A Tale of Green Cities

Exploring Opportunities for Minnesota through the Natural Step Process and Sustainable Communities in Sweden

Alison Lindburg

Dr. Jeff Howe
Dr. Steve Bratkovich
Kathryn Fernholz
Dr. Jim Bowyer

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Introduction

In 2009, a member of the Dovetail Partners team traveled to Sweden for five weeks to examine sustainability initiatives in Swedish communities, including the Natural Step process. Based on similarities in climate, population density, and environmental challenges, it is conceivable that many of the observed practices could be implemented in Minnesota and other Great Lakes communities as well. This report provides background on Swedish communities visited on the tour and highlights strategies employed by communities, companies, and various organizations to move toward sustainability goals. The report covers areas pertaining to waste management practices, renewable energy production and consumption, utilization of local resources, sustainable forestry, water quality, and environmental education, and offers some suggestions for implementation in Minnesota and other North American communities.

Trip Background

The communities and businesses represented in this report were visited as part of the Rotary Foundation's Group Study Exchange (GSE) program[2]. The trip, sponsored by Rotary District 5960 of Minnesota and Wisconsin, and hosted by Rotary District 2360 of Sweden, occurred in March and April of 2009 over a period of five weeks, and involved travel throughout Western Sweden. GSE tour participants visited over 80 different businesses and organizations, and stayed with host families in eight different Swedish communities.

Demographics of Minnesota and Sweden

Minnesota and Sweden are similar in terms of population density, climate, forest types and landscape, and environmental challenges.[3] The country is also similar to other parts of the Great Lakes region. Based on these similarities, there may be opportunities for applying lessons learned about eco-communities on the GSE trip to Minnesota and other North American communities.

Minnesota

The state of Minnesota has a population of 5.2 million and a landmass of roughly 87,000 square miles. The Twin Cities of Saint Paul and Minneapolis are the largest urban area in Minnesota, with 60% of the state's population. The average population density statewide is roughly 59 people per square mile.

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[1] For clarification: this tour was not part of the Sustainable Sweden Association' tour program
[2] http://www.rotary.org/en/serviceandfellowship/fellowship/GroupStudyExchange/Pages/ridefault.aspx
[3] For information comparing forestry in Minnesota and Sweden, see the Dovetail Report, *Learning through Comparisons: A Look at Forestry in Minnesota, Ontario, Finland and Sweden,* available at http://www.dovetailinc.org

Minnesota's landscape is characterized by intensive agricultural production in the southern and western regions, and forestry and mining activities in the northern regions. Minnesota is called the Land of 10,000 Lakes, and is known for its recreational activities involving water and the outdoors. Duluth is home to the United States' largest inland harbor. The climate of Minnesota can be described as "extreme," with four seasons and temperatures ranging from -60F in the winter to 114F in the summer.

Natural resource based industries are a prominent part of Minnesota's economy. Agricultural products, forest products (including paper), and iron ore are among the goods derived from Minnesota's natural resources. Minnesota is known for its advanced technology, manufacturing, health care research facilities, and educational institutions. Minnesota ranks among the nation's top five producers of ethanol (from corn) and wind energy. Tourism is also a major revenue producer in Minnesota, with arts, fishing, hunting, water sports, and winter sports bringing millions of visitors each year. The State is home to nineteen Fortune 500 and thirty-six Fortune 1000 companies. The rate of unemployment in Minnesota as of June 2009 was 8.4%.

Sweden

Roughly 9.2 million inhabitants populate the country of Sweden across a land mass of roughly 174,000 square miles. About 85% of Swedes live in the metro areas of Stockholm, Gothenburg, and Malmö. The average population density for the country as a whole is roughly 53 people per square mile.

The extreme southern and western borders of Sweden are defined by coastal and fishing regions, while inland the south is largely dedicated to agriculture, with forests predominant in the central, northern, and western portions of the country. Göteborg is home to the largest harbor in Scandinavia and Lake Vänern is the largest lake in Sweden and the third-largest lake in Europe. Sweden is sometimes referred to as the Land of 100,000 Lakes. Swedes are very connected to nature and outdoor recreation, especially sailing, hiking, and winter sports. The climate of Sweden is temperate, with four changing seasons. Seasonal temperatures range from about -15F in winter to the low 90'sF in July-August. Fifteen percent of Sweden is located above the Arctic Circle and experiences no daylight during the middle of winter and no darkness in mid-summer.

The economy of Sweden is diverse. Forestry, iron ore extraction, hydropower production, agriculture, pharmaceuticals, automotive production, engineering and design, and telecommunications are a few of the main industries of Sweden. Like Minnesota, outdoor recreation and tourism are large industries. Several major companies are headquartered in Sweden, including IKEA, Volvo, Saab and Ericsson. The unemployment rate as of May 2009 was around 9%.

Education in Sweden (including University education), health care, and elderly care expenses are provided for by the federal government. Taxes in Sweden are among the highest in the world, and Swedes are taxed on the national, county, and municipality level. In comparison to the United States, the total tax revenue portion of GDP for Sweden in 2007 was 48%; compared to 28% for the U.S. In terms of income tax, the top rate in Sweden is 57% (when national and municipal taxes are taken into account) and 35% in the United States.[4]

[4] The top corporate tax rate in the U.S is 35% while the corporate tax rate in Sweden is 28%.

The Natural Step

Many methods and planning tools exist to aid communities to become more sustainable. The Natural Step[5] framework was developed in Sweden in 1990 to fulfill a need for a set of principles that could guide human actions toward a more sustainable path regardless of the starting point. The Natural Step framework uses a science-based approach to deal with complex systems, taking an upstream approach to problem-solving that addresses all departments and facets of a community.[6] Natural Step can be applied at any structural level of a government or organization. There are many examples of projects worldwide that have utilized the Natural Step, and two were encountered on the GSE Sweden trip.

The Natural Step provides *Four System Conditions*[5] that must be met in order to frame sustainable solutions.

> 1. *In the sustainable society, nature is not subject to systematically increasing concentrations of substances extracted from the Earth's crust.* Matter cannot be created nor destroyed, meaning that anything mined from the earth cannot be permanently disposed of, and chemicals and toxins created from earth's minerals do not simply disappear over time. Anything humans bring into the atmosphere is forever there.
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> 2. *In the sustainable society, nature is not subject to the systematically increasing concentrations of substances produced by society.* Humans are creating synthetic substances much faster than they can be broken down. Of the over 70,000 chemicals in common use, many do not break down easily and can move easily into other ecosystems. Some chemicals are known to cause cancers, interfere with brain development, and are increasingly found in many species of animals, including humans.
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> 3. *In the sustainable society, nature is not subject to systematically increasing degradation by physical means.* Natural systems, such as land, water, forests, soil, and ecosystems not only provide humans with places of recreation and peace, but are also life-support systems for oxygen, water, food, and carbon sequestration. Human activity is currently breaking down natural systems faster than they can replenish themselves.
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> 4. *In the sustainable society, people are not subject to conditions that systematically undermine their capacity to meet their needs.* In order for sustainability to succeed, the basic human needs of air, water, food, and shelter need to be satisfied first.

Four *Sustainability Objectives*[5] can be translated from these system conditions:

1. Reduce wasteful dependence upon fossil fuels, scarce metals, and minerals that accumulate in nature.
2. Reduce wasteful dependence upon chemicals and synthetic substances that accumulate in nature.
3. Reduce encroachment upon nature.
4. Meet human needs fairly and efficiently.

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[5] *The Natural Step* [http://www.naturalstep.org/]

[6] Including Housing, Transportation, Public Facilities, Historic Preservation, Recreation, Natural Resources, Economic Development, Land Use & Regulation

In Sweden, the Natural Step approach outlines a basic societal point-of-view. Not all communities and businesses visited on the trip make use of the Natural Step process, but most incorporate the general principles into everyday practice, often without realizing the approach had a formalized name. IKEA and the Scandic Hotel were among the organizations visited that are formally using the entire Natural Step process. The Natural Step framework could provide a useable framework for communities and organizations in Minnesota.

Introduction to Communities

Since 1995, the Swedish government has adopted national sustainability objectives to be met by all levels of government within the country. Communities meet these goals in their own ways, and usually then set goals beyond the national goals. It is the responsibility of the municipalities and communities to meet all goals using their own funding, which typically comes from local taxes.

GSE participants visited Västra Götaland län in western Sweden

The national government of Sweden has committed to reduce carbon emissions, limit energy consumption, and be one of the leading producers of renewable energy in the world. Consequently, following adoption of both the Kyoto Protocol and Agenda 21, energy planning for many Swedish communities began as early as 1995. The result can be seen in national statistics: the renewable proportion of energy use of dwellings, increased from 32 to 75% from 1990 to 2006[7]; while the proportion of renewable energy in district heating increased from 24 % to 55 %.[8] Landfill waste diversion is 96%; and 85% of PET[9] bottles are recycled or returned.[10] In addition, Sweden has a per capita energy consumption of 5,780 kilograms of oil equivalent per person, compared to 7,885 in the United States (Ewing et al. 2008).[11]

Swedish lands are broken into governmental bodies comparable in size and function to U.S. states, counties, and cities. A *län* translates into "county" and is similar in size and function to a small-sized American state. A *kommun* translates into "municipality" and is similar in size and function to an American county. A *kommun* typically consists of one city of significant population and its surrounding smaller towns and lands. A listing of the communities visited and an overview of the practices highlighted in this report are provided in Table 1 (following page).

[7] excluding electricity and district heating

[8] Wood fuels, including pulping liquors, are the source of 23% of renewable energy.

[9] Polyethylene terephthalate, the type of plastic labeled with the #1 code

[10] Compared to about a 22% PET bottle recycling rate in the U.S.

[11] www.footprint.org/en/index.php/GFN/page/methodology/

Table 1. Listing of Communities and Practices Highlighted in this Report

Name	Population	*Sustainability Goals*	*Overview of Best Practices*
Alingsås	37,300	Improve sustainability and the quality of life.	Passivhus, non-expansive development, pedestrian & bike-friendly infrastructure, existing housing, local materials, wind energy
Vänersborg	37,000	Clean water, fair trade, and clean energy.	Community education on water & waste management, biogas from organic waste, cooperation at county & local levels, hydropower, heat conversion from smelting plant to district heating, Frugården farm & forestry, wind energy plan, renewable energy vehicles.
Uddevalla	51,000	Increase sustainability & renewable energy use.	Certified to EMAS, sustainability coordinator in all sectors, involvement at all levels, employee & community education, district heating, renewable energy from trash, proper medication disposal.
Trollhättan	54,300	Decrease reliance on fossil fuels by 50% by 2010, by 90% for municipal offices	Hydropower, Agenda 21 goals, energy use reduction, roundabout installation, renewable fuel cars, no idling, green tourism (Scandic hotel & the Natural Step), solar energy production.
Göteborg	500,000 (900,000 in metro area)	Utilize technology, address unsustainable practices and create public policy in a new way, Göteborg 2050.	Collaboration with universities, fuel-saving driving techniques, green manufacturing & LCA, green shipping, IKEA & the Natural Step, prefabricated housing, public education & EkoCentrum, urine-separating toilets, KRAV.
Strömstad	11,600	Balanced and sustainable development, where food quality, environmental and cultural values are reinforced.	Agenda 21 goals, "Fair Trade City", "Heat Pump City" (over 50% use some type of heat pump), EkoPark & community education.

Alingsås

The municipality of Alingsås, population 37,300, is located in Västra Götalands *län* (county) in Western Sweden. The town of Alingsås is the seat of the municipality, with 26,000 inhabitants. Historically the economy was based on manufacture of textiles and clothing; today the main industries include high-technology and manufacturing of sheet steel, stoves, and dishwashers. The city has won awards for its historically preserved town center and pedestrian-only streets, and annually hosts thousands of visitors for "The Lights of Alingsås" celebration, where innovative lighting designers create exhibits that are on display during the month of October. GSE visits included the Alingsås town hall, Passivhus Centrum (an educational facility on Passivhus construction), Futurum (a non-profit community planning organization), a city architect and planner, FlexoPrint Paper Company, an organic farm, and a community-owned wind turbine.

Celebrating 400 Years

The city of Alingsås has established community-wide sustainability goals as part of an initiative called Alingsås 2019, which will be the city's 400-year anniversary. The goal-setting process involved input from citizens and the local government (which makes up 30% of the local workforce). One component of the goal identification process included looking to regional neighbors Denmark and Norway for additional ideas on sustainability.

In Alingsås, tour participants learned about sustainable city planning and the Passivhus concept.

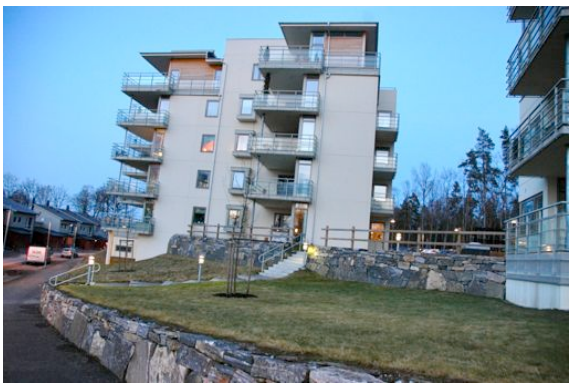
The main goal of the Alingsås 2019 initiative is to move toward sustainability and to improve the quality of life of inhabitants. The city wants to grow in population to 42,000 by 2019 and hopes to achieve this in a sustainable fashion that includes limiting the geographic expansion of development. The city's development plan includes the addition of two thousand new energy-efficient housing units, one thousand of which will be in the new Stadsskogen[12] development, located on previously undeveloped wooded land in the Alingsås city limits. The project was designed so that the homes will be constructed in clusters with trees preserved. Three hundred units have already been completed in a range of housing types; single-family, multi-family, townhomes, and "multi-generational" houses for larger-sized families, which are common in Sweden. Biking and walking trails are scattered throughout the development, and the bus and train are within walking distance. The project involves many different developers, builders, and architects working on different parts of the property, which creates architectural diversity in the development. Stadsskogen also includes an elementary school built to the Passivhus[13] standard. While some negative reactions to Stadsskogen's modern architectural style were initially received, many in the community agree that the trees are more noticeable than the buildings, and that taking the environment into consideration was the right thing to do.

[12] "city in a forest", http://www.stadsskogen.se/

[13] "Passivhus" is called Passivhaus in Germany or Passive House in the U.S. For Europe, a Passivhus's total primary energy use for all appliances, domestic hot water and space heating and cooling must be less than 120 kWh/m^2/yr. See the following paragraphs for more information.

Green Buildings – New and Existing

One sustainability goal of Alingsås 2019 is improved energy efficiency of buildings. Sweden's national energy target for buildings is 110 kWh/m^2 based on a blower-door test. In Alingsås the suggested target is 90 kWh/m^2, meaning a much tighter and more energy-efficient building. Alingsås is also investigating wind energy possibilities, and is one of seven cities participating in REBECEE[14], or Renewable Energy and Building Exhibitions in the Cities of Enlarged Europe. The goal of REBECEE is to promote renewable energy heating/cooling applications and energy efficiency solutions for buildings.



Multi-family housing at Stadsskogen.

To hit their energy efficiency goals, Alingsås gives preference to Passivhus designs in local building policy. The idea of Passivhus buildings originated in Germany and Sweden and is gaining popularity as a way to build extraordinarily energy-efficient structures. Passivhus buildings are super-insulated and sealed extremely well, and are heated using primarily body heat and heat from appliances. A heat recovery exchange system is typically installed to circulate air and promote good indoor air quality. A secondary heating system can be installed if desired, but most Swedish builders believe it is unnecessary. The Passivhus Centrum, which provides technology and technical education around the Passivhus concept, is located in the heart of Alingsås.

Like Minnesota, Sweden has the challenge of making existing housing more sustainable and energy-efficient. The Brogården multifamily project in Alingsås used the Passivhus standards to guide energy renovations. New windows, balconies and cladding were added, and more insulation was incorporated into the walls. Although no insulation previously existed beneath the foundations of the 1960's-built buildings, added insulation in the basements proved beneficial. After the renovations were complete, energy consumption was cut by more than 55 percent, with energy efficiency improving from 216 kWh/m^2 to 92 kWh/m^2.

Another community goal is to encourage walking and better health. Obesity is becoming a concern in Sweden, and there is interest in building "living areas" instead of just houses. One main objective is that people of all ages should be able to live, work, and learn in Alingsås. This includes incorporating the concept of Universal Design to ensure buildings can sustain multiple uses and generations. Choosing door handles and faucets with levers instead of knobs, including wide doors for wheelchair access, installing rocker light-switches, and locating all necessary amenities (bathroom, kitchen, bedroom) on one level are all universal design concepts.

Alingsås also focuses on transportation as part of their sustainability initiative. Similar to Minnesota, Sweden's infrastructure is automobile-heavy as a result of developed areas stretched over long distances. Alingsås encourages bike commuting, and has an objective to be known as the

[14] http://www.rebecee.de/

"bike town". The community provides free biking maps of local trails and bike-friendly streets, and has committed to ensuring that every resident is within 3km (1.8 miles) of a biking route.

Alingsås is bike-friendly and contains many pedestrian-only streets.

Incorporating the use of local materials is also one of Alingsås's goals. The region is heavily forested, and like much of Sweden, most buildings are made from wood. Using local wood saves money, supports local industries and reduces carbon emissions. Alingsås is called the "wooden city" due to the large number of historically preserved 18th and 19th century wooden buildings. Wood is also widely used as a heating source because it is locally available and renewable.

Renewable Energy

Like many Swedish communities, renewable energy is being researched and implemented in Alingsås. Besides using locally harvested wood for energy, wind power is also gaining in popularity. One community just outside of Alingsås built a cooperative local wind turbine. The effort was led by a local organic farmer who began researching the idea in 2000 and was met with challenges of finding a nearby power station close enough to land in which nearby property owners were comfortable with a wind turbine near their property. In 2008 three potential plots were identified and an informational meeting was held in hopes to generate interest as well as tactical and financial support from the local community. In order to keep profits and decision-making authority in the hands of community members, financial investment was limited to only people living within the community. Financially the community needed to provide 30% of the funds in order to secure a bank loan for the rest. At that first meeting, over 150 people wanted to sign on immediately, resulting in twice as much money being raised as was needed to secure the loan. The wind turbine began producing energy in September of 2008 and six months later, based on a combination of local support and energy generated, had almost paid back the bank loan (equivalent to $1 million USD). The farmer who initiated the project stated that not only did the wind turbine produce renewable energy, but it also returned the power of energy production back into the hands of the farmers and the local community, who generations ago used their own windmills for power.

Vänersborg

Vänersborg is the name of a city and municipality located in Västra Götalands county in western Sweden. The city of Vänersborg has a population of around 22,000 inhabitants of the total 37,000 in the municipality. Vänersborg is located on the southern tip of Lake Vänern, which is the largest lake in Sweden. Principal areas of commerce include automobille production, metal manufacturing, business, tourism and trade. Vänersborg has created a comprehensive plan for a community-based sustainability initiative. Part of this includes dedication to clean water, fair-trade, and clean energy. The places visited during the Vänersborg stay included Frugården (a farm), Värgon Alloy (a smelting plant), the Vänersborg municipality planner, and Ragn-Sells Heljestorp AB (a waste management facility).

Clean Water, Clean Energy and Waste Management

Clean water is a priority in Vänersborg. Lake Vänern is the largest lake of the roughly 100,000 in Sweden and the third-largest lake in Europe. The national goals for water include "no europhtication[15], healthy lakes and water, and a toxin-free environment." Both the Vänersborg municipality and the Västra Götalands county created local initiatives to meet these goals and to also restore marine wildlife and their habitats. As part of this initiative community education programs and brochures about fishing and polluting were developed, and a program of intensive, regular environmental monitoring was initiated. Through new regulations also held local businesses responsible for cleaning up pollutants.

At the Ragn-Sells Heljestorp AB plant in Vänersborg, organic waste is converted into compressed biogas for automobiles.

Clean energy is also a goal in the community of Vänersborg. This has been realized through adoption of a strategy that combined hydropower from a local river, biogas from in a new production facility, and heat from a local smelting plant to power the communities' district heating plant. The clean energy goal has a direct connection to the innovative solutions to waste management initiative that is also underway in Vänersborg.

Along the tour of Vänersborg and surrounding region, red and green plastic waste bags could be found in homes and businesses in addition to designated places to separate items for recycling. Organic material is sorted into green bags, and burnable non-recyclable waste is sorted into red bags. Larger or hazardous items are taken to separate waste facilities, and recyclable materials are dropped off at recycling centers typically located in grocery store parking lots. In Sweden it is common that product manufacturers are responsible for what happens to their packaging. This has created an incentive in the country to use packaging that can be recycled or burned so the manufacturers do not have to pay for its disposal.

At the Ragn-Sells Heljestorp AB waste management plant in Vänersborg, the green and red bags are collected and the green bags are processed into biogas (in compressed air form) to fuel vehicles. The plant has been running for 9 years, and with 2,000 trucks used for collection, it is the largest waste handling company in Sweden. The plant receives on average 70,000 bags a day – 25,000 of which are green bags. Each green bag creates enough biogas to drive a car for 2.5 km (1.5 miles),

[15] Eutrophication is an increase in the concentration of chemical nutrients in an ecosystem, in this case, a water ecosystem

and last year the plant produced as much biogas as the petrol equivalent of 1.2 million liters (317,000 gallons)/ In addition to the biogas, the plant also creates liquid fertilizer that is certified by the EU to be eco-friendly. The red bags are transported to other facilities to be burned for energy. Ragn-Sells Heljestrop AB is the only plant in Sweden that is producing biogas from their waste in this particular way.

Heat from the Värgon Alloy plant is transferred to the city's district heating system.

Biogas is changing the way people in the Vänersborg area drive their vehicles. The biogas from Ragn-Sells Heljestorp AB can be used in most cars that run on natural gas, and conversion kits are available for cars that don't. The biogas produced is used to fuel the company's fleet of trucks and the plant's employees use the biogas in their own vehicles. Regarding biogas generally, many cities throughout Sweden use biogas for running buses and taxis as part of their sustainability initiatives, and biogas tends to be less expensive than petrol. In Sweden there is no tax, tolls or registration fees on cars if they produce less than 120 grams of carbon dioxide per kilometer, and parking is reduced or even free for these types of vehicles. This has increased the number of cars that run on renewable energy by more than 30 percent from 2006 to 2007 (Swedish Energy Agency 2008). Many Swedish car companies now make cars that run on biogas or other renewable energy due to demand.

In order to implement the green bag/red bag program successfully, public education was needed. A large booklet was provided to every household, a television campaign was waged, and a website and free demonstrations helped explain waste separation into the red and green bags. The program began ten years ago with 175 users; now 200,000 people participate.

The city of Vänersborg is partially heated by excess heat from the Värgon Alloy smelting plant. Värgon Alloy is located in the city limits and primarily manufactures FerroChromium, a ferroalloy for making stainless steel. The plant began transferring excess heat from the high-temperature smelting process into the city districting heating system through an energy recovery system in 1983. Through this system, 50% of energy produced can be recovered. The plant typically produces 40-50% of the city's heat and at peak production it can supply up to 90%. The company facilities are also heated through this system. Due to Sweden's sustainability initiatives, Värgon Alloy itself has increased its sustainability practices in the last few years, including improving water quality, minimizing chromium leakage in dust dump sites, and reducing CO_2 emissions. The company complies with REACH[16] standards and follows ISO 14001 and 9001 standards.

Farm Forestry

The farm Frugården is a good local example of sustainability through self-sufficiency. It is located on the peninsula of Vänersnäs in lake Vänern, about 25km from Vänersborg. The farm dates back to the year 1550, and a large manor house there was built in 1760. Frugården itself consists of 1,000 hectares of forest and 250 hectares of farmland and contains 20 separate rentable homes. While the

[16] Registration, Evaluation, Authorisation and Restriction of Chemical substances. The new EU law began in June 2007.

farm produces mainly forest products it also produces rapeseed (canola) and grain. The wood products that Frugården produces include some lumber but mainly pulp wood and wood for heating. Hunters, fisherman, and beekeepers work and live at Frugården and provide various goods to Frugården and the local community. The owners of Frugården also grow most of their own food, have a composting system, and collect wine bottles to be crushed to make roads along the farm. Despite being a historic farm, inside the main house all of the bathrooms have dual-flush toilets and in-floor radiant heating.

Wind and wood represent two renewable energy resources at Frugården and Vänersnäs.

The forests at Frugården are sustainably managed according to both FSC and PEFC standards.[17] The owner says that he gets a higher price for wood that is certified, and that his lands have always been managed with a forest management plan. The owner recently purchased a wood chipper in order to find a use for branches leftover from milling oak lumber. He plans to chip the wood into fine flakes because they burn better than wood pellets and will be able to be fed automatically into burners he has at the farm. He will use the flakes to heat the farm but plans to sell them as well.

Wood from the local forests is the primary heating fuel at Frugården, as in many homes in Sweden. Most of the 20 rental homes on the property contain wood burning stoves. The large manor and a few other buildings are heated by a wood-fueled hot water heating system, similar to a district heating system. The heating system contains 3,500 L of hot water, which is piped into and out of the house, and is controlled by an electronic system. The wood furnace is located in a small building behind the manor, and is fed twice daily. In the summer the furnace is fed once a week for hot water use in the house. One of the other homes on the property uses an air-to-air exchanger in addition to a wood furnace to maximize energy efficiency. The owner has had such success with this method of heating that he has already laid piping to connect the main hot water heating system from the manor to another house located nearby, and will finish the installation this summer. He estimates that using wood in Sweden is 10% of the cost of using gas heating.

Social Sustainability

Vänersborg municipality has been creating a Green Plan to keep the environment in mind as their population grows to a projected 40,000 by the year 2015. Human health is a main concern under the

[17] The Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification schemes (PEFC) have established international guidelines for responsible forest management.

environmental health category, and three aspects are considered – cultural, social, and biological. Part of the plan includes creating an inventory of existing natural resource amenities and preserving green space. A better biking experience where bikes can go straight through (and cars have to drive around) is another. Like many communities in Sweden, Vänersborg has community gardens available, complete with a water source and a small shed at each plot to hold tools. Identifying potential areas for renewable energy development and increasing energy efficiency are other goals of the municipality.

Tour participants learn about mapping potential areas for wind energy.

Both Frugården and Vänersborg municipalities are interested in utilizing wind energy as a source of renewable electricity. Located so close to the water, the peninsula Vänersnäs, where Frugården is located, has a lot of wind potential. There are already four wind turbines located at one end of the peninsula. The city of Vänersborg is mapping potential areas for wind turbine development, but Vänersnäs is currently not included in the plan, partially because some community members are concerned with how the wind turbines will affect the views of Lake Vänern, and partially because of eagles that nest near the lake. Because these are social and biological concerns, they fit into the three tiers of consideration in the Vänersborg Green Plan, and other areas will likely be targeted for development instead. Wind energy analyses also consider factors such as proximity to buildings (no closer than 5m from a dwelling) and proximity to other wind turbines (preferable to be closer together to be linked to same energy distribution center).

Uddevalla

Uddevalla is the seat of Uddevalla municipality in Västra Götaland county. Uddevalla has a population of 30,513[18], and the municipality has a population of 51,000. The city is located along the western coast of Sweden in the bay of Byfjorden, about 80 km north of Göteborg. Historically Uddevalla was known for its large shipyard, fishing, and trade passage; today the shipyard and fishing are less prominent but the 270 km of shoreline and proximity to both Göteborg and Oslo make it a popular destination for recreational outdoor activities. Information technology and communications are primary industries of this region. Uddevalla is a place for small businesses; out of 3,900 companies and NGO's in Uddevalla, only 75 have more than 25 full-time employees. The largest local employer is the

[18] According to 2005 census

Uddevalla municipality (4,500 employees), and the largest private employer is Pininfarina-Volvo automotive company (800 employees). At the time of the visit, many car companies in Sweden were facing drastic cut-backs due to the world economic crisis, and this was seen in Uddevalla as well. A few places visited on the Uddevalla tour included the Uddevalla municipality office, the Volvo plant, and Uddevalla Energi, the local energy plant.

The office of the Uddevalla kommun is covered in solar panels, and a screen at the entrance displays solar energy production information.

Benchmarking

One of Uddevalla's environmental goals was to certify the municipality to the European Union's Eco Management and Audit Scheme (EMAS)[19], which helps organizations report, evaluate, and improve their environmental performance. Environmental coordinators in Uddevalla municipality recognized a need for a more systematic approach (like the Natural Step process), and began working with EMAS in 1999.

In 2004, Uddevalla became the first municipality in Europe to register with the EMAS program. Because no extra money existed within the municipality to implement the program, departments and communities were forced to be both systematic and creative to adhere to this system. The entire municipality was required to participate so that different areas could work together and align their goals to make compliance easier in the long term. Each different area within the municipality (i.e., childcare, health & safety, etc.) has their own coordinator and also an EMAS group to deliver counseling assistance, provide education, and make transitions easier.

It was important to the Uddevalla municipality to involve all members and inhabitants of the municipality in the process. An environmental survey was completed by both inhabitants and employees of the municipality. This helped create shared support in the community by using a bottom up approach, which is similar to the Natural Step process. From survey results, 15 environmental areas of interest were identified, and the administrators of each community formulated their environmental goals based on those areas. The board of the municipality created a list of general goals as well. To encourage participation, each municipal administration was required to put together a presentation of their environmental goals.

Education and internal communication were identified as very important to achieving established goals. The municipality worked together with leaders in the environmental sector and an environmental consulting firm to aid in education around the new environmental management system. Biannual educational conferences are one means of delivering education to employees in the municipality, and each administration holds its own educational courses relative to their areas. A

[19] http://ec.europa.eu/environment/emas/index_en.htm

municipality-wide website was created to answer questions and post topics and new information relevant to the environmental management system.

Renewable Energy

One of the goals of Uddevalla has been to increase the use of renewable energy in the community. Uddevalla was one of the first communities in Sweden to begin using a district heating system. The system was installed in 1965 and since 1985, when a biomass energy plant was built, renewable energy has been part of Uddevalla's heating system. As part of the environmental initiative and to practice better waste management, a new waste incineration plant was recently built. Uddevalla Energi opened in August 2008 and is used in conjunction with the biomass plant to supply almost 100% of the city's heat as well as provide electricity to the main grid. Fifty percent of the electricity from the plant is used in Uddevalla and the other half is used in Trollhättan, a neighboring community. Employee vehicles and collection trucks run on biogas from the plant in Vänersborg, and the electricity from the Uddevalla plant is used to power the plant and its facilities.

Tour participants visit the Uddevalla Energi trash incineration plant

The Uddevalla Energi plant is one of the participants in the red bag/green bag waste management program. The red bags are sorted and transported to the incineration plant. Hazardous, electronic, and recyclable materials should be excluded from red bags, and organic materials are discouraged as they belong in green bags. Some examples of acceptable items in a red bag might include diapers, clothing, textiles and plastics. The bags themselves are also burned. The recent economic downturn has resulted in people producing less trash. In order to keep up with the demand for energy, some waste burning facilities in Sweden have been importing trash from other countries, such as Germany.

While the plant facilities are very clean, the burning of trash itself is a dirty process. The Uddevalla Energi plant has state-of-the-art facilities to ensure that clean air and clean water are produced from the process. The system conserves energy by collecting and recycling steam and using it for both heat in the plant and for the district heating system. Slag produced at the plant is used in road construction. The only waste from the plant is a type of sludge, which is sent to an island in Norway that was once mined for gypsum. The sludge, when mixed with waste from a Norwegian paint factory, creates a material with a neutralized pH that is being used to fill old mining pits, restoring environmental conditions on the island and bringing back wildlife.

In Uddevalla tour participants were introduced to another system that helps protect clean water in Sweden – proper disposal of old and unused medicine. Many pharmacies in Sweden provide medicine recycling bags so that chemicals don't end up in the soil or water supply. The bags can then be returned to a pharmacy, which disposes of them in a manner that does not contaminate the environment.

Trollhättan

The city of Trollhättan is located in the Trollhättan municipality in Västra Götaland county. The city has a population of 45,000 (total population of the municipality is 54,300[20]) and is situated about 80 km north of Göteborg. Trollhättan is known for its large waterfalls on the Göta River and for its series of locks along the Göte Canal. It is also known for its connection to the Swedish film industry and for its Saab and Volvo automobile production plants. Two places visited during the stay in Trollhättan the locks at Trollhättan and the Scandic hotel, offered insight into how Trollhättan meets its objectives of environmental sustainability.

The Trollhättan municipality used the Agenda 21[21] agreement as a basis for forming its environmental objectives. Since then, it has won several awards for environmentalism. One award was the King Carl XVI Gustaf Environmental Prize, which named Trollhättan as the most environmentally sound municipality in Sweden.

Renewable energy is a big part of the Trollhättan environmental initiative. The municipality aimed to decrease its dependence on fossils fuels by 50% from 1996 to 2010. The administration of the municipality wanted to be a leader in demonstration and agreed to decrease its non-renewable fuel consumption by 90%. Heating and transportation are currently the two primary uses for non-renewable fuels. Trollhättan is also working to increase the use of renewable energy for its heating and electricity sources. In order to meet renewable energy goals, stakeholder collaboration and cooperation regarding both energy supply and energy demand were needed.

Water Power

Hydropower turbines were first used in Sweden in the 1880's, and the waterfalls in Trollhättan were one of the first to generate hydroelectric power. Over 300,000 litres of water rush over the falls every second, roughly 13% the volume of water as Niagara Falls[22]. Two hydroelectric plants are currently in operation in Trollhättan, helping supply electricity throughout western Sweden. Trollhättan is also heated through a district heating system. Since 2006, over 95% of the heating fuel has been biomass, primarily woodchips from local forests. A solar energy plant is also in development.

Hydropower is harnessed from the waterfalls in Trollhättan.

[20] Population as of 2007 census.

[21] Agenda 21 is a United Nations initiative formed in 1922 related to sustainable development. http://www.un.org/esa/dsd/agenda21/

[22] Over 600,000 gallons (2,272,000 liters) rush over Niagara's Horseshoe Falls every second.

Trollhättan is a region of commuters – tens of thousands of people pass through the community every day. In order to reduce energy consumption and carbon emissions, transportation was a focus in the sustainability initiatives. Related strategies included converting intersections into roundabouts, which increase safety and decrease the amount of time idling at traffic lights. Trollhättan is also a community with a strict "no idling" policy, including steep fines for idling automobiles for more than one minute. In addition, Trollhättan has increased its use of biogas vehicles for taxis and commuter buses. Pamphlets and other marketing materials were used to promote more fuel-efficient methods. American participants on the trip noticed that one way Swedes avoided idling was to start the car only after every passenger had shut the door and buckled the safety belt.

Scandic Hotel in Trollhättan partakes in the Red Bag/Green Bag program.

Green Tourism

During the tour of Trollhättan, participants stayed at the Scandic Hotel. The Scandic Hotel chain has gone through the Natural Step process to set and achieve environmental goals and is now considered a leader in environmental sustainability and profitability. Their environmental goals directly reflect the four sustainability objectives of the Natual Step. Currently Scandic has over 100 Swan[23] labeled hotels, KRAV[24] labeled food, and a goal to eliminate all fossil-fuel emissions by 2025. Tour participants noticed red and green waste containters in hotel rooms (indicating the hotels' participation in the Red and Green Bag program to create biogas and renewable energy production), refillable shampoo containers, and need-driven lightswitches activated by the room keycard.

Göteborg

With a municipality population of about 500,000 and roughly 900,000 inhabitants in the metropolitan area, Göteborg (also called Gothenburg) is the second-largest city in Sweden (after Stockholm). Göteborg is located on Sweden's western coast at the mouth of the Göta River in Västra Götaland county, and has the largest harbor in all of Scandinavia. As a large metropolitan city, Göteborg is home to many different cultures (20% of the population are immigrants), sports teams, museums, music, and educational institutions. Places visited in Göteborg included the Göteborg *Hamn* (Port of Göteborg) the Göteborg Operahouse, the Göteborg Botanical Gardens, a children's hospital, a library, the SKF ball-bearing manufacturing plant, an art museum, a church, EkoCentrum (a center for environmental education), Chalmers University of Technology, a tire recycling plant, and a prefabricated housing plant. In Göteborg many companies were visited that had incorporated their own sustainability initiatives.

[23] Swan is an eco-label for Nordic countries with a goal of a sustainable society through sustainable consumerism. Over 67% of people in Nordic countries recognize the label.

[24] KRAV is the Swedish "organic" label. http://www.krav.se/System/Spraklankar/In-English/

Göteborg has been heavily involved in pioneering sustainability objectives and many sustainability initiatives have arisen from the Göteborg area. At the Gothenburg Summit in June 2001, EU leaders launched the first EU sustainable development strategy based on a proposal from the European Commission. A declaration was formed there that became the basis of the EU's policies of sustainable development, including objectives to address unsustainable practices and creating public policy in a new way. Another sustainability initiative is Göteborg 2050, which is focused on five main themes: energy, transportation, urban planning, food and building construction. Göteborg's approach to sustainability has been very focused on technology. The collaboration between Göteborg's two main educational institutions of Chalmers University of Technology and University of Gothenburg has helped Göteborg perform research to support their sustainability goals.

Green Shipping

One of the primary sustainability leaders in Göteborg has been the Göteborg *Hamn*, or Port of Göteborg. The Port is the largest harbor in Scandinavia and has over 1,200 employees. It is owned and operated by the City of Göteborg. In 2008 over 43.3 million tons of product was shipped through its harbor. The Port believes sustainability is achieved by incorporating environmental efficiency into the logistics chain as a part of everyday practices. A few of the environmental practices achieved include becoming ISO 14001 certified and training their workers on "eco-driving" techniques. "Green bunkering" practices, which include using a refueling device that prevents spills and drips, have become mandatory for all ships unless they pay a high fee.

The Port of Goteböorg has won many awards for sustainability.

The Port of Göteborg also implemented a new Onshore Power Supply. It was installed because of a request by a large shipping customer[25] that wanted a cleaner way to have electricity on its ships while docked in the harbor (large ships typically keep the engines running rather than connecting to the shore for power). The new energy system is partially supplied by wind turbines[26] located near the Port, and is also connected to a new electric railroad system (that also increases loading capabilities that are supplied by renewable energy for the Port itself). The switch to the new electric Onshore Power Supply has notably increased air quality in the area since implementation. The Port requires ships to become compliant with the Port's new system in order to eliminate all carbon emissions from ship engines while docked in the harbor. For its sustainability practices, the Port has won many awards, including the Clean Marine Award from the EU Commission, the Clean Seas Award, and recognition from the World Ports Clinton Conference. Other harbors, such as Los Angeles and Shanghai, are looking to Göteborg for ideas on becoming more sustainable.

[25] StoraEnso

[26] The wind turbines are owned by a private company and also supply power to the main grid of Göteborg.

Green Manufacturing

Another company on the tour in Göteborg that aligns its practices with sustainability is SKF. SKF is a large ball bearing production company that also produces lubricants, sealants, and sensors for testing ball bearings. While its primary target industry is the transportation sector, a large portion of business today is making parts for wind turbines. SKF has been listed on the Dow Jones Sustainability List every year for the last nine years.

In 2005, SKF launched its own environmental initiative called BeyondZero, which sets objectives to not just create zero negative impact to the environment, but to go beyond zero negative impact to actually create positive impact. To accomplish their goals, SKF felt the initative needed to be incorporated on all levels in the company. Part of this initiative includes minimizing energy use within the company and during production. Other examples include capturing heat from the production plant and diffusing it to heat other areas of the building, encouraging employee bike commuting, employee participation in SKF's three-day environmental seminars, recycling and reuse of materials, and encouraging vendors to utilize sustainable practices.

Tour participants learn about energy efficient lighting at EkoCentrum and sustainability efforts of the SKF ball bearing manufacturing plant.

To go beyond zero impact, SKF's environmental iniative also includes increasing the energy efficiency of many products and making parts for renewable energy production. In 2005, the Swedish Environmental Research Institute (IVL) evaluated the environmental impact of some SKF products through a Life Cycle Assessment (LCA), which showed that the newer ball bearings produce less friction (higher in durability and energy efficiency) and use less material than previous models of ball bearings. SKF also created an energy efficient label for its bearings so consumers know which products are more efficient.

IKEA & The Natural Step

Another major Swedish company near Göteborg that is dedicated to sustainability is IKEA. The IKEA furniture company was founded in 1943 and since 1956 has moved toward a goal of being cost-effective and innovative through design and packaging. Today there are over 253 IKEA stores in 24 countries. IKEA began incorporating environmental sustainability in 1986 and began considering social issues in the 1990's. IKEA is owned by a foundation rather than shareholders, which enables them to invest in long-term initiatives and goals. IKEA wanted to be proactive rather

than reactive in relation to environmental sustainability, and created a vision that "the IKEA business shall have an overall positive impact on people and the environment."

IKEA developed a wide range of environmental goals using the Natural Step process. The framework allowed the company to work according to their own vision and to incorporate sustainability across all facets, including within the company and for the products themselves. Four focus areas were identified: products and materials, suppliers, energy and transport, and community involvement. Four goals were identified to combat climate change: energy efficiency and emissions reductions, efficient transport of products, efficient transport of people, and climate projects with the World Wildlife Fund (WWF).

Prefabricated housing is one opportunity for increasing energy efficiency and durability

Some of these objectives led to a change when sourcing materials, including incorporating a life-cycle perspective, minimizing harmful chemicals, and using their own "e-wheel"[27] for cradle-to-grave consideration. IKEA is working with WWF to map the sources of the wood used in their products. Waste management is also considered a priority; currently 92% of all waste is sorted, and new ways to minimize packaging are always under development. Organic foods are available in their restaurants and bistros.

Minimizing their carbon footprint is another IKEA goal. By the year 2010 they hope to have reduced their energy consumption 25% from 2004 and to be using 100% renewable energy. They are also working on developing transportation solutions that reduce emissions, such as using more trains, and are researching ways to decrease their customers' carbon footprints from traveling to and from their stores. Products themselves will be redesigned if it creates a package that fits better with other packages and is easier and more cost-effective to transport. While environmental benefits were always a goal, cost-effective production has been what made the IKEA sustainability objectives a win-win situation.

Prefabricated Housing for Quality and Environmental Benefits

A prefabricated housing plant was included in the tour of Göteborg. Prefabricated construction makes up around 90-95% of all housing in Sweden. Swedes generally believe that prefabricated homes are high-quality because they are precision produced in controlled environment manufacturing facilities, inspected prior to on-site assembly, and must be tested for energy efficiency post-construction. Prefabricated construction also helps control waste management during the construction process.

In the walls of some prefabricated homes, plumbing and electrical components are installed prior to leaving the manufacturing facility instead of installed on-site. This ensures that insulation and vapor barriers will not be compromised by contractors during plumbing and electrical installation. All houses use triple-pane windows, wood siding (typically vertical rather than horizontal to enhance

[27] According to IKEA, the "e-wheel" has several checkpoints, which are divided into four phases: raw material, manufacturing, product use and end of life

durability), and have either clay or metal tile roofs (no asphalt). Due to technology, most prefabricated housing facilities can create a prefab home according to any house plan.

Public Education

Education seems to be a key to creating successful eco-communities and encouraging innovative solutions, and environmental education was available in many places in Göteborg. Tour participants visited the EkoCentrum, a year-round educational facility that provides answers about a wide array of environmental concerns. EkoCentrum is run by an NGO that partners with the University of Chalmers and works with individuals, communities, and organizations by providing information in a wide variety of educational styles. For example, the EkoCentrum facility has a wide array of different "green" products on display for people to experience for themselves, including urine-separating toilets[28], KRAV-certified food products, and high-efficiency wood stoves. EkoCentrum also researches and writes about important connections found in the natural resources sector. Businesses interested in sustainability may hire EkoCentrum for private consulting and educational services about environmental management systems or standards.

Urine-separating toilet

The EkoCentrum facility itself acts as a demonstration in green building techniques. It was renovated in 2003 to be more environmentally sustainable. It houses the first urine-separating toilet in Göteborg[29] and all toilets in the building flush with collected rainwater. The windows are argon-filled and were designed to reflect heat during the summer. Many existing materials were reused, including radiators, and the building uses heat exchangers to maximize energy efficiency.

Strömstad

The community of Strömstad is located 165km north of Göteborg on the western coast of Sweden. Strömstad is a city of roughly 6,000 inhabitants in Strömstad municipality (population 11,600) in Västra Götaland county. Historically a herring fishing town, the area is now known for shopping, shrimp fishing, yachting, spas, nature, and tourism. Some visits in the region around Strömstad included Tanum rock carvings, EkoPark learning center, a marine biology lab, a historic fishing village, and a farm.

Strömstad based its environmental initiatives around Agenda 21. The results included a master plan for the municipality and for each community. Strömstad plans to review its environmental objectives at a minimum every four years. Every time the plan is updated, public involvement is encouraged. The current plan was placed on display at numerous locations within the municipality for public comment, and documents were available for download online. The environmental vision of Strömstad is "balanced and sustainable development, where food quality, environmental and

[28] Urine-separating toilets separate phosphorous, which can be used to create fertilizer

[29] Urine-separating toilets are used in many buildings, including a 600-pupil school outside of Göteborg where only urine separating toilets are installed, and in many households the Strömstad-Tanum community

cultural values are reinforced." Strömstad is a FairTrade City, which means that it is dedicated to ethical consumption practices and houses many businesses with fair trade products certified through the Fairtrade Labeling Organization International (FLO). Inhabitants of Strömstad are encouraged to buy these products, which are listed at the website of the municipality.

The map of Strömstad, the "heat pump city,"shows over 50% of buildings using a heat pump. Solar, hydro, and wind energy are also used in the community.

The Heat Pump City

Energy efficiency is a main goal of Strömstad, and currently over 50 percent of buildings in the city use some type of heat pump to improve energy efficiency. Strömstad was recently awarded the "heat pump city" award for the most heat pumps per capita. The installation of heat pumps was a response to high energy prices and a need to improve the energy efficiency of existing buildings. Ground source heat pumps function well in Strömstad because the granite terrain can be drilled through and the heat is extracted easily. Air-to-air exchangers are also very popular if ground source or geothermal heat pumps are not an option. Many people in the area upgrade their electric heating system by installing a wood pellet stove because it is inexpensive and wood can be obtained locally. A few homes also utilize solar energy and two small individual wind turbines also exist in the city to provide electricity to individual buildings. The hospital in Strömstad uses a heat pump, taking heat from the nearby sea. In Strömstad, converting to a heat pump is economical after a few years and saves, on average, 30%-60% in heating costs over the long run.

Another area addressed by the Strömstad municipality is new construction. Strömstad is working toward maximum energy-efficiency of new buildings with a goal of all newly constructed buildings meeting Passivhus standards.

Education

Members of the Strömstad community believe that education is important when meeting sustainability goals. The EkoPark learning center in Strömstad was created in order to educate people beginning at a young age about ecosystems and the environment. Educational facilities were funded by the EU, the national government, and the municipality as part of the Agenda 21 objective. The building was built and created with help from local volunteers and has been open to the community since 2000. The main goal of EkoPark is to make learning about the environment simple and fun. Some areas of education include recycling, hydroelectric power, solar energy, transportation and emissions, and biodiversity.

Conclusion

The communities visited on this trip demonstrate many possible sustainability practices for Minnesota and other North American communities to consider when developing environmental objectives.

- Looking for **local energy resources** (e.g, wood or trash) decreases the carbon footprint of communities and enhances local economic development.
- Leading by example and providing **continuing education** to community members is a key strategy for local governments.
- Requiring **energy testing for houses** before a sale could help Minnesota evaluate the energy efficiency of existing housing and help communities plan for improvements.
- Employing **the Passivhus standard** drastically reduces the amount of energy used in buildings and can be applied to existing housing.
- Encouraging the use of **air-to-air heat pumps** offers an inexpensive option for improving energy efficiency of buildings.
- Using **prefabricated construction** reduces waste, improves energy efficiency and creates opportunities for durability and quality control.
- Encouraging **non-automobile transportation**[30] of goods and people reduces carbon emissions and promotes good health of citizens.
- Offering incentives for **vehicles that use renewable energy** can dramatically increase interest in and use of such vehicles.
- Enforcement of a **no-idling policy** in city limits can have significant positive effects on air quality while also reducing fuel consumption.
- Encouraging **purchasing policies** that promote fair trade, organic, and sustainable forestry practices, and promoting a life-cycle perspective in purchasing are important strategies for moving toward sustainability.
- **Holding local companies responsible** for clean water, packaging disposal, and proper disposal of pharmaceutical products can quickly bring about change.

The Bottom Line

There are many reasons why Sweden is a world leader in creating sustainable communities. Social acceptance around climate change, creating shared environmental goals, and education are keys to successful eco-communities in Sweden. Regulations and policy also contribute to the implementation of sustainability practices. Because of environmental, social and economic similarities, it is likely that many practices incorporated by the Swedish communities in this report could be achieved in Minnesota and other North American communities.

Swedish communities did not achieve success completely on their own. They looked to examples of other communities and countries, utilized public stakeholder engagement processes, and followed frameworks and standards to stay focused. A community that is first looking toward sustainability could benefit from looking at the Natural Step process, EMAS, Agenda 21 and the Kyoto Protocol. These programs can provide starting points for communities in framing and identifying sustainability objectives.

[30] Possibilities include biking, walking, mass transit, trains, ships

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DOVETAIL PARTNERS, INC.
528 Hennepin Ave, Suite 202
Minneapolis, MN 55403
Phone: 612-333-0430
Fax: 612-333-0432
www.dovetailinc.org