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CENG 440

Final Report

Innovation Hub for Sustainable Development Proposal

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Abstract

This report culminates research completed in the Netherlands on sustainable cities, specifically covering the Buildings & Energy area of action from Spokane's Sustainable Action Plan (SAP). The report includes an examination at the importance of sustainable development in cities, the role of civil engineers in sustainable development, various Dutch sustainable solutions relating to buildings & energy and a proposal for an innovation hub for sustainable products and practices in the Spokane area.

Building a Sustainable City

A sustainable city considers economic, social, political, and environmental factors when approaching types of infrastructure with the goal of sustaining the city for future generations. The United Nations has a Sustainable Development Goal (SDG) related to sustainable cities including Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable (United Nations, n.d.). Based on this goal, for a city to be sustainable efforts must focus on the cross-section between the development of civil infrastructure supporting anticipated growth of a population in the coming years and major considerations of economic prosperity, environmental conditions, public health and wellbeing. Striking a balance between these issues is the fundamental practice of sustainable development in the United Nations SDGs, the Netherlands and growing cities around the world including the US.

During the 18th century in Europe and the 19th century in the United States large quantities of people moved towards cities due in part to the Industrial Revolution as professional opportunities increased in cities. In 1800 more than 90% of the global population lived in rural regions and in the United States it was 94% (National Geographic Society, 2021). By 1900, rural regions accounted for 60% of the US population and in 2020 was reported at 17.34%, displaying a steadily decreasing population over the last century as shown in the below Figure 1 (Trading Economics, 2022). It was not until 2008 that the world's urban population outnumbered the rural population and current estimates suggest that two thirds of the world's population will live in cities by 2050 (United Nations, 2022). Growing populations in cities has and will continue to increase the importance of making cities sustainable, in additional part due to climate change related environmental effect.

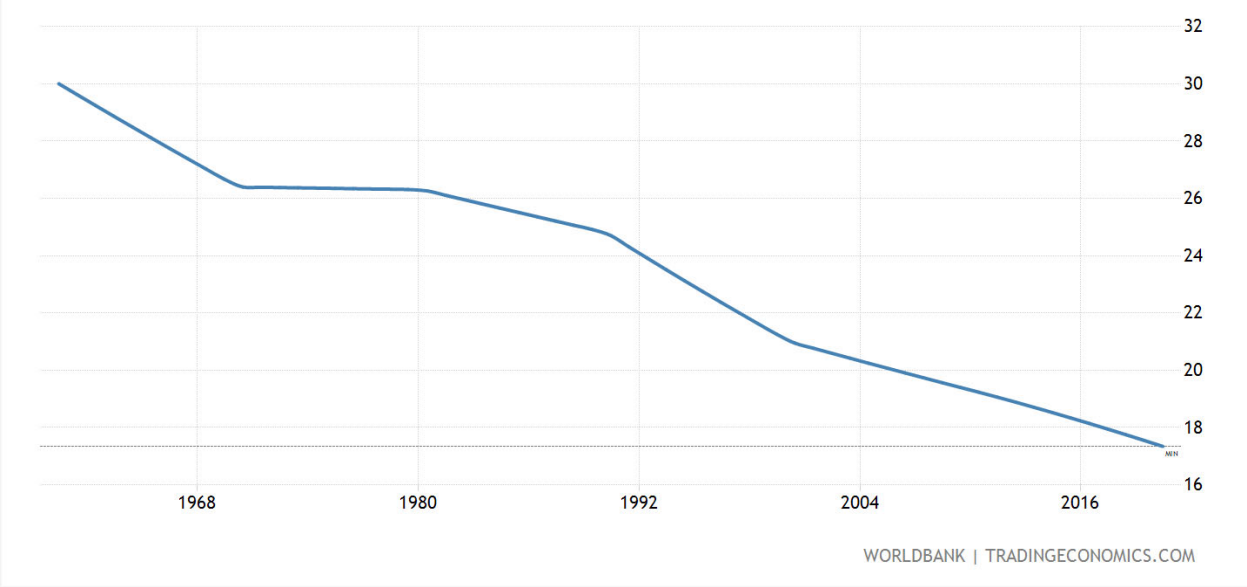

Figure 1 – Rural Population as Percentage of Total in United States (Trading Economics, 2022)

Around the world cities often operate independently from one another in terms of economic trade, social, political, and cultural practices, and religious conviction. With the intent of maximizing the effectiveness of sustainable development approaches, synthesizing a specific development plan for a particular city takes into consideration these and many more aspects of life resulting in an improved fit for the city. The culture of a city becomes highly relevant when implementing sustainable development plans as there may exist major cultural differences between cities and towns within individual countries. The Netherlands recognizes these differences and integrates city culture into the development of new sustainable infrastructure, which subsequently functions much more effectively. Recognizing important differences between cities allow for unique approaches to sustainable cities and promotes the potential for city-to-city comradery around sustainability, furthering global efforts toward sustainable living.

Civil engineers play an important role in promoting and developing economically, socially, and environmentally sustainable urban environments through technical understanding and problem-solving experience. For a purely economic consideration, practicing engineers will have the best understanding of the costs involved in effectively designing and completing different projects. A construction management engineer with experience in city planning will be able to inform decisions surrounding design approaches in sustainable cities and follow through on issues that arise during that process. Transportation engineers can effectively develop plans and inform

decisions for the use of roads, arterials, walking paths, bike routes, metro and railway throughout a city under varying conditions. Environmental engineers have the expertise to support the development of city-wide sustainable infrastructure and evaluate the long- and short-term environmental impacts of different approaches. Water and wastewater engineers have the resources to develop and maintain facilities for transporting and disposing of water and wastewater within city environments. The practical, technical skills of civil engineers provide an effective approach to developing sustainable city infrastructure while prioritizing economic, social and environmental conditions.

The Importance of Buildings and Energy

The area of action associated with buildings and energy from Spokane's Sustainability Action Plan (SAP) aims to improve energy efficiency and renewable energy use in new construction and upgrade existing facilities to meet renewable energy standards set by the WA Clean Buildings Act concerning Energy Use Intensity. This area also focuses on promoting local renewable energy production by investing in community-scale energy generation and storage systems, harnessing energy through waste resources and neutralizing carbon emissions from buildings and transportation. The final piece in this area includes garnering community engagement in renewable energy and energy efficient practices through public outreach and education alongside regional building and energy organizations. These building and energy goals outlined in Spokane's SAP are central to city sustainability as it pertains to two major pieces of civic infrastructure necessary to the city and its people: buildings and energy.

With limitations in the local economy, efficient building practices are necessary to sustain a city for future generations, especially when considering variable conditions in the global economy affecting local construction supplies and worker availability, local weather conditions, a changing climate, and unforeseen pandemics. Growing populations requires the construction of new facilities and retrofitting of old buildings to keep up with demand for residential, commercial and other urban spaces. Efficient energy use and production becomes increasingly important when considering the growing threat and impact of global warming on our cities. During periods of global economic crisis, the issue is further magnified and solutions increasingly desirable. A brief

overview of some of the relevant solutions adapted from the research conducted in the Netherlands in accordance with the Spokane SAP are outlined below.

Modular construction is a prevalent practice in the Netherlands where sections of a building are manufactured in a factory and assembled in the field thus minimizing energy consumption, reducing material waste and decreasing carbon emissions. Improvements on construction time, productivity and material sustainability further decreases the environmental impact of construction projects utilizing modular design. Examples of modular design in the Netherlands include residential housing, hotels, bathroom pods, office buildings, tiny homes and floating homes (DMT, 2022). Given the Netherlands' abundance of canals and general lack of building land, tiny and floating homes are becoming increasingly popular and speaks to their cities' very high population density. In the United States modular construction is on the rise with a compound annual growth rate of 4% and approximately 200 companies operating as of April 2021 (O'Malley, 2021). In the context of Spokane, modular building will become increasing relevant as construction space decreases and rapid construction to fulfill a growing population increases.

Green roofs and facades are used throughout the Netherlands to benefit the environment through improved air quality and preventing heat islands in cities. Extreme heat related deaths in the United States are reported annually at 600 and an average of 65,000 hospitalizations. Spokane has significant issues with heat islands and current work is being completed to evaluate the issue in depth as it effects citizens across the city (Gonzaga, 2022). For cities like Amsterdam and Rotterdam in the Netherlands, incorporating green spaces, planting trees and installing green roofs and facades has become a consistent approach to limiting the heat island effect. This approach would improve Spokane's heat island related health issues and environmental effects from increased civic temperatures.

Repurposing older buildings and energy efficient retrofitting promotes environmental improvements by avoiding new construction and improving energy consumption. This practice is included in the circular economy production and consumption model where processes are regenerative by nature and materials are designed to be reused and repurposed for as long as possible. This process decreases the economic burden of large construction projects, decreases the overall material waste as well as decreasing overall carbon emissions. The high population density

of cities in the Netherlands comes as a result of highly efficient and effective repurposing of old buildings. With buildings dating back to the 10th century, Dutch cities retain their cultural heritage by repurposing these building and making energy consumption improvement in order to maintain environmental standards (Heilmeyer, 2021). In addition, repurposing old industrial facilities allows for the reclamation of large city spaces without the material waste and additional construction costs associated with demolition. Spokane could benefit economically from similar construction practices in the downtown and the industrial district while also preserving civic heritage and historic charm.

Another solution for sustainable building and energy is developing a center for public engagement and sustainability innovation. Various projects have been developed in the Netherlands that organize a city's sustainability entrepreneurs to encourage their work and inform public awareness of sustainable practices. The observed facilities come in the form of repurposed central buildings to encourage its exposure and relevance, large field labs where research can be conducted, or university spaces where innovators can work with university staff to develop effective solutions. Spokane currently has a sustainability focus and culture that promotes environmentally friendly ways of life. By creating a similar confluence of these efforts in the form of an innovation hub could promote further progress and stimulate public awareness.

Innovation Hub

The strategy proposed here is an innovation hub for sustainable products and practices that unifies Spokane's efforts toward sustainable development. Imagine a facility that provides a platform for innovating sustainable solutions and promotes education and awareness of sustainability. A collaboration across backgrounds working toward a unified goal of developing a more sustainable world and a better future. The proposal of an innovation hub is inspired by two important organizations in the Netherlands: BlueCity and The Green Village. Located at the heart of Rotterdam, the major southern port city in the Netherlands, BlueCity is an icon for the idea of circular economy as it provides a space for circular entrepreneurs to innovate, develop products and share their work with the city and the world. Like Spokane, Rotterdam has an innovative spirit surrounding the environment and a culture to support growth in this area. In 2015, BlueCity took a derelict swimming pool building and with the notion of circular economy transformed the facility

into an epicenter for circular innovation that inspires the city and the world about the importance of this aspect of sustainable development. The facility, pictured below in Figure 2, includes desk space, areas for collaboration and events, individual workspaces and underground labs where entrepreneurs can develop their innovations. Providing free access to the facility for tours, education and regularly hosted events, BlueCity has grown into a destination for locals and tourists alike to discover circular innovation in the Netherlands (BlueCity, 2022).

Figure 2 – BlueCity Former Swimming Pool Area (BlueCity, 2020)

The Green Village has created a similar space for sustainable innovation of any kind on the campus of TU Delft, a highly ranked technical institution in Delft, Netherlands. As a field lab for sustainable innovation, The Green Village promotes sustainability by providing a physical space for university staff, entrepreneurs, government bodies, students and local citizens to research, build and develop their sustainable innovations, and share those solutions with the world. With opportunities for tours, events and education, the space has become a center of collaboration for entrepreneurs, educators and anyone interested in developing solutions for the future. Among the innovations in The Green Village are: Bluebloqs, an urban circular water system that collects and

prevents flooding during rainstorms and conversely collects and makes rainwater available during periods of drought; Rainroad, a below pavement water reservoir that cools roads during hot days and provides buffer capacity during heavy rainfall designed specifically for implementation in high density city environments; the Ruisdael Observatory, a nationwide atmospheric observatory that models small scale atmospheric conditions in order to make highly detailed weather forecasts that are very useful in the chaotic weather conditions of the Netherlands; and TILER, a ground imbedded charging tile for e-bikes (The Green Village, 2022a, 2022b, 2022c, 2022d). The facility, displayed below in Figure 3, boasts several other solutions and space available to entrepreneurs for continued innovation as well as a newly erected meeting hall (not pictured) made entirely of glass where innovators can host discussions, presentations and collaborate on future projects.

Figure 3 – The Green Village (Do IoT Fieldlab, 2020)

Taking inspiration from these two organizations, Spokane's sustainable innovation hub would encompass the best of the city's culture and drive for success while promoting the need for

sustainable development. Associated with Spokane's SAP Buildings & Energy "Goal 3: Engage community in energy efficiency and renewable energy", an innovation hub would promote Spokane's sustainable development goals and spread public awareness about the city's efforts while inviting the general public to engage in fortifying their future (City of Spokane, 2021). By supporting the development of entrepreneurial solutions, sustainable innovations can be synthesized specifically for the city by local citizens supporting both the economic outcome and environmental well-being of the region. A hub of this type would allow for companies to centralize their efforts and through comradery would promote Spokane's SAP goals even further. Systematic celebration of individual's and company's efforts would promote local pride and morale about sustainability. Forging a sustainable future requires engaging the adults of the tomorrow: by setting up the facility for tours and engaging in the education system, students in Spokane's public school district can learn early on ideas of sustainability and innovation as it pertains to their own city.

An earnest consideration for developing this facility would be renovating the Jensen-Byrd Hardware building in Downtown Spokane given its central location and proximity to many downtown restaurants and popular shopping destinations. Essential to effective public awareness is the location of this facility. Relevancy can be incited through physical proximity to Spokane citizens and visible promotion of its presence. While a location outside of the downtown area may remain functional, a more centrally located facility would promote the importance and relevance of sustainability in the minds of Spokane's general public. In addition, proximity to regularly used facilities such as restaurants, shops, performance venues, office buildings, etc. presents easier accessibility and advertisement to citizens and visitors.

Aligned with Spokane's affinity for outdoor recreation and natural attractions are concerns for the environment and impacts of a changing climate. While Dutch concern for a changing climate comes more into play with flood potential due to their proximity to the ocean, its relevance in both societies is irrefutable. Sustainable innovation has become a trend in the Netherlands and is successfully promoted and played on by facilities like innovation hubs due to cultural relevance. Spokane's growing concern for the environment, especially within the expanding younger generation, can be harnessed through an innovation hub and subsequent efforts directed toward Spokane SAP goals.

A potential difficulty with implementing an innovation hub in Spokane relays back to selecting an optimal location. Establishing an innovation hub in a central location where citizens and tourists have access to the facility and may naturally stumble upon it is essential to its success. The facility acts as a vehicle for educating the public about sustainable innovations and central locations promote messages more effectively than abstract ones, despite additional advertisement. Like the BlueCity in Rotterdam, a central location provides implicit advertising for the facility and the cause of sustainable development. Alongside this consideration is developing a memorable and visible symbol for the hub. The innovation hub represents the city's efforts toward a sustainable future and without a visible symbol these efforts lack the iconic nature that effectively communicates to large audiences. Navigating the optics of the innovation hub presents the greatest challenges as this symbol must coincide with the culture of Spokane in addition to relevant to sustainability.

Conclusions and Recommendations

When considering a city to be sustainable, a balance must be struck between the development of civil infrastructure for future growth and major considerations of economic prosperity, environmental conditions, public health and wellbeing. Civil engineers play a crucial role in developing sustainable infrastructure due to technical background and experience with real-world projects. By proposing the innovation hub for sustainable products and practices, this approach aims to unify the city's efforts towards sustainable development and ignite a cultural movement toward sustainable development in Spokane through education, innovation and practical solutions. This approach relates to Goal 3 from the Buildings & Energy area of action from Spokane's SAP, "Engage community in energy efficiency and renewable energy", however moves beyond buildings & energy by potentializing solutions across the other areas of actions. New and innovative ideas carry the future of sustainability and by facilitating the cultivation of sustainable solutions the city can also promote cultural support for sustainability.

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