OCTOBER 2021

NET-ZERO EMISSIONS FEASIBILITY STUDY FOR SPOKANE REGION

PREPARED BY

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Cover photo location: Spokane Riverfront Park
Photo credit: All photos taken by Brian Burrow

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What will Spokane achieve by 2050?

ABOUT REALLY CLEAN ENERGY

WHO WE ARE & WHAT WE DO

Really Clean Energy is an environmental consulting firm based in Spokane, Washington specializing in greenhouse gas reduction, renewable energy, and alternative fuels.

We are passionate about improving management of renewable resources and helping communities create a more circular green economy and transition to zero net emissions.

We consult with local government, utilities, and private companies with large waste streams to reduce carbon footprint, reduce energy consumption, and provide renewable energy solutions.

We foster the development of new technologies and innovative solutions to better support the communities and customers we serve.

MISSION

Our mission at Really Clean Energy is to be a world leader in carbon reduction and waste elimination while providing communities with affordable clean energy solutions.

VISION

Our vision is to build net zero communities around the globe.

HOW DO WE ACHIEVE **ZERO WASTE?**

HOW DO WE REDUCE **GHGs?**

WHAT IS THE **FUTURE** OF OUR CITY?

HOW DO WE RAPIDLY **DECARBONIZE?**

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HOW DO WE **REDUCE ENERGY CONSUMPTION?**

HOW DO WE FIND **BUSINESS-FRIENDLY SOLUTIONS?**

HOW SHOULD WE **MEASURE PROGRESS?**

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HOW CAN WE BEST USE THE **RESOURCES** WE HAVE?

HOW CAN WE REMAIN **ECONOMICALLY** COMPETITIVE?

HOW DO WE ACHIEVE **NET-ZERO EMISSIONS?**

EXECUTIVE SUMMARY

The Spokane region has a rich history of driving clean energy ideas and advancing the conversation around environmental stewardship. Indeed, as Spokane approaches its 50th anniversary of the International Exposition on the Environment, better known as Expo '74, our community boldly pivots to accept another historic invitation to lead the way in innovation in order to accomplish mandates put in place to reduce greenhouse gases.

The Washington State Clean Energy Transformation Act (CETA) calls for the decarbonization of homes, commercial buildings, and transportation systems with the intent of transitioning off fossil fuels in order to achieve zero net emissions and 100% renewable energy.

While City leaders have committed to tiered improvements with established milestones, the most feasible way to achieve zero net emissions, without major unintended consequences, is a strongly debated topic. Sharp energy price increases and grid instabilities that disproportionately affect business owners and lower income households are under-developed topics at both the City and State level and require further planning.

Rethink Clean Energy contracted Really Clean Energy (RCE) to provide an independent, third-party report to the citizens of Spokane. Rethink's aim is to help ensure the successful transition of net-zero efforts as City and County leaders plan for the future.

RCE was tasked with identifying pathways for the City to meet net zero emissions targets, report on those options that are most viable, and provide feedback around feasibility and risks.

According to our (RCE) evaluation, the City has several viable opportunities to consider before finalizing any comprehensive plan.

This study presents a clear pathway focused on sound, best-practice solutions for consideration which, if implemented, would achieve zero net emissions targets on time with minimal energy cost increases and without prematurely eliminating low-cost, reliable energy sources.

Based on regional climate data and reported power outages, it is clear that natural gas, in some form, remains to be a necessary energy source until a viable replacement is made available for heating and adequate infrastructure is in place. Spokane would be wise to not reduce resiliency of homes, businesses, and critical infrastructure during any one of the region's common winter power outages without a viable energy replacement alternative in place. For this reason, the net-zero solutions designed and presented herein are ones which achieve zero net emissions without eliminating natural gas used in residential and commercial heating.

The residents of Spokane can best predict their future success by implementing independent science-driven checks and balances, such as this study, to evaluate the likely outcome of ambitious clean energy policies and projects before they are officially adopted.

Top concerns uncovered during this study, which deserve further evaluation and planning, include the City underestimating the potential economic impact of their decisions, overestimating the reliability of the power grid in an all-electric future, and the need to fully vet the impact of banning natural gas before policy is established.

“What you do makes a difference, and you have to decide what kind of difference you want to make.”

Jane Goodall

FEASIBILITY STUDY OVERVIEW

The question at hand is, "how does the Spokane region most feasibly move towards a state of zero net emissions?"

This study draws from publicly-available data on local energy consumption, energy production, carbon footprint, and mandated targets to analyze the size and extent of the decarbonization effort ahead. The study then evaluates potential pathways for the City to meet it's sustainability goals and milestone targets given the existing infrastructure, local climate, local sector needs, and locally available renewable resources and assesses whether current goals are achievable based on the initiatives and plans in place.

This study finds that in order for Spokane to accomplish the aggressive and admirable goals around greenhouse gas (GHG) reductions and renewable energy usage included in the draft Sustainability Action Plan (SAP), two key net zero approaches (reduction & production) should be implemented in strategic phases with distinct guiding principles.

The guiding principles that lie within will require additional elaboration but are meant to support the draft SAP, which outlines a much broader plan for multiple areas of sustainability. Creation of a tactical road map for conversion to renewable energy and achieving the City's goals will be an immediate and important next step.

STUDY GOALS AND OBJECTIVES

The objectives of this study are as follows:

- Broadly evaluate the feasibility of the City of Spokane's sustainability goals.
- Consider all forms of renewable energy and available technologies suitable for the Spokane region and identify a pathway forward with an all of the above approach.
- Offer recommendations for alternative, or augmented, solutions that would help Spokane meet its clean energy goals.

TOP CONCERNS

1. The regional impact of a natural gas ban (either by the State Building Code Council or City Council) that has **not** been fully vetted.
2. Economic impacts being underestimated
3. Grid reliability being overestimated

Study Assumptions & Terminology

This feasibility study made a number of assumptions as the content was created. These assumptions are listed in “Appendix – Assumptions." All of the data acquired for this feasibility study is referenced in “Appendix – References."

Study Terminology

CETA
CETA is the acronym for Washington State’s Clean Energy Transformation Act.

Gasification
Gasification is any technology that uses thermal energy to convert solid waste (such as MSW) into a usable gas for fuel. The term pyrolysis, used interchangeably in this study, is a variation of the process resulting in gas + oil + char rather than gas + ash.

GHG
GHG stands for greenhouse gases. Greenhouse gases are believed to be a factor in climate change. They are the gases (predominantly water vapor) that form a barrier in the upper atmosphere that “trap” heat and cause warming of the air in the upper atmosphere. Greenhouse gases are typically reported as MTCO2e, which are Metric Tons of CO2 equivalents.

Incineration
Incineration is the burning of solid material. Low burn temperatures cause harmful emissions.

MSW
Municipal Solid Waste, otherwise known as common household garbage, consists primarily of food scraps, plastics, textiles, wood, glass, metals, and other household type waste.

MTCO2e
MTCO2e is the standard for converting any gas into metric tons of carbon dioxide equivalents. For example, one metric ton of methane (CH4) is equal to 25 metric tons of CO2 as reported by the Intergovernmental Panel on Climate Control (IPCC).

NZE
NZE stands for Net-Zero Emissions, or zero net emissions, and refers to a state carbon neutrality or net-zero carbon dioxide emissions. This is achieved by balancing the emissions of human-produced carbon dioxide with its removal or by eliminating carbon emissions from daily life.

NWPP
Northwest Power Pool (NWPP) is an organization of power producers in the Northwest.

PV Solar
Photovoltaic Solar, or PV Solar, uses photovoltaic panels to capture the energy from the sun and convert it into DC currents; inverters then convert the DC power into AC.

Zero Energy
Zero energy refers a design concept where the total amount of energy used in a structure, campus, or community is equal to the amount of energy created within the given footprint.

Zero Waste
Zero waste encourages the redesign of consumption and waste so that all product and waste produced in a community are used with zero leftover.

REGIONAL DATA

THIS SECTION INCLUDES LOCAL DATA USED TO ANALYZE THE REGION'S ELECTRICITY MIX, ENERGY NEEDS, RESOURCES, AND RELEVANT MANDATES

Photo location: Spokane Finch Arboretum

Housing

Population

The current population of the City of Spokane is 220,050 residents residing in 97,825 housing units. Population density is 3,229 people per square mile. The number of people per household in Spokane is 2.3 versus the US average of 2.6 people per household.

Growth Trend

The city of Spokane is currently growing at a rate of 1.22% annually and experienced a population increase of 8.93% since the 2010 census. The future 6-year population growth rate for Spokane County is estimated to be 4.1% in population and 4.3% in housing units.

Aging House-Stock

50.7% of households were built prior to 1960 with the median age of homes in Spokane being 59 years old. Typically many of those homes are in need of significant insulation updates to ensure energy efficiencies.

Children & Elderly

49.1% of households in Spokane have children living in them and 14.7% of households are in the 65+ demographic. Nearly 64% of the population would be considered vulnerable and are impacted the greatest during temperature extremes, power outages, and are hardest hit by utility rate increases.

Climate

Spokane will typically experience a 90-100 degree swing in temperature over the course of 12 months. According to weatherbase.com, “The highest recorded temperature in Spokane was 109.0°F (42.78°C), which was recorded in July, 2021. The lowest recorded temperature in Spokane is -25.0°F (-31.7°C), which was recorded in December, 1968.” This broad range results in a need for heat through the cooler months and conditioned air through the warmer months which results in its own challenges and emphasizes the need for reliable, local renewable energy production and increased grid resiliency.

Utilities

Waste Carrier

The City of Spokane is serviced by Waste Management. Single stream “all in one” recycling is executed by Waste Management at their SMaRT Center and can process about 30 tons per hour.

Sewage Generation

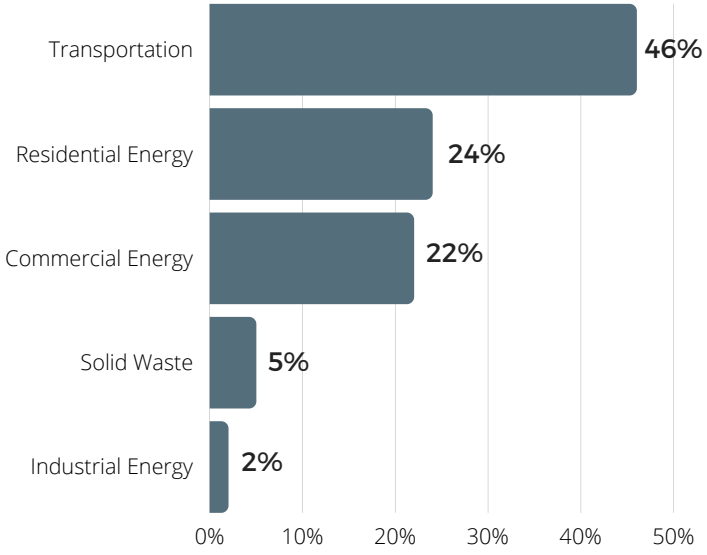
Spokane’s sewage disposal plant, the Riverside Park Water Reclamation Facility, treats about 34 million gallons/day and removes 6,500 tons of solids annually from the effluent. It can handle up to 150 million gallons/day.

Utility Provider

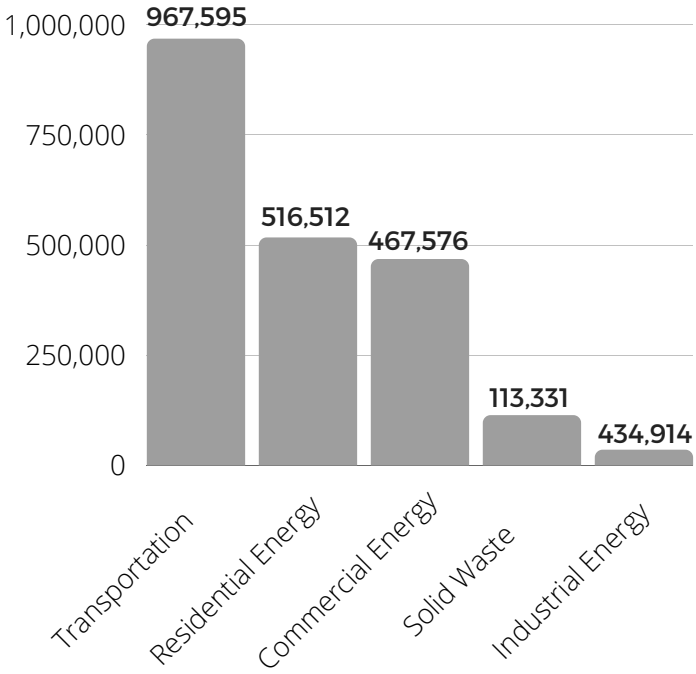
Within city limits, electricity and natural gas are both provided by Avista Utilities.

Greenhouse Gas Emission by Sector

The City of Spokane has identified the following sectors to focus on for the goal of reducing GHG emissions. **Transportation** is the highest greenhouse gas emitter accounting for **46% of all GHG emissions** in Spokane.



Above table shows % of GHG emissions by sector



Above table shows MTCO2 emissions by sector per SAP data

Sector	*Annual MTCO2	% of Total
Transportation	967,595	46%
Residential Energy	516,512	24%
Commercial Energy	467,576	22%
Solid Waste	113,331	5%
Industrial Energy	34,914	2%

Transportation Type	% of Transportation
Passenger Vehicles	44%
Light Duty Trucks	18%
Regional Airports	16%
Railroad	11%
Heavy Duty Vehicles	10%
Public Transportation	1%

Current Energy Mandates

Following are the existing relevant mandates, and/or goals, relating to carbon reduction and renewable energy that were used to guide recommendations and timelines for this study.

I. Regional

- **100% Renewable Energy by 2030**
  City of Spokane 2018 Ordinance C35668

- **Net Neutral by 2050**
  2021 GHG Reduction Targets / City of Spokane (draft) Sustainability Action Plan Goal

- **Calculate & Publish GHG Emissions**
  2017 Climate Change/Environmental Stewardship Ordinance C35519

- **Utility & WTE Plans to Be In Alignment With**
  - Avista Utilities Integrated Resource Plan (IRP)
  - Spokane County Solid Waste and Moderate Risk Waste Management Plan

II. State

- **2025 No Coal Standard, 2030 GHG Neutral Standard, 2045 100% Renewable Energy**
  Clean Energy Transformation Act (CETA) | E2SSB 5116, 2019

- **45% Reduction in GHG Emissions by 2030**
- **70% Reduction in GHG Emissions by 2040**
- **95% Reduction in GHG Emissions by 2050**
  Clean Energy Electric Utilities, Washington State RCW 70A.45

- **70% Annual Net Energy Consumption**
  Washington State Energy Code RCW 19.27

III. Federal

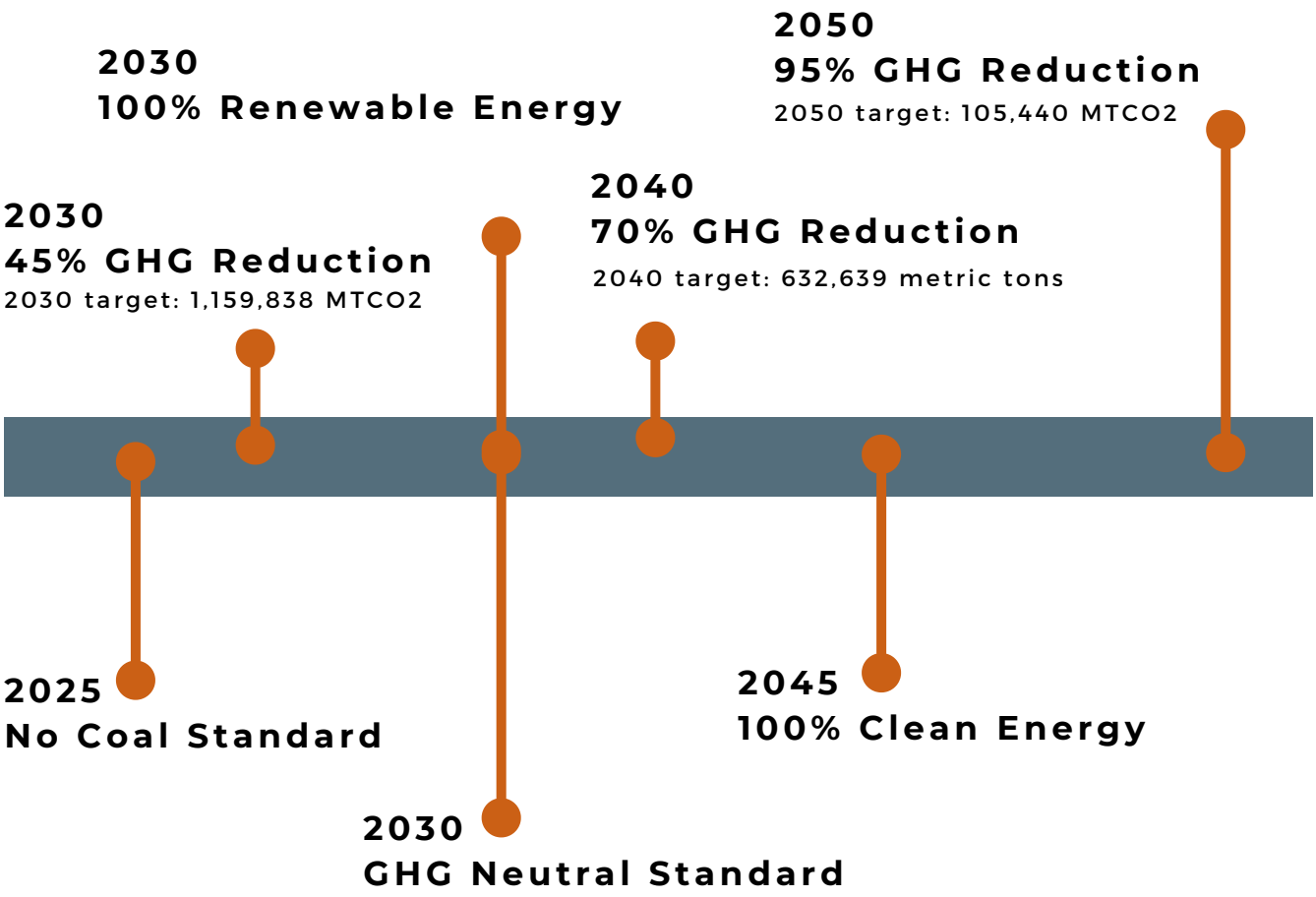
- **Net Zero Global Emissions by 2050**
  Federal House Resolution | H. Res. 109 (Proposed Green New Deal)

- **Intergovernmental Panel on Climate Change**

*Note to the reader - *often times plans will appear to have overlap. Local plans have to at least meet (be in line with) State & National plans but City plans can have additional requirements. In this case, the City's plan would surpass what the State requires because the City meets and then exceeds the State's requirement by 15 years.*

Current Mandate Timeline

Spokane Targets



WA State Targets

Energy Classifications - Green vs Renewable

Not all energy that is green, or zero-carbon, is considered to be renewable. The table on the next page presents important energy classification information to consider when plotting the goals of carbon neutrality and 100% renewable electricity. Most importantly, although hydropower is GHG emissions-free and makes up more than 48% of Spokane's energy portfolio, hydropower may not always be classified as a renewable energy source. This is due to consequences around fish migration and regional climate and habitat changes attributable to dams and is therefore continually at-risk of being declassified as a viable renewable energy source. If hydropower were to ever be disallowed as a renewable resource for electricity production then the community would have a significantly greater challenge meeting zero carbon and 100% renewable energy targets and further evaluation would be necessary.

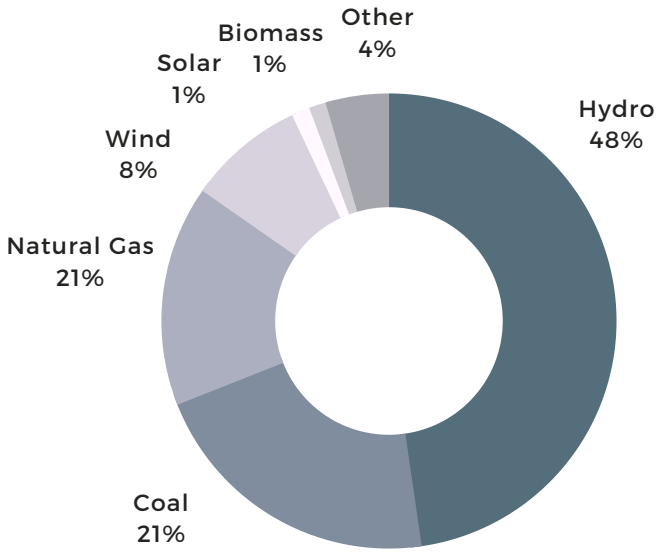
Energy Sources and GHG Production

Hydropower is a key component to Spokane's low carbon footprint. The continued use of hydropower establishes a firm base where roughly 59% of the power is generated from zero-emission sources.

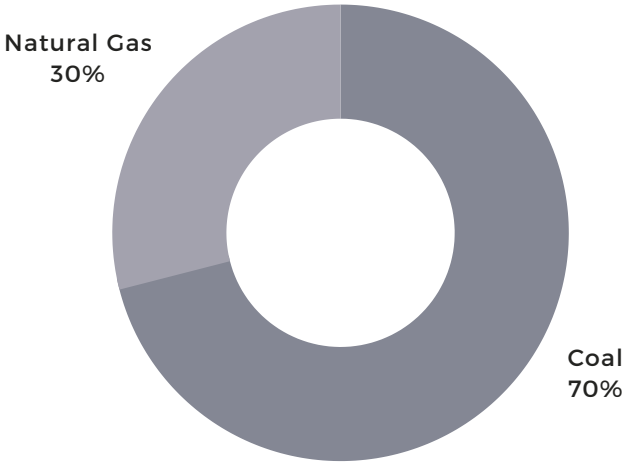
It is important to note that, according to the EPA, natural gas produces 898lbs CO2 per MWh for the energy it produces and coal produces 2,180lbs CO2 per MWh. In comparison, hydro, wind, solar, and other renewable energy options, **produce zero CO2 in the process of generating electricity**.

Of all the energy sources currently used to produce electricity for Spokane, coal, gas, and the incinerator plant are the only sources producing net positive GHG emissions.

These figures represent the electricity provided primarily to homes and businesses and the GHGs currently produced through providing that service to the Spokane community.



Electricity Sources Servicing Spokane (NWPP)



Percentage of GHG Production by Electricity Source

Photo location: Spokane Monroe Street Bridge

59%

of Spokane's electricity comes from zero-emission sources

Energy Usage and Sourcing

Power Consumption

The City of Spokane uses an average of 9,552 kWh per household annually based on the formula (930,053,623 kWh + 4,325,000 kWh) / 97,825 homes).

GHG Emissions (Carbon Footprint) of the Energy Supply

Electric homes and vehicles are only as clean as the electricity used to power them. The electricity servicing the Spokane grid produces approximately 0.63 lbs CO2/kWh.

The table below shows the diverse mix of energy sources that make up the electrical power supplied to Spokane. (U.S. average GHG emissions relative to each individual energy source are also shown below.)

	Spokane's Electricity Mix by Percentage	U.S. Avg MTCO2 per MW Produced by Fuel Source	Spokane's approx CO2 Emission by Production Source
Hydro	48 %	0	0 %
Coal	21 %	2,180	70 %
Natural Gas	16 %	898	30 %
Wind	8 %	0	0 %
Solar	1 %	0	0 %
Biomass	1 %	0	0 %
All Other	4 %	N/A	0 %

Energy Classifications - Green vs Renewable

Not all energy that is green, or zero-carbon, is considered to be renewable. The table on the next page presents important energy classification information to consider when plotting the goals of carbon neutrality and 100% renewable electricity. Most importantly, although hydropower is GHG emissions-free and makes up more than 48% of Spokane's energy portfolio, hydropower may not always be classified as a renewable energy source. This is due to consequences around fish migration and regional climate and habitat changes attributable to dams and is therefore continually at-risk of being declassified as a viable renewable energy source. If hydropower were to ever be disallowed as a renewable resource for electricity production then the community would have a significantly greater challenge meeting zero carbon and 100% renewable energy targets and further evaluation would be necessary.

	Green/Carbon Neutral	Renewable Energy	Used in Spokane	Viable Options for Spokane
Biomass	✓	✓	✓	✓
Biodiesel	✓	✓	✓	✓
Biojet	✓	✓	✓	✓
Ethanol	✓	✓	✓	✓
Landfill Gas	✓	✓	✓	✓
Municipal Sewage	✓	✓	✓	✓
Municipal Solid Waste	✓	✓	✓	✓
Wood and Wood Waste	✓	✓	✓	✓
Coal			✓	
Geothermal	✓	✓	✓	✓
Hydropower	✓		✓	✓*
Incineration (MSW)			✓	
Natural Gas	✓		✓	✓*
Nuclear	✓	✓		
Petro Fuels			✓	
Renewable Hydrogen Gas	✓	✓		✓
Renewable Natural Gas	✓	✓		✓
Solar	✓	✓	✓	✓
Tidal	✓	✓		
Wind	✓	✓	✓	✓

Note- RCE is **not recommending dismantling existing dams. Nor do we recommend prohibiting the installation of natural gas infrastructure without affordable, viable substitutes being in place.*

NET-ZERO CONCEPTS

THIS SECTION INCLUDES DETAILS AROUND NET-ZERO CONCEPTS WITH PROJECT EXAMPLES AND CALCULATION METHODS

- **NET-ZERO EMISSIONS**
- **ZERO ENERGY**
- **ZERO WASTE**

Photo location: off I-90 near Vantage, WA

HOW NET ZERO WORKS

Net-Zero Emissions

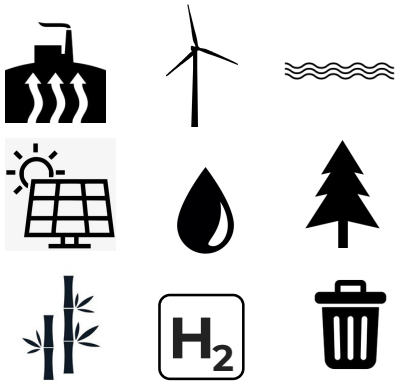
Zero net or net-zero emissions refers to a state of carbon neutrality or net-zero carbon dioxide emissions. Net-zero emissions is achieved by balancing the emissions of human-produced carbon dioxide with its removal or by eliminating carbon emissions from daily life entirely. There are multiple pathways to achieving a carbon-neutral equilibrium and the ideal solution will vary based on geography, locally available renewable resources, and method of calculation.

Carbon-Producing Activities

Fossil Fuel Extraction
Gas Appliances, Boilers, Turbines, Petro Combustion Engines, Waste Incineration

Carbon Elimination

100% replacement of carbon-emitting activities with zero-carbon alternatives such as clean electricity and hydrogen gas,



Carbon Equilibrium

Major reduction of carbon-emitting activities balanced with zero-carbon alternatives and carbon offset activities such as biofuel production, waste-to-energy, and reforestation.

Net-Zero Emissions

Net Zero Plan Creation

A comprehensive Net-Zero Plan should collaborate with local stakeholders to prioritize projects around energy reduction, efficiency gains, infrastructure improvements, renewable energy generation, and ongoing monitoring & reporting.

The plan should incorporate resource mapping, infrastructure audits, economic impact studies, workforce needs analysis, project site selection, and an initial round of engineering so as to provide a targeted road-map with calculated costs. outcomes, and measurable benchmarks.

Zero Energy

A zero net energy building or campus means that the total amount of energy used by the building or campus on an annual basis is equal to the amount of energy created on-site. This is often made possible through energy use reductions, building efficiencies, and the use of renewable energy sources such as solar, digesters, and hydrogen gas to produce on-site power.

Zero Waste

Zero waste is a set of principles that encourages the redesign of consumption, product reuse, and waste so that all products and waste produced in a community are used with zero leftover. Reducing single-use and packaging waste, composting, recycling, reusing, and clean waste-to-energy conversion all help to eliminate landfills, incinerators, and garbage in the oceans.

Waste-to-Energy

Organic material such as clean green, food scraps, cardboard and paper, sewage solids, animal waste, agricultural residue and wood waste are all *feedstocks* that can be used to make renewable energy products such as biodiesel, electricity, ethanol, hydrogen gas, and renewable natural gas using anaerobic digestion and other processes. Similarly, nonorganic carbonaceous waste streams such as commercial waste, MSW, plastics, and rubber tires can also be used to produce renewable electricity, diesel, ethanol, and jet fuel using pyrolysis or gasification.

Negative Carbon Footprint

When diesel, jet fuel, or renewable natural gas, for example, are produced from organic components in MSW and other carbonaceous waste streams, they can have a zero or even a **negative carbon footprint**. Organic matter that is sent to a landfill decomposes and emits methane (CH4), which the IPCC states is 25 times more harmful than CO2 as a greenhouse gas. As a result, every ton of released methane is determined to have a value of 25 MTCO2e. By diverting the organic MSW from the landfill and into diesel or jet fuel production, the resulting fuel has a negative carbon footprint, as long as the resulting fuel is not more than 25 times dirtier than the methane that would have been released in a landfill.

Similarly, GHG reductions from diesel produced using plastics are calculated by comparing the GHG emissions to standard diesel emissions which are then assessed against the carbon footprint created to make the plastics.

Using biomass and waste that is currently being landfilled or incinerated to produce renewable fuel contributes in the following ways:

- decreases use of fossil fuels
- eliminates waste
- generates revenue
- increases resiliency
- reduces GHGs by greater than 100%

Net-Zero Emissions

means the greenhouse gases we put into the atmosphere are equal to the greenhouse gases we take out of the atmosphere.

carbon increase [+]

combustion engines
(non hydrogen)

fossil fuel extraction & refinement

incineration
(coal, forest fires, MSW, natural gas, petro fuels, plastics, rubber tires, volcanic eruptions, etc.)

organic decomposition

---

carbon neutral [+/-]

biofuels

geothermal

hydrogen fuel

hydropower

nuclear

solar

tidal

wind

---

carbon reduction [-]

carbon capture & storage

gasification

photosynthesis

SPOKANE FINDINGS

THIS SECTION CONTAINS KEY PROJECT FINDINGS WHICH CONTRIBUTED TO THE NET-ZERO REGIONAL RECOMMENDATIONS

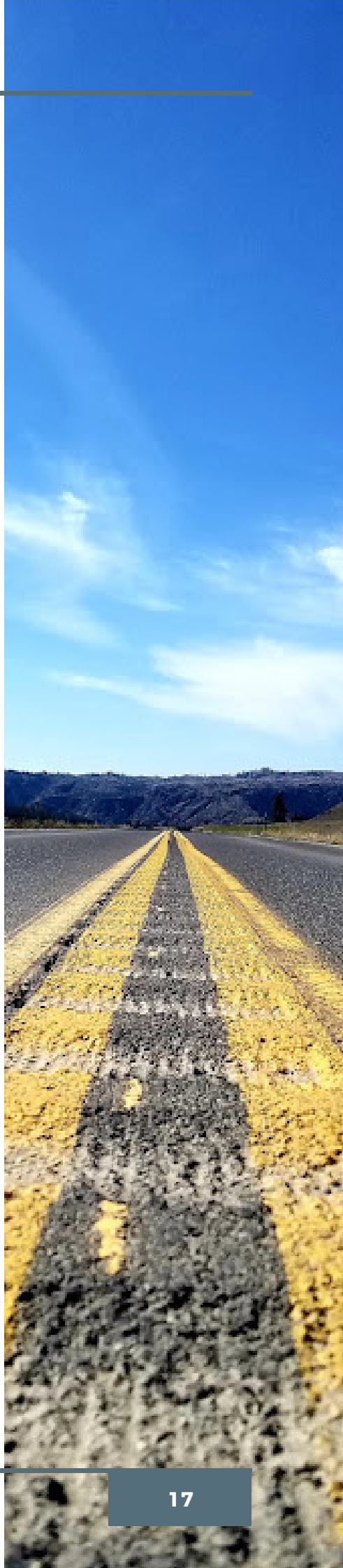


Photo location: Palouse Highway

Analysis of Spokane's Target Goals

Spokane's sustainability goals as outlined in the 2021 draft Sustainability Action Plan are:

1. 95% Reduction in GHG Emissions by 2050
2. Build Resiliency
3. Prioritize the Most Impacted

Generally speaking, many of the risks and consequences associated with swiftly decarbonizing any community relate primarily to price increases and the universal reliance on imperfect and inadequate energy supply and infrastructure. While this study was underway, an updated draft Sustainability Action Plan (SAP) was released which expanded the original draft SAP goals to include more green renewable fuels. The updated draft SAP also removed a previous action item that would have banned natural gas hookups. RCE applauds these revisions and believes they will provide greater local resiliency and price control.

GHG Reduction

A 95% reduction in GHGs is equivalent to approximately 2,016,634 MTCO2e which must be eliminated annually. Although hydropower is the predominant energy source providing more than 48% of electricity production needed to power homes and buildings at the current demand, electricity produced by fossil fuels (made up of natural gas and coal) comes in second at 37%.

Effective in 2025, the State's No Coal Standard will require utility companies to decouple coal-fired power plants from transmission lines delivering power within the state. For Spokane, this will result in a swift elimination of a significant amount of GHGs as coal currently accounts for about 21% of the power servicing the Spokane grid and is accountable for the majority of the GHGs that come from the utility company's power production servicing Spokane.

Fossil fuels consumed by the transportation sector contribute 46% of all GHGs in Spokane. The combined GHG emissions from electricity production and from transportation account for nearly all of Spokane's GHG emissions.

It is the opinion of this study that the City of Spokane would not achieve the goal of a 95% reduction in GHGs without addressing the energy production methods and transportation fuels utilized in the Spokane region.

In order to achieve a 95% reduction in GHGs, emissions from transportation must be addressed and cleaner sources of local electricity must be utilized in place of fossil fuels currently used to generate electricity for the Spokane grid. If the electrification of vehicles and buildings is considered a top strategy for Spokane to reduce their carbon footprint (as presented in the draft SAP), then the positive or negative marginal impact of such decisions must reflect the fact that **37% of the electricity provided today to charge electric vehicles and power electric homes and buildings is still derived from fossil fuels.** In order to see the positive impacts of actions taken to reduce GHGs, electricity must be produced by a clean method at the site.

Build Resiliency

A resilient community or resilient home is one that can withstand or recover quickly from an adverse event such as as a power outage.

Resiliency starts with adequate infrastructure and local energy production.

Record heat throughout the region in summer of 2021 caused rolling blackouts as the increased use of air conditioning stressed the grid beyond its capacity. The Spokane community routinely suffers from power outages due to high-speed winds and freezing precipitation dropping trees and branches onto above-ground power lines. Burying power lines below ground would lessen power outages significantly in the Spokane region.

Eliminating gas as an optional home/building energy source without reliable infrastructure could result in tens of thousands of Spokane residents being stranded without heat during winter months leading to property damage from frozen pipes. Health concerns related to cold temperatures and impact to hospitals, first-responders, airports, and other critical infrastructure should be of paramount importance and should receive exemptions for gas heat and power as needed congruent with regional climate.

Although it may not be favorable in terms of zero carbon emission goals, energy choice and redundancy (gas + electricity) does unarguably increase resiliency in colder weather climates such as Spokane by lessening the impact of the regular widespread winter power outages experienced in the region. On average, Spokane experiences roughly 128 days below freezing compared to Seattle which is typically around 30 days or less each year. In other words, **Spokane has 300% more freezing days than Seattle.**

CETA modeling suggests that "electricity demand in Washington could grow by 13-20% over 2020 levels by 2030. Electricity load growth then accelerates, and by 2050 is up to 92% above the 2020 level... The parallel requirements for carbon-neutral electricity by 2030 and 100% non-carbon emitting by 2045 — will require diverse, new non-carbon-emitting generation resources."

The only long term solution to avoid sharp price increases and build energy independence is to introduce new technologies to produce local renewable electricity and fuels for less than the market rate.

While evidence supports that the Spokane region would not be able to fulfill such a significant increase in electricity demand from within its own borders, or guarantee zero power failures due to increased stress on the distribution infrastructure in its current state, **the region is particularly rich in renewable and zero-carbon resources and has the potential to be entirely self-sustaining in a mostly-electric future and still remain economically competitive.**

However, by not investing into renewable energy infrastructure, Spokane will be subject to market rates for power purchased from outside the region to replace the 37% of the grid currently powered by fossil fuels plus the 92% increase in demand forecasted in the CETA.

As stated in Avista's 2021 Integrated Resource Plan (IRP), the utility provider plans to purchase renewable energy from the Idaho jurisdiction and retire only 40% of their eligible renewable energy credits (RECs) in order to artificially and temporarily buffer residents from a 2025 price increase when coal power is no longer acceptable. This practice is not a long term solution and will eventually result in price increases.

Photo location: West Broadway Ave

Households with children

25%

Households in 65+ demographic

14.7%

People living in poverty

1 in 5

Considered a vulnerable population

64%

Median household wage in 99707 zip code

$38,000

Homes build prior to 1960

51%

Median age of homes

59 years

Prioritize the Most Impacted

Because every viable strategy to reduce GHGs long term relies so heavily on investments into infrastructure or purchasing renewable energy from another jurisdiction, there is high risk of an energy price increase which would disproportionally affect lower and medium income households.

In order to see significant reductions in housing sector GHG emissions and energy usage, homes should be made to be more energy efficient. This could be a sizable undertaking and cost as 51% of the homes in Spokane were built prior to 1960, with a median age of almost 60 years. Also important to note is the majority of those homes are located in the lowest income neighborhoods.

Without some sort of gas heat, Spokane's aging homes with old windows and poor insulation, do not provide livable conditions for residents during a prolonged winter power outage.

ELECTRIC HOME CONVERSION CHECKLIST

Energy Efficiency Improvements

Insulation	$3,500
Roof	$20,000
Windows	$10,000

Electrification Retrofits

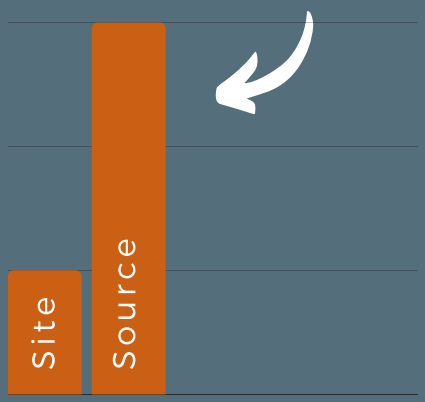
Electric dryer	$500
Electric heat pump	$2,150
Electric water heater	$1,200
Electric stove	$650
EV charging station	$1,000
Solar panels	$15,000

Total Cost **$54,000***

*142% of the median income in 99207

GHG RELOCATION VS GHG ELIMINATION

Price and GHGs per therm for electricity produced at source to provide building heat



Price and GHGs per therm for gas to provide building heat on site

Growing in popularity among more environmentally progressive communities is the desire to ban the use of natural gas within communities/cities to reduce GHG emissions in residential and commercial buildings. A ban of this type would affect primarily commercial boilers and kitchens, backup generators, and residential furnaces, fireplace inserts, stoves, and water heaters.

Without investment into new renewable energy production infrastructure, **the result of this type of mandate is merely a relocation of GHG emissions currently produced within the city limits from heating buildings and homes to outside the city limits** to produce electricity to heat the same structures losing efficiency and increasing global GHGs. Modern high-efficiency gas appliances can burn natural gas with less GHG emissions than a utility company can typically burn the same natural gas (or coal) to supply the needed electricity to replace the gas appliance.

If GHG reduction is the end goal, then targeting sectors and operations with the highest GHG emissions *first* would have a significantly greater and more immediate impact than banning future gas hookups.

Banning gas hookups and electrifying buildings and vehicles prior to replacing fossil fuel power production facilities and fossil fuel engines is likely to result in increased power costs, lessened local resiliency, and increased health risks from cold exposure with no noticeable impact to GHG levels. Additionally, it prevents cleaner burning gases from being used in the future.

The data points below indicate that the Spokane region is ahead of the US average for lowering CO2 emissions. The future of the Spokane region should continue to include additional sources of energy that are both considered to be renewable and also have a neutral or negative impact to GHG emissions.

37%

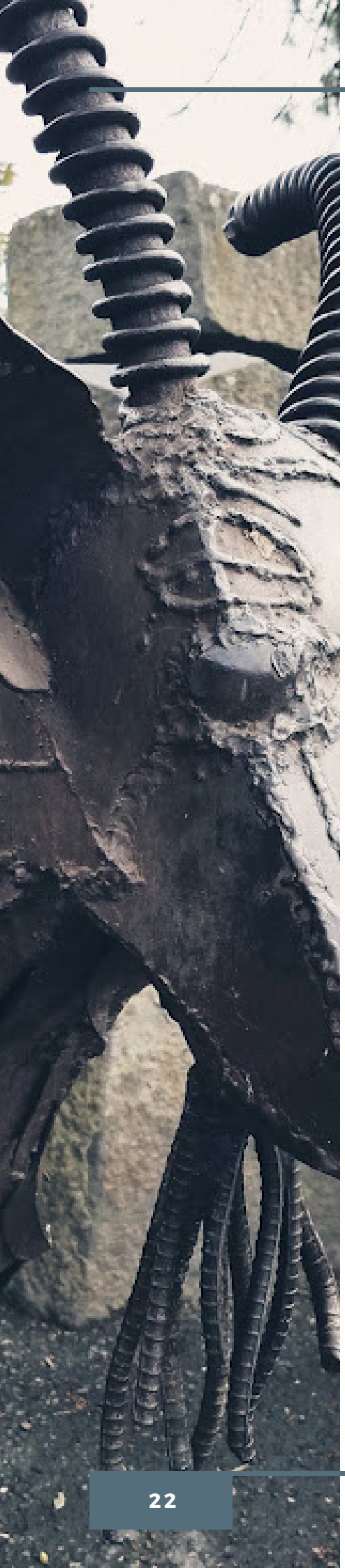
of Spokane's electricity mix is produced from nonrenewable fossil fuel sources

33%

lower CO2 emissions in Spokane compared to that of the national average

300%

cost increase for electricity from natural gas converted at the source versus gas delivered to the site



RECOMMENDATIONS

THIS SECTION INCLUDES A TWO-PHASE APPROACH FOR PRIORITIZING AND IMPLEMENTING STRATEGIES THAT WILL RESULT IN NET-ZERO EMISSIONS

Photo location: Spokane Riverfront Park

Recommendations for Net-Zero Planning

In order for Spokane to meet their aforementioned renewable energy goals, this feasibility study recommends two necessary phases (with ongoing monitoring) that will move the city toward their desired net-zero future with minimal risks and unintended consequences.

Phase I - Reduce & Plan

Adopting a "Reduce Before You Produce" philosophy in planning aimed at reducing current energy usage and improving efficiencies of the existing transportation and buildings sectors is critical in order to minimize the size and scale of new energy production facilities. The study analyzed residential and commercial buildings, automobiles, and light duty trucks to identify practical energy reduction steps which can be taken. A reduction of 25% energy usage would reduce the City of Spokane's GHG emissions by 843,151 MTCO2e annually. **If current energy consumers can be made more efficient then that reduced load no longer needs to be replaced with new power generation.**

The desired outcome of Phase I is a detailed Net-Zero Road Map to be executed in Phase II which includes sector-wide energy reductions to form a new energy demand baseline and enough power generation to satisfy the increased electricity demand of a mostly-electric city.

Phase II - Produce & Replace

The local production and replacement activities of Phase II are vital to the future success Spokane is wanting to achieve. Without local energy generation, replacing fossil fuels will likely become a significant financial pain-point for the city and its utility payers.

The table below illustrates key objectives for the proposed phases being recommended herein.

Target Sectors	Phase I - Reduce & Plan	Phase II - Produce & Replace
Transportation	Accelerate "Work, Play, Live" communities; streamline movement of people & goods	Local production of biofuel and hydrogen
Residential Energy	Create large-scale campaign to update aging house-stock	Underground power lines; clean grid power; onsite energy production
Commercial Energy	Incentivize building retrofits; incentivize NZE plans at building and campus levels	Energy saving updates; clean grid power; onsite energy production
Solid Waste	Identify opportunities for antiquated technologies, systems, and processes	Replace incinerator with pyrolysis/gasification

Ongoing - Net-Zero Monitoring & Reporting

Sophisticated energy and GHG monitoring providing targeted insight to utility companies and intelligent, interactive feedback and controls for home and building owners is made possible with advanced smart home and smart grid technologies. Installing fiber during construction or as power lines are buried and curbside EV charging stations are installed will better prepare the community for the smart, electric home of the future and allow real-time monitoring & reporting via dashboards and apps with interfaces designed for the type of user.

PHASE I
Reduction

Reduce Before You Produce

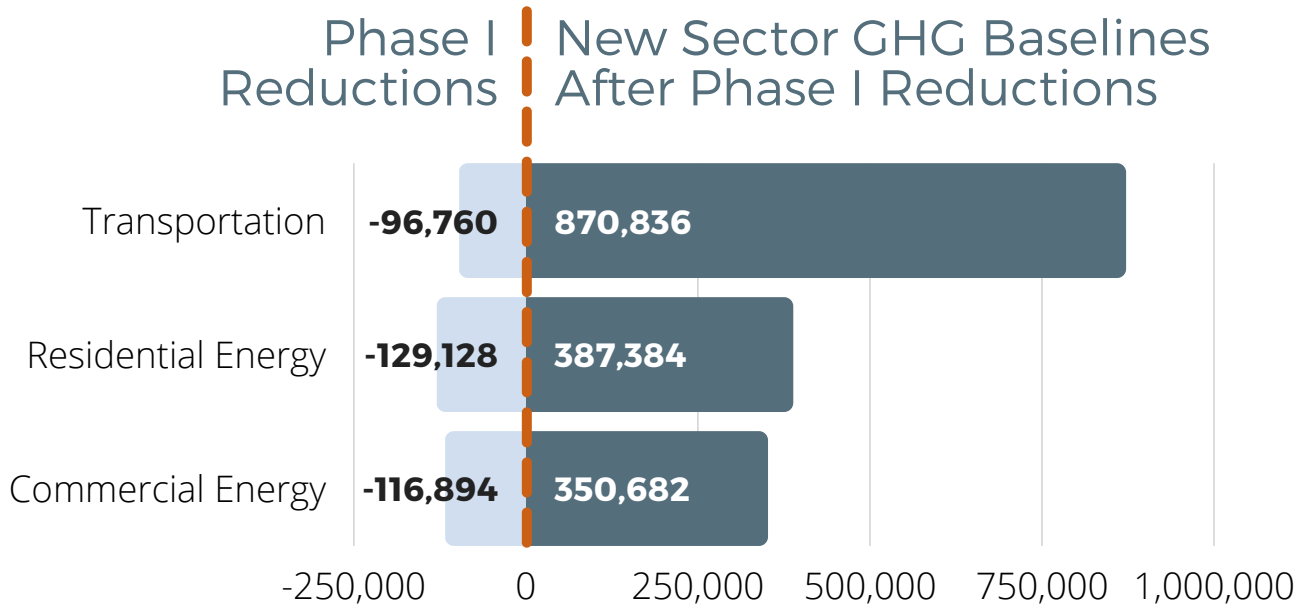
Phase I would focus on reducing the total energy needed by improving the efficiency of existing transportation systems and buildings which together make up 92% of Spokane's GHG emissions. Energy reductions up to 10% in transportation and 25% in commercial and residential sectors are possible without major capital expenditures and would reduce the City of Spokane's GHG emissions by over 340,000 MTCO2e annually.

Reducing energy consumed by residential and commercial buildings, automobiles, and light duty trucks before producing net new energy is critical in order to minimize the size and scale of any new energy production facilities. If existing homes, buildings, and transportation systems can be made more efficient then that reduced load no longer needs to be replaced with new power generation. Likewise, if future building and transportation projects can be completed with energy reduction in mind then it will reduce future energy needs, making the transition to renewable energy and net zero emissions even more feasible.

A quick analysis shows :
**based on current local usage*

- 4,247 kWh*/person/yr is consumed (934,378,623 kWh/y per 220,000 residents) prior to Phase I reductions
- 9.4 MTCO2e*/person is generated (2,065,015 MTCO2e/yr per 220,000 residents) prior to Phase I reductions

This study suggests optimizing existing residential and commercial buildings and transportation systems to form a new energy baseline needed by sector prior to initiating large capital expenditure projects. A variety of practical methods are provided on the next page.



Breakout of the current GHG emissions (MTCO2) for the City of Spokane with Phase I GHG reductions

Reduction Opportunities by Sector

The most efficient ways to reduce GHG emissions is to first improve the efficiencies of existing GHG generators, which reduces the need for clean technologies to offset the current utility demand, and then to simply use less carbon-based fuels.

In addition to investment into necessary infrastructure, there are numerous practical opportunities for improving efficiencies and offering carbon-based fuel alternatives through education, promotional campaigns to steer buying decisions, and through offering incentives and rebates.

GHG REDUCTIONS BY SECTOR

Transportation

- Commute reduction and ride share programs
- Non-motorized transit
- Work from home
- Hydrogen vehicles
- Hybrid vehicles
- Electric vehicles
- Home and work EV charging stations
- City-wide curbside EV charging stations
- Zero-carbon and biofuel production with strategically-placed fueling stations

Residential & Commercial Properties

- Smart home and building controls
- Less gas, more electricity
- On-site electricity production & storage
- LED lighting
- Window film
- Window location
- Improved natural lighting
- Heat reflecting paint
- Hybrid refrigerants
- Improved R-value insulation
- Sealed tight, ventilated right approach
- Optimization of buildings as grid resources
- Replace inefficient equipment & appliances
- Geothermal heating and cooling

Solid Waste

- Regenerative vs centrifugal motors/blowers
- Adjustable speed drives (ASD, VFDs)
- Methane capture and re-use over flaring
- Gasification over incineration or landfill

Industrial

- Replace inefficient equipment
- Plant efficiency evaluations

Infrastructure Opportunities

- LED public lighting
- Positive graded off ramps
- Negative graded on ramps
- Roundabouts versus traffic lights
- “Park and pick-up” versus drive-thru food service (even the most efficient cars get zero mpg when they aren’t moving)
- Neighborhood-level and building campus-level micro grids
- Underground power lines and fiber for smart homes and buildings
- Energy sharing between structures
- Modification of land use to streamline movement of people and goods

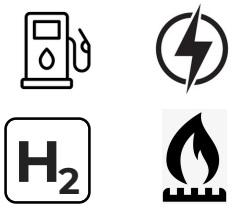
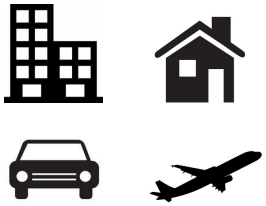
Local Renewable Resource Evaluation

A recommendation of this study is that the City of Spokane overlay and augment reduction efforts by shifting ***away*** from burning waste and ***towards*** using waste in the production of low-carbon and zero-carbon renewable electricity and transportation fuels to replace the use of fossil fuels using locally-available renewable resources.

Zero Waste Opportunities

There is a significant opportunity for Spokane to improve the existing incineration plant with advanced gasification and pyrolysis technologies. Given the key part that locally-produced waste plays in the pathway to zero net emissions, it is a strong recommendation to introduce advanced gasification, pyrolysis, and other clean waste-to-energy technologies to the Spokane community in a pilot setting before scaling up to commercial-scale production and decoupling the existing incinerator in Phase II.

Some of the identified pilot projects using readily available technology that may be a good fit include the following:

Waste Streams	Green Products	Sectors Impacted
		
Biomass MSW Plastics Sewage	Biofuel- diesel, jet Electricity Hydrogen Renewable Natural Gas	Commercial Residential Transportation

Electricity Sources	lbs CO2/MWh
U.S. Average	947
Avista (NWPP)	639
Spokane Incinerator	1,296
Coal	2,180
Natural Gas	898
Advanced Gasification	0
Hydro	0
Solar	0
Wind	0

Advanced waste conversion technologies target the most impactful sectors possible by reducing fossil fuels used for transportation and by providing clean, renewable electricity and/or low-carbon gas to homes and buildings.

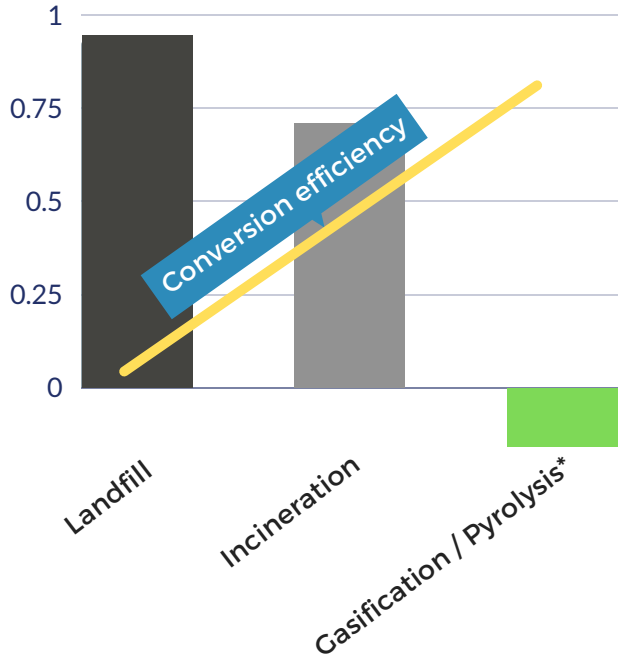
Photo location: Spokane Reservation near Wellpinit

There is a significant opportunity to replace the old waterfall burner system in the existing incinerator with modern advanced gasification and pyrolysis technologies. Today's advanced gasification systems not only process MSW more efficiently but also do so with less carbon output thus producing more and cleaner energy than is possible with the current incinerator facility.

Traditional incinerators typically convert MSW to electricity at about 30% efficiency whereas advanced gasification with a more modern turbine and heat recovery design can recover upwards of 60% to 80% of the energy contained in the MSW or plastics and have a negative effect on GHGs.

The diagram to the right, showing MTCO2 emissions per ton of MSW, illustrates the relative impact that the incinerator had on the GHG emissions, as well as expected improvements by introducing advanced gasification technologies.

MTCO2 Emissions per Ton of MSW



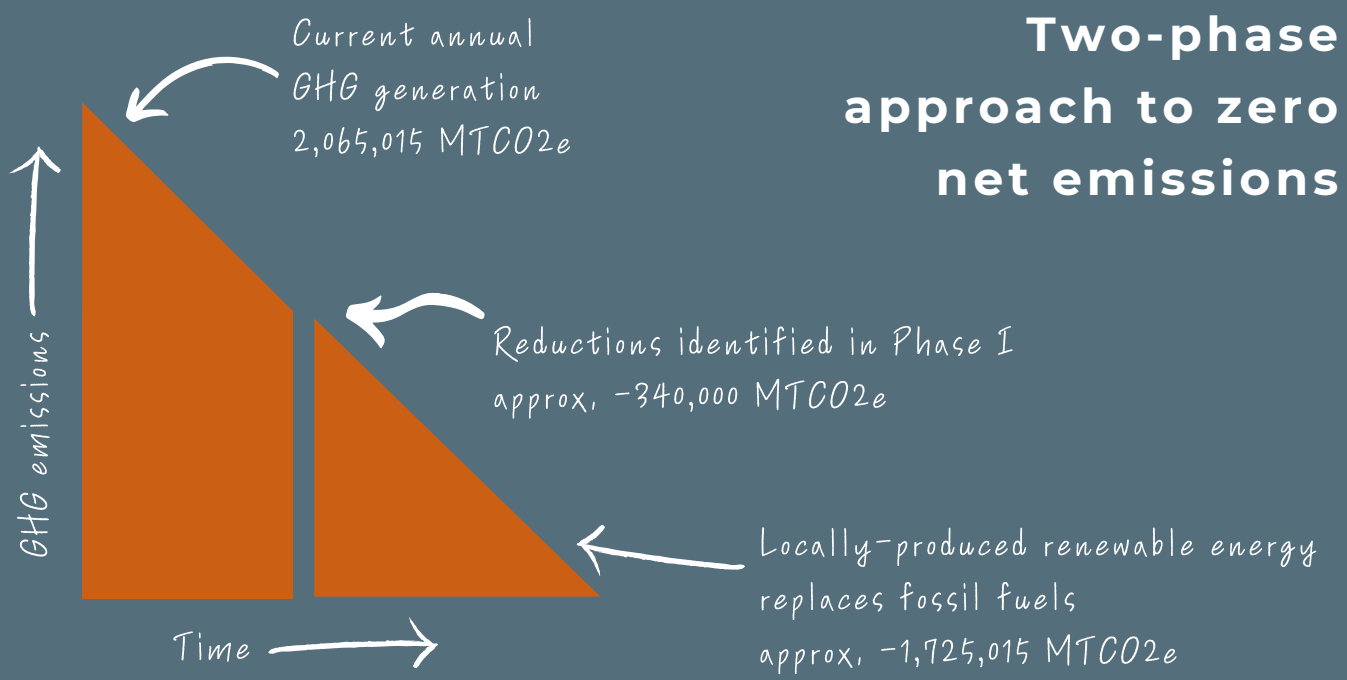
*exact calculation requires a waste evaluation

Negative Impact on GHGs

In addition to eliminating the 5% contribution to Spokane's GHG total, waste material which would be landfilled or burned is recycled and converted to renewable fuel it serves to lower GHG reporting figures by offsetting the emissions of disposal and counts toward renewable energy metrics by replacing fossil fuels with renewables.

Targeted Impact on GHGs

Together, the transportation, commercial energy, and residential energy sectors account for **93%** of Spokane's GHG emissions. Gasification or pyrolysis of waste can be used to produce fuel to lower GHGs from the transportation sector and to produce renewable hydrogen or electricity to reduce GHGs in the commercial and residential sectors.



Two-phase approach to zero net emissions

PHASE II SOLUTION

Production

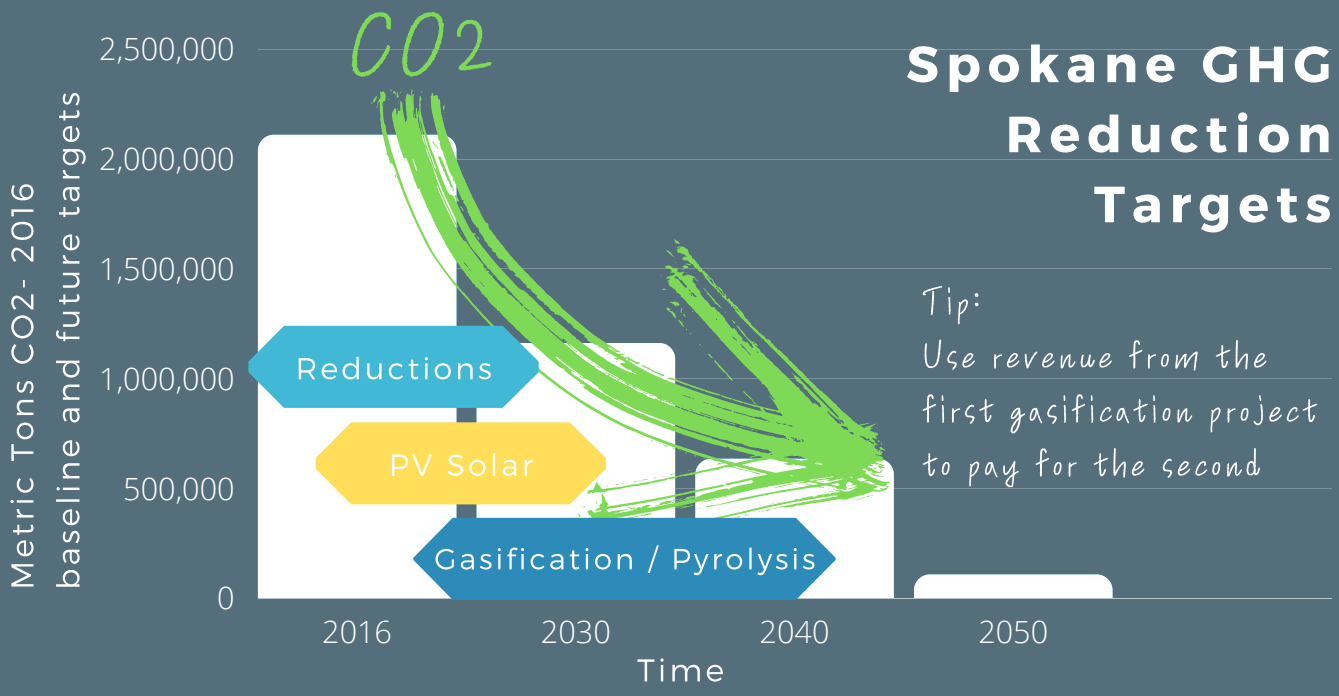
Modernize Technology

An important aspect of Phase II is to use the data collected in Phase I to update existing energy production facilities where possible. Introduction of new production facilities may be necessary to replace the energy currently provided by fossil fuels and by the aging incinerator facility. Upon evaluation of numerous renewable energy options (including wind, solar, hydro, and waste-to-energy) that other cities of similar size, demographic, and geographic attributes have successfully utilized, the recommendations herein represent an optimal blend of renewable energy and alternative fuels which best utilize Spokane's available renewable resources in order to offset energy and fuel demand primarily in the transportation and building sectors, which combined total 92% of Spokane's GHGs.

Increasing renewable energy production within the Spokane jurisdiction using local renewable resources is critical for replacing fossil fuels and building resiliency and energy independence.

It is the recommendation of this study that the city move towards adding 14 MW more solar production and replacing the existing incineration technology with cleaner, more efficient advanced gasification and pyrolysis technologies.

The existing incineration facility has served the City of Spokane very well and was a dramatic improvement over sending the city's MSW to the city's landfills. The current incinerator not only reduced the GHGs (primarily CH4 methane) from 0.94 MTCO2e/ton MSW to 0.7 MTCO2e/ton MSW (7.4% reduction), it also provided the City of Spokane with 22 MW of electrical power. **However, if the existing incinerator produces 22 MW of power which results in 113,331 MTCO2e to produce 192,720 MWh annually, then the net carbon footprint is greater than both the Avista average and the US average** as calculated in the formula *((113,331 MTCO2e/yr)x(2,204.6 lbs./MT))/((22 MW)x(24 hrs./day)x(365 days/yr)) = 0.588 MTCO2e/MWh* which equates to (2,204.6lbs/MT) = 1,296 lbs./MWh.

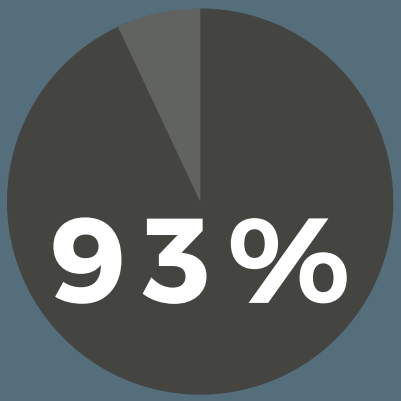


Cleaner Power Production

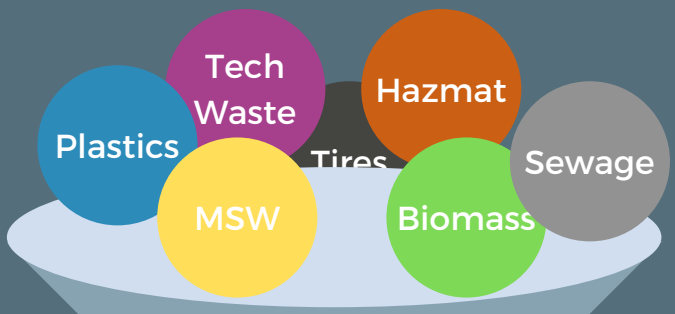
The transportation and building sectors make up the majority of GHG emissions in nearly every community. RCE's approach is to begin every net-zero emissions project by looking for ways to use locally available renewable resources from within a community's footprint and jurisdiction to fulfill as much of the demand from those sectors from within before purchasing renewable energy from outside a community's footprint and jurisdiction.

In order to achieve the stated goals, efforts should be prioritized to target the heaviest polluters and energy users by reducing overall energy consumption as stated in Phase I. In Phase II the priority is on **replacing fossil fuels used in transportation and electricity production by introducing cleaner power production technologies** suitable for the region using locally available resources**.** Two of the technologies identified for the Spokane area are Gasification and PV Solar.

Transportation, housing, and commercial buildings account for 93% of all of Spokane's GHG emissions



Gasification Basics



1 waste material goes into zero-oxygen gasification chamber

2 extreme heat Is applied

3 syngas, inert vitrified ash, and metal slag exit chamber

4 syngas is cooled, scrubbed, and prepped for downstream processes

5 syngas converted into electricity, hydrogen gas, and liquid fuels

- Thermo-chemical process for eliminating waste
- Not the same as combustion
- Oxygen-free environment, no trash burning
- High temp separates waste at the molecular level
- Waste converted to gas – mainly H2 and CO
- Gas can be converted into green renewable fuel and electricity
- Inert material converted to vitrified ash
- Metal passes through and is collected with the ash and recycled + precious metal recovery
- Cleanest and safest way to destroy hazardous material and harmful chemicals
- Zero emissions from landfills or incinerators

Gasification Systems

Gasification and pyrolysis are processes which uses thermal energy in the absence of oxygen to convert carbonaceous material (i.e. garbage, plastics, rubber tires, sewage) into a synthesis gas, or syngas, and pyrolysis oil which can then be used downstream for a number of purposes. Syngas is typically composed of hydrogen and carbon monoxide which are the building blocks for many fuels and products.

Gasification and pyrolysis qualify as a renewable energy source when calculating carbon footprint and energy mix. Introducing advanced gasification and pyrolysis technologies to the Spokane region would increase efficiency and productivity as well as eliminate the 5% GHG contribution from the current incineration plant.

The most common renewable energy products using syngas are listed below.

- Electricity
- Diesel
- Hydrogen Gas
- Ethanol
- Jet Fuel
- Renewable Natural Gas

The advanced gasification and pyrolysis technologies recommended in this solution will be able to supply the Spokane community with a number of locally produced fuels that would be used to offset the energy needs in Phase II.

Two separate waste conversion systems are being recommended using Municipal Solid Waste (MSW) and additional plastic materials. One system would be designed and designated to produce renewable electricity and green hydrogen while the second system would be designed and designated to produce green diesel fuel and green aviation fuel.

Required MSW & Plastic Input Per Day by Weight

Required Energy	GHG Reduction by Sector	Annual Requirement	Conversion Rate	Required Tons
Electricity	Residential Commercial	144,540 MWh (16.5 MW)	.04 MW/ton MSW	415 MT/day MSW
Hydrogen	Transportation	26,203,000 lbs.	153 lbs. H2/ton MSW	470 MT/day MSW
Jet Fuel	Transportation	18,oo1,350 gal	140 gal/ton plastics	195 MT/day plastic
Diesel	Transportation	20,178,000 GAL	200 gal/ton plastics	276 MT/day plastic
TOTAL				1,356 MT/day

Feedstock Necessary for Gasification

The table on the previous page shows the MSW & plastic weights that would be required to offset each form of energy recommended in this study in order to meet Spokane's zero net emissions target. The following local data was used to calculate available waste streams to use as feed material.

The City of Spokane diverts 45% of their 800-1300 tons waste/day through recycling or composting. Recycling includes aluminum cans, corrugated and non-corrugated cardboard, clean pizza boxes, mixed paper (not shredded), most types of paper (not coated or laminated), other metal and tin cans (no lids or tips), plastic bottles/tubs/jugs (empty, no lids), and glass.

The existing incinerator accepts between 800 to 1,300 tons of solid waste each day or 310,677 tons per year of MSW which is sent to the incinerator. Approximately 16% of the MSW are plastics, which are currently being removed for recycling.

This graph below suggests that the following weights are available for the advanced gasification.

MSW & Plastics Available for Advanced Gasification

Feedstocks	Metric Tons Available	Metric Tons Required
MSW	850	885
Recycled Plastics	162	471
Total	1,012	1,356

Initial calculations show that there is **insufficient tonnage** of MSW and plastics generated by the City of Spokane to achieve the sustainability goals through efficiency and advanced gasification and pyrolysis alone.

This shortage can be addressed in two different ways:

1. Import additional MSW & plastics from City of Spokane Valley and other surrounding areas (344 MT/day)

2. Utilize PV Solar to produce 14 MW of power

PV Solar Energy Production

The city's waste material shortage is easily remedied by the addition of 14MW PV solar start.

Although not leveraged extensively in Spokane today, PV solar remains a very viable support technology to gasification in this circumstance. Solar is not subject to windy days generates power during daylight hours when the majority of the commercial buildings would be requiring the most energy. PV solar is a much more viable form of renewable energy than wind or geothermal for the local region and can be installed on individual structures to increase energy resiliency.

Installing PV solar is a more sustainable solution in terms of local energy production than attempting to import additional MSW and recycled plastics from the surrounding area, however, it poses a threat to the environment if landfilled in mass quantities.

171
sunny days
in Spokane

70%
solar generation
potential than
that of California

Local Impact

Current Process Flow of Municipal Solid Waste

This feasibility study suggests that all the City's MSW would continue to be collected, transported, sorted, and delivered in the same fashion that it is currently. A quick feedstock analysis would determine whether additional waste sorting equipment would be necessary. Otherwise, use of current transfer stations and primary location would remain the same.

Process Flow of Recyclables

This feasibility study suggests that all the City's recyclables would continue to be collected, transported, sorted, and delivered in the same fashion that it is currently. Some minimal infrastructure changes may be required to divert certain plastic types for processing into fuels and would be scoped in more detail in a subsequent engineering study.

Plastics are an ideal feedstock for liquid fuel production. The current recycling center would be an ideal location for liquid fuel production, however, the WTE facility is located in a flight zone and may require an alternative location and drop-off location for recycled plastics. This should be evaluated in a more granular study.

Facility Location Impacts

Some additional infrastructure would be required and would be scoped in more detail in a subsequent engineering study. However, the basics of the infrastructure changes would include equipment for inventory storage, technology conversion, finished fuel storage, and distribution.

The new advanced gasification units would be housed at the current incineration facility. In this type of solution, waste is collected, transferred, sorted to remove the majority of metals and inert material, and delivered to be processed. Once processed, the feedstock is converted to syngas and then to liquid fuel ready for use. On-site storage tanks are necessary to store fuel between production and distribution to the end user.

Some initial front-end engineering design is recommended. However, upon initial review, it appears the existing incineration campus and building structures should be large enough to accommodate any necessary additional waste sorting and preparation equipment.

GHG (Carbon Footprint) Impacts

If implemented as recommended, the solution result will be a **95% reduction in GHG emissions by 2050.**

Energy Usage Impacts

The modeling that was completed for this feasibility study shows that the energy usage of Spokane could be reduced by 2,016,634 MTCO2 through the use of industry-accepted technologies and best practices.

Workforce Impacts

Introducing advanced gasification, fuel production, and additional PV solar to the Spokane region would result in a big win for the number of green jobs. However, the job skills needed are essentially those of the workers currently responsible for the collection, handling, and processing of recyclables and MSW. While worker training will be necessary, the resulting net new jobs added is minimal because it is offset by "non green" workers being trained and assigned to the same job with a new green label.

The table below provides insight into the necessary job roles associated with local renewable energy production.

Job Type	Temporary Position	Permanent Position	Green Job	Opportunities for Non-Green Training
Project Engineers	✓		✓	
Project Management	✓		✓	
Marketing & Communications	✓		✓	
Construction	✓		✓	
Project Support (accounting, admin, bookkeeping, etc.)	✓		✓	
Training	✓		✓	
Ops Engineers		✓	✓	✓
Ops Management		✓	✓	✓
Field Technicians		✓	✓	✓
Recycling Collection		✓	✓	✓
Utility Linemen		✓	✓	✓
Waste Collection		✓	✓	✓
Waste Handling		✓	✓	✓

The state will need to **grow** and **manage** clean, reliable **electricity generation** to meet **increasing demand** from buildings, industry and transportation.

Clean Energy Transformation Act

NEXT STEPS

THIS SECTION INCLUDES TARGETED NEXT STEPS TO ACCELERATE ACHIEVING NET-ZERO EMISSIONS

Photo location: Spokane Riverfront Park

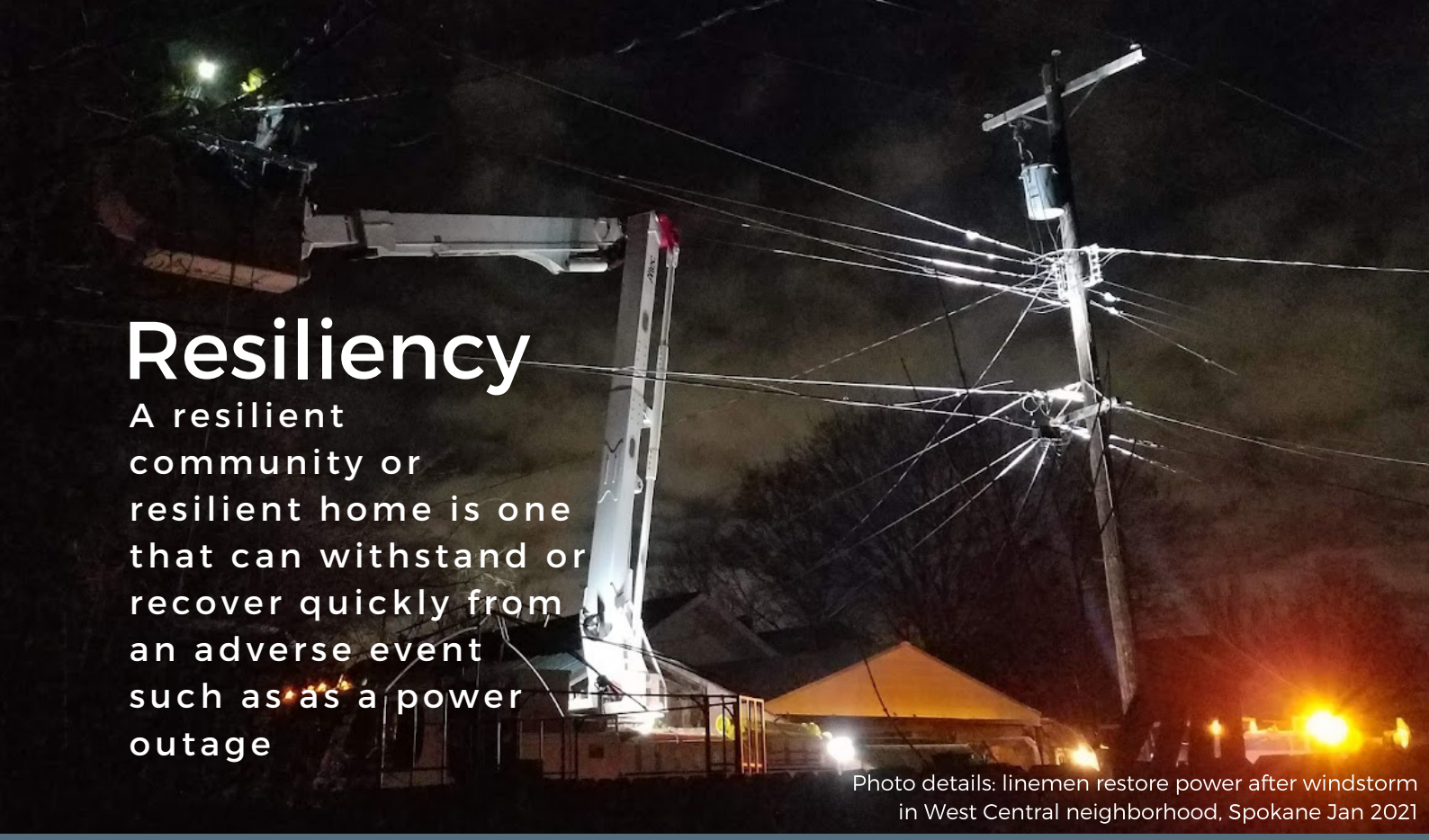
Next Steps Overview

The recommended phases to achieve net-zero emissions include two complimentary approaches: conserving energy and using it more efficiently and then decarbonizing electricity at the production source by replacing it with as much locally-produced electricity and alternative fuels as possible using existing local renewable resources. Equally important, is to plan for infrastructure improvements and upgrades in order to support the continual increase of electricity flowing through the grid. Implementing one without the other or any siloed approach pursued in isolation, will likely result in a costlier transition to net-zero emissions and less community resiliency.

Recommended Action Steps

RCE can assist with any or all of the items below. In order to achieve net-zero emissions, we recommend taking the following next steps:

1. Create a Net-Zero Plan which identifies specific areas where significant energy reduction is addressed and targeted renewable energy generation pathways are pursued; NZE Plan should also include more granular studies into the following topic areas:
    a. Fossil fuel reductions in transportation sector through use of alternative fuels and other methods for largest potential GHG reduction.
    b. GHGs from Spokane homes and commercial buildings including natural gas alternatives to maintain resiliency, energy choice, and backup power options in the workplaces and dwellings of tomorrow.
    c. Phased conversion of incinerator plant including some portion of facility design and zoning research to estimate project schedule and budget.
    d. Economic impact to local residents, businesses, and city government related to the cost of future home and building updates and retrofits as well as energy price increases, job losses, and tax revenue shifts.
    e. Equitable access to needed funds and in-bill options for home and building energy efficiency improvements and electrification retrofits.
2. The City of Spokane should work with the SBCC to delay any gas ban until the Spokane power grid is proven more resilient and the City has examined the use of existing gas infrastructure for renewable natural gas and other cleaner burning natural gas alternatives.
3. Modify SAP goals to include the following:
    a. Include burying power lines and installing fiber to lay the foundation for the smart, electric neighborhoods of the future.
    b. Emphasize the value of solid waste and plastics as a renewable energy source with significant regional impact and commitment to the community to modernize the current incinerator plant in order to convert the facility from a GHG emitter to a major contributor in the effort to achieve net-zero emissions.
    c. Provide a clear road map for exclusions, exemptions, permissions, and use of natural gas and alternative fuels as well as target dates for priority goals in the SAP.
4. Work with regional and statewide stakeholders to introduce a waste-to-energy incubator to advance technologies such as anaerobic digestion, gasification, and pyrolysis for the conversion of MSW, plastics, and sewage to renewable electricity and transportation fuels.
5. Accelerate incentives and rebates for home and building owners to make efficiency updates and convert to electric services.
6. Create NZE Dashboard for website with community-facing interactive app for monitoring and reporting progress toward net-zero emissions and educating residents.
7. Begin a regional solar panel recycling program to minimize unintended consequences of increased solar use such as landfilled solar panels and harmful lithium extraction methods.



Resiliency

A resilient community or resilient home is one that can withstand or recover quickly from an adverse event such as as a power outage

Photo details: linemen restore power after windstorm in West Central neighborhood, Spokane Jan 2021

ENERGY RESILIENCY SCORECARD

Equipment properly maintained and replaced _____

Infrastructure scaled to match future needs of electric homes and vehicles and local climate _____

Smaller grids and building energy sharing utilized to limit impact of a power outage _____

Transmission lines located below ground _____

Critical infrastructure supported by backup power sources _____

Community serviced by diverse energy mix _____

All available local renewable resources being used to fulfill local energy demand _____

Skilled workforce trained for rapid restoration _____

Multiple energy sources and energy storage permitted for residential and commercial structures _____

Community well-informed around emergency preparedness measures with access to resources _____

Appendix – Assumptions

- The Information in the 2021 Draft of the Spokane Sustainability Action Plan is accurate
- The BTU value of Spokane's MSW is comparable to that of the US average
- The composition of Spokane's MSW is comparable to that of the US average
- The residential energy usage per household in Spokane is comparable to the US average
- The water usage per household in Spokane is comparable to that of the US average
- The 6-year projected growth rate of Spokane County is 4.1%

Appendix – References

Executive Summary

- https://www.commerce.wa.gov/wp-content/uploads/2020/02/CETAOverview.pdf

Study Terminology

- CETA | Clean Energy Transformation Act
  - Overview
    - https://www.commerce.wa.gov/wp-content/uploads/2020/02/CETA-Overview.pdf
  - Washington State Department of Commerce
    - https://www.commerce.wa.gov/growing-the-economy/energy/ceta/
  - Clean Energy Transformation Act
    - https://www.commerce.wa.gov/growing-the-economy/energy/ceta/
- SAP | City of Spokane's (draft) Sustainability Action Plan
  - https://static.spokanecity.org/documents/bcc/committees/public-infrastructure-environment-sustainability/sustainability-action-subcommittee/spokane-sustainability-action-plan-draft-2021-05-18.pdf
- NWPP | Northwest Power Pool
  - https://www.nwcouncil.org/reports/columbia-river-history/NorthwestPowerPool

Regional Data

Demographic Overview – https://advantagespokane.com/

- Population
  - Spokane 2020 Population 222,050
    - https://www.bestplaces.net/people/city/washington/spokane
  - City of Spokane 2021 Population 227,579
    - https://worldpopulationreview.com/us-cities/spokane-wa-population
- Growth Rate
  - City of Spokane
    - https://worldpopulationreview.com/us-cities/spokane-wa-population
  - Spokane County 6-year projected growth rate being 4.1% and 4.3% respectively
    - https://www.spokanecounty.org/DocumentCenter/View/38201/Spokane-County-SWMP_DRAFT_2021?bidId=
- Aging House Stock
  - https://www.bestplaces.net/housing/city/washington/spokane
- Children & Elderly
  - https://www.bestplaces.net/people/city/washington/spokane

- Climate – https://www.weatherbase.com/weather/weather-summary.php3?s=58727&cityname=Spokane,+Washington,+United+States+of+America
- Highest Temperature
  - https://www.krem.com/article/weather/spokane-inland-northwest-high-temperature-records-likely-broken/293-444e2adf-1b11-459c-9d8f-faf44df91db3
- Lowest Temperature
  - https://www.currentresults.com/Yearly-Weather/USA/WA/Spokane/extreme-annual-spokane-low-temperature.php
- Spokane residents enjoy roughly 171 days of sunshine per year
  - https://www.bestplaces.net/climate/city/washington/spokane#:~:text=On%20average%2C%20there%20are%20171%20sunny%20days%20per%20year%20in%20Spokane.&text=Spokane%20gets%20some%20kind%20of,average%2C%20115%20days%20per%20year

Current Plans & Laws

- Spokane City Ordinance C35668
  - https://world.350.org/spokane/files/2019/01/2018_SpokaneClimateOrdinance.pdf
- City of Spokane Sustainability Action Plan 2009 | Section 4.1.2-A
  - https://static.spokanecity.org/documents/publicworks/environmental/sustainability-action-plan.pdf
  - (final draft) https://static.spokanecity.org/documents/bcc/committees/public-infrastructure-environment-sustainability/sustainability-action-subcommittee/spokane-sustainability-action-plan-final-draft-2021-09-27-v2.pdf
- Spokane City Ordinance C35519, Section 15.05.020, paragraph C "The City shall calculate and publish the GHG emissions created by activities from within the City of SPokane boundaries."
  - https://world.350.org/spokane/files/2019/01/2017SpokaneClimateOrdinance_Ord-Re-Sustainability-Action-Plan-Climate-Change-Global-Warming-SMC.pdf
- Avista's IRP for 2021
  - https://www.myavista.com/about-us/integrated-resource-planning
- Spokane County Regional Solid Waste | (draft) Comprehensive Solid Waste and Moderate Risk Management Plan (SWMP)
  - https://www.spokanecounty.org/DocumentCenter/View/38201/Spokane-County-SWMP_DRAFT_2021?bidId=
- Washington State's Clean Energy Transformation Act (CETA) | E2SSB 5116, 2019
  - https://lawfilesext.leg.wa.gov/biennium/2019-20/Pdf/Bills/Session%20Laws/Senate/5116-S2.SL.pdf
- 2025 No Coal Standard, 2030 GHG Neutral, 2045 100% Clean Standard
  - https://www.commerce.wa.gov/growing-the-economy/energy/ceta-overview/
- Washington State Building Code - Tiered targets requiring a stepped approach to reducing GHG emissions and improving efficiencies
  - https://apps.leg.wa.gov/rcw/default.aspx?cite=19.27
  - https://www.sbcc.wa.gov/about-sbcc/2021-code-proposals
- Revised Code of Washington Limiting Greenhouse Gas Emissions | RCW 70A.45
  - https://app.leg.wa.gov/RCW/default.aspx?cite=70A.45.020
  - https://app.leg.wa.gov/RCW/default.aspx?cite=70A.45.005
- Federal Green New Deal | H. Res.109
  - https://www.congress.gov/bill/116th-congress/house-resolution/109
- Intergovernmental Panel on Climate Change
  - https://www.ipcc.ch/

Statistics

- Population
  - Population 222,000 with 97,825 housing units
- Tons of MSW generated each year
  - Spokane County residents produce between 800 to 1,300 tons of solid waste each day (https://my.spokanecity.org/solidwaste/recycling/) or 310,677 tons of waste per year that is burned at WTE facility or landfilled, an average of 3.3 pounds per person per day (2018, SAP p.50)
- Tons of sewage generated each year
  - Spokane's Sewage disposal plant, the Riverside Park Water Reclamation Facility, treats more than 30 million gallons/day and removes 6,500 tons of solids annually from the effluent (https://www.spokesman.com/stories/2020/nov/16/then-and-now-riverside-park-water-reclamation-faci/) and it can handle up to 150 million gallons/day (https://en.wikipedia.org/wiki/Riverside_Park_Water_Reclamation_Facility)
- Total or percent recycling and what they recycle
  - Divert 45% of their 800-1300 tons waste/day waste through recycling or composting
    - https://my.spokanecity.org/solidwaste/recycling/
  - Aluminum cans, corrugated and non-corrugated cardboard, clean pizza boxes, mixed paper (not shredded), most types of paper (not coated or laminated), other metal and tin cans (no lids or tips), plastic bottles/tubs/jugs (empty with no lids), glass
    - https://www.spokanecounty.org/2027/recycling

Water Usage

- Average water usage per household in Spokane
  - City of Spokane Data: Year round median water usage among residential customers equals about 8 units of water/month (about 6,000 gallons a month). Median water usage in the summer equals about 23 units/month (or about 17,000 gallons). A unit of water is a standard of measurement in the water world; it equals 100 cubic feet or 748 gallons of water.
    - https://my.spokanecity.org/publicworks/utility-billing/new-water-use-tier-structure/
  - 180 million gallons/day supplied to city by City of Spokane's Water Department
  - City of Spokane's Water Department pumps 33 million gallons/day in winter and 155 million gallons/day in summer after a week of hot, dry weather
    - https://static.spokanecity.org/documents/publicworks/water/spokane-water-system-plan-march-2016.pdf
  - City's 2019 measurement of daily gallons consumed per connection:
    - SF Residential Indoor 113 gallons/day (Dec 15- Feb 14)
    - SF Residential Outdoor 553 gallons/day (July 15-Sept 14)
      - https://static.spokanecity.org/documents/publicworks/water/water-conservation-master-plan-2020-04-27.pdf
    - The average American family uses more than 300 gallons/day at home
      - https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiv45TEprvxAhUNk2oFHT6IBhsQFjADegQIFBAD&url=https%3A%2F%2Fwww.phila.gov%2Fwater%2Feducationoutreach%2FDocuments%2FHomewateruse_IG5.pdf&usg=AOvVaw18__ClDN9dZi_wkkgRPyZB

GHG Emissions

- Estimated Carbon footprint (metric tons CO2) per household in Spokane
  - "The Residential Buildings sub-sector accounted for the emissions generated from electricity and fuels used in households within the City of Spokane"
    - https://world.350.org/spokane/files/2019/01/2019-04-29_City-of-Spokane-GHG-Emissions-Inventory-Report_Final.pdf
- Estimated Carbon footprint (metric tons CO2) per ton MSW in the US
  - 0.94 tons MTCO2e per ton of MSW entering landfill
    - https://www.sciencedirect.com/science/article/pii/S0959652617317316
- Carbon Footprint of WTE Facility
  - 235,000 metric tons MTCO2 (2014) (Per SAP, p. 50)
  - Or, 100,437.67 MTCO2e (2016)
    - https://world.350.org/spokane/files/2019/01/2019-04-29_City-of-Spokane-GHG-Emissions-Inventory-Report_Final.pdf

Energy

- Electricity provider
  - Avista, and IPL (Inland Power and Light) Electricity (2016)
    - https://world.350.org/spokane/files/2019/01/2019-04-29_City-of-Spokane-GHG-Emissions-Inventory-Report_Final.pdf
- Energy Source
  - Avista: 51% Hydro. 4% wind. 2% biomass. 9% coal. 34% NG. (Dec 2019)
    - https://www.myavista.com/about-us/about-our-energy-mix
  - IPL: Biomass 0.1%. Coal 1.14%. Hydro 79.92%. NG 0.65%. Nuclear 10.27%. Non-biogenic 0.03%. Petroleum 0.02%. Solar 0.08%. Wind 7.79%.
- Natural Gas provider
  - Avista, supplied therms available
    - https://world.350.org/spokane/files/2019/01/2019-04-29_City-of-Spokane-GHG-Emissions-Inventory-Report_Final.pdf
- Average kWh used per household in the US (or Spokane if avail)
  - City of Spokane: (930,053,623 kWh + 4,325,000 kWh) / 97,825 homes = 9,551.53 kWh per household annually (used above household count)
    - https://world.350.org/spokane/files/2019/01/2019-04-29_City-of-Spokane-GHG-Emissions-Inventory-Report_Final.pdf

Resiliency

- Avista's Integrated Resource Plan (IRP)
  - https://www.myavista.com/about-us/integrated-resource-planning
- Climate Comparison
  - https://www.bestplaces.net/climate/?c1=55367000&c2=55363000
  - https://www.ncei.noaa.gov/pub/data/ccd-data/mnls3218.dat
- Whole Home Electrification Cost
  - https://nahbnow.com/2021/03/how-much-does-whole-home-electrification-cost/

Waste

- Waste company
  - Single stream "all in one" recyclables sorting is done by WM at their SMaRT Center (https://www.spokanecounty.org/2027/Recycling) and can process 100,000 tons per year or about 30 tons per hour (next door to WTE Facility)
    - https://www.wmnorthwest.com/smartrecycling/gif/factsheet.pdf
  - The City of Spokane is the waste service provider for the city (City of Spokane Solid Waste Services)
    - https://spokaneriver.net/wastedirectory/vendor/city-of-spokane-curbside-trash/
    - https://my.spokanecity.org/solidwaste/
  - The Recycling and Disposal site is in the City of Spokane (https://my.spokanecity.org/solidwaste/locations/), but there are two other local transfer stations for the COUNTY of Spokane (same link)
  - County (not city) additional info – www.spokanecountysolidwaste.org/
- Transfer stations
  - 3 including WTE Facility – (WTE Facility is technically a transfer station) except for WTE ash or if the WTE Facility is down
    - The Spokane County North Transfer Station – 22123 N Elk-Chattaroy Road, Colbert, WA 99005
    - The Spokane County Valley Transfer Station – 3941 N Sullivan Road, Spokane Valley, WA 99216
    - WTE Facility – 2900 S Geiger Blvd, Spokane, WA 99224
    - https://www.spokanecounty.org/4637/Spokane-County-Transfer-Stations and https://my.spokanecity.org/solidwaste/locations/
  - Each facility's tipping fee is $110/ton for MSW and $53/ton for green waste. Fees are projected to jump to $114/ton for MSW without grant funding
    - https://www.spokanecounty.org/DocumentCenter/View/38201/Spokane-County-SWMP_DRAFT_2021?bidId=
- Landfills
  - 2 in operation, 5 closed. WTE is the primary disposal site though by a significant margin. Landfills are only really used by City of Spokane for ash disposal from the WTE facility or if the WTE facility is down
  - There are also private inert landfills (more details available)
  - Roosevelt Landfill – open. This is where the WTE ash goes after removing ferrous metals
  - Northside Landfill – open
  - Greenacres landfill – closed (operated 1950-1972)
    - https://www.spokanecounty.org/4728/Greenacres-Landfill
  - Mica landfill – closed (1972-1991)
    - https://www.spokanecounty.org/4727/Mica-Landfill
  - Colbert Landfill – closed (1968-1996)
    - https://www.spokanecounty.org/4726/Colbert-Landfill
- WTE Facility additional info
- Facts & Figures – https://www.spokanecounty.org/DocumentCenter/View/4831/WTE-Facts-and-Figures-PDF?bidId=

Make-up

- Top biggest industrial companies
  - There are six total facilities within the municipality (six facilities: Pacific Steel and Recycling, Pyrotek, Coeur d'Alene Window, Haskin Steel Co., Metal Sales Manufacturing, and Melcher Manufacturing Company, Inc.) and all were too small to be mandatory reporters of GHG emissions (p.35). Avista reported supplying 65,710.59 kWh (2016) for Manufacturing & Construction, and IPL reported 5,053 MWh (2018) (p. 18).
    - https://world.350.org/spokane/files/2019/01/2019-04-29_City-of-Spokane-GHG-Emissions-Inventory-Report_Final.pdf
  - The SAP calculates that industrial GHG is 2% of the city's GHG
  - GSI's Regional Demographics – https://advantagespokane.com/

Other notes

- All local photos taken by RCE team and are property of RCE
- Municipal Energy Balance Document 2015
  - https://static.spokanecity.org/documents/news/2017/04/21/on-earth-day-city-of-spokane-celebrates-net-zero-energy-consumption/city-of-spokane-municipal-energy-balance-chart.pdf
- Comprehensive Solid Waste and Moderate Risk Waste Management Plan for Spokane County Regional Water Waste System
  - https://www.spokanecounty.org/DocumentCenter/View/38201/Spokane-County-SWMP_DRAFT_2021?bidId=
- Washington's SB 5116
  - https://app.leg.wa.gov/billsummary?BillNumber=5116&Year=2021&Initiative=False
- Waste to Energy (WTE) Info:
  - "Scientific Truth about WTE"
    - https://static.spokanecity.org/documents/solidwaste/wastetoenergy/wte-report-2021.pdf
  - "Energy Recovery Council; 2018 Directory" (includes other data) Spokane's facility is found on pg. 49
    - http://energyrecoverycouncil.org/wp-content/uploads/2019/10/ERC-2018-directory.pdf
  - A look at the Boiler
    - https://www.youtube.com/watch?v=-nn5_BGFrYY&list=PLw8PRE3WhPqARfVnKf7dmdlglcAuSNu9_&index=5
  - Virtual Informative Tour
    - https://www.youtube.com/watch?v=5Z32wPt3MWQ

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