

Sustainability: Buildings and Energy

The Future of Reimagining our Existing Buildings



SIERR Building at McKinstry Station. Courtesy of McKinstry (2011)

Blake Beckwith

CENG 440

Final Report

Abstract

Sustainable cities strive to provide a green and eco-friendly place based on three foundational pillars: social, economic, and environmental matters. Civil engineers are instrumental in designing and planning a sustainable city, especially in terms of green infrastructure, that promote these pillars. With goals in reducing the greenhouse gas emissions stated in the City of Spokane's SAP, city officials must look at buildings and construction, which accounts for 36% of global energy consumption. Using the Netherlands as inspiration for sustainable improvements, using a space to innovate sustainable, green building technologies will lead to educating the local population in sustainable practices. Additionally, instead of tearing down the existing buildings to make room for new construction projects, adaptive reuse of existing structures and retrofitting buildings for greater energy efficiency will show a 45% reduction in operational energy use from buildings, a positive step towards the advancement of the local economy, environment, and well-being of citizens. This report should act as a recommendation to the City of Spokane to highlight the sustainable benefits of adaptive reuse and retrofitting to enact change now for combating the threats to climate change, and protecting the quality of life for future citizens.

Table of Contents

<u>Chapter</u>	<u>Page</u>
Chapter 1 – Reflection on Sustainability	2
Chapter 2 – Area of Action for Sustainability: Buildings and Energy	4
Chapter 3 – Adaptive Reuse	8
Chapter 4 – The Solution in Spokane	11

Chapter 1: Reflection on Sustainability

Sustainable Cities

Sustainability is a word used by many in today's world but has been poorly defined in recent history. Defining sustainability as the ability to meet the needs of people today without compromising the needs of future generations, this definition from the 1987 report from the UN World Commission on Environment remains a principal message for people today (Ayers, 2017). Sustainability is often described by its three foundational components, or pillars, which are social, economic, and environmental matters.

Sustainable cities address social, economic, and environmental impacts by promoting a clean and eco-friendly space. With sustainability on the forefront of urban planning and city development, sustainable cities have an infrastructure that generates less pollution and manages resources better than average urban environments. Sustainability varies in terms of what it looks like in an urban environment and on a state or national level, with size, economics, and political affiliation all having an impact on the sustainable development of different sized places. Despite these conditions, it is indisputable that civil engineers play a vital role by planning, developing, and maintaining sustainable systems that contribute to the success of socially aware, economically prosperous, and environmentally conscience communities and developments.

Sustainability on a State and National Level

The main way to create a sustainable city is by finding effective ways to create an eco-friendly environment that improves and promotes a clean, green society. This process of creating sustainable cities has been seen done before across the world, even in the United States, but what is more difficult is creating a sustainable nation. For many, it might seem as easy as implementing the same functionality of a sustainable city across the state or country, but as it stands in today's world, the task has not been totally figured out. The United States is a great example of how sustainable cities might exist, but have not been translated to a larger, national agenda. Portland, Oregon has seen great success in implementing eco-friendly systems and have worked diligently to create policies and goals for the state in creating a sustainable future (Oregon Department of Energy, 2020).

On a national level, the U.S. has been working towards creating policies that promote sustainability, but with economic dependence on nonrenewable resources and different political motives from government officials, the implementations of sustainable goals become harder (Pipa et al., 2022). Without policies and incentives for sustainable development on a national level, the goals for an entire country to become sustainable seemingly ends with the major cities for which have taken the steps in creating a sustainable environment.

One area of importance in moving towards a national sustainability agenda is creating a social culture of sustainable and eco-friendly practices. The U.S. as a country has a culture of disposable goods, with little consideration to reuse something. Recently, with new initiatives such as the single-use plastic bag ban put in place in Washington this year, the nation can begin to build up a culture that rewards sustainable practices, but it is still a long and difficult task (KIRO 7 News, 2021).

Role of Civil Engineers to Sustainability

Just as important as it is to create a culture of sustainable practices in a city or state, so is the city design and urban development. As a civil engineer, thinking about urban infrastructure is essential in creating a sustainable system as the early development decisions have a direct impact on the sustainable future of the city. The designs and construction of such infrastructure is a key element of success in a sustainable environment. For example, roadways that connect places around the city by bike have a much greater focus on sustainability and removing the negative environmental and societal consequences that cars pose to a city. Additionally, civil engineers are responsible for water conservation efforts, designing systems so cities can manage stormwater runoff and utilize treated wastewater to reduce consumption of the Earth's freshwater resources. Whether its designing transportation systems that promote cleaner forms of mobility, or creating infrastructure that carefully manages water resources, civil engineers have an essential role in creating the eco-friendly, economically viable, and socially positive components of a sustainable city.

With the impending threats of climate change from negative social and environmental practices in the world, creating sustainable cities and nations will be essential in the survival of the planet. Civil engineers have the important responsibility of planning for the future through infrastructure design that directly impacts the sustainability of a city. Focusing on the specific

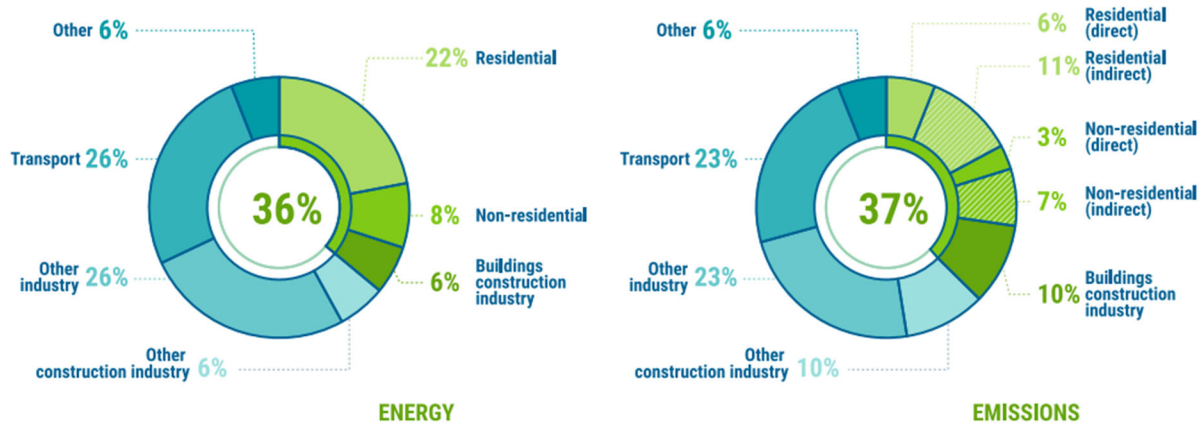
area of buildings and energy, goals outlined in the City of Spokane's Sustainable Action Plan (SAP) can be achieved with understanding green ways a building can reduce energy consumption. Using inspiration from building practices in the Netherlands, such as adaptive reuse of existing structures, sustainability can be achieved in Spokane in tangible and effective ways.

Chapter 2: Areas of Action for Sustainability: Building and Energy

The City of Spokane's SAP outlines multiple areas of actions for which the greater community and local professionals, including civil engineers, should engage in to promote and protect sustainable practices for the prosperity of future generations. With the threats of climate change on the forefront of local planning, a sustainable community can build up a resilience for protecting not only their own present quality of life, but the quality of life of their children and grandchildren. Of the main action areas outlined in the SAP, buildings and energy plays a significant role in the sustainability of a city as it decreases the amount of greenhouse gas emissions into the atmosphere, reduces the amount of energy consumed, and becomes more economically beneficial to residents and business owners. Local economy and social well-being of Spokane citizens will be improved with careful consideration of sustainable building as improvements to the city would come from the people's motivation for it, with help from city officials and industry experts in guiding towards a more informed and engaged community.

Sustainability of Buildings and Energy

Urban areas are significant contributors to pollutants such as carbon dioxide (CO₂), and cities consistently experience air pollution beyond safe levels. Figure 1 outlines this share of global energy and emissions for buildings and construction in 2020.



Courtesy of International Energy Agency and the United Nations Environmental Programme - Global Status Report (2021)

Figure 1. Buildings and construction share of global energy and CO₂ emissions, 2020

Buildings play a substantial role in CO₂ emissions, with 37% of total annual global emissions and 36% of global energy consumption attributed to the built environment (United Nations Environmental Programme [UNEP], 2021). Despite falling nearly 10% lower than in 2019, the global emission levels in the building sector were largely due to pandemic-related circumstances, with efforts to decarbonize buildings having a small impact (UNEP, 2021). It is apparent that significant improvements still need to be made to reduce greenhouse gas emissions globally, but it should start with local level contributions. The City's SAP outlines these specific goals for reduction, shown in Figure 2.

Emission Source	2016 Baseline 2,108,796 MT		2030 Reduction Target 45% & 948,958 MT		2040 Reduction Target 70% & 1,476,155 MT		2050 Reduction Target 95% & 2,003,356 MT	
	Metric Tons CO ₂ e	Percent of Total	Metric Tons CO ₂ e	Percent Reduction	Metric Tons CO ₂ e	Percent Reduction	Metric Tons CO ₂ e	Percent Reduction
Electricity	587,418	28%	83,114	80%	41,557	90%	0	100%
Gas	381,273	18%	411,163	30%	205,581	65%	24,369	95%

Courtesy of City of Spokane's Sustainable Action Plan (2021)

Figure 2. City of Spokane's GHG Reduction Targets for Buildings and Energy, 2021

With the largest of the sectors for greenhouse gas emissions being from buildings and construction, it is vital that the City of Spokane look at improving this area first to make substantial efforts to the reduction targets outlined.

Sustainability in Spokane and the Netherlands

With the goal of being a center for building carbon neutrality, the City of Spokane has a large responsibility to enforce and innovate the local green building technology (Spokane Sustainable Action Plan [SAP], 2021). In the Netherlands, sustainable buildings are researched in designated spaces where new technology can be applied in real-world, neighborhood situations. Not only serving as an opportunity for engineers and other students to research new sustainable practices and technology, the facilities give the community an opportunity to visit, engage, and see for themselves the inspirational innovation that sustainable practices can bring to a community. From the combination of learning about green building and inspiring a community for sustainable innovations, the Netherlands invests in scientific research for the betterment of the future. One such space for this research is at the Green Village at TU Delft campus in the Delft, Netherlands, seen in Figure 3.



Courtesy of TU Delft Campus Webpage

Figure 3. Green Village at TU Delft in the Netherlands for experimental research in green building

By investing in the research of scientific innovation for green building, local students and professionals get the hands-on and actual experience in building and learning about sustainable building. At a time when climate change threatens the world, there is not enough time to just think about planning for green building, but to actually do it on a small, tangible scale to further research how it can be implemented on a larger scale locally.

Impact of Buildings and Energy on Local Economy, Environment, and Well-Being

The City's SAP references many impacts that should be resolved through careful planning and reaching benchmarks, specifically when contributing to the future improvements of the local economy, natural environment, and social well-being. As it relates to the buildings and energy area of interest, the SAP is built around providing investments to the energy efficient needs of the city with consideration towards residents. By retrofitting existing buildings with energy efficiency improvements instead of demolishing them, economical advantages can be made over the course of the building's existing life without wasting the building materials and other already existent environmentally damaging actions. Energy efficient retrofits can reduce operational energy use by over 45% in some instances, in turn reducing the cost of living especially in older downtown buildings, attracting more potential tenants (Calderone, 2015). Additionally, retrofitting existing buildings with energy efficient lighting and HVAC systems, it is an investment in the local tradesmen population, working towards a collective goal of sustainability with an economically prosperous community of craft workers. Constructing a new building would not have the same sustainable benefits as restoring existing buildings to consume less energy, and the SAP mentions that in Strategy 1 of Goal 1 (SAP, 2021). Retrofitting is a lower cost way to create substantial sustainable change in reducing building energy consumption and should be incentivized just as much as other approaches made by the city.

Not only are there considerable long-term economic and environmental benefits for green buildings, dwellers in buildings also experience better health benefits. The health benefits of green buildings are substantial, and research defends this conclusion. Green homes implement cleaner, nontoxic building materials that allow residents to breath cleaner air with less pollutants (Benjamin, 2015). Additionally, modern ventilation reduces the number of particles from the outside, improving the living or working situations for vulnerable populations. The SAP considers the health outcomes of improved buildings as co-benefits, which is a great word to describe the collective benefits people in the community receive when practicing sustainable improvements. A cleaner and greener living or working environment for people should be a priority just as much as creating economically viable construction project. With careful planning and design, the improvement of the building sector can benefit the local environment, economy, and well-being of residents.

Learning from how other countries have improved their conditions in sustainability, such as the Netherlands, Spokane can offer specific opportunities to improving the local built environment, not only in an environmental way, but in ways influencing the local economy and well-being of citizens.

Chapter 3: Adaptive Reuse

As mentioned prior, buildings account for a significant amount of the global energy use and CO₂ emissions. The main sources for these environmentally damaging effects come from a new building's construction. By improving the current state of a building instead of starting from scratch on a new project, expensive and environmentally damaging building materials would be saved. Defined as adaptive reuse, existing buildings that may be considered obsolete or approaching disuse are to be left in their basic structure as a fresh slate for new applications (Langston, 2008).

Between material production, acquisition, and transportation, the constructing of a new building is already posing a substantial impact on the environment. Data suggests that building materials consume 30-50% of the raw resources around the globe, with a large contribution of 40% to waste in landfills (Walker-Morrison, 2007). The SAP indicates the encouragement for using renewable and low-carbon materials which is a great step towards a cleaner environment, but is this enough if existing buildings are still torn to waste?

In the city of Delft, Netherlands, the old central train station was replaced in 2015 with a newer station to accommodate more people (Zoutewelle, 2017). Instead of demolishing the old central station, Dutch officials, engineers, and architects reimaged the historic building to serve new purposes. Opening back up in 2018, the once central train station is now home to a multipurpose space with offices, shops, and the largest restaurant in Delft (Zoutewelle, 2017).

Similar projects are becoming more common in the United States, with investors seeing the potential that older buildings have not only in an aesthetic perspective, but in sustainability too. In Portland, Oregon, the historic Troy Laundry building, constructed in the early 1900s, features tall, decorative brick walls and large windows, an appealing aesthetic to architects

across the nation (MacKenzie, 2021). What one may have seen as an old building with little to no appeal for modern use is now set to become a lively building with an office space, gym, and even a pool for private members. With rehabilitation to the existing brick and window exterior, the historic building remains in its original glory, and the investments made to protect rather than demolish have considerable sustainable advantages in reducing building waste and cost.

Spokane is home to an array of such historic buildings, some of which have remained abandoned for decades. One such example is the old Coast Trading Company Grain Elevator that is a sore eye for locals travelling on Ruby and Division Street in the University District, shown in Figure 4.



Courtesy of Frank H. Jump

Figure 4. Abandoned Coast Trading Co. Grain Elevator in Spokane, WA

Despite the 1920's building being purchased multiple times by investors pondering possible opportunities, nothing has been done (Crompton, 2004). Considering the perspective of adaptive reuse, this building is not the first of its kind to be an opportunity for reimagination. In Akron, Ohio, the Quaker Square Inn gave guests a one-of-a-kind experience to stay in a grain silo converted into a hotel in the historic Quaker Oats factory (Biliczky, 2013). The once factory of grain silos turned hotel will now serve as a residence hall for students at the University of Akron, seen in Figure 5.



Courtesy of Quaker Square Inn Webpage

Figure 5. Converted grain factory into a hotel at Quaker Square in Akron, Ohio

There is no denying the comparisons to the situation in Spokane, with an amazing template for a unique hotel near Gonzaga University and downtown. Just as seen in Akron, the otherwise unattractive silos have the potential to become a unique place for tourists or parents of students to stay, without the negative environmental effects from demolishing the existing building and constructing something new.

The City of Spokane has a role to play in the potential of these adaptive reuse projects. The voice of authority is an essential component for the urgency needed to combat the impending negative threats of climate change. In the Netherlands, efforts in building green have started with requiring permit applications for new buildings to be nearly all energy neutral starting in 2021 (Bodelier & Herfkens, 2021). With requirements on what is needed to construct a new office building, residence, or other facility, green building should be demanded and not a decision. Stricter laws requiring new construction to follow sustainable guidelines might also encourage investors to look at existing buildings for their projects. These two strategies align perfectly with the SAP's goal of achieving benchmarks in carbon-neutral building science ahead of state mandates (SAP, 2021).

Spokane has seen successful implementations of such reuse projects before. The SIERR building at McKinstry Station is a national standard for reinventing historic buildings. Once a building that had seen years of abuse in the rail industry, the SIERR building was seen for what

it could be instead of being torn down for something else. Receiving a LEED Gold certification for sustainable building, the SIERR building highlights an array of innovative systems that integrate sustainability in the preserved shell of the historic brick building (Budd, Ashraw, & Lang, 2014). An inspiration for the future of the city, the SIERR building is the beginning of a great practice of adaptive reuse for the City's sustainable future. Spokane has the opportunity to become a statewide model for sustainable and reimaged existing buildings.

Steps in planning for the future of the urban built environment should ensure that new and reinvented existing buildings are designed to no longer produce the CO₂ emissions that have negative environmental impacts on the world. From experiencing these practices in the Netherlands, there should be nothing else to do but implement similar practices.

Chapter 4: The Solution in Spokane

Sustainable cities promote social, economic, and environmental impacts to protect the quality of life for future generations. Civil engineers are essential in designing infrastructure that addresses the sustainable needs in a city. Considering the practices in the Netherlands, Spokane can adopt specific requirements for new construction with special considerations for the adaptive reuse of existing structures to meet the outlined emissions goals in the SAP. With large energy consumption, material demand, and waste accumulation from new construction, new strategies must be out in place locally to ensure limited resources are not depleted prematurely.

The City's plan is an accurate and helpful guide for residents and professionals alike. The threats of climate change pose difficulties to our community even more than others with dramatic increases in warmer and drier conditions in the summer, raising the wildfire risk to our beloved landscape. No one wishes for such a catastrophe to happen, but with careful execution of reusing and retrofitting buildings for energy efficiency, the local community can respond to the impending impacts of climate change. Since there is no replacement for our planet, it is the collective duty of people to protect it, and each day that goes by without substantial efforts towards a greener tomorrow is another day too late for future generations to preserve what is left behind.

Works Cited

- Ayers, J. C. (2017). *Sustainability: An Environmental Science Perspective*. CRC Press.
- Benjamin, H. (2015). "Green Homes 101". U.S. Green Building Council, Washington D.C.
- Biliczky, Carol. (2013). "Akron's landmark Quaker Square hotel to close Sunday." Akron Beacon Journal. Akron, Ohio. June 27, 2013.
- Bodelier, M., & Herfkens, J. (2021). *Every New Building in the Netherlands Must Be (Almost) Energy Neutral Starting Jan. 1, 2021*. National Law Review, Volume XI (6). January 6, 2021.
- Budd, D., & Lang, J. (2014). *Sustaining by Preserving*. High Performing Buildings Magazine.
- Calderone, L. (2015). *Retrofitting Buildings to Improve Energy Efficiency*. AltEnergyMag, Huntington Beach, CA. April 3, 2015.
- City of Spokane. (2021). Buildings and Energy. In the City of Spokane's Sustainable Action Plan. Retrieved June 14, 2022.
- Crompton, Kim. (2004). "Granary north of downtown is sold." Spokane Journal of Business. Spokane, Washington. December 23, 2004.
- International Energy Agency and the United Nations Environmental Programme. 2021 Global Status Report: towards a zero-emission, efficient and resilient buildings and construction sector. October 2021.
- KIRO 7 News Staff. "Statewide plastic bag ban now in effect." KIRO-TV affiliated with CBS. Olympia, Washington. October 1, 2021.
- Langston, Craig A. (2008). *The sustainability implications of building adaptive reuse*. Mirvac School of Sustainable Development, Bond University. Gold Coast, Australia. November 3, 2008.
- MacKenzie, Iain. (2020). Renovation and Addition to Historic Troy Laundry Planned. Next Portland LLC, Architecture and Development in PDX. June 12, 2021.

Oregon Department of Energy. (2020). ODOE Sustainability Plan: 2021-2024. Salem, Oregon. December 4, 2020.

Pipa, A., Rasmussen, K., & Pendrak, K. (2022). “The state of Sustainable Development Goals in the United States.” Brookings Center for Sustainable Development. March 16, 2022.

U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) (2021). Highway Statistics 2019.

Walker-Morrison, A., Grant, T., & McAlister, S. (2007). *The Environmental Impact of Building Materials*. BEDP Environmental Design Guide. RMIT University – Centre for Design, Melbourne, Australia. May 2007.

Zoutewelle, Ilse. (2017). We can eat pizza and pastain the old station. Indebuurt News. Delft, Netherlands. March 31, 2017.