An Exploratory Analysis of Environmentally-Certified Wood Products (ECWPs) in the Residential Leadership in Energy and Environmental Design (LEED) Market: 2018 and 2011

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Abstract

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Green building programs incentivize building practices to reduce a building's impact on the environment and provide healthier spaces for occupants. These programs have gained popularity across the world, and the Leadership in Energy and Environmental Design (LEED) program, founded by the United States Green Building Council (USGBC), is one of the most popular green building certification systems in the U.S. In a LEED for Homes project, residential builders can earn certification points through a variety of practices. One of these practices is using environmentally-certified wood products (ECWPs) in various building components. Before 2016, the LEED point system only recognized the Forest Stewardship Council (FSC) certification as an ECWP. However, a new Alternative Compliance Path (ACP) in LEED recognizes additional wood product certifications, including the Sustainable Forestry Initiative

(SFI) program. For these reasons, the residential LEED market provides a large and growing market for both FSC- and SFI-certified products.

With the growing popularity of LEED, the development of the ACP in LEED, and the expansion of forest certification systems throughout the world, this research seeks to understand the current perceptions and use of ECWPs in the residential LEED market. In this study, we surveyed LEED homebuilders and remodelers across the U.S. to assess their awareness, perceptions, and use of FSC- and SFI-certified wood products. We also compared these data to a similar survey conducted in 2011 to track changes over time. We found that survey respondents in 2018 showed similar levels of awareness of FSC and SFI products, but they were more likely to use FSC-certified wood in their building practices. We also found that the overall usage of both ECWPs has not changed significantly between 2011 and 2018, although some results point to a decreasing awareness of both certification systems. Additionally, we identified trends in the residential LEED market and correlations between different builder attributes and their levels of awareness and use of ECWPs. Overall, this research provides a more comprehensive picture of recent trends in the residential LEED and ECWP markets.

Contents

Table of Figures

Table of Tables

Literature Review

Introduction

Various programs certify environmentally-certified wood products (ECWPs), and this research analyzes the use and familiarity of wood products certified by both the Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) systems, the most widely-used forest certifications in the United States. Specifically, we analyze ECWP use in residential Leadership in Energy and Environmental Design (LEED) construction, as this remains a large potential market for ECWPs. We evaluate current perceptions and usage of ECWPs in this market, and we also track these trends over time by comparing our data to results from a similar study conducted in 2011.

The following literature review presents a synthesis and evaluation of relevant literature concerning ECWPs and the residential LEED construction market. We begin with a review of forest certifications and ECWPs using peer-reviewed literature and other primary sources, giving an understanding of the research to date on these certification programs and the current status of the programs. We also evaluate the LEED building market, giving particular attention to the patterns in residential LEED building over time and how the building program may influence the use of ECWPs now and in the future. This literature review helps guide our research as we seek to understand the perceptions and use of ECWPs in residential LEED construction today.

Forest Certification Overview

Research has shown that consumers show an interest in, and demand for, wood products that are sourced through sustainable practices (Gronroos & Bowyer, 1999; Kozak, Cohen, Lerner, & Bull, 2004). To address this demand and demonstrate their environmental

sustainability, some forest product firms verify their practices through voluntary environmental certification programs. These certifications are meant to give consumers the power to buy products that are sourced using socially, economically, and environmentally sustainable practices. While there are numerous certification systems meant to verify sustainable forest management (SFM) and ECWPs; the most widely used programs in the U.S. are the Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) certifications. FSC is a global system, while SFI is primarily used in North America and is endorsed by the Program for the Endorsement of Forest Certification (PEFC), an international organization.

FSC is an international program with global influence. Originally spearheaded by non-governmental organizations (NGOs) such as the World Wildlife Fund (WWF), FSC was institutionalized in 1993 to address rainforest degradation in the tropics (Tollefson, Gale, & Haley, 2008). Since then, FSC's reach has expanded, and the group now certifies more land in temperate regions than in tropical ones. To achieve FSC forest certification, a land manager must meet many requirements, including upholding indigenous community and worker's rights, employing sustainable silvicultural techniques, and taking measures to protect biodiversity (FSC, 2019).

Figure 1. FSC label (FSC, 2019).

PEFC is a separate, international umbrella organization that assesses, endorses, and recognizes national forest certification systems worldwide. Importantly, PEFC does not directly certify forests. Instead, they independently assess other certification systems. This allows regional and national systems to tailor their processes to the specific needs of an area while also demonstrating that the system is compliant with internationally-accepted requirements. PEFC was originally

Figure 2. PEFC label (PEFC, 2019).

founded in 1999, and the organization endorsed SFI in 2005. PEFC has endorsed 43 national certification systems to date (PEFC, 2018).

Figure 3. SFI label (SFI, 2019).

The American Forest and Paper Association (AF&PA) established the SFI program in 1994 to provide a forest certification system specific to the needs of U.S. forestry practices, and the system added voluntary third-party verification in 1998 (American Forest & Paper Association, 2016; Sustainable Forestry Initiative, 2019). Now, SFI is a fully independent non-profit, governed equally by a board representing economic, social, and environmental interests. This program focuses on forestry practices in Canada and the United States, and it requires firms to adopt responsible environmental and business practices. It also has a strong outreach and education component (Perera & Vlosky, 2006; Sustainable Forestry Initiative, 2019).

Two other certification systems, while not directly studied in this research, are used extensively in North America and should be noted in this literature review. The Canadian Standards Association's (CSA) Sustainable Forest Management System (SFM) is also used in Canada to certify sustainable forest practices. CSA released their program in 1996, and PEFC endorsed the system in 2005. CSA is Canada's national standard, and because most of Canada's forestland are publicly-owned, the certification has a strong public involvement element (CSA, 2019).

Additionally, while the SFI system is generally used to certify large landowners, nearly two-thirds of forestland is owned by smaller, family forest landowners in the U.S. (ATFS, 2019). The American Tree Farm System (ATFS) certification was designed to meet the specific needs of smaller tree farms. Originally created in 1941, PEFC endorsed ATFS in 2008 (PEFC, 2018).

SFI recognizes both the CSA and ATFS standards, so wood products that are sourced from CSA-certified or ATFS-certified forests may carry an SFI label.

While myriad forest certification systems exist globally, the FSC and SFI certifications are the predominant wood product certifications used in the U.S. This research therefore focuses specifically on familiarity with and usage of FSC and SFI wood products in the U.S. residential homebuilding industry.

So, Which is Better – FSC or SFI?

The obvious question here may be to ask which is better, FSC or SFI? There is no clear answer to this question, and many sources believe that both programs are credible and very similar (ATFS, 2019; National Association of State Foresters, 2013). Both certification systems emphasize maintaining sustainable harvest levels, protecting biodiversity and water quality, ensuring forest regeneration, and more. The National Association of State Foresters (NASF) write that the ATFS, FSC-U.S., and SFI all include "fundamental elements of credibility and make positive contributions to forest sustainability" (NASF, 2013).

There are slight differences in the programs, however, and it important that land managers choose the system that is fitting for their location, business, and forest management goals. One particular difference to note is that SFI has one national standard in the United States, while FSC identifies eight different regions in the U.S., outlining slightly different requirements for each region. Additionally, while both programs allow clear cuts, the SFI standard allows an average clear cut size up to 120 acres, and FSC allows clear cuts up to 80 acres, with regional variation (and does not specify the maximum area for clear cuts in some regions). Both programs emphasize forest management plans. SFI specifies that the plan must document annual trends and does not specify intervals at which the plan must be updated, and FSC requires a full

revision of the plan ever 10 years, with no requirement for annual documentation. Further, both plans require training; SFI outlines specific items on which individuals must be trained, and FSC sets performance-based targets.

Thus, the goals of both management plans are similar, yet companies, nonprofits, and individuals continually debate the merits of both systems. These opinions are less likely to be published in journal articles and more often appear online and in newspapers and magazines, yet they help shape business and consumer decisions and trends.

Critiques of FSC include that, because the standard was written by WWF and other NGOs, it places too much emphasis on environmental and social issues, and not enough on economic interests (Auld, Gulbrandsen, & McDermott, 2008). Peterson (2001) wrote that FSC will "either change course or fade from the landscape because… it is too closely aligned with the crisis crowd." Instead, he proposes that the SFI system will become the dominant certification process because of its scientifically-backed principles and standards. Whether FSC has changed course, as Peterson predicted, is up for discussion, but both FSC and SFI continue to draw global attention.

However, many NGOs favor FSC over SFI, often citing (whether correctly or incorrectly) that FSC provides better environmental and social benefits. The World Wildlife Fund (WWF) claims that FSC is the "most robust certification system to ensure environmentally responsible, socially beneficial, and economically viable management of forests" (World Wildlife Fund, 2019).[1] WWF's position is logical, given that WWF helped develop the FSC certification system.

[1] Notably, a 2015 report published by WWF found that PEFC international standards met 70% of the "Standard Strengths" indicators concerning forest management practices, thereby acknowledging many of the strengths of the PEFC SFM practices (World Wildlife Fund, 2015).

Other NGOs prefer FSC as well. Greenpeace claims that SFI is an "unreliable and weak standard, amounting to industry-backed greenwashing" (Greenpeace Canada, 2016). The Natural Resource Defense Council also promotes FSC-wood, claiming that it is the "gold standard" for verification systems (MacMillan, 2016). Whether right or wrong, many influential NGOs claim that FSC is the only verification label that may be trusted.

The answer, however, to which certification system is better may be in how you ask the question, and there is no clear victor in this debate. Which is better for the small landowner operating in Costa Rica? Which is better for a large industrial manager in the U.S.? Which is better for wildlife conservation in Norway? The questions we may ask are numerous and varied, and the existence of multiple standards may provide land managers with helpful choices. As NASF writes, forest ecosystems are complex, and a simplistic "one size fits all approach to certification cannot address all sustainability needs" (National Association of State Foresters, 2013). Oliver and Deal (2007) agree with this sentiment and propose that, "sustainable forestry is too difficult to be achieved through international centralized planning and dictating of activities."

Overall, both the SFI and FSC system have similar goals of encouraging sustainable forest management and giving consumers the ability to purchase sustainably-sourced forest products. Some sources believe that the systems are strikingly similar, and the programs have become less distinct over time (Pepke, 2010). Land managers should therefore choose the certification system that is fitting for their specific management objectives. As Fernholz et al. (2011) writes, "Ultimately, the decision to choose between one program and another will depend upon unique and perhaps personal considerations, whether they be economic, social, or environmental."

We should also note that this topic of debate, and the spotlight it has placed on forestry, may provide new, unforeseen challenges for the forestry and forest products industries. Auld et al. (2008) write succinctly when they say that "greater scrutiny on forestry practices can have the unintended effect of making them appear environmentally unfriendly relative to other products just because these alternatives have not been publicly scrutinized." Perhaps, then, it is less important to debate the merits of different forest certification schemes and instead understand and promote the overall benefits of sustainable forest products compared to their alternatives.

Certified Forest Area

Certified Area Globally

As of January, 2019, 84 countries had FSC-certified forestland, with approximately 484 million acres certified in total (FSC, 2019). Comparatively, in 2018, PEFC endorsed 43 national certification systems and had 49 national members. These national systems certified more than 759 million acres of forestland (PEFC, 2018). Adding these together, we find that approximately 1.24 billion acres of forestland is certified by PEFC and FSC globally.

Notably, some forestland land is double-certified by both a PEFC-endorsed system and FSC. In 2017, a joint study between PEFC and FSC found that about 16.5% (or 175.7 million acres) of certified forest land was double-certified globally (PEFC & FSC, 2018). Therefore, in mid-2017, approximately 1.07 billion acres of forest area was certified by a PEFC-endorsed system, FSC, or both (PEFC & FSC, 2018). A recent study suggests that about 10 percent of forests worldwide are certified, and most of this land is in industrialized nations, including Canada, the U.S., and various European countries (Rotherham, 2011).

Certified Area in Canada and the U.S.

Both FSC and PEFC-endorsed systems certify forest land in Canada and the United States. PEFC-endorsed systems in North America include SFI (in both Canada and the U.S.), Canada's CSA, and the U.S.'s ATFS.

FSC has certified approximately 160 million acres of forestland in the U.S. and Canada, which is more than one-third of the organization's global total. About 124.9 million of these acres (78%) are in Canada, and 34.7 million acres (22%) are in the United States (FSC, 2019) (Table 1). In the U.S., Minnesota, Wisconsin, and Michigan have the greatest number of FSC-certified acres, with more than 6.3 million acres, more than 6.5 million acres, and nearly 4.2 million acres certified, respectively (FSC, 2018).

Yet PEFC-endorsed certifications are more prevalent in North America. As of September, 2018, ATFS, CSA, and SFI had certified more than 420 million total acres of forestland in North America (PEFC, 2018) (Table 1). Approximately 80% of this total is in Canada, and the remaining 20% is in the United States.

Of the three PEFC-endorsed systems in North America, this research is primarily interested in the SFI-certified land. In 2018 SFI had certified about 311.7 million acres of forestland in Canada and the U.S.; 63.8 million acres (20%) were in the U.S., spread among 30 different states (PEFC, 2018) (Table 1).

Table 1. A review of certified forest land under the FSC, PEFC, and SFI standards at various geographic levels (unless otherwise noted, PEFC and SFI data retrieved from PEFC Global Statistics, 2018; FSC data retrieved from FSC, 2019).

	FSC	PEFC	SFI
Acres Certified Worldwide	484.2 million (84 countries)	759 million (49 national members)	NA
Continent with most Acreage Certified	Europe (50.4% of total)	North America (55% of total)	NA
Acres Certified in North America	162.9 million (33.6% of total)	420.1 million (56% of total)	311.7 million
Acres Certified in Canada	124.9 million	337.7 million[2]	247.9 million
Acres Certified in U.S.	34.7 million	82.4 million[3]	63.8 million
State with most Acreage Certified	Wisconsin[4] (6.5 million acres)	NA	Minnesota[5]
Acres Certified in Washington State	373,647	NA	6.8 million[6]

Because some of this land is double-certified, adding total forest area in Table 1 above would overestimate net certified forest area. The joint study between PEFC and FSC found that approximately 21.8 million acres of forestland were double-certified in the United States, and 43.2 million acres were double-certified in Canada (PEFC & FSC, 2018). Thus, about 65 million acres of forestland are certified under both the FSC-system and a PEFC-endorsed system in Canada and the United States.

The U.S. contains approximately 521 million acres of timberland (Oswalt & Smith, 2014) (Figure 5). When accounting for the double-certified land in the U.S., we find that approximately

[2] Includes CSA SFM and SFI
[3] Includes ATSF and SFI
[4] (FSC, 2018)
[5] Based on reported data 2010 (Fernholz, Bowyer, Howe, & Bratkovich, 2010)
[6] Retrieved from SFI database (SFI, 2018)

18% of U.S. timberland is certified by either FSC, ATFS, or SFI.[1] About 6.7% of all timberland is FSC-certified, 12.2% is SFI-certified, and 3.6% is certified under ATFS. Note that adding the FSC, SFI, and ATFS certified land area together does not total 18% because these values do not account for double-certification. Also of note, we should be aware that this calculation includes all ownership categories of timberland, including both privately and publicly-owned certified area.

A Brief Review of Total U.S. Forest Area

To provide a frame of reference, and to enhance our understanding of forested area in the U.S., this literature review includes a brief review of total U.S. forestland here.

There are approximately 766 million acres of forestland in the United States, and about two-thirds of this, or 521 million acres, is timberland (American Forest & Paper Association, 2016). In the nation, 74 million acres of forestland are classified as reserved forest, and 172 million acres are classified as other forest (Oswalt & Smith, 2014) (Figure 5). Interestingly, the country's population has tripled since 1910, and the forest area in the United States has remained relatively stable, increasing from 753 million acres to 766 million acres between 1910 and 2014 (Oswalt & Smith, 2014).

At the national level, private entities own more forestland than the government. Private corporations own 147 million acres, or about 19% of the total forestland, and private non-corporate entities own 298 million acres, or 39% of total forestland (Oswalt & Smith, 2014). This means that 58% of the total forestland is owned by approximately 11 million private landowners. However, this ownership pattern varies by region. While public forest lands account

[1] See *A Brief Review of Total U.S. Forest Area* section below

for more than half of total forestland in the West, the South and North are both dominated by private ownership (Figure 4).

Owner class/ land class	Region			
	U.S.	North	South	West
	Million acres			
All owners	**766**	**176**	**244**	**346**
Timber land	521	167	210	144
Reserved forest	74	7	4	63
Other forest	172	2	31	139
National Forest	**145**	**12**	**13**	**120**
Timber land	98	10	12	75
Reserved forest	27	1	1	24
Other forest	20	0	0	20
Other public	**176**	**35**	**20**	**122**
Timber land	63	29	15	19
Reserved forest	47	5	3	39
Other forest	67	0	2	65
Private corporate	**147**	**29**	**65**	**53**
Timber land	111	29	61	21
Reserved forest	0	-	0	0
Other forest	36	0	4	32
Private non-corporate	**298**	**100**	**147**	**51**
Timber land	249	99	121	28
Reserved forest	0	0	0	0
Other forest	48	1	25	22

Figure 5. U.S. forestland ownership by class in 2012 (Oswalt & Smith, 2014).

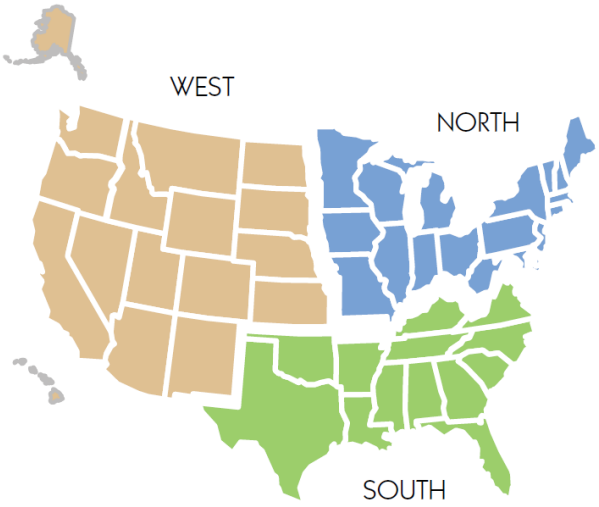

Figure 4. Region designations used by Oswalt and Smith (Oswalt & Smith, 2014).

Certified Area in Washington State

Since this study was conducted by researchers at the University of Washington, the state's timberland and certified forest area are of particular interest to the researchers; we therefore conducted an analysis of the state's certified forest area to provide local perspective.

Washington is the 18th largest state in the U.S. by area, with about 42.6 million acres of land. This total area is split almost evenly between forestland and other land area, such as urban and cropland (Washington Forest Protection Association, 2004). There are approximately 21.3 million acres of forestland in Washington, and the government owns 63.3% of this total (13.5 million acres). Notably, more forestland is owned by the government than by private owners in the state[1].

In Washington, the federal government owns 44.1% of the total forestland (9.4 million acres), 10.6% of the total forestland is state trust land (2.27 million acres), and 7% of land is designated Native American land. Additionally, counties and municipalities own 1.6%, or 0.35 million acres, of land (WFPA, 2004) (Figure 6).

Private forest landowners own a total of 7.8 million acres, or 36.7% of the total forestland in the state (WFPA, 2004). These 7.8 million privately-owned acres can be further subdivided into industrial (4.57 million acres, or 21.5% of the total forestland) and nonindustrial (3.24 million acres, or 15.2% of total forestland) land (WFPA, 2004). Industrial private landowners are defined as companies and individuals with statewide holdings of 1,000 acres or more, while nonindustrial private landowners have statewide holdings of less than 1,000 acres (WFPA, 2004).

[1] This ownership trend is typical of the western U.S., and in the eastern U.S. the opposite trend is seen, where private landowners account for more than half of forestland ownership (Oswalt & Smith, 2014).

	Acres (000)	Acres (000)	Percent of Total
Washington Total Land Area		**42,588**	**100 %**
Forestland		21,305	50.0%
Other Land (urban, cropland, etc.)		21,283	50.0%
Total Government Forestland		**13,492**	**63.3%**
Federal		9,389	44.1%
National Forest Service	4,984		
National Forest Service Wilderness	2,569		
National Forest Scenic & Recreation	190		
National Parks	1,451		
Department of Defense	60		
Bureau of Land Management	50		
US Fish & Wildlife, National Wildlife Refuges	85		
State Trust Lands		2,265	10.6%
Native American		1,492	7.0%
County and Municipal		346	1.6%
Total Private Forestland		**7,813**	**36.7%**
Industrial Private Landowners*		4,573	21.5%
Nonindustrial Private Landowners**		3,240	15.2%

* Industrial Private Landowners – Includes companies and individuals operating wood-using plants and nonindustrial companies and individuals not operating wood-using plants but with statewide holdings totaling 1,000 or more acres.

** Nonindustrial Private Landowners – Includes companies and individuals not operating wood-using plants and having statewide holdings totaling less than 1,000 acres.

Figure 6. Washington's total land area and ownership of forestlands, as presented by WFPA (WFPA, 2004).

SFI is the most widely-used forest certification system in Washington. Across the state, approximately 6.8 million acres of forestland are enrolled in the SFI system (SFI, 2018). Thus, SFI certifies about 30 percent of the total forest area (15 percent of the state's total land area). Of the 6.8 million certified acres, 2.44 million acres are managed by Washington's Department of Natural Resource (DNR); the organization reports that all of their forestland is SFI-certified (WA DNR, 2018). Sixteen different companies and organizations, the vast majority of which are private entities, own the remaining 4.26 million SFI-certified acres in Washington. The certified land area owned by these private entities varies from about 24,000 acres to 1.33 million acres (SFI, 2018).

FSC certified land is less prevalent in Washington. At the end of 2017, there were approximately 374,000 FSC-certified acres in the state (FSC, 2018), and Washington's DNR

managed nearly half of this total (approximately 176,000 acres) (WA DNR, 2018). Notably, the FSC-certified forestland managed by DNR was dual-certified by both the SFI and FSC certifications.

The Washington Tree Farm Program (WTFP) is the primary certifying body for smaller, family-owned operations in the state, and ATFS recognizes this certification. WTFP helps manage over 400,000 acres of private forestland, assisting landowners in the development of healthy forests that provide a variety of goods and services, including timber and wood products, recreational area, wildlife habitat, and more (Washington Tree Farm Program, 2018).

Taken together, we can estimate the area of certified forestland in the state. There are approximately 7.2 million acres of industrial and state land in Washington, which supply the majority of the state's forest harvest (Washington Forest Protection Association, 2004). [1] The total FSC- and SFI-certified land (considering double-certification on state trust land) is approximately 6.9 million acres, if we assume that the remaining FSC-certified acres are not double-certified. Given this, we calculate that up to 95% of large private and state land is either FSC- or SFI-certified. However, even if we removed all FSC-acreage from our calculation and assume a certified area of 6.7 million acres, we would still conclude that over 90% of all large private and state land is certified. Therefore, even our conservative estimations find that the vast majority timber harvests from Washington state are certified under a sustainable forest management certification.

[1] About 98% of the timber harvested in Washington comes from non-federal forestland, and about 76% of the total harvest comes from privately owned forestland (WFPA, 2004).

Forest Certification for Land Managers

This literature review finds that landowners have varying experiences with the costs, benefits, and management changes associated with attaining forest certification. While forest certification may sometimes be expensive for landowners, research suggests that landowners and managers often make changes to their forest management practices to enhance sustainability and meet certification, and they often believe the process to be positive overall.

Some research indicates that there can be a high cost associated with forest certification. One study found that the FSC-certification process increased costs for approximately 78% of small landowners and resource managers and 55% of industrial private or public managers, averaging a direct cost of about 15 cents per acre, with reported costs up to 45 dollars per acre (Hayward & Vertinsky, 1999). Other landowners report that the cost of the certification is the greatest impediment to attaining certification (Moore, Cubbage, & Eicheldinger, 2012).

However, despite an increase in costs, landowners pursue certification for a variety of reasons. Hayward and Vertinsky (1999) found that smaller landowners were more driven to achieve FSC certification because of the potential for learning and improved management, while larger industrial owners were more likely to cite price premiums and improved market access as primary motivations for attaining FSC certification. The reasons for attaining certification are therefore varied and nuanced and depend upon a forest manager's goals.

Once a landowner chooses to obtain forest certification, research has also shown that they often modify their original management practices. Moore et al. (2012) found that organizations certified through FSC and SFI implemented an average of 13 to 14 changes in forestry, environmental, social, and economic system practices, and there was no difference in total number of changes between the two programs. FSC-certified forest owners were more likely to

make environmental or forest management changes, while SFI-certified forest owners were more likely to make economic or systemic changes (Moore et al., 2012). We should note that in this study the organizations seeking FSC or SFI certification may have different original management practices and goals, which could influence the changes they make and the certification they pursue. Thus, we should *not* consider this study to be a descriptive of the rigor of both programs. However, this study reinforces the notion that earning forest certification requires changes to current practices and cannot simply be attained by filling out the required paperwork. While these sorts of changes may present certain challenges to a manager, they may also afford environmental, social, or economic benefits.

Still, despite some increasing costs and challenges associated with attaining certification, many landowners report significant benefits to attaining certification and that they are likely to recertify (Moore et al., 2012). Most landowners also agree that they learned something through the certification process (Hayward & Vertinsky, 1999), and land managers reported many perceived benefits, including enhancing forest management practices, improving the strategic position of the organization, increasing corporate responsibility, and retaining or gaining market access (Moore et al., 2012). Many landowners also report that their certification process was more positive than they originally expected, and the conversations and interactions between certifiers and owners was constructive and amiable (Hayward & Vertinsky, 1999).

Overall, while merely attaining forest certification does not cure all forest management ills, studies have shown that attaining certification generally improves forest management and/or improves owner knowledge of forestry practices. In general, landowners also report positive experiences with attaining certification (Hayward & Vertinsky, 1999; Moore et al., 2012). Forest

certifications, both FSC and SFI, may therefore be regarded as positive steps towards improving the management of forests.

Chain of Custody Process

Yet forest certification is only the first step in certifying a wood product in the market. These certification systems also include chain of custody (CoC) processes, which track the wood biomass from the forest to the wood product used by the consumer. In the CoC process, an organizations that sources, processes, trades, or distributes forest products may obtain a CoC certification and track the certified biomass through its custody (FSC, 2016). Additionally, when products move through multiple locations and organizations, each entity that handles the certified wood must have the proper CoC certification for the final wood product to receive the ECWP label. This tracking process is important because organizations in the supply chain generally handle both certified and non-certified wood and wood products, and wood products often move through many facilities and owners on their way to the end user. The CoC process ensures that certified forest products are identified and accounted for throughout the entire supply chain and successfully arrive at their final destination.

FSC, PEFC, and SFI all have CoC standards. FSC has awarded 36,020 COC certificates in 124 countries worldwide, with 3,196 certifications in North America (2,438 in the U.S.) (FSC, 2019). Comparatively, PEFC has administered 11,361 COC certificates in 70 countries worldwide, with 441 certificates in North America (249 in the U.S) (Table 2) (PEFC, 2018). Because PEFC's and SFI's CoC systems recognize fiber certified to an "acceptable forest management standard," biomass from ATFS, SFI, or CSA programs are counted as certified fiber in both CoC standards.

Table 2. COC certificates granted by FSC and PEFC.

	FSC[1]	PEFC[2]
CoC Certificates Worldwide	36,020 (124 countries)	11,361 (70 countries)
Continent with most CoC Certificates	Europe (51.3% of total)	Europe (82% of total)
CoC Certificates North America	3,196 (8.9% of total)	441 (3.9% of total)
CoC Certificates in Canada	618	176
CoC Certificates in U.S.	2,438	249

Ultimately, once the product reaches the end consumer, the certification label signifies that the product was sourced from a certified forest and the forest product was properly tracked through a CoC process. This may be an effective way to enhance the perception of, and market for, wood products. Yet there are various challenges associated with the ECWP market.

The Market for ECWPs

Price Premiums and Willingness to Pay

Because voluntary environmental certifications require a firm to take additional management actions beyond what is legally required, ECWPs are often associated with a price premium (Sedjo & Swallow, 2002). A study of exported products from Bolivia found that FSC-certified wood received a five to 50 percent higher price than non-certified wood (Nebel, Quevedo, Bredahl Jacobsen, & Helles, 2005). Similarly, a study of wood from Malaysia found that FSC-certified products received a premium from two to 56 percent, depending on the quality and type of timber (Kollert & Lagan, 2007).

[1] FSC data from FSC Facts and Figures (2019), with the exception of state data, which was published 2017.
[2] PEFC data retrieved from PEFC Global Statistics (June, 2018).

The sale and usage of ECWPs are therefore dependent on a consumer's interest in ECWPs and their willingness to pay (WTP) this price premium. Multiple studies find that consumers indeed show an interest in, and demand for, wood products that are sourced through sustainable practices, even if they are more expensive than non-certified alternatives (Gronroos & Bowyer, 1999; Kozak et al., 2004; O'Brien & Teisl, 2004; Teisl, 2018). However, we should also note that this demand for certified wood may not be homogenous across all product types (Stevens, Ahmad, & Ruddell, 1998). For example, consumers may be more willing to pay a premium for certified value-added products, such as floors, furniture (especially garden and patio furniture), architectural molding, and architectural panels with decorative veneers (Stevens et al., 1998), compared to products such as structural lumber.

To more comprehensively understand ECWP market, we should not only study whether a consumer is willing to pay a price premium, and for which products, but we should also discern the geographic, demographic, and attitudinal variables that motivate ECWP purchasing decisions. This allows ECWP vendors to effectively segment the market and seek out consumers who show a higher interest in such products. Sellers may then expand their sales regions or advertise in locations where current sales show room for improvement. Extensive research has evaluated this consumer willingness to pay (WTP) throughout different user categories, often finding that demand and WTP vary based on a number of demographic, geographic, and psychographic factors.

Importantly, multiple studies have shown that the demand for ECWPs may change based on a consumer's spending and income levels (Aguilar & Vlosky, 2008; Gronroos & Bowyer, 1999). A 1997 survey conducted in the upper Midwest U.S. found that homebuyers who had recently purchased more expensive houses indicated a greater WTP for ECWPs than those who

purchased less expensive homes (Gronroos & Bowyer, 1999). A 2007 survey of U.S. residential consumers indicated similar findings, concluding that a consumer's WTP for ECWPs is positively correlated with the respondent's income (Aguilar & Vlosky, 2008).

Other research attempts to explain ECWP use based on demographic and geographic variables, finding that consumers who are willing to pay a price premium for ECWPs are often female, members of the Democratic party, members of an environmental organization, and politically liberal (Vlosky & Ozanne, 1997). There may also be a correlation between the use of ECWPs and geographic location (Bowers, Ganguly, & Eastin, 2014). Previous research on ECWPs indicates that awareness and usage of these products were higher on the west coast than in other areas of the United States (Ganguly & Eastin, 2007; Stevens et al., 1998). Thus, by using these studies to describe potential ECWP consumers, a vendor could segment the population and find areas in which to expand sales.

However, other variables may more effectively segment the market for ECWPs. By using a cluster analysis of American homeowners, Ozanne and Smith (1998) found similar trends in demographic variables as those described previously, and they also found that attitudinal and trust measures better segmented the ECWP market. Here, the researchers quantified attitudinal measures by asking homeowners about the relative seriousness of current issues and their self-rate knowledge of environmental topics, and the study quantified trust variables by evaluating how much trust a consumer showed in different certifying bodies, such as NGOs, the government, or the industry (Ozanne & Smith, 1998).

Similarly, Vlosky et al. (1999) found a positive correlation between WTP and environmental consciousness, consumer certification involvement, and the perceived importance of environmental certifications. Straughan and Roberts (1999) also found that environmental

attitudes more effectively segment the market for green products when compared to demographic variables. Thus, this literature review finds that basic demographic and geographic features may help describe the ECWP market, yet other attitudinal and psychographic variables can often be better descriptors. Vendors interested in expanding ECWP sales should therefore thoroughly characterize the market, using a host of demographic, geographic, and psychographic factors.

Additional research takes an alternative approach to increasing ECWP sales. Rather than segmenting the market and evaluating WTP based on current certification labels, other research evaluates the efficacy of increasing WTP by changing the eco-label's contents. Research suggests that a more detailed label, compared to a simple eco-seal, may increase the probability that a consumer will choose a certified product over a lower priced, less-sustainable one (O'Brien & Teisl, 2004). Additionally, defining terms used in the certification, such as worker's rights or sustainable management, may increase the importance a consumer places on each certification attribute and their overall WTP (O'Brien & Teisl, 2004). Thus, manufacturers and vendors may be able to increase ECWP usage by both understanding which consumers are willing to pay and revising the eco-label.

Is this WTP real, and does it matter?

Importantly, we should be wary of a consumer's stated WTP in an academic study, as this demand may not necessarily manifest in the marketplace. Surveys of manufacturers and vendors help understand this actual demand for ECWPs, and these organizations often report that either consumers are unwilling to pay a premium or a premium does not exist for ECWPs in their market.

A 1998 study surveyed wood manufacturers that both sold and did not sell ECWPs; 126 companies did not sell ECWPs, and 28 companies did sell the products. This study found that

86% of manufacturers that did not sell certified wood products believed that there was no WTP in their primary market (Stevens et al., 1998). A separate survey of wood product manufacturers in Wisconsin support these findings, showing that that manufacturers who had attained CoC certification often did not increase sales or earn a price premium (Hubbard & Bowe, 2005). Both of these studies suggest that, although some potential customers claim they will purchase ECWPs, vendors do not see this demand in the marketplace.

Perhaps, however, understanding consumer WTP for ECWPs, and the resulting manifestation in the marketplace, is less important than some research suggests. Interestingly, Gulbrandsen (2006) argued that "eco-labelling" is not about meeting consumer demand but is instead a result of corporations responding to activist pressure. He writes, "transnational environmental group networks and their targeting of firms were key to the emergence of nonstate eco-labelling schemes, and… most firms decided to support or participate in such schemes only after intensive environmental group pressure" (Gulbrandsen, 2006). As Gulbrandsen (2006) suggests, it is possible that consumer WTP never drove the market for ECWPs.

Other ECWP Market Players: Home Centers, Home Builders, and Architects

The individual consumer is only one link in the overall demand for ECWPs. It is also important that distribution centers choose to supply such products and builders choose to use these products in their building processes. Thus, research has surveyed home centers, builders, and architects to understand their decisions to supply and use ECWPs, and this literature review indicates that usage and perceptions are low among these market participants.

In a survey of home centers in the U.S., certification and ecolabeling ranked last of 21 criteria used to select wood product suppliers. Fair prices, product quality, and consistent delivery ranked at the top (Perera, Vlosky, Dunn, & Hughes, 2008). Even more, these home

centers indicated that the top two reasons they decided to carry certified wood products were because it was the only product available and it improved the company image; consumer demand, increase sales volume, and the business's own commitment ranked lower (Perera et al., 2008). Only 11% of these home centers answered that they promoted certified products to consumers (Perera et al., 2008).

Similarly, merchants of ECWPs in a separate study reported that they did not expect profits to increase by selling certified products. Instead, these vendors sold the products because of the company's own commitment to environmental issues (Humphries, Vlosky, & Carter, 2001). Therefore, despite some consumers' reported interest in certified wood products and WTP, sellers may not believe there is profit to be gained, nor is there a strong market among their market base for ECWPs.

There are various markets for ECWPs, and while many home centers are concerned with individual consumers, the homebuilding industry is likely the largest potential market for certified wood products (see *U.S. Construction Industry Value and Wood Product Usage*). Some researchers are particularly interested in analyzing the homebuilder industry and its familiarity with and use of ECWPs. A 2014 survey of single family and multi-family homebuilders indicated that 45% of builders were not aware of the SFI label, 41% were aware of but did not use the label, and 14% used the label to make product decisions. Additionally, 39% of these builders were not aware of the FSC label, 38% were aware of but did not use the label, and 23% used the label to make product decisions (McGraw Hill Construction, 2014). This study finds that most homebuilders did not use the SFI and FSC labels to make product decisions, and many respondents were not even aware of the certification systems.

A similar study of architects in the U.S. green building industry found that almost a quarter of respondents had never heard of SFI-certified wood and 13% of respondents had not heard of FSC-certified wood (Bowers et al., 2014). These two recent studies suggest a low level of ECWP awareness and usage in homebuilding, which represents a significant loss of potential market share for ECWPs. These findings should be of particular interest and concern to those wanting to expand the ECWP market, who should prioritize increasing awareness and usage among builders and architects.

Projecting Trends in ECWP Usage

Yet despite low levels of awareness and consumption of ECWPs in multiple user categories, understanding and usage may be on the rise, and some studies project that this trend will continue. Consumer awareness of wood certification concepts was increasing in the early 2000s (Ozanne & Vlosky, 2003). Home centers, too, reported a moderate or significant increase in ECWP sales in the early 2000s (Perera et al., 2008), and consumer sales in the early 2000s were projected to increase in the future (Humphries et al., 2001; Perera et al., 2008). In the homebuilder industry, even though previous research shows that many builders had not heard of ECWPs, a 2005 study found that most U.S. homebuilders believed their usage of ECWPs would increase in the future, led in large part by an increase in usage by large builders (Ganguly, Bowers, Eastin, & Cantrell, 2013).

Interestingly in this literature review, wood product manufacturers demonstrated opposing forecasts. The 1998 study by Stevens et al. indicated reason to believe that the ECWP market would improve, but respondents in the 2005 Hubbard and Bowe study thought that the market for ECWPs is a phase that will abate.

Still, most of the studies referenced in this literature review anticipated an increase in ECWP familiarity and usage across multiple user and consumer categories. Notably, however, most of these studies were completed at least a decade ago, and it is therefore challenging to describe the current market for ECWPs and the perception of such products. To help bridge this gap, our research seeks to understand U.S. homebuilders' current familiarity with and use of ECWPs in the residential LEED market. This will help track the trends in usage over time and provide a clearer picture of the current marketplace for such products.

U.S. Construction Industry Value and Wood Products Usage

The U.S. construction industry boosts both the national economy and the global wood products industry. In November 2018, the U.S. Census (2018a) estimated total construction value at nearly $1.3 trillion per year, which is approximately 6% of national GDP (Trading Economics, n.d.). About 42% of this total was spent on residential projects, and the remaining value was spent on nonresidential construction, such as lodging and office, commercial, and health care projects (U.S. Census Bureau, 2018a). Thus, the U.S. construction industry plays an important role in the national economy.

Construction also drives much of the country's wood products usage. While the U.S. accounts for approximately 5% of the global population, the nation consumes an estimated 28% of the Earth's industrial wood products (Oswalt & Smith, 2014). The construction industry uses a large majority of this total, accounting for about two-thirds of the U.S.'s solid wood consumption (McKeever, 2009). Other uses of wood in the U.S. include the packaging and shipping industry, which consumes approximately 12% of lumber (primarily in wood pallets), and manufacturing (including furniture and other manufacturing that uses wood components), which consumes approximately 8% of lumber. Solid wood is also used in do-it-yourself projects, roof supports in

mines, upkeep of non-residential structures, and other activities, which together account for about 15% of total solid wood consumption (McKeever, 2009). Far and away, the construction industry dominates the country's use of solid wood products.

We can further divide construction into various sub-categories and determine the volume of wood used by each subgroup. New residential projects consume the highest share of solid wood, accounting for approximately 52% of all wood used in construction (McKeever, 2009). This category includes new single-family homes, multifamily apartments, and manufactured housing (McKeever, 2009), and the share fluctuates between 20% and 45%, depending on the economy and strength of the construction industry (Elling & McKeever, 2018). The repair and remodeling (R&R) industry uses a large portion of construction wood as well, accounting for approximately 37% of the total, and non-residential projects account for the remainder, at about 12% of the total (McKeever, 2009). U.S. homebuilding, including new homes and R&R activities, therefore dominates wood consumed by the U.S. construction industry.

Taken together, this indicates that new residential construction projects use approximately one-third of all wood consumed in the U.S. (McKeever, 2009). We can again subdivide the new residential construction industry into two primary categories: single-family and multifamily buildings. The majority of both types of projects use wood; in 2013 builders framed approximately 94% of single-family homes and 87% of multifamily buildings with wood (U.S. Census Bureau, 2018b). Yet single family projects use most of the wood used in residential construction, accounting for approximately 86% of the total (U.S. Census Bureau, 2018b).

Overall, the construction of single-family homes, multifamily units, and R&R activities are valuable industries that drive many of the national wood consumption trends, and wood product manufacturers often depend on the construction industry to sustain and strengthen their

own businesses. Therefore, this research considers homebuilder and remodeler use and perceptions of wood products, specifically ECWPs, as these builders account for a large share of the potential ECWP market.

Sustainable Construction

In recent decades, many individuals in construction have shown a heightened awareness of the industry's impact on the environment. This concern has given rise to various forms of "sustainable construction," which remains an evolving and growing industry, attempting to address a host of environmental challenges.

The concept of sustainable construction takes myriad forms and considers varying levels of environmental impacts. Some research related to sustainable construction evaluates environmental impacts of the construction process, evaluating the production of landfill wastes and noise, odor, dust, vibration, and chemical pollution (Fuertes et al., 2013). Other sustainable construction practices give attention to waste disposal during construction, the use of harmful substances, working environments, and environmental management systems (EMSs) (Varnäs, Balfors, & Faith-Ell, 2009). Still other environmental assessments are more limited and simply require an overall analysis of air, noise, water, and waste pollutants generated by the project (Shen, Tam, Tam, & Ji, 2010).

Many elements of sustainability (an opaque and developing topic itself) are overlooked in current sustainable construction conversations. To evaluate and reduce environmental impacts of construction, builders and contractors may use EMSs, and current research sometimes concludes that these systems are inadequate to guide truly sustainable development (Ball, 2002; Ding, 2008). For example, in EMSs, it is not uncommon to emphasize the environmental impacts of the construction process while giving less attention to the impacts of the building itself.

Additionally, sustainable construction often ignores the total impacts of the products used in the building process (Fuertes et al., 2013).

Seeking sustainable construction seems to be a microcosm for our global efforts to achieve "sustainability." That is, as humans become more aware of environmental degradation and our impact on the natural world, the list of environmental problems only lengthens. Yet we still have reason to remain optimistic about these challenges. As Ball (2002) wrote, "A society that is working towards the minimization of harmful impacts, whether through eco-labelling or EMSs [environmental management systems], must be considered to be at least environmentally awakening." Becoming aware of the challenges we face, and the potential solutions to those challenges, is still progress toward a better future.

> "IF YOUR COMPANY IS DOING [ECO CONSCIOUS ACTIONS], IT'S A GOOD IDEA TO LET THE WORLD KNOW. THERE IS A WEALTH OF FINANCIAL VALUE TO BE REAPED BY COMMUNICATING YOUR ORGANIZATION'S ENVIRONMENTAL INITIATIVES. "
>
> Axelrod (2000)

The Green Building Industry

In response to this environmental awareness and the concept of sustainable construction, various "green building" programs have emerged throughout the world, which attempt to lessen the global impacts of construction and provide verification for buildings constructed with a reduced environmental footprint. Research indicates that the green building industry is quite successful, and demand will continue to rise into the future (McGraw Hill Construction, 2014).

The green building industry's positive forecast may be partially attributed to the profitability of green projects, as many any builders indicate that their customers are willing to pay a premium for a green certified home. Seventy-three percent of single-family builders and 68% of multifamily builders surveyed answered that their customers would pay more for a green home (McGraw Hill Construction, 2014). In a separate study, over 68% of builders and 84% of

remodelers stated their customers were willing to pay for green, averaging a willingness to pay a premium of three percent for new green homes and five percent for green remodel projects (McGraw Hill Construction, 2014). Thus, surveys consistently find that consumers are willing to pay a premium for a green certified home.

Other studies validate these survey results, finding that green homes indeed generate a premium compared to their conventional counterparts. A McGraw Hill study found that green certified homes generated 3.5% higher rental rates than conventional counterparts, and they provided a 6.6% higher return on investment (McGraw Hill Construction, 2009). A recent study in California also found that green-labeled homes averaged a 9% price premium in homes sold in the state between 2007 and 2012 (Kok & Kahn, 2012).

Overall, the market for green buildings looks strong, growing, and profitable. Lockwood (2006) suggests that the cost to produce green homes is not exorbitant, and given these conditions, we can expect the green building industry to progress into the future.

Leadership in Energy and Environmental Design (LEED) Certification

The Leadership in Energy and Environmental Design (LEED) certification system, developed by the non-profit U.S. Green Building Council (USGBC), is one of the most widely-used green building programs in the world. This market-based, voluntary certification process encourages building strategies that will help the building industry achieve seven goals: reverse contributions to climate change; enhance individual human health and well-being; protect, enhance, and restore water resources; promote sustainable and regenerative material resource cycles; build a greener economy; and enhance social equity, environmental justice, and community quality of life (USGBC, 2014b).

Originally launched in 2000, LEED was designed specifically for commercial projects. In 2008, USGBC launched its LEED for Homes program, which provides a green building certification process for residential buildings. Additionally, there are now LEED programs for a wide variety of projects, including new commercial developments (which is further broken down into different building types, including schools, hospitality, and data centers), building operation and maintenance, neighborhood development, communities and cities, and others.

The LEED certification system is thought to be an evolving system to account for an ever-changing landscape, and as such, USGBC releases periodic updates to the programs. The most recent version, released in November 2013, is called LEED v4. It includes updated provisions for enhanced technology, stronger energy performance standards, increased water efficiency, improved material selection, and more (USGBC, 2014b). USGBC also expanded the certification system to accommodate a wider variety of industries, including mid-rise residential buildings, data centers, schools, and retail centers. The most up-to-date version of the LEED for Homes certification is therefore called Leed v4 for Homes.

LEED Point System

There are four certification levels in the LEED system, and projects accrue points to achieve one of the levels. The most ambitious certification level is Platinum (110 to 80 points), followed by Gold (79 to 60 points), Silver (59 to 50 points), and finally Certified (49 to 40 points).

USGBC designates different point systems based on the type of project. In the LEED for Homes process, single family homes and multi-family residential buildings of one to three stories fall in the same category ("Homes and Multifamily Lowrise") and share the same point system. Multifamily units with four to seven stories are classified as "Multifamily Midrise," but the

certification requirements are very similar. A high-rise multifamily building (eight or more stories) is certified under the Building Design and Construction (BD+C): New Construction (NC) requirements.

Each point system is further subdivided into different subcategories, and points are allocated unevenly between each group. The LEED v4 for Homes scoring system (which includes both the Homes and Multifamily Lowrise and Multifamily Midrise categories) includes eight total subcategories: location and transportation (15 possible points), sustainable sites (7 possible points), water efficiency (12 possible points), energy and atmosphere (38 possible points), material and resources (10 possible points), indoor environmental quality (16 possible points), innovation (6 possible points), and a "regional priority" category (4 possible points). A project may also earn up to two points for using an integrative process. Notably, the energy and atmosphere category holds the largest share (35%) of the total available points, allowing 29 points alone in the "annual energy use" credit. Indoor environmental quality holds the second highest share of potential points, comprising 15% of the total.

LEED for Homes by the Numbers

In 2014, USGBC reported that they had certified 53,554 housing units under the LEED for Homes program worldwide. Approximately 25% of these housing units are single family units (12,955 units), and the other 75% are multifamily units (40,599 units) (USGBC, 2014a). About 27% of these units had attained Platinum certification, the most prestigious and difficult level to achieve. Thirty-one percent of the units achieved Gold certification, 24% earned Silver certification, and 8% had earned LEED-certified status (Figure 7) (USGBC, 2014a). Thus, units most commonly earned Gold status, with Platinum and Silver also being common certification levels.

USGBC is based in the United States. As such, the vast majority of LEED-certified homes are in the U.S., although the certification has global reach. In 2014, the United States had 136,731 projects certified and registered (note that not all registered projects have earned certification) (USGBC, 2014a). California, New York, and Texas have the highest number of LEED-certified homes (Kriss, 2014) (Figure 8).

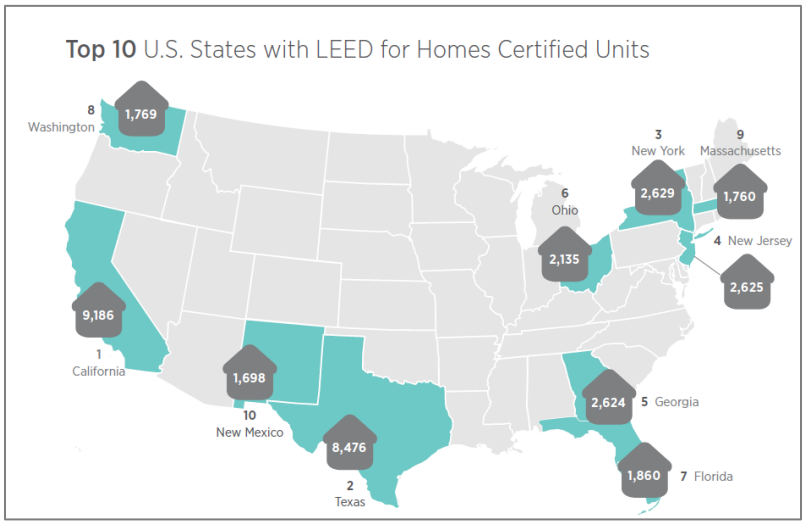

Figure 7. The top 10 U.S. states with LEED for Homes certified units (USGBC, 2014).

Canada accounts for the second highest number of LEED for Homes units, with 2,332 projects certified and registered, and Saudi Arabia also has many units certified and registered (809). Other countries with over 50 units certified and registered include Cayman Islands (109), China (98), Haiti (87), Turkey (68), and Montenegro (59) (USGBC, 2014a) (Figure 7). Worldwide, USGBC estimates that approximately

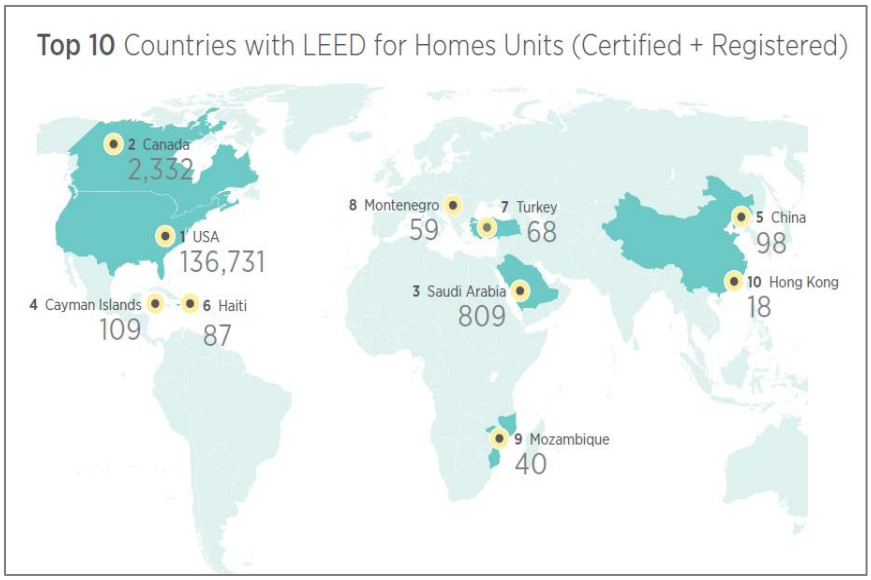

Figure 8. The top 10 countries with LEED for Homes units (certified and registered) (USGBC, 2014).

150,000 units are certified if calculations account for multifamily buildings certified under the commercial LEED system (USGBC, 2014a).

Challenges and Limits of LEED Practices

Of course, no green building system is perfect, and some architects, builders, and industry professionals critique the LEED system. Attaining LEED certification requires a certification fee, and some research finds that fees range between $1,750 and $22,500, with an average cost of $2,000 (McCormick, 2008). Despite additional research finding that green-certified houses fetch a price premium (McGraw Hill Construction, 2009), builders may cite that the certification fee is a barrier to certification (McCormick, 2008). Other builders consider the process to be too time- and money-intensive, especially when it comes to the first costs (McCormick, 2008).

We should also note that it is possible to build a "green" building without using the LEED system. A builder may follow sustainable practices without attaining certification, or they may follow one of the many other green building certifications that exist in the U.S. and throughout the world. LEED may therefore be a popular, valuable, and useful green building program, but it is not the only way to reduce the global environmental impacts of the construction industry.

ECWPs in LEED for Homes

Overview

Importantly, all wood in a LEED for Homes project must be "nontropical, reused or reclaimed, or certified by the Forest Stewardship Council, or a USGBC-approved equivalent" (USGBC, 2018). Thus, if a builder uses new tropical wood in their project, it must be environmentally-certified.

Historically, USGBC has only recognized the FSC program as a valid wood certification system. However, a recent pilot program expands the options of wood products that may be used to earn points in the LEED program. This alternative compliance path (ACP) for wood and paper products, released by USGBC in April of 2016, recognizes SFI, ATFS, Canadian Standards Association (CSA), and PEFC-endorsed standards to achieve points toward a LEED building (SFI, 2016). As of March 2019, this ACP was still in its pilot phase. If implemented permanently, it will allow builders to continue to earn points in their LEED projects by using a wider variety of ECWPs.

Table 3. Maximum points for compliant building components in the Environmentally Preferable Products subcategory (reproduced from USGBC, 2018).

Component	Max. Points
Flooring – Base floor only (i.e. sealed concrete, no floor covering)	2
Floor covering	1
Insulation	1
Sheathing	1
Framing	1
Drywall, interior finish	1
Concrete: cement and / or aggregate	1
Roofing	1
Siding	1
Additional Components (install at least 3 of the following): • Doors (not including insulated doors or garage door) • Cabinets • Counters (kitchens and bathrooms) • Interior trim • Decking or patio material • Windows	1

In LEED for Homes, a builder may accrue points in their residential project by using ECWPs in the Environmentally Preferable Products credit, which is in the Material and Resources (MR) section of the standard. The Environmentally Preferable Products subcategory is worth 0.5 to 4 points in Homes, and 0.5 to 5 points in midrise multifamily projects.

In this subcategory, ECWPs may earn points if they are used in a number of building components. These components include base flooring, floor covering, sheathing, framing, roofing, siding, or any three of the following: doors, cabinets, counters, interior trim, decking or patio material, and windows (Table 3). Each of these components can earn one point, with the exception of the base floor, which may earn two points. Notably, most of these building components are built with hardwood products, as opposed to softwood products, which may influence the forest certification program that a builder will use to earn LEED points. Also of note is the significant difference between the residential LEED program and the commercial LEED point system. In commercial LEED projects, builders earn one point if at least 25% of the total value of permanently installed wood products are certified by FSC or a USGBC-approved equivalent (USGBC, 2019).

Importantly, however, a builder can earn full points in the Environmentally Preferable Products credit without using ECWPs. The building may use other environmentally preferred materials in the building components above, such as reclaimed (salvaged, refurbished, or reused) material, material that is 25% postconsumer or 50% preconsumer content, and/or bio-based materials. Builders can also earn up to 1.5 points by using locally extracted, processed, and manufactured products in the framing, aggregate for concrete and foundation, and/or drywall or interior sheathing of the building. Overall, while ECWPs can be an effective way to earn points in a LEED for Homes project, their use is not required, nor do these products account for a large portion of the total potential points.

Evaluating ECWP Use in LEED Projects to Date

Given the potential use of ECWPs in the LEED certification process, LEED for Homes is a large potential market for these products. Further, builders who participate in the LEED for

Homes process likely have a higher awareness of ECWPs compared to non-LEED builders. Multiple studies have analyzed this usage of ECWPs in the green building industry, seeking to understand the motives and patterns of use throughout the U.S.

One survey analyzed U.S. architects' usage of ECWPs in green building projects, finding that respondents cited the environmental benefits and the products' contributions to green building points as reasons to use the products (Bowers et al., 2014). These reasons for using ECWPs validate the concept that ECWP consumption may be increased by encouraging their use to achieve certification points in green building programs. Yet to more completely understand the use of ECWPs in green building, we should also pay attention to geographic trends and the challenges of using such products in the building industry.

One recent study found that projects using ECWPs to earn LEED points have become more clustered since 2000, and the researchers identified "hot spots" around major cities where builders used ECWPs (G.D. Estep, DeVallance, & Lacombe, 2015). Thus, it may be more common for builders to use ECWPs if they are building in major metropolitan areas, including Seattle, Portland, San Francisco, and Denver, and this clustering likely has impacts on total usage throughout the U.S.

Additionally, research has also identified some challenges associated with using ECWPs in the green building industry. A survey of Oregon design professionals with experience in green building found that although wood was viewed as a more sustainable construction material, green building programs do not incentivize the use of wood compared to steel and concrete (Knowles, Theodoropoulos, Griffin, & Allen, 2011). Knowles et al. (2011) also found that even though builders wanted to use more wood in their projects, especially FSC-certified wood, they believed that the lack of availability was a barrier to its use. This cited lack of availability could

pose a major challenge to the widespread use of ECWPs, and our research should also seek to understand the perceptions of availability today.

Notably, in the Knowles et al. study, respondents showed a positive view of FSC and a negative view of SFI-certified wood. In 2011, when this study was published, the LEED process only recognized FSC-certified wood as an environmentally-preferred product. It is therefore not surprising that design professionals favored FSC over SFI. Yet given the recent ACP, the perceptions of SFI-certified wood may have improved since this study. Our research therefore seeks to understand the current perceptions of both FSC and SFI products in the residential LEED building market, which may help explain patterns of use of both products.

Overall, however, we must remember that while using certified wood products in a LEED-certified home may earn a project a limited number of points, ECWPs are not the primary concern in LEED for Homes building projects. In fact, a 2014 survey of homebuilders found that energy efficiency was the most important green practice by remodelers and builders of new single-family and multi-family homes (McGraw Hill Construction, 2014). Further, builders stated that utility cost savings was one of most important benefits to communicate to buyers, and reduced environmental impact ranked much lower in the list of communication priorities (McGraw Hill Construction, 2014).

Thus, as this literature review presents, the green building industry and LEED certification process evaluate a plethora of issues, and ECWPs represent a small segment of a project's focus. Still, green building programs such as LEED for Homes represent a potential market to expand the use of ECWPs.

Problem Statement

The literature review presented herein evaluates a host of relevant topics, including the benefits and difficulties associated with forest certification, consumer WTP a premium for an ECWP, historical use of ECWPs in the residential LEED market, and the evolution of LEED for Homes. We find that given the growth of the LEED market, the implementation of the ACP, and the expansion of forest certification systems worldwide, LEED for Homes is a large and growing market for the use of ECWPs. However, the current familiarity with and use of ECWPs among LEED homebuilders warrants further investigation. We believe this is important because understanding the ECWP market will help forest managers and ECWP organizations discern potential markets for their products. Ultimately, a strong ECWP market provides economic incentive for forest managers and companies to attain or maintain certification, and we hope that this may encourage sustainable forest practices and the use of sustainably-sourced wood products.

In this research, we therefore seek to provide an enhanced understanding of the usage and perceptions of ECWPs among residential LEED builders and remodelers, and our ability to compare these data to a similar study conducted in 2011 permits a compelling analysis. Herein, we endeavor to answer the following questions:

1. What is the current familiarity with and use of ECWPs among residential LEED builders in the U.S.? How does this compare to familiarity and use in 2011?
2. Can we segment the residential LEED market to better evaluate the trends in use of ECWPs?
3. Are there avenues to expand the ECWP market in LEED homebuilding?

These research questions are translated into three primary objectives which help guide our research and inquiry in this study:

1. Understand the familiarity with and use of ECWPs among residential LEED builders in the U.S.
2. Compare the current familiarity with and use of ECWPs among residential LEED builders in the U.S. to responses from 2011.
3. Understand and interpret current ECWP use among different LEED market segmentations and discern trends since 2011.

Methods

Survey Structure

The survey distributed in 2018 closely mirrors a similar survey administered in 2011 by Indroneil Ganguly, Tait Bowers, and Ivan Eastin at the University of Washington's Center for International Trade in Forest Products (CINTRAFOR) (Bowers et al., 2014). We recreated questions from the 2011 survey in the 2018 version, ensuring that the questions were as close to the original format and language as possible, given minor changes in the survey platform's interface. The 2011 survey asked questions concerning annual business activity in the 2010 calendar year, whereas the 2018 survey asked questions concerning annual business activity in the 2017 calendar year. We also removed some questions from the 2011 survey in the 2018 version, including various questions that were lengthy and unnecessary for our analysis. We did this to reduce overall response time and encourage more respondents to complete the survey.

One notable change concerns the screening process used in both survey versions. The second question in the 2018 survey asked respondents how many homebuilding projects they had completed in 2017. If the homebuilder had completed zero projects, the survey was terminated. This is the same logic used in the 2011 survey, but in the earlier version, homebuilders who completed less than two projects were excluded from the study. We changed this screening methodology primarily to allow responses from multi-family builders who had worked on one project in a year.

We structured the survey using logically sequenced questions. This means that the response to one question determined the subsequent questions presented to each respondent. For example, if a homebuilder indicated that they were not familiar with FSC-certified building

products, the survey did not present additional questions regarding their use of FSC products in the past two years. This resulted in a data frame that had multiple subsets of data, addressing a range of research questions.

We also included new questions in the 2018 survey which asked respondents about their familiarity with and use of CLT building materials. These questions also used logical sequencing, and we did not analyze these survey questions in this paper.

Before survey administration, various individuals, including those with experience in the forest products industry, pretested the survey to ensure the survey's clarity, accuracy, and functionality.

Administering the Survey

We administered the 2018 survey using Qualtrics, an online survey platform. This is the same survey platform used by the researchers in 2011. Online surveys are flexible and allow for logically sequenced questioning, which was an important feature for our survey structure. Additionally, online surveys are a cost-effective method of reaching a large number of participants, and they record data automatically, allowing for more efficient analysis (Wyatt, 2000). Survey administration followed suggestions of survey methods as presented by Dillman et al., and we gave particular attention to internet-specific suggestions (Dillman, Smyth, & Christian, 2014).

We emailed the survey to respondents through Qualtrics. The initial email included text in the body of the email which explained the purpose of the study and included contact information of the survey administers. The email also contained a link that took the respondent directly to the survey. Whenever possible, we addressed surveys to the individual builder we were contacting, as suggested by Dillman et al. (2014). To improve response rate and provide

incentive, we offered the first 100 respondents a $10 gift card to an online retailer, which they received upon completion of the survey.

We sent two email reminders to non-respondents at least one week after the previous email. The second reminder did not significantly increase response rate, and in accordance with suggestions by Dillman et al. (2014), we did not send subsequent reminders.

When phone numbers were available, we also made phone calls to firms and asked builders to complete our survey. If a builder indicated interest, we immediately sent the standard email to the email address provided, addressing the message to the individual. If the phone call reached a voicemail, we left a message with a description of our research and contact information of the researchers. We made one additional phone call a week later to those contacts that we did not reach on the first call. Emails gathered via this method received the same reminders as those described above.

Data collection occurred between October 2018 and February 2019.

2018 Survey Respondents

In 2018, we re-contacted LEED builders from the 2011 contact list. We also created a new database of homebuilders and remodelers, using publicly available lists of residential LEED builders. We gathered phone numbers and email addresses for these businesses from the internet.

In total, we emailed surveys to 624 homebuilder and remodeler email addresses. Of these emails, 123 bounced back. We received 75 total responses. Five responses were incomplete and removed from the data. An additional six responses did not fit the qualifications of our survey because their reported primary business was outside the scope of our research (general contractors, green building certifiers, sustainability consultant, etc.). Three survey responses

were duplicates, and we removed the second response of each duplicate from the data. This resulted in 61 complete, usable surveys, which yielded a response rate of 12.2%.

2011 Survey Respondents

The 2011 data consisted of 102 complete surveys from homebuilders and remodelers, which included builders and remodelers from the LEED for Homes program and from the National Association of Home Builders' (NAHB) National Green Building Standard (NGBS) program. In this research, we were primarily interested in those respondents from the LEED for Homes program. We therefore removed survey respondents who had less familiarity with and use of LEED compared to NGBS. This resulted in 49 builders that were likely associated with the LEED for Homes program; 46 builders had used LEED for Homes, one builder had heard about the program and planned to use it, and two builders had heard of it, but never used it (Table 4).

Table 4. Cross table of familiarity with and use of NGBS and LEED for Homes building programs in surveyed eco-builders in 2011. Shaded boxes represent the surveys used in this analysis (total n = 102, n of shaded region = 49).

		Familiarity with USGBC's LEED for Homes				
		Haven't heard about it	Heard of it, but never used it	Heard about it, and am planning to use it	Have used it	Total
Familiarity with NAHB's NGBS	Haven't heard about it	0	2	0	3	5
	Heard of it, but never used it	0	0	1	16	17
	Heard about it, and am planning to use it	0	1	0	2	3
	Have used it	0	43	9	25	77
	Total	0	46	10	46	102

Analytical Methods

We downloaded initial responses from Qualtrics into SPSS 19.0.0. We used SPSS 19.0.0 and R, Version 3.5.1, for the data analysis herein.

This analysis utilizes Pearson's chi-square tests. This statistical method is used to test the relationships between categorical variables, and it is therefore fitting given the structure of our surveys. A chi-square test compares the observed frequencies in a contingency table to the expected frequencies, had the observations happened by chance. The test holds several key assumptions: (1) we took a simple random sample, (2) the observations are independent, (3) the variables are categorical, (4) no more than 20% of the expected frequencies are less than five, and (5) none of the expected frequencies are zero. Assumption (5) is more important than assumption (4), and in some cases we combined categories to account for low expected frequencies in our contingency tables.

We employed two types of chi-square tests: a chi-square test of independence and a chi-square test of homogeneity. Both tests use the same mathematical equation to derive the test statistic, but the hypotheses and conclusions vary between the two tests. In a chi-square test of independence, we ask if one attribute is independent of another. This test is used when comparing relationships in the 2018 data, as researchers use it when one sample is taken. In this test, we pose the following null and alternative hypotheses:

H_o: Observed frequencies = Expected frequencies (the assignment into each category is independent)

H_a: Observed frequencies ≠ Expected frequencies (a relationship exists and the assignment into each category is not independent)

The chi-square test of homogeneity, comparatively, asks if proportions are equal among two groups. Specifically, in the case of our analysis, we ask if the proportions in each response category (assigned into columns) are equal between the 2011 and 2018 survey (assigned into rows). We therefore use this test when analyzing the relationships between the 2011 and 2018 survey results. A chi-square test of homogeneity poses the following null and alternative hypotheses:

H_o: There is no difference in the distribution of the categorical variable between the two populations (assignment into each column category is the same for each row category)

H_a: An inequality exists (the assignment into each column category is not the same for each row category)

The Pearson's chi-square test statistic is calculated using the following formula:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(f_{ij} - \hat{f}_{ij})^2}{\hat{f}_{ij}}$$

Where: $\hat{f}_{ij}$ = expected frequency in the i^{th} row and j^{th} column
f_{ij} = observed frequency in the i^{th} row and j^{th} column

And: df = (r-1)(c-1)

Where: r = number of rows
c = number of columns

When the results of these tests showed significance, we computed the standardized residuals to discern trends and determine which observations had the greatest contribution to the overall test statistic.

Additionally, when we reduced data to 2x2 contingency tables, we used a Yate's Continuity Correction. This calculation accounts for the discontinuity between the continuous χ^2 distribution and the discreteness of the data. The Yates Continuity Correction is as follows:

$$x_y^2 = \frac{N\left(|f_{11}f_{22} - f_{21}f_{12}| - \frac{N}{2}\right)^2}{C_1C_2R_1R_2}$$

Where: f = observed frequencies
N = sample size
C = column sum
R = row sum

These methods formed the foundation for our analysis of both the 2018 survey results and the 2011 to 2018 survey comparison. See *A Note About Reporting Results* for a description of the levels of significance chosen for this research.

Preliminary Field Research and Observations

Additionally in this study, before administering the survey, researchers visited lumber vendors and retail centers in the Seattle area to explore ECWP supply throughout the region. We first observed the wood products at each location, paying particular attention to the presence of eco-labelling. If a product carried an eco-label, we recorded the type of wood product, eco-label used, price, and the presence or absence of a similar, non-labelled product. We also searched online and in-store for information regarding the vendor or retail center's commitment to sourcing sustainable wood products. This provided an understanding of ECWPs as they appear to a retail consumer and gave an overall sense of the ECWP market in the Seattle area.

We also asked employees at each location if they were aware of ECWPs and where consumers could find such products in the store. At multiple locations, we spoke with individuals knowledgeable in wood product sourcing to understand their experiences with ECWPs. We

asked these individuals about their familiarity with ECWPs and their opinions of different certification systems. We also asked if they received questions about eco-labelled wood from their customers, and if interest from consumers had changed over time. These interviews provided invaluable insight into difference experiences with ECWPs, including how customers and suppliers perceived the products. We used this information to enhance our understanding of the wood product market, and we compared this anecdotal information to the survey results.

In our visits, we found that eco-labels for wood products were difficult to find in all locations. In total, we observed the SFI label on one product that was dual-certified by FSC and SFI, and there was no similar alternative to the eco-labelled product. The FSC label was more common, although it was far from ubiquitous. Additionally, when we observed the FSC label, there was rarely a non-labelled alternative. It was therefore difficult to compare prices or attributes between certified and non-certified versions of products.

In conversations with employees, it was clear that most employees had no knowledge of ECWPs. The managers who had experiences using ECWPs reported different perspectives on the labels, but they generally indicated a higher awareness of FSC-certified wood compared to SFI-certified products. Additionally, these individuals reported a declining interest in ECWPs among consumers over the past five years, and at least one product manager also cited the high cost of ECWPs as a barrier to their use and sale. These anecdotal results provided additional insights into the ECWP market, and we've referenced these experiences in this research where applicable.

Results and Discussion

A Note about Reporting Results

We report all statistically significant values at the 95% level of confidence. Thus, if we report that a relationship is statistically significant, the p-value is less than 0.05. We use the following general rules when reporting and interpreting contingency tables in this report (as originally suggested by Ganguly et al. (2010)):

1. We present a contingency table only when we find that the differences in the table are statistically significant, using a Pearson's chi-square test ($p < 0.05$).
2. We use color-coding to indicate significant differences found in post hoc tests. Yellow color-coding indicates that the ratio between the two rows in the given column are different from what would be expected, given our statistical tests.

Demographics of Survey Respondents

We gathered 61 usable survey responses in the 2018 survey. This included 46 homebuilders (75%), 9 remodelers (15%), and 6 "other" respondents (10%) that did not precisely fit either of these categories but participated in homebuilding and remodeling activities (Figure 9). These six respondents included multi-family builders, designer/builder firms, builder/remodeler firms, and other similar business descriptions. Of the 61 respondents, 41 (67%) currently use the LEED for Homes certification process, 18 (30%) answered that they had heard of the program but do not currently use it, and 2 respondents (3%) had not heard of LEED for Homes.

The 2011 survey included 49 total respondents. Of these 49 respondents, 45 (92%) were homebuilders, and 4 (8%) were remodelers (Figure 9). Forty-six (93%) of these survey respondents had used the LEED for Homes program, 1 (2%) had plans to start using the program, and 2 respondents (4%) had heard of LEED for Homes but had never used it.

A chi-square test of homogeneity showed that there was no significant difference between the ratio of homebuilders to remodelers between the 2011 and 2018 data sets. The consistency of our results gives confidence that surveys reached a similar population of homebuilders and remodelers in both years.

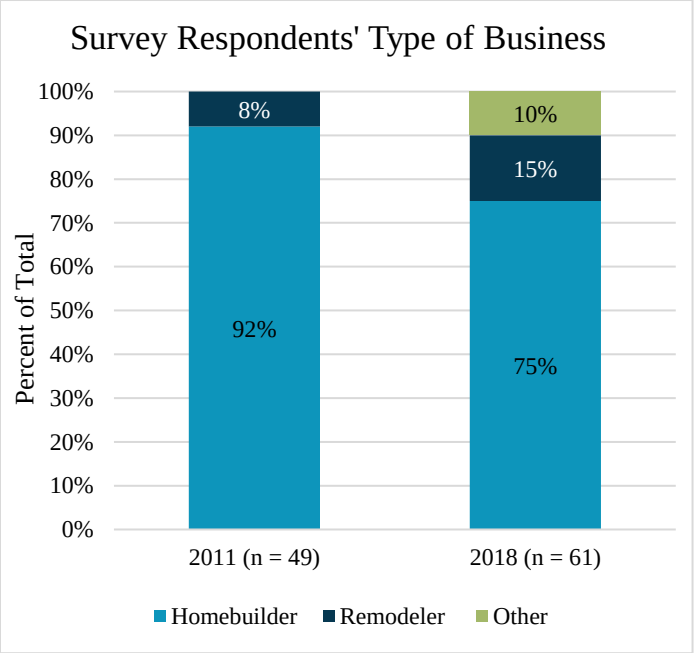

Figure 9. Survey respondents' type of business in 2011 and 2018, characterized as homebuilder, remodeler, or "other." No significant difference found.

In the 2011 survey, the researchers screened out those respondents who replied that their business was in the "other" category. This reduce both the number of responses from businesses that did not fit the study qualifications and the number of responses that needed to be removed in the 2011 survey analysis. However, we included the "other" category in the 2018 survey to allow multi-family builders to complete the survey, as multi-family construction represents a substantial portion of LEED-certified residential buildings. We also received feedback from builders who indicated they would like to answer "all of the above" in textbox of the "other" category. Note that in the analyses herein, we removed some "other" responses that did not fit our survey qualifications but kept those that were relevant to this analysis (see *Methods* section). Therefore, we did not include the "other" responses in our aforementioned test of homogeneity.

We also asked respondents in both surveys in which area their firm conducts the majority of their business, based on population size. Respondents chose from one of three options: urban/suburban ("a city or group of contiguous communities with a population greater than 50,000"), small town ("a city or town that is generally isolated from a major urban area with a population less than 50,000"), or rural ("low density population scattered over a wide area"). In the 2018 survey, 49 respondents (80%) operated primarily in urban or suburban areas, 7 (11%) were in small towns, and 5 (8%) focused on

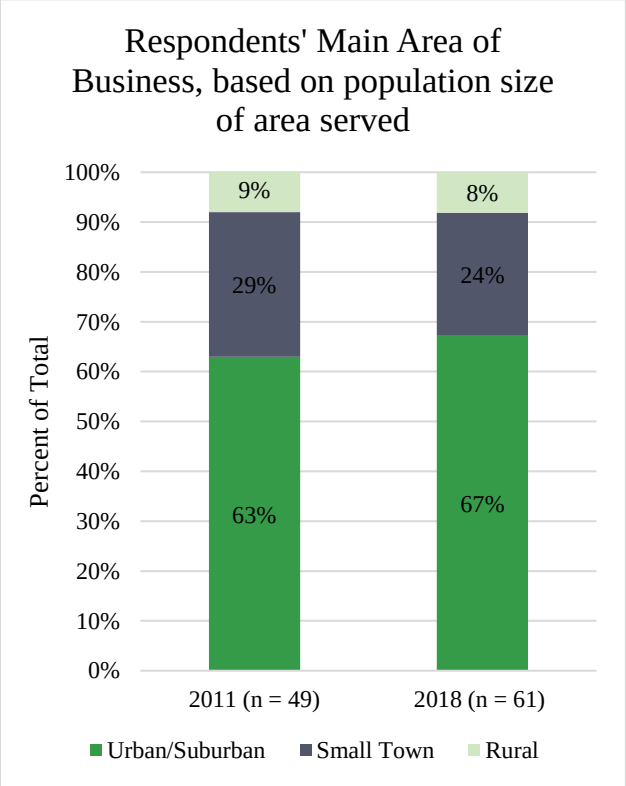

Figure 10. Respondents' main area of business in 2011 and 2018, based on population size of an area served. No significant difference found.

projects in rural areas. In 2011, 33 respondents (67%) were in suburban or urban areas, 12 (24%) were in small towns, and 4 respondents (8%) worked in rural areas (Figure 10). Chi-square test of homogeneity showed that there was no significant differences in population size of the firms' businesses between the 2011 and 2018 survey.

Notably, the majority of respondents in each survey year reported serving suburban and urban population areas, with a very small number of respondents operating in rural areas. The similar proportions from 2011 to 2018 again give confidence to our survey techniques and indicates that we reached a similar population of builders. Johansson (2011), whose study found that non-metropolitan areas had by far the fewest number of commercial green buildings per capita, also supports this distribution of builders in urban areas.

In both surveys, respondents reported their firm's annual revenue (in either 2010 or 2017) in one of nine revenue categories, as seen in Figure 11. Because of the large number of categories and low number of responses per group, we combined these original groups into three new ones, following the classifications used by Ganguly et al. (2013) (Figure 11). Using our small, medium, and large revenue categories, a chi-square test of homogeneity showed that the firm size of builders between the 2011 and 2018 survey were significantly different (Figure 12). The results suggest that the 2018 survey included more large builders, whereas the 2011 survey included more medium-sized builders.

These differences suggest a few alternative hypotheses. On one hand, this change could indicate that builders are earning more revenue than they were in 2011. This would be logical, as the 2011 survey occurred around the time of the economic crisis, which had a definite impact on the U.S. construction industry. Alternatively, these findings suggest larger builders are increasingly adopting the LEED for Homes process and dominating the market. There is also

some evidence to support this hypothesis, as research suggests that small firms have more difficulties implementing new sustainability policies (Lepoutre & Heene, 2006), and large firms are more likely to adopt innovative building practices and materials (Kelley & Brooks, 1991; C. T. Koebel, 2008; Robertson & Gatignon, 1986). Since LEED building practices are constantly evolving and the standards are often updated, large firms may find it easier to keep up with the changes in the program, whereas smaller firms might not be able to adjust to the frequent revisions. Lastly, these differences could reflect the structural changes in the U.S. homebuilding industry, as some research suggests that smaller builders were hit harder by the financial crisis (Corkery, 2008). Consolidation in the industry has allowed large builders to capture more of the re sidential building market, which may manifest in the research presented here (Timiraos, 2015).

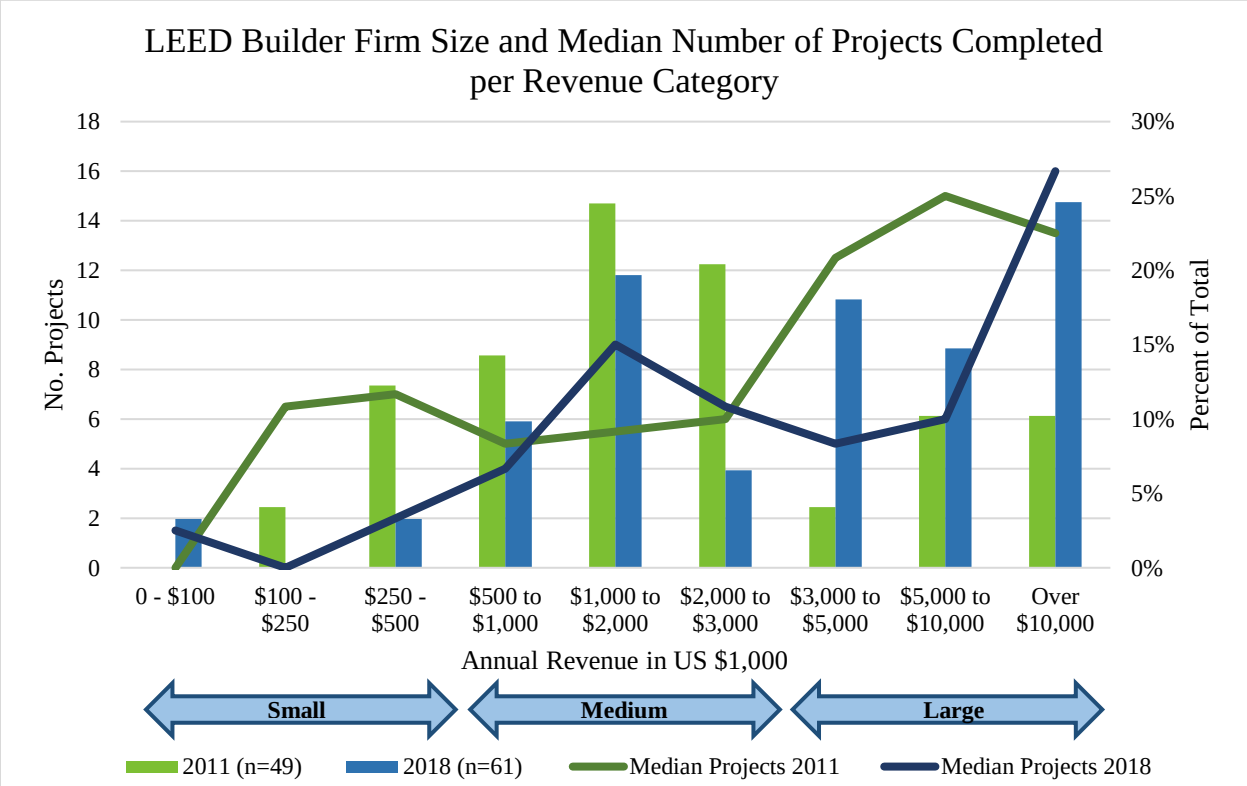

Figure 11. LEED builder firm size (based on revenue) and median number of projects completed per revenue category, 2011 and 2018.

To further explain a builder's firm size, we also tracked the median number of projects completed in each revenue category for both the 2011 and 2018 survey. By understanding how many projects firms of different sizes were completing, we could identify whether the number of projects a firm completes drives their revenue or if they are completing a similar number of projects, but of a higher value. The trend lines in Figure 11 show the median number of projects for both the 2011 and 2018 survey. While both lines show an upward trend, they do not show a distinct increase across each revenue category. This suggests that while larger firms do complete more projects compared to smaller firms, their revenue is also dependent on the value of the projects they are completing.

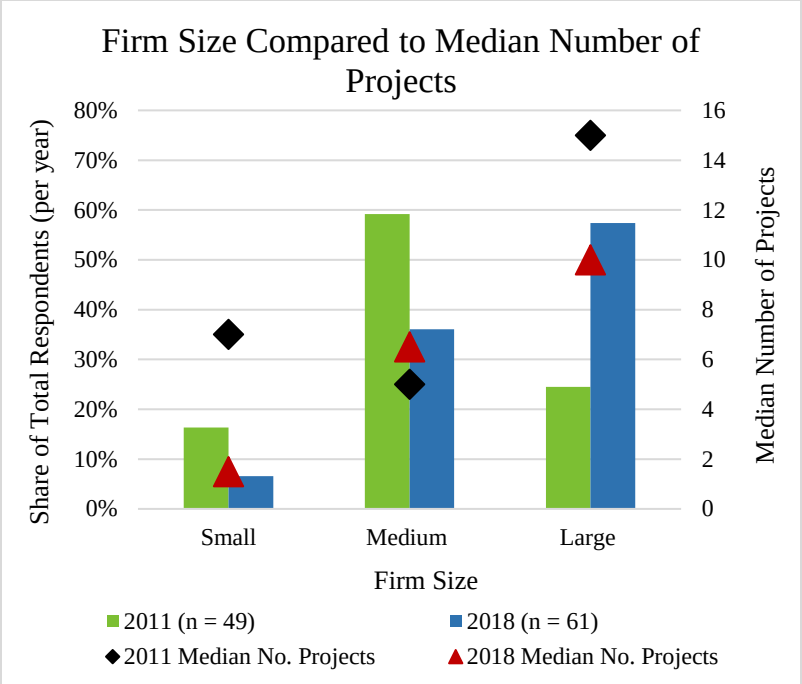

Figure 12. LEED builder firm size compared to median number of projects in three different size categories, 2011 and 2018. No significant difference in the median number of projects between builders of different sizes between 2011 and 2018.

When we analyzed the median number of projects between the firm sizes, independent samples Kruskal-Wallis tests find that there was no change between the 2011 and 2018 surveys. Large builders completed a statistically similar number of projects between both survey years. Medium-sized builders showed the same consistency, as did the small- and medium-sized builders when we combined the two categories. The consistency here shows that firms with similar revenues were completing a similar number of projects in both 2011 and 2018.

Overall, our survey results show that respondents in the 2011 and 2018 survey were similarly distributed between remodelers and homebuilders as well as between suburban/urban, small town, and rural areas of business. Builders with similar revenues also reported completing a comparable number of projects between 2011 and 2018. In the 2018 survey, we attempted to reach a population of builders consistent with those surveyed in 2011, and the similarities in these metrics gives confidence in our survey instrument and protocol. The higher proportion of large builders in the 2018 survey could suggest that large builders increasingly capture the residential LEED market, or it could also be an indication of the recovery of the residential building market since the economic crisis of 2008.

LEED Builders and Geographic Location

The surveys analyzed herein include builders from across the U.S. To understand regional trends throughout the country, we grouped builders into the four U.S. Census regions as outlined by the U.S. Census Bureau (Figure 13) (U.S. Census Bureau, 2019). Private and public entities frequently use these regions to collect and analyze a wide variety of data, including population statistics, housing data, demographic information, and more, and researchers also use

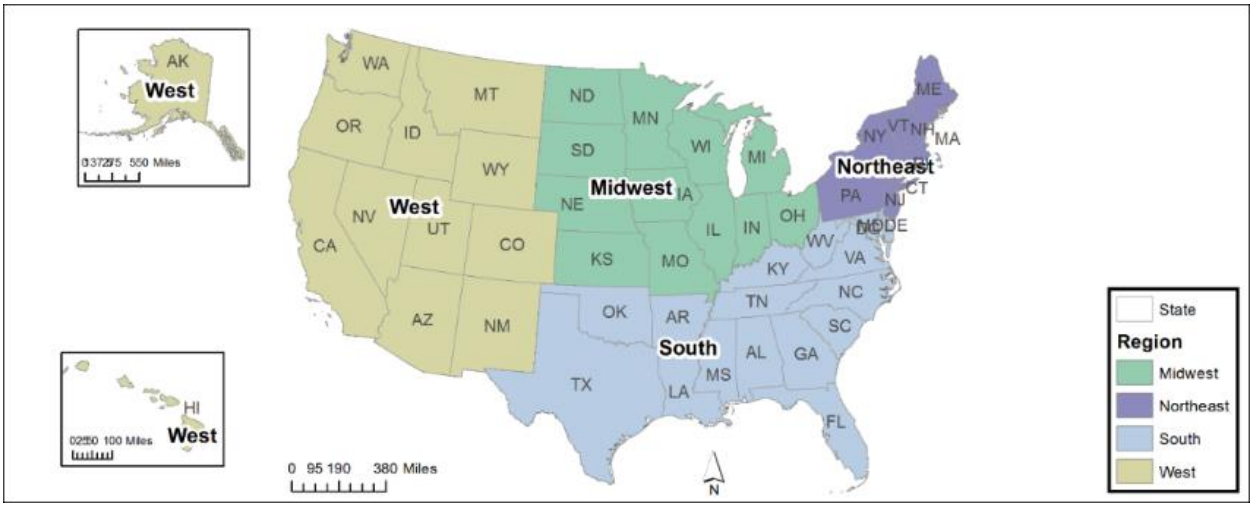

Figure 13. The four census regions as defined by the United States Census Bureau (U.S. Census Bureau, 2015).

them when designing questionnaires (Sudman & Bradburn M., 1982). These regions therefore provide helpful classifications for grouping our survey data and comparing it to a variety of other available statistics.

The 2018 survey included respondents from 26 states. Forty-nine percent of respondents were from the West, 23% were from the South, 15% were from the Northeast, and 13% were from the Midwest (Table 5, Figure 14).

In the 2011 survey, 7% of respondents were in the West, 43% were from the South, 25% were from the Northeast, and 23% were located in the Midwest. A chi-square test of homogeneity showed that the distribution of firms throughout the four geographic region was significantly different between 2011 and 2018.

These results indicate that the geographic distribution of LEED builders between these two surveys is different. While the shares of respondents from the Northeast, Midwest, and South were lower in the most recent survey, these changes were statistically insignificant in post

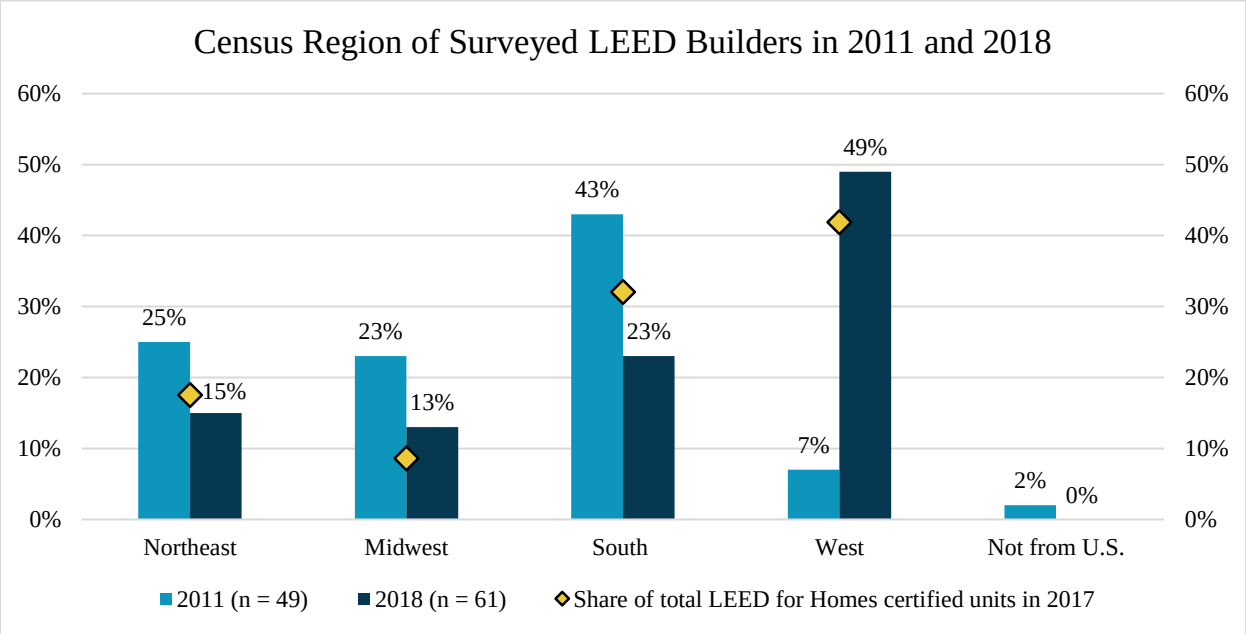

Figure 14. Census region of surveyed LEED builders in 2011 and 2018 compared to the share of LEED for Homes certified units in 2017.

hoc tests. However, post hoc tests indicated that the West had a much higher share of respondents in the 2018 survey, suggesting that we sampled a higher portion of builders from the West in 2018. Current data on LEED-certified residential units in the U.S., research on LEED adoption throughout the country, and experiences during this survey distribution process indicate that the 2018 survey may accurately portray the distribution of LEED builders throughout the country.

Table 5. Summary of survey respondents' main area of business, according to the U.S. Census regions in 2011 and 2018.

		Northeast	Midwest	South	West	Pearson χ^2 Tests
Survey Year	2011	25%	23%	43%	7%	**P < 0.001** (χ^2 value=23.46, df=3)
	2018	15%	13%	23%	49%	

First, we analyzed the share of residential LEED-certified units in each census region, and we evaluated these trends over time, using data from the LEED for Homes database for the years 2010, 2014, 2017, and 2018 (USGBC, 2019). These results show that in 2017, the West

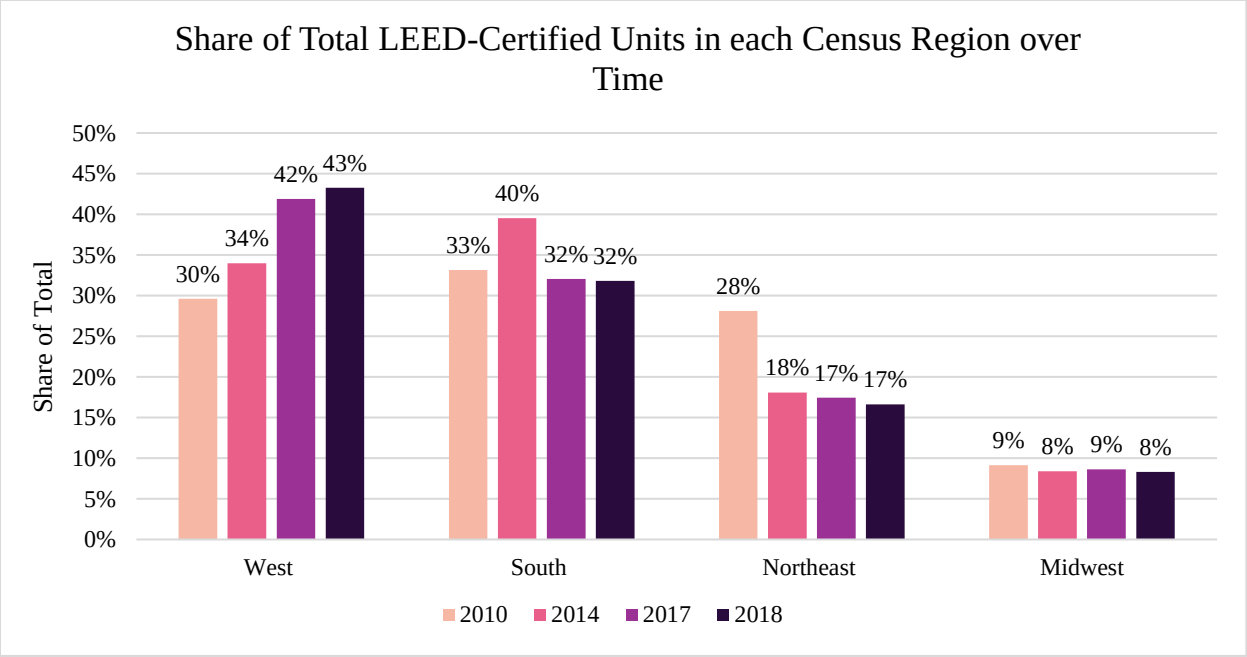

Figure 15. Share of total LEED-certified units in each U.S. Census region, in the years 2010, 2014, 2017, 2018.

accounted for 42% of all LEED for Homes certified units. The South accounted for 32% of the total, the Northeast comprised 18%, and the Midwest held approximately 9% of all LEED for Homes certified units (Figure 15). Trends over time show that, since 2010, the West has increased its share of certified units by 13%, the South has lost 1% of the share, the Northeast has lost 11% of the share, and the Midwest consistently accounts for 8 to 9% of the total certified units. Understanding this, the higher share of respondents from the West in our 2018 survey is not vastly disproportionate when compared to the residential LEED market in the region. Further, the trends in the geographic distribution of our respondents from 2011 to 2018 mirror some of the trends in green building practices over these years.

We can also compare these data of LEED-certified units to the share of total housing completes in each census region as reported by the U.S. Census Bureau (2018) to elucidate the relationship between the overall residential housing industry and LEED-certified housing in each

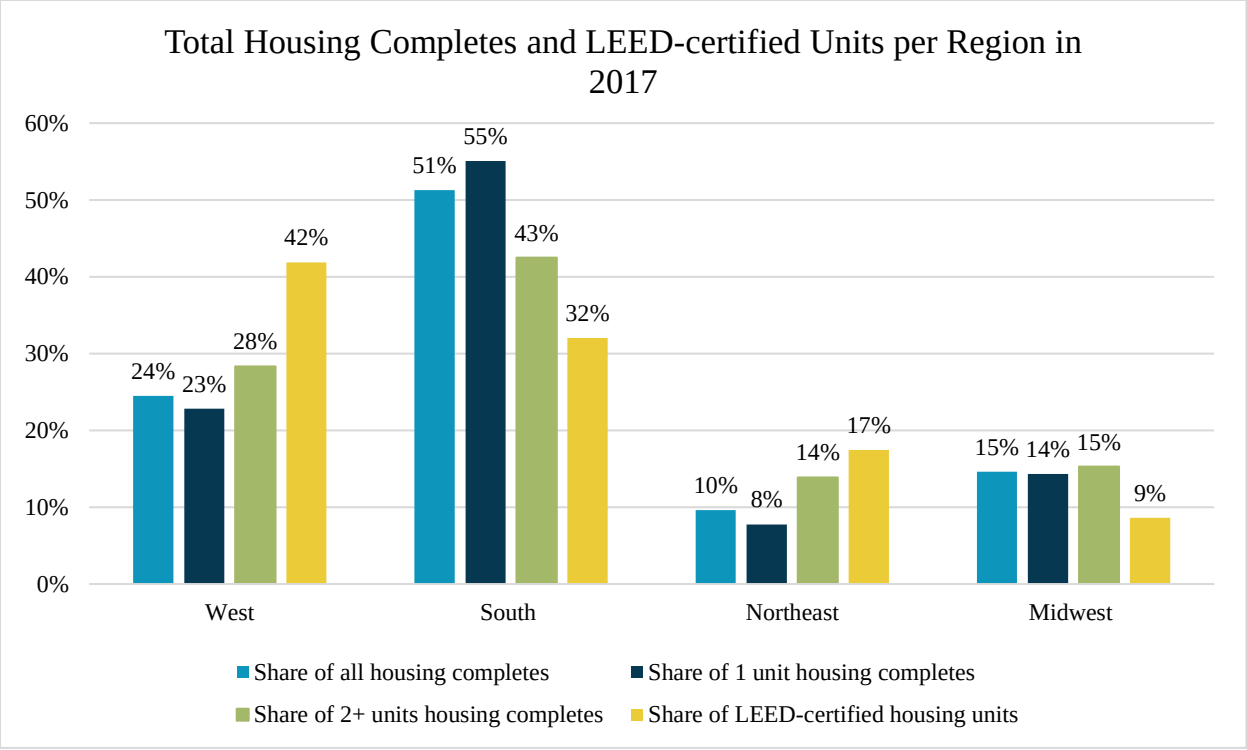

Figure 16. Total housing completes and LEED-certified housing units in each U.S. Census region in 2017.

region (Figure 16). In 2017, the South accounted for 51% of all housing completes but only 32% of all LEED-certified housing units. The West, comparatively, accounted for 24% of all housing completes and 42% of LEED-certified housing units. The Northeast had the lowest share of housing completes, at 10% of the total, and accounted for 17% of all LEED-certified units. Finally, the Midwest comprised 15% of all housing completes and 9% of all LEED-certified units. These trends show that the West and Northeast have a higher proportion of LEED for Homes units compared to the share of residential construction in the area, indicating a strong residential LEED market, whereas the South and Midwest see the opposite trend, demonstrating that the LEED market is not as prevalent in these regions compared to the overall housing market.

We should also consider the impacts of California's green building market on the residential LEED market, as the state drives many of previously described LEED trends. In 2010, California accounted for 13.6% of the total LEED-certified units. By 2018, California held approximately 23.3% of all LEED-certified home units, or 54% of the total certified units in the West (USGBC, 2019). Thus, nearly one-quarter of all LEED-certified units are located in California.[12] This large share of Californian LEED-certified residential units mirrors our 2018 survey data as well. In our 2018 survey, 10 of our 61 respondents (16%), conducted their business in California, and this sizable share may be reasonable, given the strength of the LEED for Homes market in the state.

Anecdotal evidence from our survey process reflects the shift in the residential LEED market toward the West as well. In phone conversations, builders sometimes indicated that they no longer participated in LEED for Homes or other green building programs due to a lack of

[12] Comparatively, California contains approximately 12% of the U.S. population (U.S. Census Bureau, 2017).

market or demand. Of these builders who volunteered such information, the majority of the builders were located in the South, although a small number of builders from the West and Midwest expressed similar sentiments. This reinforces our understanding of the regional changes in the residential LEED market and reflects the trends in LEED-certified home units over time.

Additionally, some research on the LEED certification process finds hot spots in LEED building trends, especially in cities in the western U.S. Johansson (2012) concluded that states along the Pacific coast, including California, Oregon, Washington, Alaska, and Hawaii lead the developments in commercial LEED construction, while those in the southern U.S. lag behind. Also in this study, Los Angeles, Portland, and Seattle had the highest number of commercial LEED-certified commercial buildings. A separate study on the green building industry in Portland identified factors that encourage LEED adoption, finding that a clustered, critical mass of green building firms, related and supporting industries in the area, and strong demand from consumers aided Portland's swift adoption of green building practices (Allen & Potiowsky, 2008). While these studies are primarily interested in the adoption of commercial LEED projects, the findings again support our sample's geographic distribution of residential LEED builders, especially the high share of survey respondents from the West.

Importantly, as noted in the Methods section, the 2011 survey included builders from the NAHB database, whose headquarters are in Washington DC. While we attempted to analyze only those builders associated with the LEED for Homes program in the 2011 survey, it is possible that the survey instrument favored builders located on the East Coast and in the South compared to our 2018 methods and survey instrument. These differences in methodology may also help explain the regional inconsistencies between the 2018 and 2011 surveys.

In summary, our 2018 survey included a higher share of builders from the West census region compared to the share in the 2011 survey. This difference aligns with data on the residential LEED market and trends in LEED construction, as well as experiences with builders in the 2018 data collection process. While we should understand that the 2011 and 2018 survey have different regional distributions, we can also be relatively confident that the 2018 survey reflects residential LEED builders in 2018.

Builders in the West Compared to other U.S. Census Regions: 2018

As previously stated, a large share of our 2018 sample (49%) was comprised of builders located in the West. This was a departure from the 2011 survey, where only 7% of surveyed builders were in the West. To understand the differences in these builders compared to those in the Midwest, Northeast, and South, we conducted an exploratory analysis, comparing demographics of builders operating in the West versus the other three U.S. Census regions. Our analysis found that builders were highly consistent between these two groups in 2018 ("West" and "Rest"). Survey respondents in both groups showed a similar distribution between firm size categories (based on total revenue), and they also had a consistent distribution between homebuilders, remodelers, and "other" respondents. Further, builders in the West compared to the other three census regions reported similar revenues from all categories: single family speculative homes, single family custom homes, remodeling, multi-family construction, and nonresidential projects.

The inconsistencies in builder geographic location between the two survey years may influence subsequent comparisons of ECWP familiarity and use, as our results show that the builders are not from a homogenous population. However, we can be relatively confident that the

builders we sampled in the West had similar demographics to those in other U.S. Census regions in 2018.

ECWP Use and Trends over Time: Summary

Familiarity and Use of ECWPs in 2018

Our results show that builders have different levels of awareness and usage of FSC and SFI-certified wood.

In our survey, we first asked builders about their overall familiarity with and use of both FSC and SFI-certified wood. In 2018, 10 builders (16%) had not heard of the FSC certification, 8 builders (13%) were aware of the label but had never used it, 22 (36%) occasionally used the wood, and 21 (34%) frequently used FSC-certified wood. Comparatively, in 2018, 17 respondents (30%) had not heard of the SFI label, 20 (33%) were aware of it but had never used it, 16 (26%) had occasionally used the wood, and 8 (13%) frequently used SFI-certified wood. A

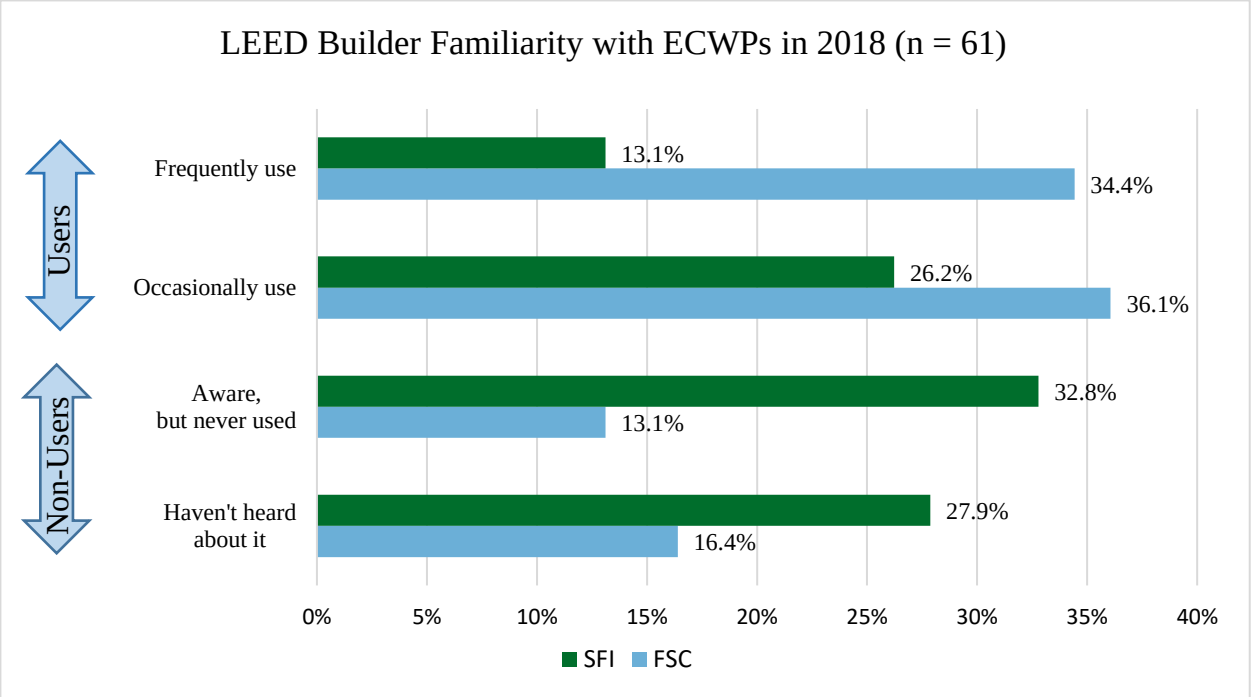

Figure 17. LEED builder familarity and use of FSC and SFI-certified wood in 2018.

chi-square test of independence showed that these differences in awareness and usage between FSC and SFI products were statistically significant (Table 6, Figure 17).

Table 6. Summary of LEED builder familiarity and use of FSC and SFI-certified wood in 2018.

ECWP Use in 2018		Haven't heard	Aware, but never used	Occasionally Use	Frequently Use	Pearson χ^2 Tests
ECWP	FSC	10 (16.4%)	8 (13.1%)	22 (36.1%)	21 (34.4%)	**P = 0.003** (χ^2 value=13.73, df=3)
	SFI	17 (27.9%)	20 (32.8%)	16 (26.2%)	8 (13.1%)	

Post hoc tests between these response levels found that the occasional users and those who had not heard of the ECWPs were statistically consistent between the two certifications. However, there was a significant difference in the ratio of frequent users of the ECWPs and those who were aware of the products but never used them. In 2018, frequent users of ECWPs were more likely to use FSC, and a higher share of respondents were aware of SFI but did not use the products.

Additionally, we grouped responses according to users and non-users to evaluate the ratio of usage between the ECWPs (Figure 18). Using this grouping, 70% of survey respondents reported either occasionally or frequently using FSC-certified wood, while only 39% of respondents answered the same of SFI-certified products. A Pearson's chi-square test with Yates continuity correction found that this difference among users and non-users was statistically significant, and there was a higher share of users of FSC

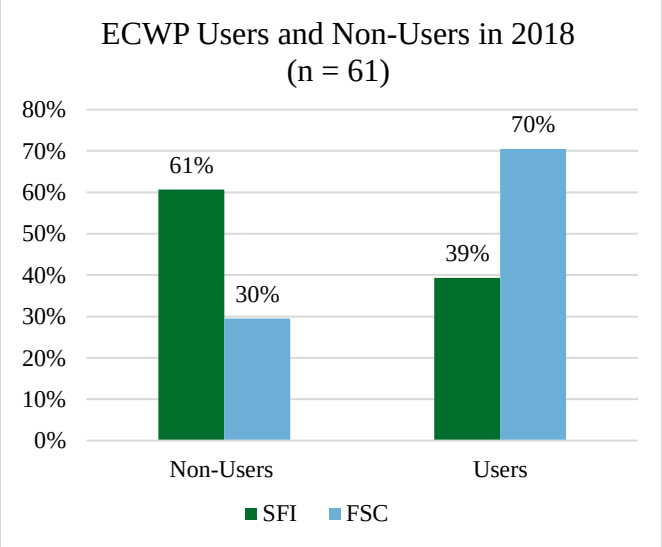

Figure 18. FSC and SFI users and non-users in 2018.

products and higher share of non-users of SFI products.

Overall, these results indicate that builders had a higher awareness and usage of FSC-certified products compared to SFI-certified wood in 2018. SFI use was generally lower, and builders that frequently used ECWPs were more likely to use FSC products. Finally, we find that respondents who had heard of but do not use ECWPs were more likely to report having heard of but not use SFI products.

To understand these differences, we should consider the various types of FSC- and SFI-certified products and how builders may use those products to earn LEED points. Under the ACP, both FSC and SFI-certified products can earn an equal number of points in each predetermined building component. That is, USGBC does not currently discern between FSC and SFI-certified wood in the point system. However, SFI primarily certifies forest areas where softwood species grow, such as Canada and the Pacific Northwest, and these species are often manufactured into structural lumber. Yet LEED for Homes awards only one point for the use of certified structural lumber, and the program awards various other points when a builder uses ECWPs in components such as flooring, siding, doors, cabinets, counters, and decking. Builders often choose to use hardwood materials in these building components, which FSC is more likely to certify. One study of LEED builders in New York State supports this concept, finding that architects using LEED chose to use FSC-certified hardwoods in their projects over softwoods by a two to one margin (Germain & Penfield, 2010).

Thus, we may hypothesize that FSC-certified products are more readily available in the building components that can earn a project LEED points, especially when we consider the area of hardwood and softwood forests certified under both programs. This, combined with the low share of points awarded for the use of certified structural lumber, may contribute to the higher

usage rate of FSC compared to SFI products among residential LEED builders, even though builders showed a similar familiarity with both certifications in our survey. A recent announcement by SFI supports these hypotheses, too. In 2017, SFI reported that 92 secondary hardwood manufacturers had earned COC certification, which the organization claimed would help them gain access to the LEED market (SFI, 2017). SFI's focus on the hardwood products industry as an important part of their overall business model suggests that the certification lacks a supply of hardwood products, and the SFI program may therefore be missing some of the potential ECWP market.

However, further analysis would be needed to verify these hypotheses. Future research might include a survey of the types of forests and forest products certified by SFI and FSC, giving specific attention to the differences between hardwoods and softwoods and the types of products manufactured. This would contribute to our analysis and better explain some of the trends identified herein.

Finally, we created a cross tabulation between the survey respondents' levels of familiarity with and use of ECWPs. In these results, half of respondents (50.9%) reported the same level of familiarity with and use of both products (numbers bolded in Table 7). Of those that had varying levels of familiarity and use, 90% reported a higher level for FSC products. Additionally, no survey respondent indicated that they use SFI products but do not use FSC products. These findings again reinforce our analysis that shows SFI awareness and use was lower than that of FSC.

We also find that this cross tabulation shows three distinct groups: those who use both FSC and SFI products (highlighted in green, 39% of all users), who we denote "ECWP Users," those who only use FSC products (highlighted in blue, 31% of all users), who we denote "FSC-

only Users," and those who do not use either of the products (highlighted in pink, 30% of all users), who we denote "Non-users." In subsequent analysis, we use these groups to determine whether builder characteristics (such as firm size and location of business) are correlated with a builder's characterization as an ECWP User, FSC-only User, or Non-users.

Table 7. Cross tabulation of familiarity with and use of FSC and SFI products among builders in 2018.

All respondents: 2018 Survey		SFI				FSC Total
		Not Aware	Aware, Non-User	Occasional User	Frequent User	
FSC	Not Aware	**11.5%**	4.9%	0.0%	0.0%	16.4%
	Aware, Non-User	1.6%	**11.5%**	0.0%	0.0%	13.1%
	Occasional User	9.8%	11.5%	**14.8%**	0.0%	36.1%
	Frequent User	4.9%	4.9%	11.5%	**13.1%**	34.4%
SFI Total		27.9%	32.8%	26.2%	13.1%	n = 61

Familiarity and Use of ECWPs from 2011 to 2018

We then compared familiarity and usage of ECWPs in the 2018 survey to those responses from the 2011 survey. Overall, results showed consistent rates of use of FSC and SFI products but an increase in builders who had never heard of both products.

In 2011, 1 respondent (2%) had never heard of the FSC label, 8 (16%) had heard of it but never used it, 21 (43%) had occasionally used it, and 19 (39%) had frequently used the wood. When compared to data from 2018, a chi-square test of homogeneity showed a slightly significant difference in familiarity and usage, with a p-value between 0.05 and 0.10 (Figure 19). At the 95% level of confidence, these results show that there was no change in familiarity with and use of FSC wood among LEED builders between 2011 and 2018. A comparison of users and nonusers from 2011 to 2018 confirms these results as well, finding no significant difference in the ratio of users to nonusers of FSC products between the two survey years.

Even though our overall results showed no significant change, a post hoc test revealed a significantly higher portion of LEED builders who had not heard of FSC in 2018 compared to 2011. Although overall familiarity and use of FSC products had not changed between 2011 and 2018, this test shows that a significantly higher portion of LEED builders had not heard of the FSC certification in 2018 compared to 2011.

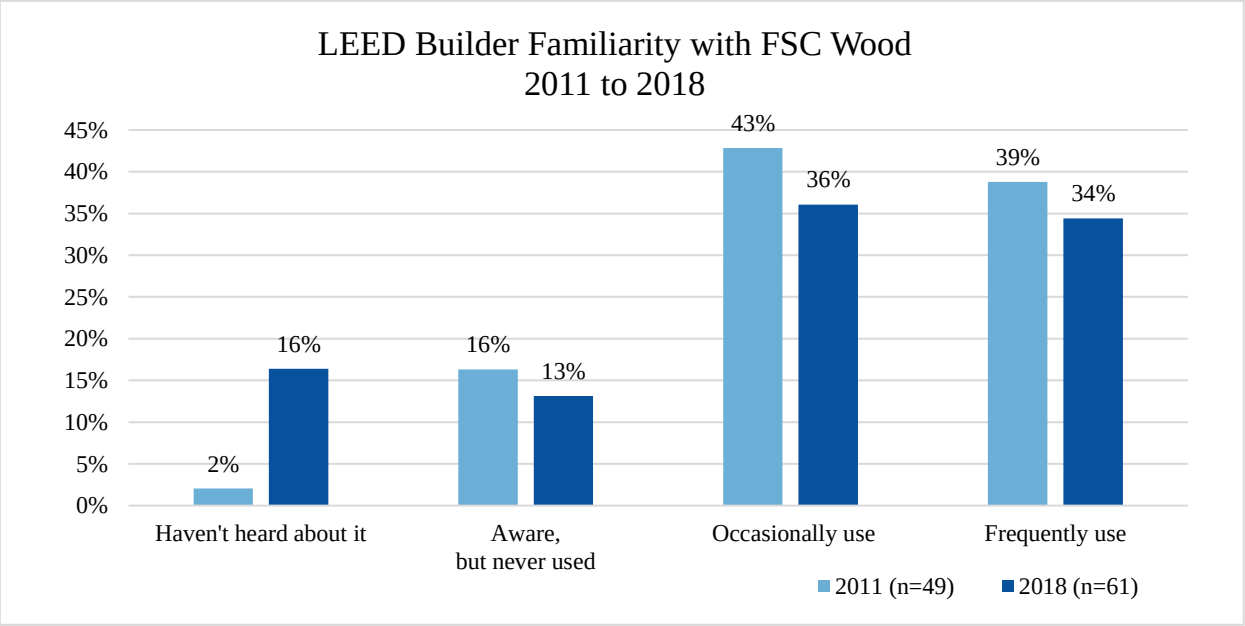

Figure 19. Builder familiarity with and use of FSC wood in 2011 and 2018. Significant differences at the 90% level of confidence.

Familiarity with and use of SFI products among LEED builders between 2011 and 2018 showed similar patterns. In 2011, 5 respondents (10%) had never heard of SFI, 17 (35%) had heard of it but never used the wood, 19 (39%) reported occasionally using the wood, and 8 (16%) frequently used SFI-certified products (Figure 20). Chi-square tests of homogeneity showed that there was no significant difference in these levels of familiarity and usage between 2011 and 2018, nor was there a difference in the ratio of users and nonusers in the two survey years.

Like the FSC data above, even though preliminary results showed no significant difference among familiarity with and use of SFI products between 2011 and 2018, a post hoc test found that a significantly higher portion of builders had not heard of the SFI label in 2018 compared to 2011. This again suggests that while overall usage of SFI products had not changed among our surveyed LEED builders, a significantly higher portion of builders in 2018 had not heard of SFI-certified products compared to seven years prior.

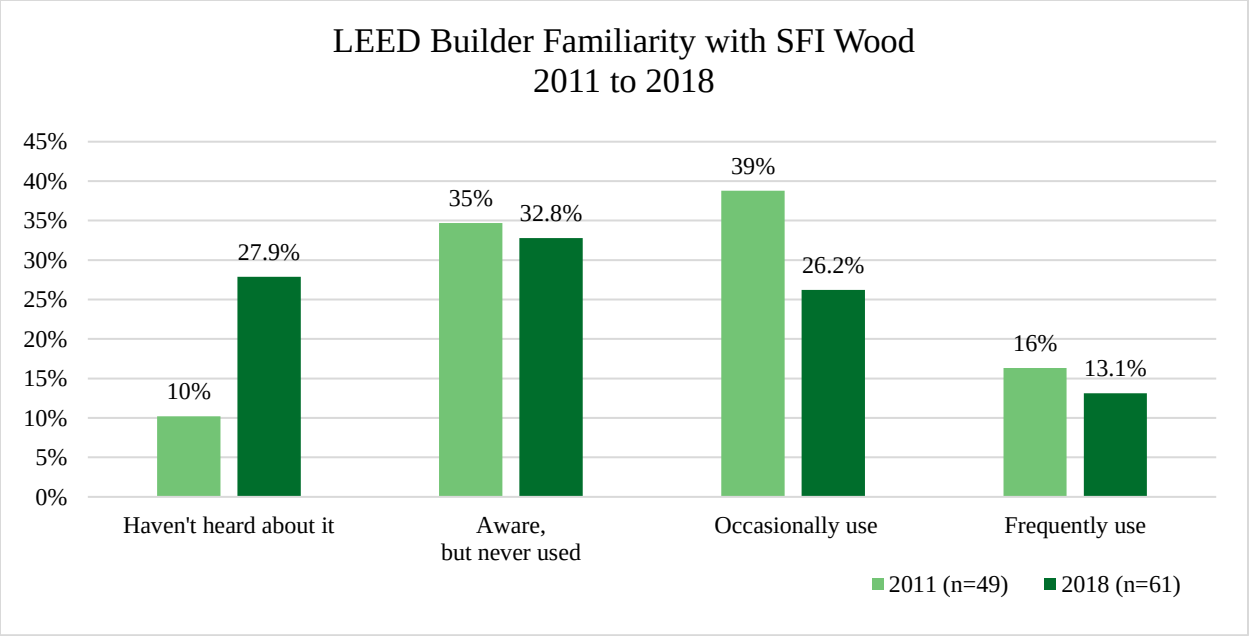

Figure 20. Builder familiarity with and use of SFI wood in 2011 and 2018. No significant difference found.

Throughout this analysis, readers should be cautious to interpret conclusions drawn from our comparison between the 2011 and 2018 data (see *Limitations* section). Our initial analysis of LEED builder demographics indicated that we sampled more large builders and more builders from the West in 2018. Ideally, our analysis would have included similar demographics of builders between the two survey years. However, the shifts in ECWP familiarity and use may reflect the overall market, but they may also be explained by the differences in demographics of our surveyed builders.

Even given the differences in builder demographics, the overall consistency in ECWP use between the two survey years is especially notable, and somewhat surprising, given previous research that projected an increase in ECWP use. Various studies in the 2000s found that awareness and use of ECWPs were increasing in multiple consumer categories (Ozanne & Vlosky, 2003; Perera et al., 2008), and studies also projected that sales and consumption of ECWPs would increase in the future (Ganguly et al., 2013; Humphries et al., 2001; Perera et al., 2008; Stevens et al., 1998). One recent study of residential builders even found that 14% of builders sought to purchase ECWPs in 2011, while 50% of builders were planning to use ECWPs in the future (Gregory D. Estep, DeVallance, & Grushecky, 2013). Our results do not support those projections and instead imply that the ECWP market, at least in the residential LEED market, has remained stable. One study of wood product manufacturers in Wisconsin coincides with our findings, where survey respondents generally believed that the ECWP industry would recede over time (Hubbard & Bowe, 2005). While our results do not show a decrease in the overall ECWP market among LEED builders, we did see an increase in the share of builders who were unaware of FSC and SFI-certified wood.

Notably, the literature presented herein suggests that research on the ECWP market was more prevalent in the early 2000s, whereas research since 2010 has become more infrequent. Predictions from the early 2000s may have manifested before the 2011 survey, which could explain why residential builders' ECWP use did not change significantly between 2011 and 2018. Alternatively, this gap in the research might be indicative of an overall lack of demand for and interest in the ECWP market, which would suggest a decrease in awareness and consumption of these products. Although not feasible with the data collected in our research, subsequent analyses could enhance our understanding of these trends over the past decade.

Additional research might survey wood product manufacturers about their ECWP production trends over time or analyze the total volume of certified wood sold between 2010 and 2018. This would help bridge the knowledge gap concerning the ECWP market over the past decade and contribute to the analyses in this study.

LEED Builder Reported Future Use of ECWPs

In both the 2011 and 2018 surveys, respondents who had used ECWPs then indicated what they thought their usage of the product would look like over the next two years. Among FSC users in 2018, 1 respondent (2%) answered that their use would decrease, 30 respondents (70%) thought that their use would remain the same, and 12 (30%) indicated that their use of FSC products would increase over the next two years. Among SFI users, 16 (67%) indicated their use would stay the same, and 8 (32%) answered that their usage will increase over the next two years (Figure 21). Thus, about two-thirds of FSC and SFI users believed that their use of the products would stay the same, and about one-third of both FSC and SFI users believed they would increase usage. The similarity here implies that the markets for these products will grow at similar rates in the residential LEED building market. Additionally, these results might suggest moderate growth of the ECWP market over the coming

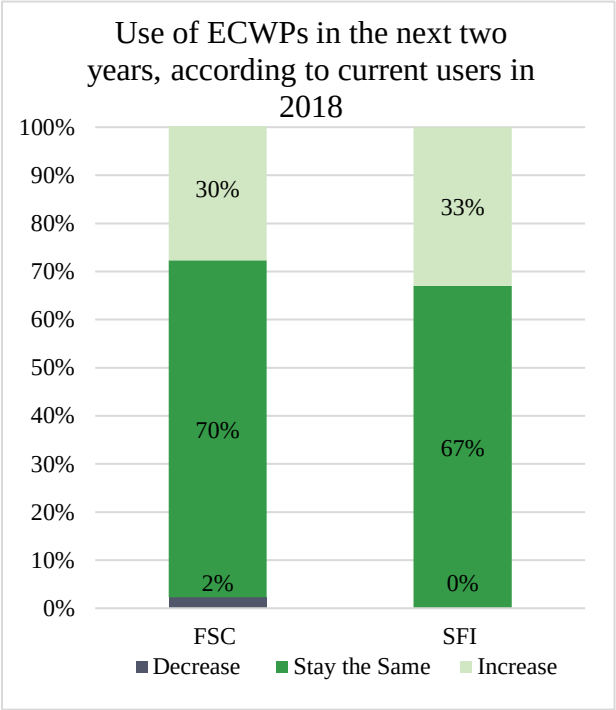

Figure 21. Use of FSC and SFI wood over the next two years, according to current uers in 2018. No significant difference found.

years, as most LEED builders who used ECWPs did not plan to increase their usage of the products.

We also compared these answers to those in the 2011 survey. In 2011, a smaller share of builders answered that their use of both FSC and SFI would stay the same, and more respondents indicated that their use of ECWPs would increase over the next two years (Figure 22). While these trends may point to an ECWP market that is reaching maturity, chi-square tests of homogeneity showed that these survey answers between 2011 and 2018 were similar for both FSC and SFI-certified wood products. Therefore, in both surveys, builders had similar projections of their ECWP use in the future.

Additionally, while it would be helpful to discern if this projected increase in use materializes over time, we did not survey builders on their net total consumption. A more comprehensive analysis of total market demand may help identify changes in overall ECWP consumption to see if these projected changes come to fruition.

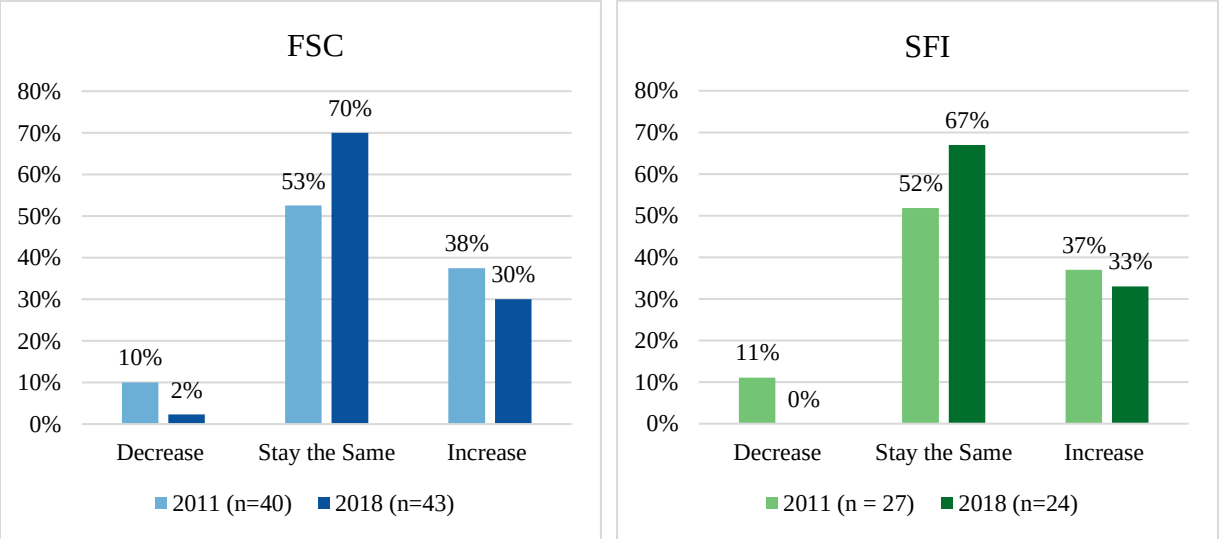

Figure 22. The projected use of FSC (blue) and SFI (green) wood over the next two years, according to current users of the respective ECWP. No significant differences found for both FSC and SFI.

Perceptions of ECWP Attributes

Price Premium Perceptions in 2018

If a respondent had heard of or used an ECWP, we then asked for their opinion regarding the price premium for wood carrying the respective label. Fifty-one survey respondents (84%) had either heard of or used FSC-certified wood. Of these respondents, 2 (4%) thought there was no price premium, 18 (35%) answered that there was a small premium of 1 to 5%, 21 (41%) answered that there was a substantial price premium of 5 to 10%, and 10 respondents (20%) indicated that there was a very high price premium of more than 10% (above 10%) (Figure 23).

Forty-four survey respondents (72%) answered that they were either aware of or used SFI-certified wood products. Of these respondents, 5 (11%) answered that there was no price premium, 16 (36%) believed there was a small price premium, 15 respondents (34%) answered that there was a substantial price premium, and 8 respondents (18%) believed there was a high price premium (Figure 23). A chi-square test of independence showed that there was no significant difference in the perceptions of SFI and FSC price premiums, indicating that LEED builders believe FSC and SFI have similar premiums.

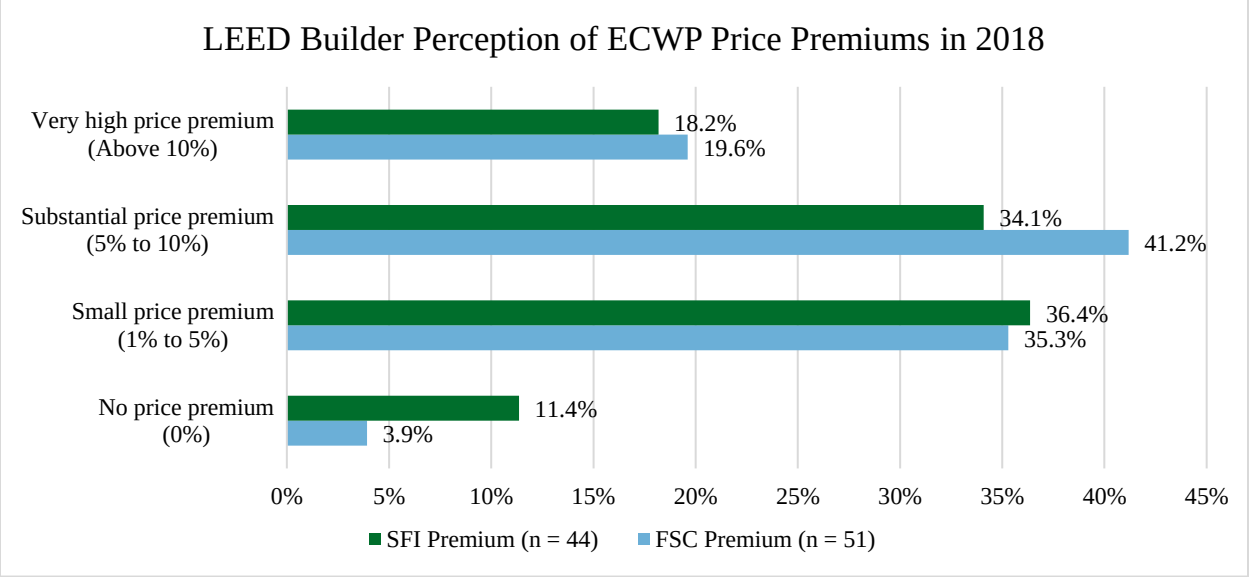

Figure 23. Price premium perceptions of FSC and SFI products among builders in 2018. No significant difference found.

A cross tabulation between the respondents' perceived price premiums support the statistical findings above, showing that the vast majority (73%) of ECWP users believed that the price premium for SFI and FSC-certified products was about the same (Table 8). This result implies that LEED builders do not differentiate between these two products based on price; About 7.3% of builders believed that there was a higher price premium for SFI wood, while 19.4% of builders believed that the premium for FSC products was higher. Both the chi-square test and this cross tabulation support the notion that most builders believed the price premiums to be the same for FSC and SFI products in 2018. When builders thought that the premiums were different, they were more likely to report a higher premium for FSC products.

Table 8. Cross tabulation of price premium perceptions of FSC and SFI products among builders in 2018.

2018 Survey Respondents		SFI Premium				FSC Total
		0%	1-5%	6-10%	10%+	
FSC Premium	0%	**2.4%**	0.0%	0.0%	0.0%	2.4%
	1-5%	7.3%	**24.4%**	2.4%	0.0%	34.1%
	6-10%	2.4%	7.3%	**31.7%**	4.9%	46.3%
	10%+	0.0%	2.4%	0.0%	**14.6%**	17.1%
SFI Total		12.2%	34.1%	34.1%	19.5%	n = 41

Price Premium Perceptions from 2011 to 2018

A comparison of the reported price premiums between the 2011 and 2018 survey showed that FSC price premium perceptions had changed slightly (at the 90% level of confidence). In 2011, 6 builders (13%) believed there was no price premium, 9 (19%) answered that there was a small premium, 16 (33%) answered that there was a substantial premium, and 17 builders (35%) believed there was a very high premium (Figure 24). A chi-square test of homogeneity of these premium perceptions between the 2011 and 2018 survey showed slight significance, with a p-value between 0.10 and 0.05. These results, although not significant at the 95% level of confidence, suggest that price premium perceptions are shifting away from the extreme

categories of either 0% (no premium) or over 10% (a very high premium), and LEED builders now believe that the premium is more moderate, between 1 and 10%.

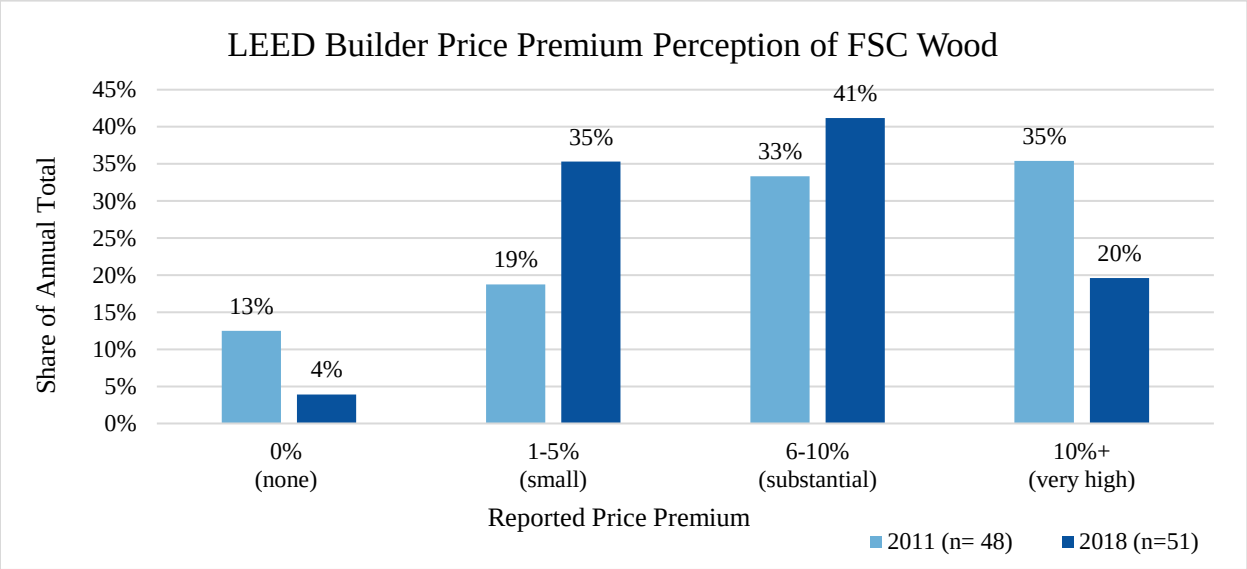

Figure 24. LEED builder price premium percpetions of FSC wood in 2011 and 2018. Significant differences at the 90% level of confidence.

This trend was not true of the SFI price premium perceptions, where a chi-square test of homogeneity showed no statistical difference between 2011 and 2018 (Figure 25). This indicates that builders had similar perceptions of the price premium for SFI products in 2018 as they did in 2011.

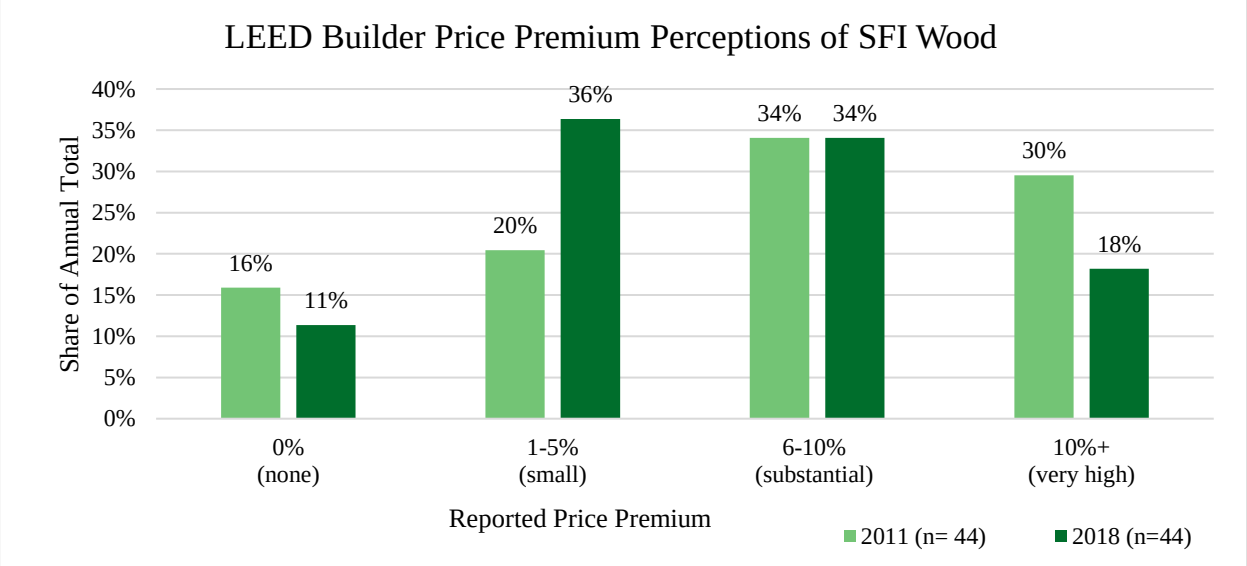

Figure 25. LEED builder price premium perceptions of SFI wood in 2011 and 2018. No significant difference found.

Builder's Area of Business (Population Size) and Use of ECWPs

ECWP Use among Rural, Small Town, and Urban LEED Builders: Current Use and Trends between 2011 and 2018

Research shows that LEED builders are more frequently located in metropolitan, or urban, areas (Johansson, 2012), and that ECWP usage is more common among builders in metropolitan areas (G.D. Estep et al., 2015). We therefore sought to understand patterns in ECWP familiarity and use among LEED builders in different population areas. Because our sample included a small number of builders operating in both small town and rural areas, we combined the small town and rural categories to compare them to those builders operating in urban areas (see *Demographics of Survey Respondents* for definitions). This data reduction therefore resulted in two population size categories: "urban/suburban" and "small town/rural."

Results indicate that suburban/urban builders were more likely to use FSC and SFI products, while those in small town/rural areas were likely to have heard about but not use ECWPs in 2018. Interestingly, this trend was not true of the 2011 dataset, where builders showed similar rates of ECWPs use between the two population areas.

The 2018 dataset included 12 small town/rural builders and 49 suburban/urban builders. Of the 12 small town/rural builders, 2 (17%) had not heard of FSC wood, 5 (42%) were aware of FSC but did not use the products, 3 (25%) occasionally used the wood, and 2 (17%) frequently used the wood (Figure 26). Thus, the majority of builders in small town/rural areas were aware of the FSC label but did not use the products. Comparatively, of the 49 suburban/urban builders, 8 (16%) had not heard of the wood, 3 (6%) were aware of the label but did not use the product, 19 (39%) occasionally used the wood, and 19 (39%) frequently used FSC-certified wood (Figure 26). The vast majority of suburban/urban LEED builders therefore used of FSC products. A chi-square test of independence showed that these levels of familiarity and usage were significantly

different between urban/suburban and small town/rural builders. Post hoc tests found that those who were unaware of FSC products, those who were occasional users, and those who were frequent users were statistically consistent between the two areas. However, those who were aware of but did not use FSC products drove the statistical differences found in the chi-square test. These results indicate that small town/rural builders were less likely to use FSC products compared to suburban/urban builders, although overall awareness was approximately the same between the two groups.

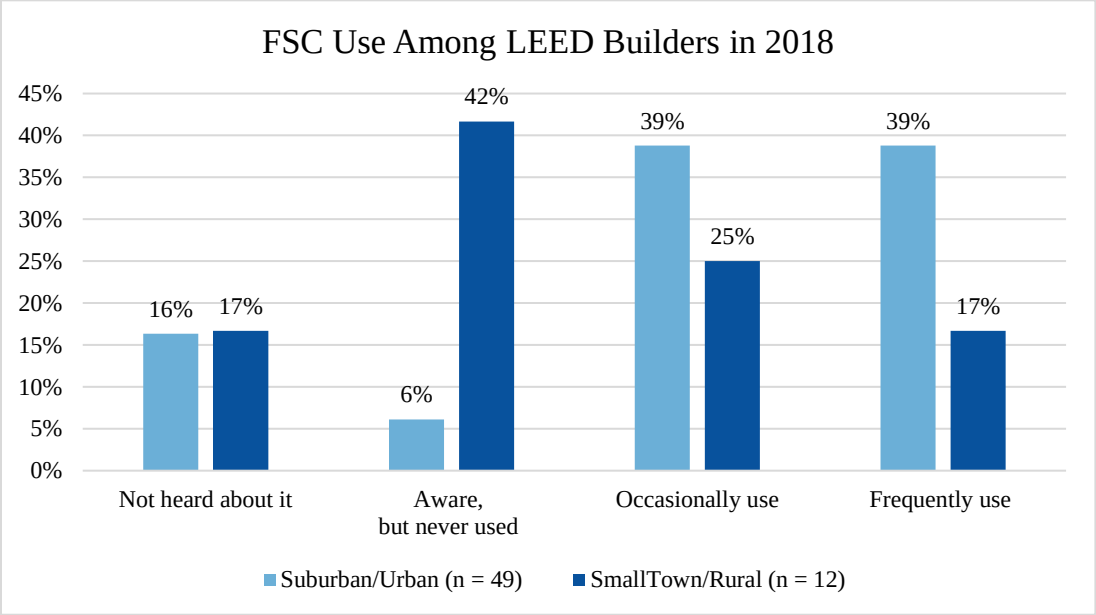

Figure 26. FSC use among suburban/urban and small town/rural LEED builders in 2018.

Table 9. Summary of FSC familiarity and use in 2018 among surburban/urban and small town/rural builders.

FSC Use in 2018		**Haven't heard**	**Aware, but never used**	**Occasionally Use**	**Frequently Use**	**Pearson χ^2 Tests**
	Suburban/ Urban	8 (16%)	3 (6%)	19 (39%)	19 (39%)	**P = 0.011** (χ^2 value=11.16, df=3)
	Small Town/ Rural	2 (17%)	5 (42%)	3 (25%)	2 (17%)	

Additionally, we grouped users and nonusers together in both population size categories and found that 78% of suburban/urban builders were users of FSC products, while only 42% of small town/rural builders used FSC-certified wood (Figure 27). A chi-square test of

independence showed that these differences were statistically significant, again reinforcing the notion that builders in suburban/urban areas are more likely to use FSC wood. Overall, we therefore found that suburban/urban builders were more likely to use FSC products, while small town/rural builders were more likely to have heard of the certification but not use the products in 2018.

Interestingly, these trends between small town/rural and suburban/urban builders were not true of the 2011 data. In 2011, there was no difference between the rates of familiarity and usage of FSC products between suburban/urban builders and those in small town/rural areas. Additionally, the 2011 data showed similar proportions of users and nonusers of FSC products between the two population areas. These findings suggest that FSC use is becoming increasingly concentrated in suburban/urban areas, whereas in 2011 use was more dispersed throughout areas of different population sizes.

Among suburban/urban and small town/rural builders, familiarity with and use of SFI-certified wood followed similar patterns to those of FSC. A chi-square test of independence showed that the differences in SFI familiarity and use between the two groups were statistically significant. Post hoc tests then indicated that two trends drove this significance: the higher proportion of suburban/urban builders who occasionally used SFI products and the higher proportion of small town/rural builders who had heard of the SFI label but did not use the products (Figure

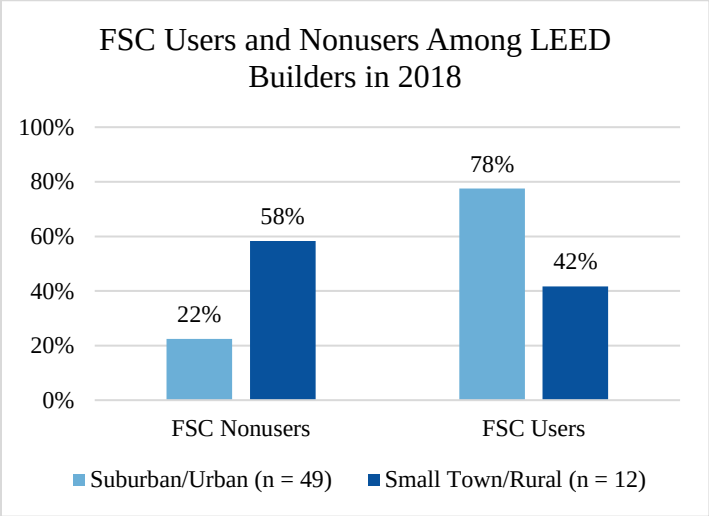

Figure 27. FSC users and nonusers among suburban/urban and small town/rural LEED builders in 2018.

28, Table 10). However, by grouping users and nonusers of SFI together in the two populations, we found that there was no statistically significant difference between users and nonusers of SFI wood (Figure 29). These results suggest that there was a difference in familiarity with and use of SFI products between suburban/urban builders and small town/rural builders in 2018, but the rates of usage were approximately equal between the two population areas.

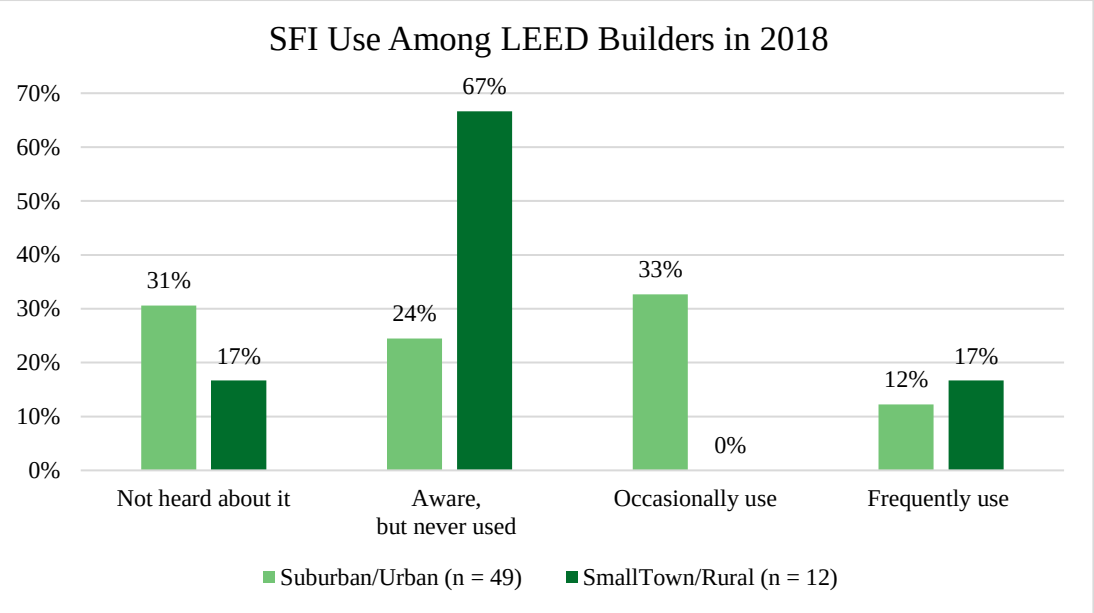

Figure 28. SFI use among suburban/urban and small town/rural LEED builders in 2018.

Table 10. Summary of SFI familiarity and use in 2018 among surburban/urban and small town/rural builders.

SFI Use in 2018		**Haven't heard**	**Aware, but never used**	**Occasionally Use**	**Frequently Use**	**Pearson χ^2 Tests**
	Suburban/ Urban	15 (31%)	12 (24%)	16 (33%)	6 (12%)	**P = 0.019** (χ^2 value=9.97, df=3)
	Small Town/ Rural	2 (17%)	8 (67%)	0 (0%)	0 (0%)	

Again, we find that these differences in SFI familiarity and use were not true of the 2011 data. In 2011, there were no statistical differences in the rates of SFI familiarity and use between the two population areas, and there was no difference between users and nonusers of SFI wood.

Overall, these results suggest that builders in suburban/urban areas and those in small town/rural areas have the same overall awareness of ECWPs, and builders in suburban/urban

areas are more likely to use the products. This trend is especially prominent in the familiarity with and use of FSC wood. Further, we find that these trends have developed over time, as data from 2011 did not show these differences between areas of different population sizes.

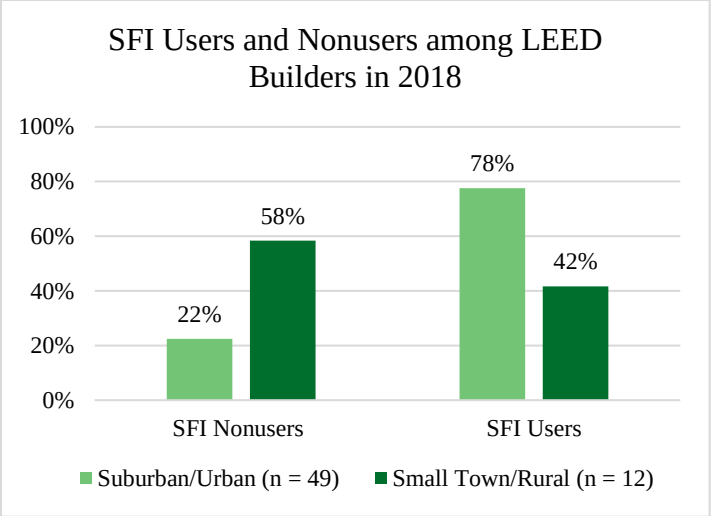

Figure 29. SFI users and nonusers among suburban/urban and small town/rural LEED builders in 2018. No significant difference found.

Notably, recent research on ECWP use in commercial LEED projects supports these findings. Estep et al. (2015) identified "hot spots" of ECWP use around large cities in the U.S., and they found that these consumption patterns had developed over time. Our findings here coincide with their research on ECWP use in the commercial LEED market, as we find similar patterns in residential LEED building.

Usage Trends among Small Town/Rural LEED Builders from 2011 to 2018

We also investigated the trends in ECWP usage between 2011 and 2018 among small town/rural builders to examine if there had been any significant changes among this subset of survey respondents.

First, we used the ECWP Users, FSC-Only Users, and Non-users categories to evaluate trends in respondents over time (see *Familiarity and Use of ECWPs among LEED Builders in 2018* for description of categories). In 2011, 19% of small town/rural builders were nonusers, 56% were ECWP users (used both FSC and SFI), and 25% were FSC-only users. In 2018, 58% of small town/rural builders were nonusers, 17% were ECWP users, and 25% were FSC-only users (Figure 30). A chi-square test of homogeneity showed that these differences were slightly

significant, with a p-value between 0.10 and 0.05. Although not significant at the 95% level of confidence, these results suggest that builders in small town/rural areas shifted away from using both FSC and SFI products and became non-users of ECWPs between 2011 and 2018.

These shifts from users to nonusers among small town/rural builders were slightly significant for the FSC and SFI products individually as well. More LEED builders in small town and rural areas were nonusers of FSC products in 2018 compared to 2011 ($p < 0.10$, Figure 31). This trend is true of SFI product, too, where more small town/rural builders were users of SFI products in 2011 compared to 2018 ($p < 0.10$, Figure 31).

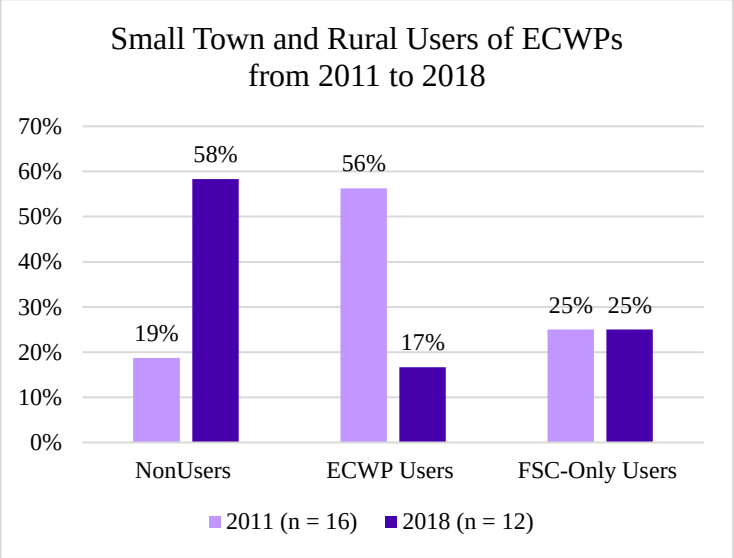

Figure 30. Use of ECWPs among small town/rural LEED builders in 2011 and 2018. Significant differences at the 90% level of confidence.

Interestingly, when we conducted a similar analysis of trends among only suburban/urban builders, chi-square tests of homogeneity showed no significant difference between the rates of FSC or SFI use and nonuse between 2011 and 2018. Overall, these results suggest that builders operating in areas with smaller populations are less likely to use ECWPs today as compared to 2011, while the rates of ECWP use among suburban/urban builders have remained statistically similar. Therefore, the changes in ECWP use among small town/rural builders may drive the

changing use patterns between areas of different population sizes, and these trends may influence an overall decrease in ECWP familiarity and use.

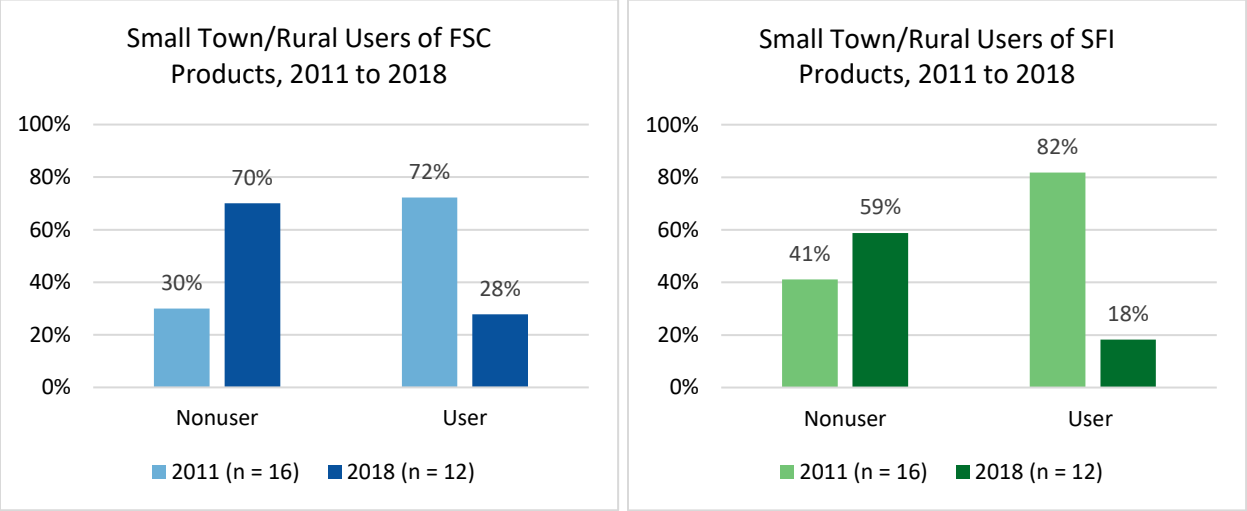

Figure 31. Users and non-users of FSC (blue) and SFI (green) among small town/rural builders in 2011 and 2018. Differences signficant and the 90% level of confidence.

Notably, both the 2011 and 2018 survey sampled a small number of builders working in areas with small populations. We should therefore interpret these results, and the statistical significance values, with caution. Because our results show slight significance in all of these trends concerning small town and rural LEED builders, it is possible that these differences in ECWP usage happened by chance. However, it is also possible that a larger sample size would increase our confidence in these results, as they mirror trends identified by other researchers (G.D. Estep et al., 2015).

Summary of LEED Builder Area of Business and ECWP Usage

This study finds that builders operating in suburban and urban areas were more likely to use ECWPs compared to those builders in small town and rural settings in 2018. Further, this is a shift from the 2011 survey results, when respondents showed a homogenous distribution of familiarity with and use of ECWPs between small town/rural and suburban/urban settings. Lastly, LEED builders in small town/rural populations are less likely to use ECWPs in 2018

compared to 2011, although these results were only significant at the 90% level of confidence. We therefore find that builders in areas of larger populations increasingly capture the ECWP market.

Those wishing to expand the ECWP market may therefore attempt to increase usage in small town or rural areas, as builders serving these areas have shown a decrease in ECWP use. Alternatively, entities may encourage this shift in use to urban areas and focus marketing resources where consumption has already become more concentrated. Future research may also investigate these changes in ECWP use and identify market or demand factors that may be correlated with, or causing, these changes among areas of different population sizes.

ECWP Use Compared to Builder Firm Size

ECWP Use among Small, Medium, and Large LEED Builders in 2018

In 2018, we surveyed more large firms than in 2011, which could be an indication that firms with higher revenue increasingly capture the residential LEED market. Additionally, some research suggests that firm size is an important part of a company's willingness to adopt innovative building materials (Kelley & Brooks, 1991; C. T. Koebel, 2008; Robertson & Gatignon, 1986). Large builders may therefore play an important role in the ECWP market, and so we subset the data to analyze the trends in ECWP usage between firms of different size, giving specific attention to those differences that might have occurred between large firms and firms with lower revenues.

In 2018, we received survey responses from 35 large builders, 22 medium builders, and 4 small builders (see *Demographics of Survey Respondents* for size definitions). In the analysis presented in this section, we combined the small and medium builders into one group to compare these firms to those with higher revenues. First, to better understand the demographics of

builders of different sizes, we compared the distribution of small/medium and large builders in areas of different population sizes (small town/rural or urban/suburban). A chi-square test of independence revealed that these differences were statistically significant, indicating that large builders were more likely to be located in suburban/urban areas, and small/medium builders were more likely to be located in small town/rural areas (Figure 32).

However, these trends were not true of the 2011 survey data, which showed no significant difference between firm size and area of business (Chi-square test of independence). Overall, this suggests that since 2011, LEED-building has shifted towards large firms, who are also increasingly located in areas of with larger populations.

Subsequent analyses indicated that ECWP usage was generally similar between small/medium builders and large builders in 2018.

First, we analyzed FSC familiarity and use among small/medium and large LEED builders. In 2018, 2 small/medium builders (8%) had not heard of FSC, 6 (23%) were aware but did not use the products, 10 (39%) occasionally used the wood, and 8 (31%) frequently used it. Comparatively, 8 large builders (23%) had not heard about FSC wood, 2 (6%) were aware of the wood but did not use it, 12 (34%) occasionally used the products, and 13 (37%) large builders frequently used FSC-certified wood (Figure 33). A chi-square test of independence found that there was no significant

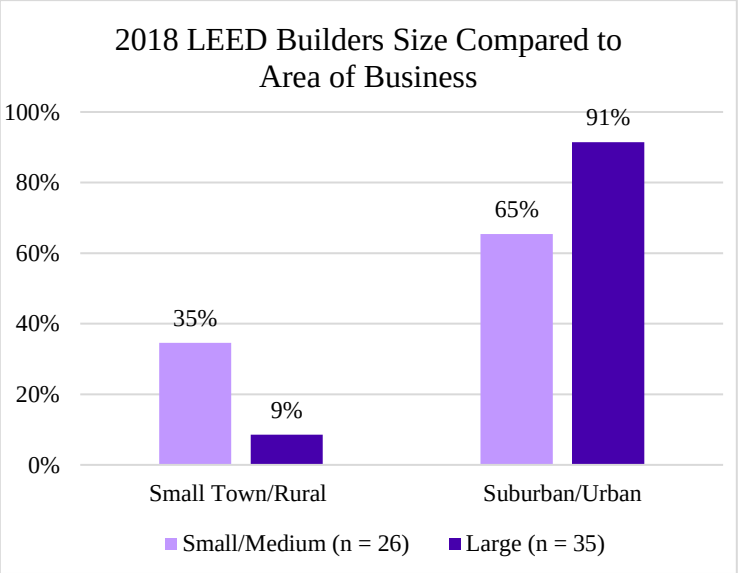

Figure 32. LEED builder firm size (small/medium versus large) compared to area of business (small town/rural versus suburban/urban) in 2018.

difference in the familiarity with and use of FSC products between large and small/medium firms. Overall, we therefore find that a firm's revenue did not correlate with their familiarity with and use of FSC products in 2018.

There was, however, a slight difference in SFI familiarity and usage between firms of difference sizes. In 2018, 5 small/medium-sized builders (19%) had not heard of SFI-certified wood, 13 (50%) were aware but did not use the wood, 6 (23%) occasionally used the wood, and 2 (8%) frequently used the products. Among large builders, 12 (34%) had not heard of SFI wood, 7 (20%) were aware of the products but did not use them, 10 (29%) occasionally used the wood, and 6 (17%) frequently used SFI-certified wood (Figure 34). These differences were significant at the 90% level of confidence ($p < 0.10$), driven primarily by the differences in those who were aware of SFI-certified wood but did not use the products. While not significant at the 95% level of confidence, these results suggest that small/medium-sized firms were more likely to have heard of SFI products but not use them compared to large LEED builders in 2018. This

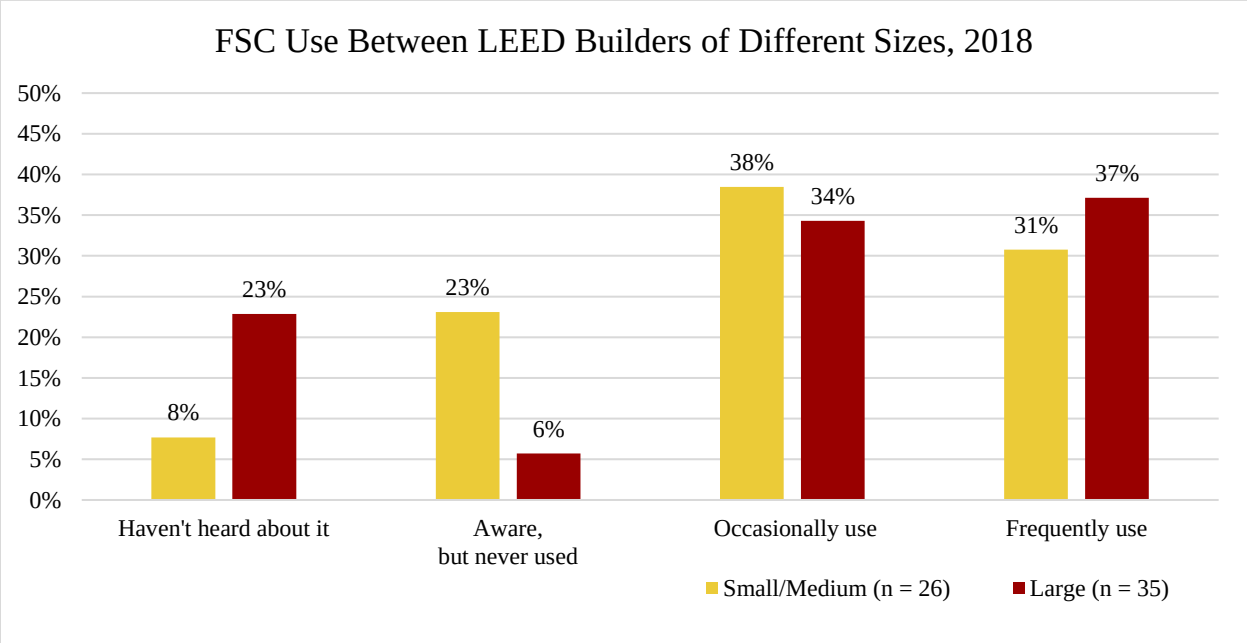

Figure 33. FSC use between LEED builders of different sizes (small/medium versus large) in 2018. No significant difference found.

aligns with our analysis of SFI use between small town/rural and urban/suburban builders, which found that small town/rural builders were more likely to have heard of SFI-certified products but not use them compared to LEED builders in suburban/urban areas.

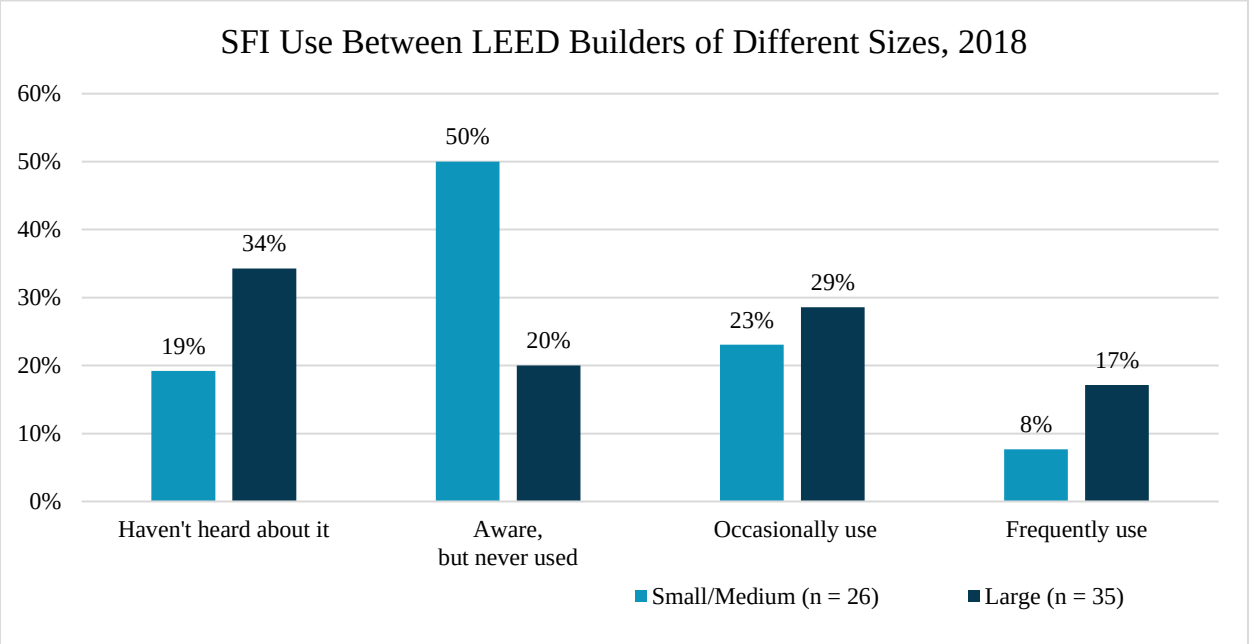

Figure 34. SFI use between LEED builders of different sizes (small/medium versus large) in 2018. Differences signficant at the 90% level of confidence.

Additionally, between small/medium firms and large firms, Pearson's chi-square test with Yate's continuity correction showed that there was no significant difference between users and nonusers of FSC or users and nonusers of SFI wood. These results indicate that large firms do not have different rates of usage of ECWPs compared to small/medium firms. Overall, in 2018, the size of a LEED builder did not correlate significantly with their decision to use or not use ECWPs.

Comparison of ECWP Usage in Large Builders from 2011 to 2018

Next, we analyzed the trends in ECWP usage among large builders between 2011 and 2018 to identify if large builders were adopting ECWPs faster than the rate of adoption among smaller firms. Some research suggests that this pattern is typical in the adoption of innovative

building materials in the residential housing market (Kelley & Brooks, 1991; C. T. Koebel, 2008; Robertson & Gatignon, 1986), and previous surveys of residential builders found that large builders were more likely to believe that ECWP use would increase in the future (Eastin, 2008).

The 2011 survey included responses from 12 large LEED builders, and the 2018 survey reached 35 large LEED builders. Our research found that there was no significant difference in familiarity with and use of FSC products in large builders between 2011 and 2018. Additionally, when we grouped users and nonusers together, we found no significant difference in FSC use and nonuse among large builders between 2011 and 2018. This indicates that large LEED builders had not changed their consumption habits of FSC between 2011 and 2018.

However, familiarity with and use of SFI products among large builders had changed between 2011 and 2018. In 2011, four large builders (33%) had heard of SFI wood but did not use it and eight builders (67%) occasionally used the wood. In 2018, 12 large builders (34%) reported that they had not heard of SFI-certified wood, 7 heard of the wood but did not use it (20%), 10 (29%) occasionally used it, and 6 large builders (17%) frequently used the wood (Figure 35, Table 11). A chi-square test of homogeneity found that the differences between 2011 and 2018 were statistically significant. Then, a post hoc test indicated that the increase in builders who had not heard of SFI wood in 2018, and the larger share of builders who occasionally used SFI-certified wood in 2011, primarily drove these significant differences (Table 11).

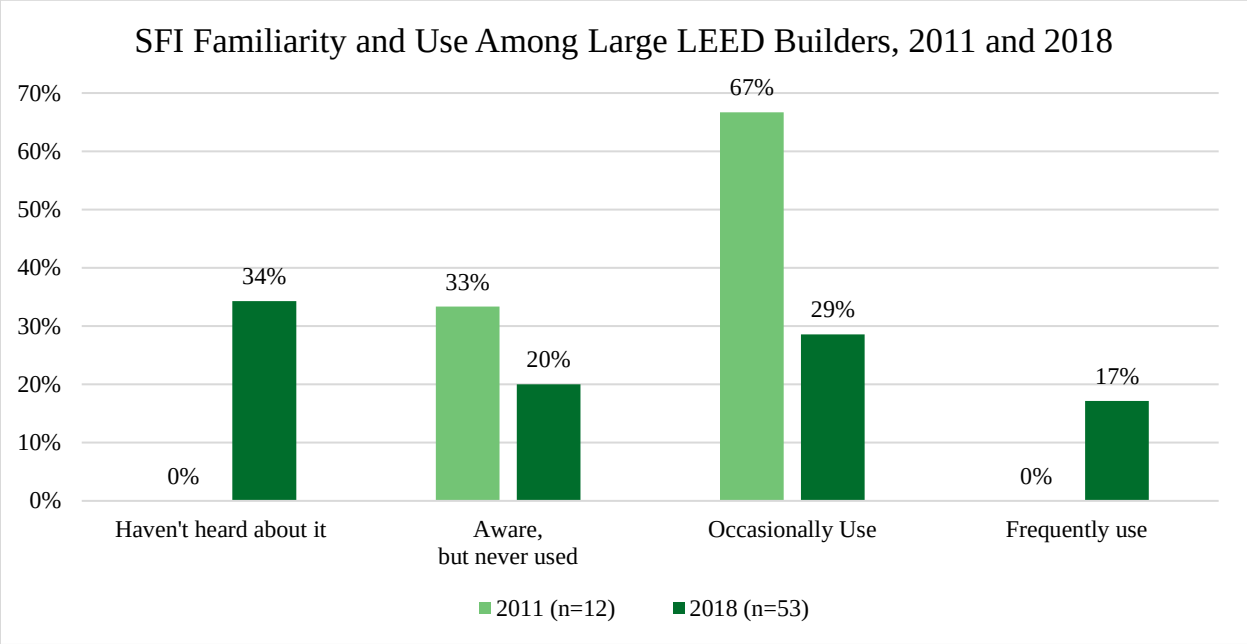

Figure 35. SFI familiarity and use among large LEED builders, 2011 and 2018.

Table 11. Summary of SFI familiarity and use among large LEED builders, 2011 and 2018.

SFI Familiarity and Use: Large Builders		Haven't heard	Aware, but never used	Occasionally Use	Frequently Use	Pearson χ^2 Tests
Survey Year	2011	0%	33%	67%	0%	**P = 0.017** (χ^2 value=10.25, df=3)
	2018	34%	20%	29%	17%	

This suggests that, compared to 2011, large builders in 2018 were less likely to have heard of SFI-certified wood, and they were less likely to use SFI products. This decrease in awareness and use among large builders is especially interesting given research that suggests large builders are the most likely to adopt innovative building materials (Kelley & Brooks, 1991; Robertson & Gatignon, 1986), and it may cause concern for those entities wishing to increase the use of SFI materials in the green residential construction industry. If the market for SFI materials were becoming stronger, we might expect the opposite trend of what our data analysis shows, especially among firms with higher revenues.

When we grouped users and nonusers together in 2011 and 2018, however, a chi-square test indicated that there was no significant difference between users and nonusers of SFI wood among large builders between the two surveys. Considering the results found above, this indicates that more large builders in 2018 had not heard of the SFI label, but this did not affect overall rates of usage among large builders between the two survey years.

Again, we should be cautious when interpreting these results, as the 2011 survey only included 12 large LEED builders. A larger sample size may have found stronger relationships, or it may invalidate our significant findings, as the significant values herein could have occurred by chance due to the low sample size. However, overall, these trends show that there was no significant difference in use and nonuse of SFI products between 2011 and 2018 among large builders, but a larger share of firms in 2018 had not heard of SFI-certified wood.

Summary of Firm Size and ECWP Use Trends

While some research suggests that firm size is correlated with a builder's decision to adopt innovative building materials (Kelley & Brooks, 1991; Robertson & Gatignon, 1986), other research finds that a builder's size is not related to their adoption of green building innovations (T. C. Koebel, Papadakis, Hudson, & Cavell, 2004). This analysis supports the latter conclusion and finds that large LEED builders were no more likely to use ECWPs compared to firms with lower revenues. Further, trends over time suggest that large builders increasingly dominate the LEED building market, yet large firms had not increased their use of FSC or SFI-certified wood products between 2011 and 2018. In fact, more large builders in 2018 had not heard of the SFI label compared to those surveyed in 2011.

These trends are especially notable for those wishing to expand the ECWP market. Large builders often lead the changes in green building material use (C. T. Koebel, 2008), and smaller

firms are often constrained by a number of factors that affect their adaptations to new sustainability policies (Lepoutre & Heene, 2006). If the ECWP market were strengthening, we might expect large builders to show a higher level of awareness and use of ECWPs compared to smaller firms. We might also expect to see an increase in ECWP use among large builders since 2011. We found that neither of these trends were true. This should indicate to the ECWP industry that adoption of, and market for, their materials have not gained significant ground in residential LEED building in recent years.

Census Region and ECWP Use

In the 2018 survey, 30 of our respondents (49%) were located in the West, while in 2011, 21 (42%) of the survey respondents were located in the South (Figure 36). Because a large portion of each sample is located in one region, and because these regions are not the same, many potential geographic analyses of the datasets prove difficult. However, multiple studies indicate that cities in the West show the highest use of ECWPs (Eastin, 2008; G.D. Estep et al., 2015), and we can therefore explore similar questions about the trends in familiarity and use of ECWPs in the West compared to other regions.

We did this by combining data from the Northeast, Midwest, and South census regions in the 2018 dataset to determine if the West showed differences in ECWP familiarity and use when compared to the rest of the country. Chi-square tests of independence found that familiarity with and use of FSC was homogenous between the West and all other regions as was familiarity with and use of SFI products (Figure 36).

This analysis, while somewhat limited due to the regional distribution of our sample and the low sample size in some regions, implies that FSC and SFI familiarity and use was be similar in the West compared to other regions in 2018. This opposes some research that finds ECWP use is higher in the western U.S. (Eastin, 2008; G.D. Estep et al., 2015). However, it also agrees with other research that finds no significant differences in ECWP use among homebuilders in different census regions (Ganguly et al., 2013). Future research might enhance this analysis by gathering more survey responses, especially more respondents from the South, Midwest, and Northeast, to identify potential relationships in ECWP use throughout the country.

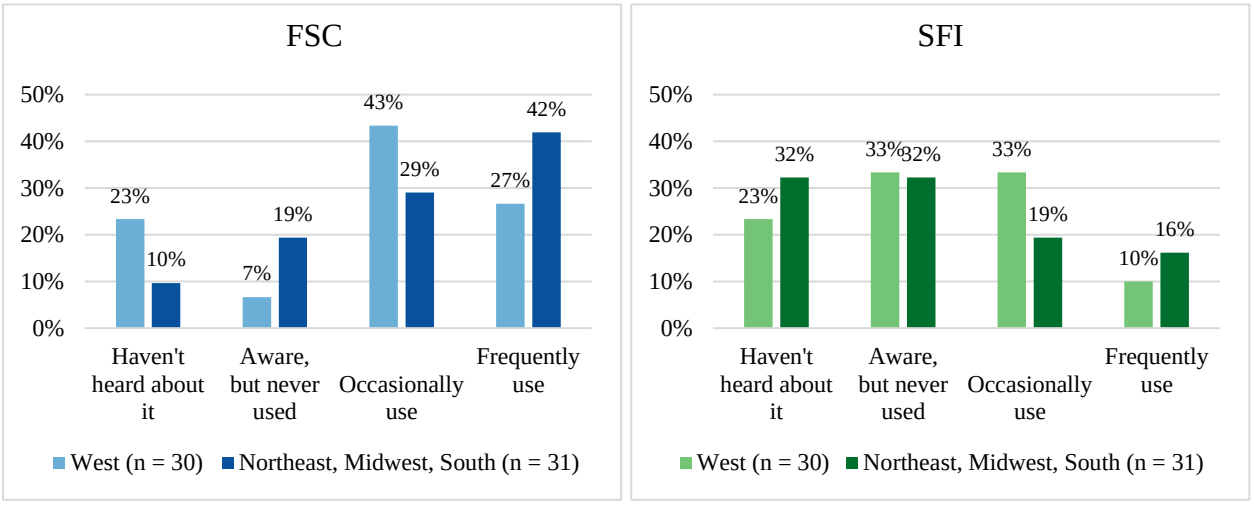

Figure 36. FSC (blue) and SFI (green) familiarity and use among LEED builders in the West compared to all other U.S. Census regions in 2018. No significant differences found for both FSC and SFI.

Conclusion

This research has identified both trends in the residential LEED market and the familiarity with and use of ECWPs among LEED homebuilders and remodelers. Herein, we have provided an updated understanding of the perceptions and use of ECWPs in residential LEED building. Our analysis also tracks trends in familiarity with and use of ECWPs by comparing our 2018 survey responses to a similar survey conducted in 2011.

First, the changes in respondent demographics between the 2011 and 2018 surveys suggest that the residential LEED market is shifting towards the western United States. Additionally, firms with higher revenues increasingly capture this market. Despite these changes, we also found that LEED builders were no more likely to be located in areas with larger populations in 2018 compared to 2011.

We also found similar rates of awareness of both FSC and SFI-certified products in 2018. However, a higher share of residential LEED builders had heard of the SFI label but did not use it compared to those who were aware of but did not use FSC products. These results indicate that while overall awareness of FSC and SFI was similar among our surveyed builders in 2018, builders were more likely to use FSC products. These trends may be attributed to the different types of wood species and products certified by FSC and SFI, or they may be related to the structure of the residential LEED point system. However, further investigation would be needed to identify reasons for this gap in usage.

Our analysis also found that the usage rates of ECWPs among LEED builders had not changed significantly between 2011 and 2018. However, more builders in 2018 reported that they had not heard of the SFI and FSC certifications compared to the respondents in 2011. These

results suggest that the ECWP market has remained relatively stable among LEED builders, although some aspects of our analysis suggest a decrease in awareness of ECWPs. This should be especially notable for those wishing to expand the ECWP market, as the residential LEED program provides a large and growing opportunity for the ECWP market, yet some of this opportunity may be unrealized to date.

We also compared ECWP familiarity and use to various builder attributes and demographics to identify correlations between a firm's characteristics and their use of certified wood. We found that a builder's location of business, categorized as either in an urban/suburban or small town/rural setting, correlated strongly with their familiarity with and use of ECWPs. While overall awareness of FSC and SFI products was similar in both location categories, builders located in suburban/urban areas were more likely to use both FSC and SFI products, and small town/rural builders were more likely to have heard of both products and not use them. Additionally, we found that since 2011, small town/rural builders were increasingly becoming non-users of ECWPs, yet there had been no change in ECWP use among suburban/urban builders since 2011. These results suggest that ECWP use among residential LEED builders is concentrated in suburban/urban areas and has become more concentrated in these areas over time.

Notably, both the 2011 and 2018 survey had relatively small shares of respondents in small town/rural areas. Our reported trends in ECWP use among small town and rural areas should therefore be interpreted with caution. To enhance this analysis, future research may evaluate the ECWP market in areas of different population sizes, specifically focusing on those areas with smaller populations.

We also find that the size of a LEED firm, as determined by their annual revenue, was not correlated with ECWP familiarity and use. In 2018, familiarity with and use of ECWPs was similar among builders of different sizes. Additionally, while our study suggests that large builders increasingly dominate residential LEED building, large builders showed no change in ECWP use between 2011 and 2018. These findings point to a homogenous use of ECWPs between firms of various sizes, and our results also suggest that this homogeneity has been consistent between 2011 and 2018.

Finally, while this study focuses specifically on residential LEED builders in the U.S., myriad building programs and industries provide opportunities for the use of ECWPs throughout the world. Additional research might study the use of ECWPs in other end-uses, such as in commercial LEED projects or in other green building programs. Additionally, surveys of wood product manufacturers and forest product suppliers might complement this research and enhance our understanding of the total ECWP supply chain.

Limitations

Readers should note the limitations of this research before drawing inferences from our results. In this study, we did not implement a true temporal sampling technique. In the 2018 survey, we re-contacted builders from the 2011 contact list and added LEED homebuilders and remodelers to the sample using publicly available data in 2018. While this allowed us to increase our sample size, it may also have affected builder demographics. Builder firm size and geographic region of the business were significantly different in the two samples collected. These shifts may reflect true changes in the LEED building market, but they may also be a result

of our sampling technique. We should therefore note that the two samples were not homogenous populations, and these demographic differences may influence our comparison of ECWP familiarity and use over time.

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Appendix I: Survey Text

CINTRAFOR 2018 LEED Builder Survey

Start of Block: Intro Screener

Q1 Which of the following best describes the business your company conducts?

- ○ Homebuilder (1)
- ○ Remodeler (2)
- ○ Architect (3)
- ○ Other (please specify): (4) _____

End of Block: Intro Screener

Start of Block: Number Projects Screener

Q3 In 2017, how many homebuilding projects (new construction and/or remodeling) did you participate in?

- ○ Number of projects: (1) _____

End of Block: Number Projects Screener

Start of Block: Revenue

*

Q4 Approximately what percentage of your company's sales revenue was generated from the following activities in the last two years (2016 and 2017)?
Single Family Spec Homes : _____ (1)
Single Family Custom Homes : _____ (2)
Multi-Family Construction : _____ (3)
Home Improvement/Remodeling : _____ (4)
Nonresidential Construction : _____ (8)
Other (please specify): : _____ (7)
Total : _____

End of Block: Revenue

Start of Block: Location

Q5 In which state did your company's local operations build the greatest number of homes during the past 12 months?

▼ Alabama (1) ... I do not live in the United States (52)

Q6 Which of the following best describes the area in which your company conducts most of its business? (select one)

- URBAN/SUBURBAN: A city or group of contiguous communities with a population greater than 50,000. (1)
- SMALL TOWN: A city or town that is generally isolated from a major urban area with a population less than 50,000. (2)
- RURAL: Low density population scattered over a wide area. (3)

End of Block: Location

Start of Block: Revenue

Q8 Approximately what was your firm's total sales revenue in 2017? (select one)

- ○ $0 to $100,000 (1)
- ○ $100,001 to $250,000 (2)
- ○ $250,001 to $500,000 (3)
- ○ $500,001 to $1,000,000 (4)
- ○ $1,000,001 to $2,000,000 (10)
- ○ $2,000,001 to $3,000,000 (11)
- ○ $3,000,001 to $5,000,000 (12)
- ○ $5,000,001 to $10,000,000 (13)
- ○ Over $10,000,000 (14)

End of Block: Revenue

Start of Block: Material Selection

Q10 How important are each of the following attributes in influencing your selection of building materials?

	Not at all important (1)	Not important (2)	Neutral (3)	Important (4)	Extremely Important (5)
Long life (1)	○	○	○	○	○
Ease of installation (2)	○	○	○	○	○
CO2 emissions during manufacture (3)	○	○	○	○	○
Made with renewable raw materials (4)	○	○	○	○	○
Recyclability of the material (5)	○	○	○	○	○
Low maintenance (13)	○	○	○	○	○
Energy usage during manufacture process (6)	○	○	○	○	○
Locally produced material (7)	○	○	○	○	○
Energy efficiency (8)	○	○	○	○	○
Made with recycled materials (9)	○	○	○	○	○
Overall price (10)	○	○	○	○	○

Availability (11)	○	○	○	○	○
Consumer demand (12)	○	○	○	○	○

End of Block: Material Selection

Start of Block: Familiarity FSC SFI

Q21 Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood:

- ○ I haven't heard about it (1)
- ○ I am aware of it, but have never used it (2)
- ○ I have occasionally used it (3)
- ○ I frequently use it (4)

Q20 Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood:

- ○ I haven't heard about it (1)
- ○ I am aware of it, but have never used it (2)
- ○ I have occasionally used it (3)
- ○ I frequently use it (4)

Display This Question:

If Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: = I am aware of it, but have never used it

Or Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: = I have occasionally used it

Or Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: = I frequently use it

Or Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: = I am aware of it, but have never used it

Or Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: = I have occasionally used it

Or Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: = I frequently use it

Q18 In your opinion, what is the price premium associated with each of the certified wood(s) below?

	0% (No price premium) (1)	1% to 5% (a small price premium) (2)	5% to 10% (substantial price premium) (3)	Above 10% (very high price premium) (4)
Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: != I haven't heard about it	○	○	○	○
FSC (Forest Stewardship Council) Certified Wood (2)				
Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: != I haven't heard about it	○	○	○	○
SFI (Sustainable Forest Initiative) Certified Wood (1)				

Page Break

Display This Question:

If Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: = I have occasionally used it

Or Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: = I frequently use it

Q27 During the **next two years**, I think my use of **FSC-certified wood** will:

- ○ Decrease (1)
- ○ Stay the same (2)
- ○ Increase (3)

Display This Question:

If Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: = I am aware of it, but have never used it

Q28 During the **next two years**, I think my use of **FSC-certified wood** will:

- ○ Stay the same (2)
- ○ Increase (3)

Page Break

Display This Question:

If Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: = I have occasionally used it

Or Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: = I frequently use it

Q24 During the **next two years**, I think my use of **SFI-certified wood** will:

- ○ Decrease (1)
- ○ Stay the same (2)
- ○ Increase (3)

Display This Question:

If Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: = I am aware of it, but have never used it

Q25 During the **next two years**, I think my use of **SFI-certified wood** will:

- ○ Stay the same (2)
- ○ Increase (3)

Page Break

Display This Question:

If Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: != I haven't heard about it

And Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: != I haven't heard about it

Q43 In your opinion, how do the FSC and SFI forest certification programs compare with respect to the following attributes:

	FSC is significantly better (1)	FSC is somewhat better (2)	Both are the same (3)	SFI is somewhat better (4)	SFI is significantly better (5)	I don't know (7)
Consumer awareness (4)	○	○	○	○	○	○
Ready availability (5)	○	○	○	○	○	○
Better for the environment (6)	○	○	○	○	○	○
Sustainable forest management (7)	○	○	○	○	○	○

Page Break

Display This Question:

If Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: = I have occasionally used it

Or Indicate your level of familiarity with FSC (Forest Stewardship Council) Certified Wood: = I frequently use it

Or Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: = I have occasionally used it

Or Indicate your level of familiarity with SFI (Sustainable Forestry Initiative) Certified Wood: = I frequently use it

Q30 The top 3 reasons **I <u>have</u> used <u>FSC and/or SFI-certified wood</u>** are:

(Select up to 3 options)

- ☐ Customer demand (1)
- ☐ Reliable availability (2)
- ☐ It is an integral part of my construction design/practice (3)
- ☐ Contributes significantly to green building points (4)
- ☐ I believe the environmental benefits are substantial (5)
- ☐ Helps differentiate my homes from competitors (6)
- ☐ Increases profitability of my homes (7)
- ☐ Increases greener image of my company (8)
- ☐ Other (please specify): (9) _____

End of Block: Familiarity FSC SFI

Start of Block: LEED Questions

Q33 Indicate your familiarity with the LEED for Homes green building program (Leadership in Energy and Environmental Design by USGBC):

- I haven't heard about it (1)
- I have heard about it, and do not currently use it (2)
- I use it (4)

Display This Question:

If Indicate your familiarity with the LEED for Homes green building program (Leadership in Energy an... = I have heard about it, and do not currently use it

Q51 Indicate your plans to use the LEED for Homes green building program in the future:

- I **do not have** plans to use LEED for Homes (1)
- I **have** plans to use LEED for Homes (2)

Q100 Have you ever used, or plan to use, any other green building programs (such as NGBS, Built Green, Earth Advantage, etc.)?

- I **have never used** and **do not plan to use** any other green building program (1)
- I either **plan to use** or **have used** another green building program (2)

Page Break

Display This Question:

If Have you ever used, or plan to use, any other green building programs (such as NGBS, Built Green,... = I either plan to use or have used another green building program

Q54 List the green building program(s) you plan to use or have used. You may select both options.

☐ I am planning to use a green building program (please specify): (1) _____

☐ I have used a green building program (please specify): (2) _____

Page Break

Display This Question:

If Indicate your familiarity with the LEED for Homes green building program (Leadership in Energy an... = I use it

Or List the green building program(s) you plan to use or have used. You may select both options. = I have used a green building program (please specify):

*

Q39 The top 3 reasons I have used a green building program are:

(Select up to 3 options)

- ☐ Strong demand for green houses certified under this program (1)
- ☐ Helps differentiate my homes in the market (2)
- ☐ Increases profitability of my homes (3)
- ☐ The documentation process is straightforward (4)
- ☐ Consumer specified the program (5)
- ☐ Architect specified the program (6)
- ☐ Other (please specify): (7) _____

End of Block: LEED Questions

Start of Block: CLT Questions

Q46 Indicate your familiarity with cross-laminated timber (CLT) as a structural building material:

- ○ I haven't heard about it (1)
- ○ I am aware of it, but have never used it (2)
- ○ I have used it (3)

Skip To: End of Block If Indicate your familiarity with cross-laminated timber (CLT) as a structural building material: = I haven't heard about it

Display This Question:

If Indicate your familiarity with cross-laminated timber (CLT) as a structural building material: = I am aware of it, but have never used it

*

Q49 The top 3 reasons I **have not** used CLT are:

(Select up to 3 options)

- [ ] Never felt the need (1)
- [ ] Not readily available (2)
- [ ] Not justified from a business standpoint (3)
- [ ] Not enough market acceptance (4)
- [ ] No green building points awarded (5)
- [ ] I do not believe the environmental benefits are substantial (7)
- [ ] Not enough testing has been done on the material (9)
- [ ] Building codes do not support CLT (10)
- [ ] Labor force unaware of how to use it (11)
- [ ] I have plans to start using it in the near future (6)
- [ ] Other (please specify): (8) _____

Q47 Please indicate your level of agreement with the following statements **comparing the attributes of cross laminated timber to steel/reinforced concrete**:

	Strongly Disagree (8)	Disagree (6)	Neutral (3)	Agree (7)	Strongly Agree (1)	Not Sure (9)
CLT buildings are/can be more aesthetically pleasing (1)	○	○	○	○	○	○
CLT as a building material is more environmentally friendly (6)	○	○	○	○	○	○
Framing buildings with CLT will reduce construction time (3)	○	○	○	○	○	○
Framing buildings with CLT will reduce the construction costs (5)	○	○	○	○	○	○
CLT in structural applications will increase the thermal efficiency of buildings (4)	○	○	○	○	○	○
CLT in structural applications will improve the fire resistance of buildings (8)	○	○	○	○	○	○

CLT in structural applications will improve the earthquake resistance of buildings (9)	○	○	○	○	○	○

Display This Question:

If Indicate your familiarity with cross-laminated timber (CLT) as a structural building material: = I have used it

Q52 Please briefly describe the reason(s) you have used CLT:

_____

_____

_____

_____

_____

End of Block: CLT Questions

Start of Block: Block 9

Q53 We appreciate you taking the survey. As a token of gratitude, we would like to offer you a $10 Amazon Gift Card. If you wish to receive the Amazon gift card code, please provide an email address where we can send the card.
(please note, under UW confidentiality protocol, none of the responses will be associated with any identifying information)

○ Yes! Please send my gift card code to (enter valid email address): (1)
_____

○ No thank you, I do not want a gift card (2)

End of Block: Block 9