycling Summary Report detailing the recycling information and data submitted by Virginia's solid waste planning units (SWPUs). SWPUs with populations greater than 100,000 are required to report annually, while SWPUs with populations of 100,000 and below are required to report every four years. The annual report published in August 2022 contained recycling data from 17 SWPUs required to report and 19 SWPUs voluntarily reporting for CY2021. The 17 SWPUs reported 2,847,066 tons in principle recyclable materials (PRMs) being recycled, 733,861 tons in credits, and 4,584,582 tons of municipal solid waste (MSW) disposed, which represented a state-wide recycling rate of 43.3%. The material most recycled was metal at 785,481 tons, followed by paper at 554,426 tons. The 733,861 tons of credits included recycling residue, solid waste reused and non-MSW recycled. The 4,584,582 tons of MSW represented the amount disposed in household, commercial, institutional, and other waste. Although this assessment is primarily focused on MSW, Virginia facilities are also directly and indirectly engaged in recycling construction, demolition, and debris waste, industrial waste, and hazardous materials.

Greenhouse Gas Emissions

Based on the WARM output, the environmental footprint was reduced by 6.5 million metric tons of CO_2 equivalent ($MTCO_2E$)[20] by recycling the materials listed above. Alternatively, if these materials were landfilled, the amount of GHG emissions would increase by roughly 72,000 $MTCO_2E$. As seen in Table 8 below, the highest contribution to the reduction of carbon emissions came from recycling metal and paper, while electronics had the least. In contrast, mixed paper had the highest amount of carbon emissions produced when landfilled, while electronics again had the least. When considering the full life cycle of the materials, production of the materials released 6.4 million $MTCO_2E$. This resulted in a net lifetime GHG reduction of nearly 96,000 $MTCO_2E$ when recycled but resulted in a net lifetime carbon emission increase of 6.5 million $MTCO_2E$ when landfilled. Table 7 below reflects the multipliers used by WARM to estimate the GHG emissions of the PRMs based on their waste management method.

[19] EPA WARM model, https://www.epa.gov/warm

[20] Carbon dioxide equivalent is a method for measuring the impact of climate change by converting all greenhouse gases to their equivalent atmospheric warming potential in tons of carbon dioxide.

Table 7 – GHG Emissions Rate for Recycling and Landfilling per Material

PRMs	GHG per Ton of Material Recycled ($MTCO_2E$)	GHG per Ton of Material Landfilled ($MTCO_2E$)
Glass	-0.28	0.02
Mixed Electronics	-0.79	0.02
Mixed Metals	-4.39	0.02
Mixed Paper	-3.55	0.07
Mixed Plastic	-0.93	0.02
Mixed Recyclables	-2.85	0.03
Tires	-0.38	0.02

Table 8 –GHG Emissions by Waste Management Method for PRMs

PRMs	GHG Emissions from Production ($MTCO_2E$)	GHG Emissions from Recycling ($MTCO_2E$)	GHG Emissions from Landfilling ($MTCO_2E$)	Net GHG Impact from Recycling ($MTCO_2E$)	Net GHG Impact from Landfilling ($MTCO_2E$)
Glass	11,228.98	-5,840.41	428.46	5,388.57	11,657.45
Mixed Electronics	NA	-4,690.79	120.98	-4,690.79	120.98
Mixed Metals	2,866,264.66	-3,449,173.28	15,909.54	-582,908.62	2,882,174.20
Mixed Paper	3,367,432.09	-1,965,730.47	41,417.26	1,401,701.63	3,408,849.36
Mixed Plastic	21,937.52	-10,837.88	237.18	11,099.64	22,174.70
Mixed Recyclables	NA	-1,086,561.14	13,018.32	-1,086,561.14	13,018.32
Tires	175,133.57	-15,330.60	825.17	159,802.97	175,958.74
Total	**6,441,996.83**	**-6,538,164.57**	**71,956.92**	**-96,167.74**	**6,513,953.75**

Energy Usage

The net energy saved by recycling the PRMs is 70,155,807.32 Million British Thermal Units (MBTUs).[21] If these PRMs were landfilled instead, they would require nearly 116,000 MBTUs of energy to dispose. As seen in Table 10 below, the largest amount of energy savings comes from mixed metals (about 52,000,000 MBTUs), while glass had the least savings (about 45,000 MBTUs). Metals have the largest per ton energy savings, costing 0.27 MBTUs per ton landfilled and saving 66.55 MBTUs per ton recycled. When considering the full life cycle of the materials, production of the materials required about 60,000,000 MBTUs of energy. There is a net lifetime energy savings of about 10,000,000 MBTUs when PRMs are recycled and a net lifetime energy cost of 60,000,000 MBTUs when landfilled. The net energy saved from recycling rather than landfilling is equivalent to the annual energy consumption of 765,729 households, as estimated by WARM. Table 9 below reflects the multipliers used by WARM to estimate the energy savings of the recycled materials based on their waste management method.

Table 9 –Energy Usage for Recycling and Landfilling per Material

PRMs	Energy Usage per Ton of Material Recycled (MBTU)	Energy Usage per Ton of Material Landfilled (MBTU)
Glass	-2.13	0.27
Mixed Electronics	-11.69	0.27
Mixed Metals	-66.55	0.27
Mixed Paper	-20.56	-0.17
Mixed Plastic	-35.02	0.27
Mixed Recyclables	-14.95	-0.05
Tires	-3.6	0.27

Table 10 –Energy Usage by Waste Management Method for PRMs

PRMs	Energy Use from Production (MBTU)	Energy Use from Recycling (MBTU)	Energy Use from Landfilling (MBTU)	Net Energy Use from Recycling (MBTU)	Net Energy Use from Landfilling (MBTU)
Glass	146,059.24	-44,960.92	5,675.05	101,098.32	151,734.29
Mixed Electronics	NA	-69,815.53	1,602.39	-69,815.53	1,602.39
Mixed Metals	39,950,447.81	-52,273,661.25	210,723.38	-12,323,213.44	40,161,171.19
Mixed Paper	16,323,987.05	-11,401,283.85	-95,833.55	4,922,703.21	16,228,153.50
Mixed Plastic	637,381.34	-410,107.15	3,141.48	227,274.20	640,522.82
Mixed Recyclables	NA	-5,693,399.29	-20,427.43	-5,693,399.29	-20,427.43
Tires	2,921,410.77	-146,768.57	10,929.44	2,774,642.20	2,932,340.22
Total	**59,979,286.22**	**-70,039,996.56**	**115,810.76**	**-10,060,710.34**	**60,095,096.98**

[21] Derived by subtracting Landfilling Net Energy Use (60,095,096.98 MBTU) from Recycling Net Energy Use (-10,060,710.34 MBTU)

RECYCLING FACILITIES SURVEY

From April 2023 through June 2023, DEQ conducted a survey of recycling-related facilities operating in Virginia to obtain in-depth information on total revenue, employment, wages, and recycling tonnages.

Survey Methodology

Since recycling facilities are not required to have solid waste permits in Virginia[22], a readily available list was unavailable to conduct the survey. The list of potential recycling facilities in Virginia was compiled by contacting various localities and organizations in Virginia and their websites. In an effort to obtain this information, DEQ contacted all 71 SWPUs, Virginia Recycling Association (VRA), State Corporation Commission (SCC), Virginia Economic Development Partnership, Virginia Department of Taxation, Keep Virginia Beautiful (KVB), Virginia Employment Commission (VEC), and the DEQ Recycling Tax Credit applicant list. For the purpose of complete analysis, DEQ also compared the compiled list of recycling facilities with EPA's Recycling Infrastructure and Market Opportunities Map (2023). Below are the results of this effort:

- Of the 71 SWPUs contacted, 41 responded with a list of the recycling facilities within their jurisdiction and 3 responded stating they had no recycling facilities in their planning unit.
- VRA provided their most current list of recycling facilities, which included facility names, addresses, and contact information.
- Recycling equipment and machinery tax credit applicants for the last two years were also included in the list.

DEQ compiled a master list encompassing all the information received above containing 172 unique contacts representing 288 recycling-related facilities. DEQ surveyed these facilities to gather relevant information related to recycling. Appendix I includes a list of survey questions.

Survey Implementation

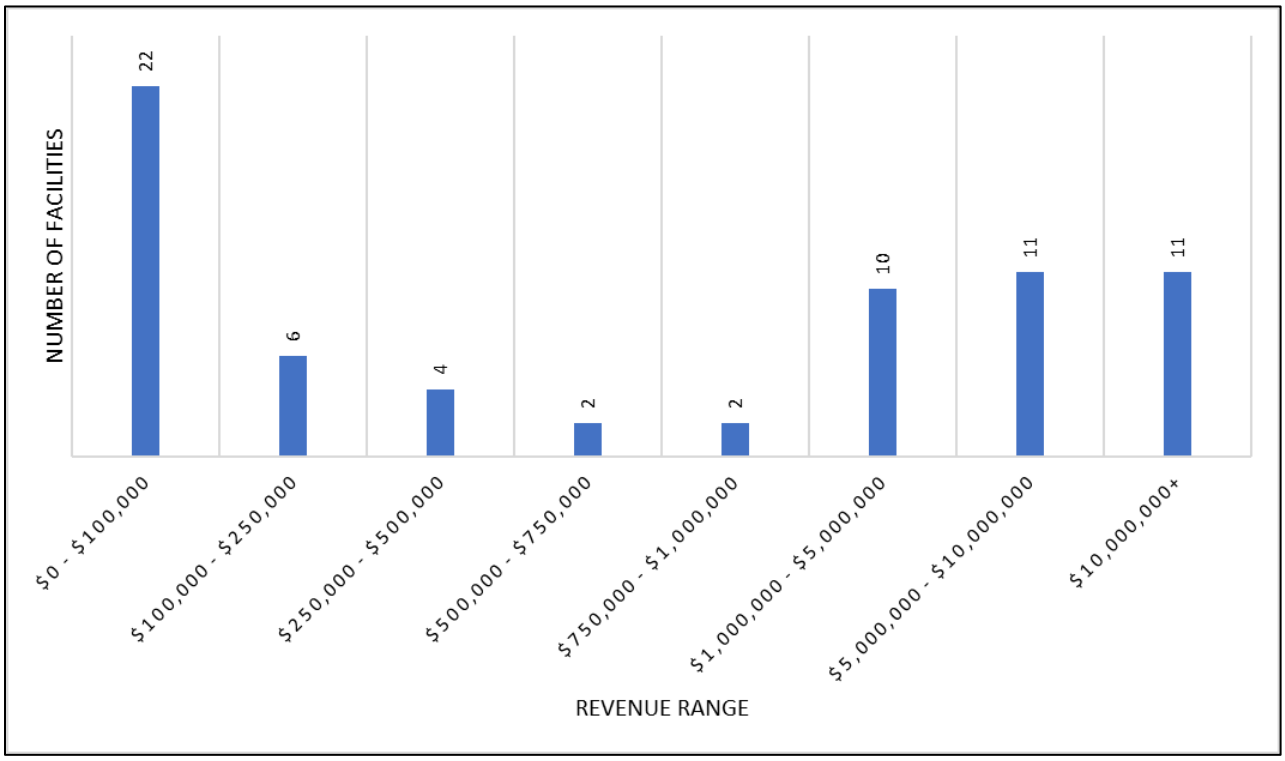
All recycling-related facilities with email addresses received an email invitation in April 2023 to participate in the online survey. SurveyMonkey was the online tool used for this survey. Facilities that did not respond to the initial invitation were sent additional email reminders before the survey was closed in June 2023.

Survey Results

Out of the 72 facilities that responded, 51 facilities indicated that they were involved in collection, 49 facilities in processing recycled materials, 15 facilities in brokering, 14 facilities in manufacturing, and 6 facilities in other recycling activities. According to the respondents, the average hourly wage was $23.57 with an average of 59 full-time employees for 2022. This is equivalent a total of $171 million in wages for recycling-related employees for the 72 facilities. Chart 7 displays the number of facilities by revenue range. Approximately, 32% of the facilities reported an annual revenue between $0 and $100,000. On the other hand, 16% of the facilities reported an annual revenue greater than $10 million. The respondents also reported recycling approximately 23.8 million tons of recycled materials, the majority of which was ferrous metal. Table 11 contains a summary of the survey results.

[22] 10.1-1408.1(J), https://law.lis.virginia.gov/vacode/title10.1/chapter14/section10.1-1408.1/

Chart 7 – Number of Facilities by Revenue Range



Source: Survey Data of Virginia Recycling Facilities (2023)

Table 11 – Tonnages of Recycled Materials from Survey Results

Material Type	Tons Recycled
Construction, Demolition, Debris	222,241
Electronics	4,993,304
Expanded Polystyrene	0
Ferrous Metals	15,515,208
Glass	7,057
Hazardous Materials	217
Mixed Recyclables	88,876
Non-Ferrous Metals	2,119,702
Other	435,837
Paper	191,055
Plastic	175,775
Tires	62,828
Total	**23,812,101**

Source: Survey Data of Virginia Recycling Facilities (2023)

CONCLUSION

DEQ created this report pursuant to HB30 in order to conduct a recycling economic and environmental impact assessment. For the purpose of this analysis, DEQ reached out to Virginia localities, solid waste planning units, industries, and other stakeholders. DEQ researched various methodologies and reports for economic and environmental impact assessments. In this report DEQ described the current state of recycling and programs dedicated to increasing recycling in Virginia. Over the span of the last 30 years, the recycling rate in Virginia has significantly increased from 19.7% in 1991 to 43.3% in 2021. Based on the assessment, it is apparent that the recycling industry has a considerable contribution to revenue, wages, and employment in the Commonwealth. From the VEC trend data received, it appears that the U.S. Economic Census CY2012 dataset, the most recently available data necessary to perform this analysis, is still relevant to the current ongoing recycling activities in the various industry sectors. The actual impact of recycling on the economy is much greater than estimated in this report due to the limitations in the available data for conducting this analysis. The total impact of the recycling industry on Virginia's economy, using the most recently available U.S. Economic Census data from CY2012, is estimated to be around $1.9 billion in revenue with $327 million in wages for 7,070 employees. The analysis of the environmental impact of recycling in Virginia indicates significant reduction in carbon emissions and energy usage has been achieved by recycling in lieu of landfilling.

SPECIAL THANKS

DEQ would like to thank all the individuals and organizations who provided input for this report for their assistance:

- AmSty –for the valuable input regarding expanded polystyrene recycling.
- EPA –for sharing details on the Waste Input-Output model used for the EPA's Recycling Economic Impact (REI) Report.
- North Carolina DEQ –for providing information on its employment trends methodology.
- SERDC –for its valuable input regarding the use of the IMPLAN model.

APPENDICES

Appendix I – Survey Questions

1. Please enter your facility information.
    a. First & Last Name
    b. Email
    c. Phone Number
    d. Company Name
    e. Facility Name
    f. Facility Street Address
    g. City
    h. Zip Code
    i. NAICS Code
2. What type of facility are you? (check all that apply)
    a. Materials Recovery Facility (MRF)
    b. Recycling Facility
    c. Solid Waste Facility
    d. Landfill
    e. Transfer Station
    f. Other (please specify)
3. How many full-time equivalent (FTE) employees worked at your facility in the previous year?
4. How many full-time equivalent (FTE) employees (including processing, manufacturing, collection, brokering, administrative, and managerial) at your facility were dedicated to recycling in the previous year?
5. If you do not know the number of employees dedicated to recycling, please estimate the percentage of your business devoted to recycling.
    a. Less than 25%
    b. 25-49%
    c. 50-74%
    d. 75-99%
    e. 100%
6. What was the average hourly wage of the employees at your facility that were dedicated to recycling in the previous year?
7. Please give an estimate of your facility's last year's annual revenue for recycling related activities.
    a. $0-100,000
    b. $100,000-250,000
    c. $250,000-500,000
    d. $500,000-750,000
    e. $750,000-1,000,000
    f. $1,000,000-5,000,000

g. $5,000,000-10,000,000
h. $10,000,000+

8. Please select all recycling related activities in which your facility participates.
    a. Processing
    b. Manufacturing
    c. Collection
    d. Brokering
    e. Other (please specify)
9. How much total waste material was recycled at your facility in the previous year (in tons)?
10. How much of each waste material below was recycled at your facility in the previous year (in tons)?
    a. Paper
    b. Plastic
    c. Expanded Polystyrene (EPS, Styrofoam)
    d. Electronics
    e. Ferrous Metals
    f. Non-ferrous Metals
    g. Glass
    h. Construction and Demolition
    i. Tires
    j. Mixed Recyclables
    k. Hazardous Waste
    l. Other
11. Do you have any other comments you would like to share with DEQ?

Appendix II – Public Comments and Responses

Commenter	Comment	DEQ Response
Dan Ciesla, Virginia Recycling Association	The Virginia Recycling Association is pleased to see the report and the economic value recycling brings to the Commonwealth. There are two comments we have regarding the report: • The report fails to address the increased cost of recycling due to some municipalities discontinuing their municipally funded curbside recycling programs (such as the City of Chesapeake and Chesterfield County) and the resulting economic impact. • The report does not mention the EPA grants awarded in Virginia for residential recycling programs under the Infrastructure Act We also encourage further discussion around advanced recycling opportunities for the Commonwealth and how we can entice those businesses to find a home here in Virginia.	The report is based on the information gathered from the recycling industry, localities, and other databases. Since most solid waste planning units only report information every four years, impacts of discontinued programs are not immediately realized in annual reporting, nor is cost information collected in the annual recycling rate survey. This report was initiated and drafted prior to EPA announcing such grant awards, and it is too soon for such grants to have a measurable impact on the economic impacts identified in the report. For awareness, the following grants were awarded in Virginia: • The DEQ received a Solid Waste Infrastructure for Recycling (SWIRF) Grant for States for planning and data collection activities. • The Northern Shenandoah Valley Regional Planning Commission received a SWIFR Grant for Communities for "Expanded and Optimized Recycling Services in the Northern Shenandoah Valley." • The Hampton Roads Planning District Commission received a Recycling Education & Outreach grant. In December 2023, DEQ published "Opportunities for Attracting Post-Consumer Recycling Product Business Entities to the Commonwealth" in response to the Governor's Executive Order 17.
Mark Swingle	My name is Mark Swingle and I am the former Chief of Research & Conservation (recently retired after 40 years) and a current Conservation Consultant for the Virginia Aquarium & Marine Science Center Foundation. The plastic pollution problem became alarmingly evident early in my career as we noted the increasingly harmful impacts of plastic debris on the health of marine animals such as marine mammals, sea turtles, and birds. As co-author	DEQ acknowledges and appreciates your comment related to handling plastics. Chart 2 of the report confirms that the amount of plastics recycled is significantly low in comparison to other recyclable materials. These suggestions targeting plastics reduction and recycling would require statutory change to implement.

Commenter	Comment	DEQ Response
	a 5-year study of marine debris on Virginia's coastal ocean beaches (VAQF_monitoring_Report_2019.pdf (longwood.edu)), we documented that more than 80% of the litter materials were composed of plastics. The most commonly found materials included single-use plastic bottles and bags despite the fact that these items could have been recycled. Plastic recycling in the U.S. is shockingly low and Virginia is no different. The December 2023 report from *Eunomia Research & Consulting and the Ball Corporation, 50 States of Recycling*, (50 States of Recycling Report) indicates that Virginia's overall plastics recycling rate is estimated at 4%, and even in the best category for hdpe bottles is only 17%. The bottom line is that plastics recycling will not solve this waste production problem. We need source reduction measures such as enhanced producer responsibility, reductions of single-use plastics such as shopping bags, and potentially implementation of a beverage container deposit program(s). Where recycling is prudent and potentially cost-effective, producer financial support for the recycling programs and infrastructure is crucial for effective implementation and maintenance at the municipal level. Finally, the suggestion of "chemical recycling" as a potential solution is not supported by the facts, either from a business or environmental perspective. Because of its hazardous waste byproducts and fossil fuel production, the process is not even allowed to be called "recycling" in European markets. Add to these facts that chemical recycling is incapable of handling normal municipal waste products and volume and we can readily understand that it is not a viable solution. I appreciate the opportunity to provide comments on the draft report and look forward to further dialogue on this important topic as Virginia moves forward to address plastic pollution.	
Zach Huntington, Clean Virginia Waterways	Clean Virginia Waterways acknowledges and values the Department of Environmental Quality's effort to enhance comprehension regarding the environmental and economic impacts of Virginia's recycling system. We have a few comments to help Virginia improve recycling systems.	Virginia's recycling rate methodology does not include solid waste to fuels or fuel substitutes. The only mention of advanced recycling is in reference to tax credits available to manufacturing facilities as defined at § 58.1-439.7.

Commenter	Comment	DEQ Response
	Increasing Recycling Rates in Virginia Recycling is intended to be a cyclical process. As stated by the Environmental Protection Agency (EPA), "A circular economy keeps materials, products, and services in circulation for as long as possible." A true circular economy is dependent on a robust mechanical recycling industry to create a system with minimal waste. Taking this approach to bolster markets for glass, metal, and cardboard recycling markets is critical to improving Virginia's recycling rates. Melting plastics to be used as additives for fossil fuels (advanced recycling) is a linear system, and these processes are not considered recycling by the EPA. In fact, the EPA specifically outlines that "Activities that convert non-hazardous solid waste to fuels or fuel substitutes ("plastics-to-fuel") or for energy production are not considered to be 'recycling' activities." This includes pyrolysis, gasification, chemical conversion, and all other plastic-to-fuel technologies. (Language is modified from the EPA Draft National Strategy to Prevent Plastic Pollution). **Economic burden on taxpayers:** The report fails to address the economic burden that recycling programs have on municipalities (taxpayers). Curbside recycling programs are mainly funded by municipalities rather than the producers of the items that are found in recycling. The DEQ report could be strengthened by including data from other states that have policies that have the "polluter pay" through extended producer responsibility requirements. There are proven policies that reduce the economic burden on localities and strengthen recycling programs. For example, in 2021, Maine signed LD 1541 into law. This legislation is intended to reduce the volume and toxicity as well as increase the recycling of packaging material. Producers of packaging pay into a fund based on the volume and recyclability of their products. The funds generated are used to reimburse localities for recycling and solid waste management activities. This approach is also supported by Virginia voters. In a 2022 Clean Virginia Waterways survey of registered Virginia voters, 71% of registered voters expressed support for policies that shift the costs of	As described in this report, solid waste planning units consisting of individual, or groups of localities are tasked with solid waste management including recycling. DEQ does not currently collect information related to the costs of implementing such local recycling programs and thus cannot easily address that information in the report. While this report presents information about other state reports and methodologies, it was only provided as background as part of DEQ's evaluation to determine the best methodology for the recycling economic and environmental impact assessment. An assessment of other policies to improve recycling, comparison of litter control and recycling fund revenue, and comparison of recycling rates in other states are out of scope of this report. Some of these elements are addressed in previous DEQ reports such as the Waste Diversion & Recycling Task Force report from November 2022 and the 2021-2023 reports of the Plastic Waste Prevention Advisory Council. Implementation of extended producer responsibility programs, beverage container deposition systems, increasing litter taxes, and removing tax credit applicability to advanced recycling facilities as defined at § 58.1-439.7 would require statutory change. The report (page 11) has been updated to include summary information about applicants seeking tax credits and the materials recycled.

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	recycling programs off of community taxpayers and onto producers. The complete survey results are available on the CVW publications page. **Litter Prevention & Recycling Grants (page 10):** The DEQ report could be strengthened by comparing the income of the VA Litter Tax ($2.9 million in FY2023) to other states and communities. Virginia's Litter Control and Recycling Fund generates the lowest revenue per capita of any state using a similar system. Much of this information can be found in the CVW publication: "Opportunities to Reduce Plastic Pollution: Policy Recommendations & Best Practices for the Virginia Litter Fund" available on the CVW publications webpage. **Plastic Recycling is shockingly low in Virginia:** The charts on pages 9 and 10 (CY2021 Principle Recyclable Materials Recycled in Tons) shows that plastics are in 13th place in terms of recycled tons—well behind metal, paper, tires, glass and eight other types of materials. Research by CVW and the Virginia Aquarium & Marine Science Center found that 83% of all debris on Virginia's shoreline is made of plastic—and most of that is single-use items such as plastic beverage containers, caps, bags, food wrappers, etc. Data collected by volunteers during the statewide "International Coastal Cleanup in Virginia" show that about 85% of littered items are made of plastic. The DEQ report could be strengthened by doing a comparison of plastic recycling rates in states that have deposits on beverage containers (bottle bills) vs. states like Virginia which do not have recycling refunds for such containers. The consistently low rates of plastic recycled in Virginia is evidence that the Commonwealth would benefit from exploring source reduction (creating less waste), increased mechanical recycling, expanded responsibility from the producers of single-use packaging, and economic incentives to consumers (deposits on beverage containers, for example). **Recycling Credits:** Recycling Tax Credits are mentioned on page 11: "For 2022, 38 applications were received from manufacturing and recycling facilities to	

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	obtain DEQ certification for the state tax credit." The DEQ report could be strengthened by expanding this section. What companies applied, and are they engaged in mechanical recycling. State tax credits for recycling should not be available for “plastic to fuel, plastic to fuel additive, or plastic to fuel substitutes” manufacturing. According to the EPA pyrolysis and other plastics-to-fuel technologies are not to be considered recycling, this will make Virginia consistent with the EPA that states: “Activities that convert non-hazardous solid waste to fuels or fuel substitutes (“plastics-to-fuel”) or for energy production are not considered to be “recycling” activities. (Language is modified from the EPA Draft National Strategy to Prevent Plastic Pollution) **Expanding Recycling Access** States across the United States have historically struggled with providing recycling services to underserved and rural communities. Michigan is investing to improve recycling in underserved areas with their Rural and Small Community Recycling and Waste Reduction Program. The program explores viable options for small, rural, and underserved communities to address waste reduction while simultaneously strengthening local markets for recycling collection. Ultimately, the program seeks to empower localities to implement policies that achieve both of these goals. Given the diversity of communities in Virginia–from highly-populated urban centers to suburbs, coastal towns, and rural farm regions–as well as concern over the increased cost of recycling, it would behoove Virginia to conduct similar investigations into how an aging and inadequate mechanical recycling infrastructure can be updated equitably and economically, instead of shuttered in favor of new, even more costly, false solutions to manage waste. We encourage continued conversation about how Virginia can improve our recycling infrastructure to benefit human, environmental, and economic health.	

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Virginia Conservation Network	Thank you for this opportunity to comment on the critically important draft report. Virginia Conservation Network and our more than 165 conservation organizations from across the commonwealth concur with and are reflected through the comments in the Feb. 1, 2024 comments submitted by Clean Virginia Waterways. We ask for the agency's consideration and incorporation of the specific issues and concerns stated therein prior to finalization of its report.	See response to above comment.
Jennifer Cole, Clean Fairfax	As someone who has worked the last 15 years in Fairfax County on recycling and plastic pollution issues, embedded as a non profit entity within Fairfax County's Department of Public Works and Environmental Services, and who sat on the Governor's Plastic Waste Pollution Advisory Council as the only environmentalist, I absolutely agree with the premise that Virginia needs to increase its recycling rate, and the value of that recycling. The question is: how do we do that in a way that is both environmentally and economically friendly? Virginia's recycling systems (and frankly, its streams and sides of the roads) are overwhelmed by plastic, the majority of which is single use and its ability to truly be recycled into something useful is slim. All of this low quality plastic (like film and flimsy single use water bottles) reduces system efficacy and lowers the value of Virginia's recycled material–the good stuff like metal and cardboard, and paper and glass. I would like to suggest that one of the first items that is missing from the DEQ's report is the EPA's assessment of Advanced Recycling/Chemical Conversion/Plastic to Fuels. Specifically, the clarification that "activities that convert non-hazardous solid waste to fuels or fuel substitutes ('plastics-to-fuel') or for energy production are not considered to be 'recycling' activities" (from the recent EPA Draft National Strategy to Prevent Plastic Pollution). Consistent with this guidance from the foremost national entity on the environment, "advanced recycling" technology is not recycling, and thus should not be part of any economic discussion about recycling in Virginia.	This report is focused primarily on recycling as defined in the Solid Waste Planning Regulations (9VAC20-130-130) which does not include solid waste to fuels or fuel substitutes in the recycling rate calculation. The only mention of advanced recycling is in reference to tax credits available to manufacturing facilities as defined at § 58.1-439.7. This report is based on the best available and consistent dataset and did mention China's implementation of National Sword as one of the many challenges affecting local recycling programs. Information related to the impact of global recycling imports has been discussed in previous DEQ reports, such as "Recycling in Virginia: An Evaluation of Recycling Rates and Recommendations (2019)." While this report presents information about other state reports and methodologies, it was only provided as background as part of DEQ's evaluation to determine the best methodology for the recycling economic and environmental impact assessment. Assessment of multi stream versus single stream recycling programs and comparison of Virginia to programs in other states like Michigan are out of scope of this report.

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	Secondly it is indeed a shame that the report relied on the Census numbers from 2012 to report out the amount of jobs in recycling and the amount of income recycling brings to Virginia, because between then and now there was this epic recycling disaster that we all know as Operational National Sword (ONS) in 2017. ONS caused the bottom to fall out of recycling as we know it here in the US, which is why the convenient "solution" since has been to simply melt it into fuel stock. But this process of turning waste into fuel derivatives and feedstock is not recycling, for it is not re-generating or re-producing any material to its original form. For those who are still unclear about the difference between a linear and a circular economy, I give you this: a circular process takes a glass bottle or a cardboard box and recycles it back into a glass bottle or a cardboard box. Third, it is unfortunate that the report did not go into the value of getting back to our roots–multi stream recycling. I do know how hard it is to get decent data from localities around the Commonwealth (maybe that should be a goal!), because there are several different ways recycling is collected–by the municipality, by private hauler, and by dedicated drop off locations that are serviced by private haulers or localities. But the "Purple Can Club" in Northern Virginia which collects glass dropped off by residents after the localities and haulers stopped picking it up has proven to be a very successful project–because that glass is clean and there is a market for it. Imagine if we had a dedicated collection for cardboard, metal cans, specific PET bottles, etc. that were already sorted for the recycling companies and MRFs? CAN YOU EVEN IMAGINE?! Excuse me while I breathe into a paper bag. In many of the discussions hashed out while I was a member of the Plastic Waste Pollution Advisory Council, it seemed we were discussing two very different topics–reducing the amount of plastic pollution, and propping up the recycling industry. And the question always was–are these two issues mutually exclusive? As an environmental advocate I believe that we can work on less plastic on the front end while supporting high quality mechanical recycling on the back end, and support the areas where there is a market for	

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	actual recycling (such as cans, paper, cardboard and glass.) And, if industry was truly concerned about plastic pollution, they'd be lining up to support plastic bottle deposit bills all around the country. Which brings me to another interesting omission in this DEQ report: of the states used in this study, only one, Michigan, has a bottle bill (which works hard to collect CLEAN plastic) but the report fails to actually mention that. Bolstering markets for glass, metal, cardboard and even plastic recycling markets (while we can quibble on whether recycling plastic bottles into industrial carpet is truly recycling and a circular economy, what we will not capitulate to is whether pyrolysis is recycling) is critical to improving Virginia's recycling rates. It is our hope that the Commonwealth supports true recycling initiatives and is not controlled by the interests of the plastics and petrochemical industries who cry crocodile tears about the sorry state of recycling while fighting every single attempt to reduce plastic pollution and limit extended producer responsibility. "Advanced Recycling," "Plastics to Fuel," "Pyrolysis," "Chemical Conversion," or any number of industry rebranded terms designed to make the process more palatable to legislators and localities, reflect a soft and disingenuous way of saying "using chemicals and heat to melt plastic which then gets burned as fuel." These terms and technologies should not be promoted by Virginia, ever. Thank you for taking Clean Fairfax's points into consideration as you move forward with rewriting this draft report to support not just the Recycling and fossil fuel/plastics industries, but the residents of Virginia as well. Surveys have shown that we are at a time when Virginians are willing to pay for better environmental solutions, so it behooves us to lead with solutions, not to follow industry lobbyists down the plastic-strewn path to, well, an Advanced Recycling Facility.	
Elly Wilson, Environment Virginia	**Definition of recycling** Recycling is intended to be a cyclical process. As stated by the Environmental Protection Agency (EPA), "A circular economy keeps materials, products, and services in circulation for as long as possible." A true circular economy is	This report is focused primarily on recycling as defined in the Solid Waste Planning Regulations (9VAC20-130-130). Changes to the recycling rate calculation and use of credits would require statutory change to § 10.1-1411.

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	dependent on a robust mechanical recycling industry to create a system with minimal waste. Taking this approach to bolster markets for glass, metal, and cardboard recycling markets is critical to improving Virginia's recycling rates. Melting plastics to be used as additives for fossil fuels (advanced recycling) is a linear system, and these processes are not considered recycling by the EPA. In fact, the EPA specifically outlines that "Activities that convert non-hazardous solid waste to fuels or fuel substitutes ("plastics-to-fuel") or for energy production are not considered to be 'recycling' activities." This includes pyrolysis, gasification, chemical conversion, and all other plastic-to-fuel technologies. (Language is modified from the EPA Draft National Strategy to Prevent Plastic Pollution). **Changes to population and the waste stream** How has this changed in the past 30 yrs. As our population has grown, are we recycling more per person? Are we generally using more per person? How has the change in materials impacted recycling, contamination rates, waste management costs and total waste? **Source reduction should not be included in recycling rates** This should not be included in recycling rates. It should be included in the report but credits should not factored into recycling rates. Source reduction is critical but SWPUs should have separate minimums in reduction. These economic and environmental impacts would be helpful to have presented. **Industrial vs consumer** Most litter comes from post consumer waste yet there is no clear information on how much post consumer waste is recycled v landfilled. Metal and yard waste are clearly heavier and more likely to be industrial than household waste so it skews how well consumers recycle. **Contamination** The report does not explain how contamination or lack of end markets are calculated into the recycling rate. Intent to recycle is not the same as actual	Your comments related to contamination are noted; however, DEQ does not have any data related to rates of contamination in materials reported by solid waste planning units. DEQ publishes a recycling rate report annually as described in the Recycling in Virginia section, pages 7-10. The annual report, available on DEQ's website, includes the total tons of each principle recyclable material as reported.

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	recycling. Ultimately, people recycle things that should not be recycled and sometimes there is no market for a material that has been collected. Less valuable recyclables sometimes are landfilled due to virgin material costing less. This report should clarify if the contaminated waste was: • counted in both categories (recycling and landfill), • reported as recycled but not landfilled • or contamination weights were reported and the total weights for recycling and sw were adjusted accordingly If the contamination rate is not calculated and it is assumed everything that is collected is indeed recycled then many of the calculations would be incorrect. 1. Contamination or lack of an end market increases emissions and energy use. Items go through transport, sorting, cleaning etc. to ultimately end up in a landfill 2. Better understanding inefficiences in the system is critical to determining Virginia's state of recycling. 3. How much money is wasted through contamination or lack of end market? Is this calculated into the economic and environmental benefits? Clarification on this point would highlight the impact of contamination which is an expressed issue raised by Virginia recyclers that manage comingled materials. **Material Recycling Rates** A shortcoming of this report is that it does not indicate a recycling rate by material. It calculated a breakdown of all recyclables and their share of the total recycling weight. This is quite different from the material recycling rate. This provides an incomplete picture of where Virginia's recycling really stands, in particular when it comes to costly household recycling programs. This is critical information because it informs how well we are actually doing with	

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	each material and the potential for growth, material source reduction, or increased financial support from producers of materials to more efficiently process Virginia's waste. 1. What materials are processed? What is the rate of recyclability (what materials can be recycled if collected properly vs what materials must be landfilled) of the materials? 2. What percent of a material recovered is ultimately landfilled? 3. What has no end market? Where are we losing on investment of infrastructure? 4. Where could we be investing in order to better recycle high value materials?	