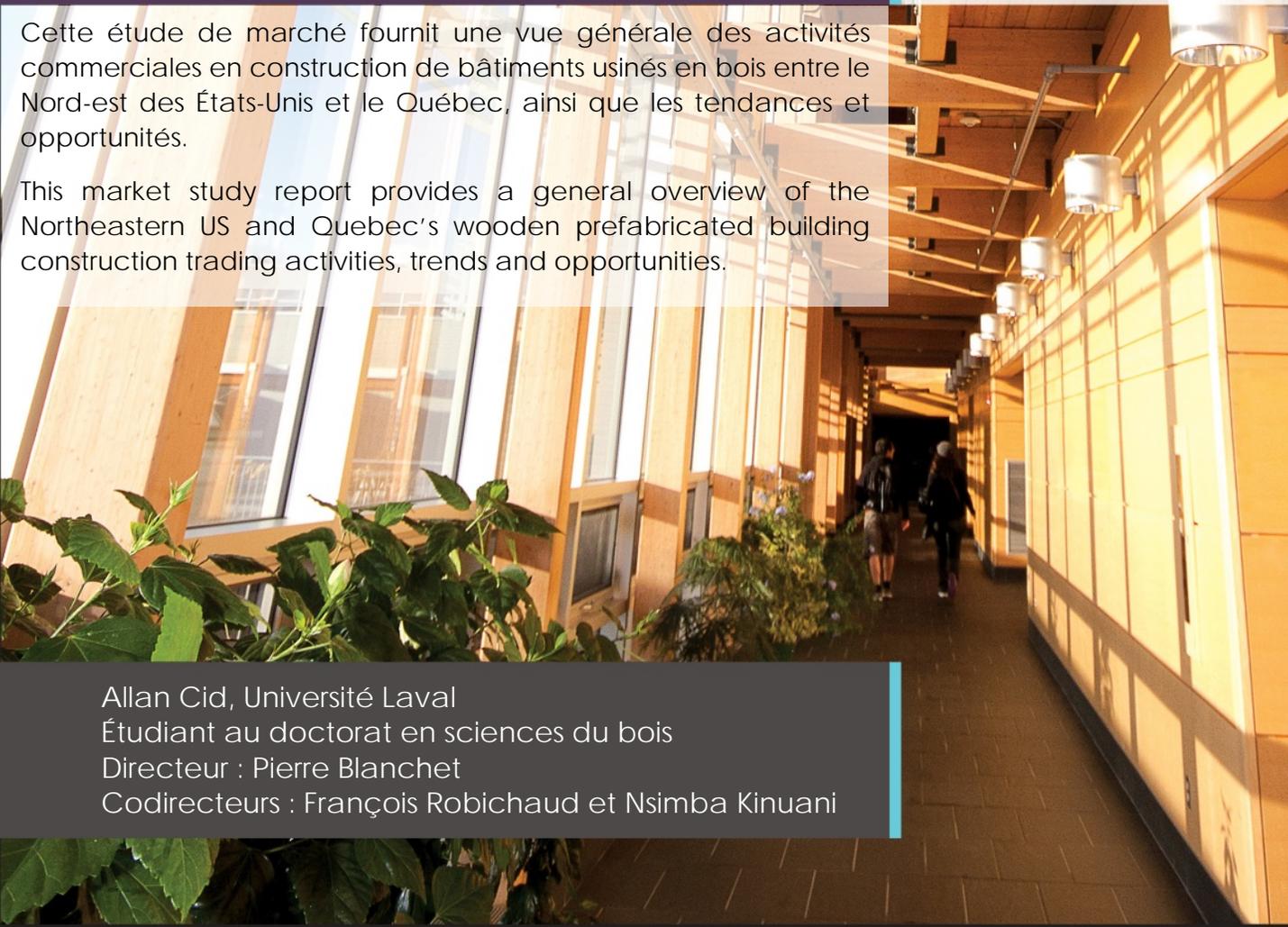




# Étude de Marché Market Study Report

Juin 2020



Cette étude de marché fournit une vue générale des activités commerciales en construction de bâtiments usinés en bois entre le Nord-est des États-Unis et le Québec, ainsi que les tendances et opportunités.

This market study report provides a general overview of the Northeastern US and Quebec's wooden prefabricated building construction trading activities, trends and opportunities.

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## EXECUTIVE SUMMARY

The objective of this study was to estimate the export potential of wooden prefabricated buildings from Quebec to the Northeastern US in the next decade in relation to the actual trade activity and production capacity of the industry. The targeted markets for this project are the territories located in the Quebec province for Canada, and the New England and Mid-Atlantic States in the United States, also known as Northeast.

This study identified the actual export activity by analyzing the wooden prefabricated buildings trade of from Quebec to the Northeastern US. Also, it measured the actual production capacity of Quebec by gathering production information from the local industry. Finally, it estimated the export activity potential by maximizing the production while keeping the infrastructure unaltered.

### **International Trade Activity in the last two decades**

The global prefabricated buildings exports rose to 9.4 USD billion in 2018. The exports are now 3.3 times bigger than in 2001, and they have been growing at a yearly average pace of 8.5% since then. The 2008 crisis shrunk the global exports in 2009 and later between 2014 and 2015.

The top losers are Canada, that reduced its exports share from 12.8% to only 2.4% since 2001, and the US, that decreased its exports share from 10.5% to 5.7% in the same period. Canada not only reduced its exports share in two decades but also its total export volume, passing from 363 USD million to 226 USD million.

The global Prefabricated Building Imports rose to 7.8 USD billion un 2018. Imports are now 3 times bigger than in 2001 and has been growing at yearly average of 7.6% since then. Imports were affected similarly to Exports due to the 2008 crisis, especially in 2009 and between 2014 and 2015.

The global Prefabricated Wood Building Exports rose to 1.9 USD billion in 2018 (+10% than 2017). Half (50.6% ) of global exports were done by only five countries and 41.3 % were done by only three countries. Both three and five-firm concentration ratios lie between 40% and 70%, indicating a medium concentration level in exports, looking like an oligopoly.

The market size rose 1.6 USD billion in 2018 (+6.5% than 2017). Baltics and Eastern Europe are dedicated to export activities. These regions have overpassed Western Europe as the biggest exporter in 2018 (37.7% Market Share). Northern America has a mixed activity between importing and exporting, although imports overcame exports in a 37% in 2018.

### **Canadian wooden prefabricated buildings trade activity**

In 2019, Canadian wooden prefabricated buildings exports rose to 94.3 USD million, 36.3% of total prefabricated building exports from Canada in that year (Canadian exports of all materials were 259.8 USD million).

Quebec wooden prefabricated building exports accounted 31.9% of Canadian exports in 2017, 31.2% in 2018 and 18.6% in 2019. Whilst Quebec kept similar values in the last three years, other provinces followed different trade patterns. Alberta accounted 3.4% of Canadian exports in 2017, 6.3% in 2018 and 37.6% in 2019. Surrounding provinces as Ontario and New Brunswick have increased their global exports in the past three years as well.

## **Quebec's wooden prefabricated buildings exports and production analysis**

Quebec exports reached 17.5 USD million in 2019, 18.7 USD million in 2018 and 17.8 USD million in 2017. The biggest destination for Quebec are the US, with 16.2 USD million in 2019 (92.34% of total exports), 17.4 USD million in 2018 (92.90%) and 17 USD million in 2017 (95.38%).

Production of wooden prefabricated buildings in Quebec<sup>1</sup> has been following a different growth trend in the last three decades. While in the production in the 90s almost doubled in a decade, the 2000's did not follow the same pattern, fixed at a 0.7% annual growth rate. The 2010's decade characteristic annual growth rate was 3.4%, and 2019 production rose to an historical maximum of CAD 170 million.

## **The American construction market**

The US construction market is one of the three biggest construction markets in the world, investing more than US\$ 1.3 trillion in 2018. In the last decade, and after the 2008 crisis effects vanished in 2011, the whole market recovered at an impressive 8% average rate per year.

US Residential market is almost completely driven by the private investment. While public residential projects exist, they represented only 2% in the last decade. Public residential investment averaged a yearly investment of 7 USD billion in the last decade, reaching its top in 2010 reaching 10 USD billion, around 4,25% of the total residential investment in that year.

US non-residential market fell after the 2008 crisis but started to grow again in 2010 in mostly every subsegment, totaling US\$ 761,113 million in 2018. While non-residential private investment rose in 2011 to US\$ 257,803 million (37% lower than in 2008), non-residential public investment touched bottom in 2013 to US\$ 264,846 million (12% lower than in 2008). Since then, both segments started to grow steadily in every subsegment.

## **American Demographics**

While baby boomers (born 1946-1964) will lead to an astounding 11.1 million age 65 and over household increase, millennials (born 1985-2004) will demand 2.9 million more 35 to 44 year-old households. Generation X (born 1965-1984) will not be able to replace baby boomers' housing stock, leaving 1.9 million 45 to 64 year-old households vacancy. As a result, we will see a net 12.1 household increase in the US.

A similar behavior is perceived in Northeastern US. Generational fluctuations will produce an estimated addition of 3,165,178 households in the region.

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<sup>1</sup> Wooden prefabricated building sales can be found at Statistics Canada under the North American Industry Classification System (NAICS) code 321992 and relate to HS940610.

## SOMMAIRE EXÉCUTIF

L'objectif de cette étude était d'estimer le potentiel d'exportation des bâtiments préfabriqués en bois du Québec vers le Nord-Est des États-Unis au cours de la prochaine décennie en se basant sur l'activité commerciale actuelle et la capacité de production de l'industrie. Les marchés ciblés étaient les territoires situés dans la province de Québec, au Canada, et ceux de la Nouvelle-Angleterre et des États du Centre de l'Atlantique aux États-Unis, connus sous le nom du Nord-Est.

L'étude a identifié le niveau actuel des activités d'exportations en analysant les échanges commerciaux des bâtiments préfabriqués en bois, du Québec vers le Nord-Est américain. On y a également mesuré la capacité de production actuelle du Québec en rassemblant les informations de production auprès de l'industrie locale. Enfin, l'étude s'est également penchée sur l'estimation du potentiel des activités d'exportations en maximisant la production en se basant sur les infrastructures actuelles.

### **Activité commerciale internationale dans les deux dernières décennies**

L'exportation mondiale de bâtiments préfabriqués a atteint 9,4 milliard \$US en 2018. Les exportations sont actuellement 3,3 fois plus importantes qu'en 2001, et elles ont augmenté à un rythme annuel moyen de 8,5 % depuis ce temps. La crise de 2008 a entraîné une réduction des exportations globales en 2009 et par la suite en 2014 et 2015. Les plus grands perdants ont été le Canada, qui a réduit sa part d'exportation de 12,8 % à seulement 2,4 % depuis 2001, et les États-Unis, qui a réduit sa part d'exportation de 10,5 % à 5,7 % au cours de la même période. Le Canada n'a pas seulement réduit sa part d'exportation au cours de ces deux décennies, mais également son volume total d'exportation, qui est passé de 363 à 226 million \$US.

Les importations mondiales de bâtiments préfabriqués ont atteint 7,8 milliard \$US en 2018. Les importations sont maintenant plus importantes qu'en 2001, et ont augmenté à un rythme annuel moyen de 7,6 % depuis ce temps. Elles ont été affectées similairement aux exportations par la crise de 2008, tout particulièrement en 2009, et entre 2014 et 2015.

Les exportations mondiales de bâtiments préfabriqués en bois ont atteint 1,9 milliard \$US en 2018 (+10 % vs. 2017). Cinq pays sont responsables de la moitié de ces exportations (50,6 %) alors que trois pays à eux seuls sont responsable de 41,3 % des exportations. Les ratios de concentration à trois et cinq entreprises se situent entre 40 % et 70 %, ce qui indique un niveau de concentration moyen dans les exportations, ressemblant à un oligopole.

La taille du marché a atteint 1,6 milliard \$US (+6,5 % vs. 2017). Les pays baltiques et de l'Europe de l'est sont dédiés aux activités d'exportation. Ces régions ont dépassé l'Europe de l'ouest en tant que plus gros exportateur en 2018 (37,7 % des parts de marché). L'Amérique du Nord est à la fois importatrice et exportatrice, mais les importations ont dépassé les exportations de 37 % en 2018.

### **Activité commerciale canadienne en matière de bâtiments préfabriqués en bois**

En 2019, les exportations canadiennes de bâtiments préfabriqués en bois ont atteint 94,3 million \$US, soit 36,3 % des exportations de bâtiments préfabriqués canadiennes pour cette même année (les exportations canadiennes tous matériaux confondus étaient de 259,8 million \$US).

Les exportations québécoises de bâtiments préfabriqués en bois ont compté pour 31,9 % des exportations canadiennes en 2017, 31,2 % en 2018 et 18,6 % en 2019. Bien que le Québec ait conservé des statistiques similaires au cours des trois dernières années, d'autres provinces ont suivi des tendances différentes. L'Alberta a compté pour 3,4 % des exportations canadiennes en 2017, 6,3 % en 2018 et 37,6 % en 2019. Les provinces voisines du Québec, comme l'Ontario et le Nouveau-Brunswick, ont également augmenté leurs exportations globales au cours des trois dernières années.

### **Analyse des exportations et de la production québécoise de bâtiments préfabriqués en bois**

Les exportations québécoises ont atteint 17,5 million \$US en 2019, 18,7 million \$US en 2018 et 17,8 million \$US en 2017. Ces exportations sont principalement destinées aux États-Unis, avec 16,2 million \$US en 2019 (92,34 % des exportations totales), 17,4 million \$US en 2018 (92,90 %) et 17 million \$US en 2017 (95,38 %).

La production de bâtiments préfabriqués en bois québécoise a suivi une tendance croissante différente au cours des trois dernières décennies. Alors que la production a doublé dans les années 90s, les années 2000 n'ont pas suivi la même tendance, avec une croissance annuelle de 0,7 %. La décennie 2010 a eu un taux de croissance annuel de 3,4 % et la production de 2019 a atteint un maximum historique de 170 million \$CAD.

### **Le marché de la construction américain**

Le marché de la construction américain, qui a investi plus de 1,3 trillion \$US en 2018, est l'un des trois plus importants dans le monde. Au cours de la dernière décennie, lorsque les effets de la crise de 2008 se sont estompés en 2011, l'ensemble du marché s'est redressé à un taux moyen impressionnant de 8 % par an.

Le marché résidentiel américain est presque complètement dominé par les investissements privés. Bien que des projets résidentiels publics existent, ils n'ont représenté que seulement 2 % du marché dans la dernière décennie. L'investissement résidentiel public a représenté en moyenne un investissement annuel de 7 milliards de dollars au cours de la dernière décennie, atteignant son maximum en 2010 avec 10 milliard \$US, soit environ 4,25 % de l'investissement résidentiel total de l'année.

Le marché non résidentiel américain a tombé après la crise de 2008 mais a commencé à croître à nouveau en 2010 dans la majorité des sous-segments, totalisant 761 113 \$US en 2018. Alors que les investissements privés en construction non-résidentielle ont atteint 257 803 \$US en 2011 (37 % plus bas qu'en 2018), les investissements publics pour ce même marché ont touché le fond en 2013, avec 264 846 \$US (12 % plus bas qu'en 2008). Depuis ce temps, les investissements publics et privés ont augmenté de façon régulière, et ce pour tous les sous-segments (US Census Bureau, 2019).

## **Démographie américaine**

Alors que les baby-boomers (nés entre 1946 et 1964) entraîneront une forte augmentation de 11,1 million de ménages de 65 ans et plus, les millénaires (nés entre 1985 et 2004) demanderont 2,9 million de ménages supplémentaires de 35 à 44 ans. La génération X (née entre 1965 et 1984) ne pourra pas remplacer le parc immobilier des baby-boomers, laissant 1,9 million de ménages de 45 à 64 ans inoccupés. En conséquence, nous assisterons à une augmentation nette de 12,1 ménages aux États-Unis.

En appliquant la même analyse aux États du Nord-Est, nous observons un comportement similaire en matière de fluctuations générationnelles, avec un ajout de 3 165 178 ménages. La génération des baby-boomers ajoutera 3 366 766 ménages dans la région, alors que celles des milléniaux en ajoutera 1 343 256. La génération X suivra la tendance nationale en réduisant de 1 544 845 ménages. Nous n'avons que considéré une projection de la population réelle dans dix ans, en appliquant le taux de mortalité moyen à chaque tranche d'âge.

# 1 INTRODUCTION

## 1.1 Objectives

The main objective of this report is to provide a general overview of Northeastern US and Quebec's wooden prefabricated construction market trade activity.

The secondary objectives are to:

1. Identify market and socioeconomic trends for both markets;
2. Develop a market forecast for both markets;
3. Present opportunities for offsite construction within the markets.

## 1.2 Approach and limitations

The targeted markets for this project are the territories located in the Quebec province for Canada, and the New England and Mid-Atlantic States in the United States, also known as Northeast.

These markets were chosen following the results and conclusions of a transportation cost analysis presented by FPInnovations back in 2015 (Julien et al., 2015). They analyzed three different shipping methods: truck, train and ship transportation and stated that a 1,000 kilometers radius is the maximum for low-cost transportation. This prioritization was confirmed during the Vision 2030 symposium in 2016, a Quebec industrial initiative launched to promote the offsite construction exportation activity.

## 1.3 Methodology

Information contained in this report comes from different sources. The most influencing are:

- State of the art reviews;
- Specialized reports;
- Scientific articles.

For further information, please refer to the Annexes and Bibliography sections.

## 2 CONTEXT

**Building construction** is defined in the Encyclopaedia Britannica as the techniques and industry used in the assembly and erection of a structure, mainly used to provide shelter (Chang & Swenson, 2019). A building can be either produced onsite or offsite. **Onsite construction** is also known as traditional construction. **Offsite construction** is also referred as prefabrication, industrialized construction, modular, manufactured construction, pre-assembly, systems building and modern methods of construction (Smith & Quale, 2017).

**Fabrication techniques** in construction are related to the location where buildings, or its parts, are mainly assembled. **Onsite construction** is the term coined to those structures completely developed at the same site where they will remain after the construction process is over. **Offsite construction** is the term coined for those structures, or its parts, partially or fully developed in a different site where the structure will remain after the construction process finishes (Rodríguez, 2019). This document will focus on **offsite construction**.

Offsite construction can be classified per the **temporary usage of buildings**. The Modular Building Institute (MBI) delivers yearly reports about offsite construction under two different labels. The first, **relocatable modular construction**, is defined in the International Building Code (IBC) as “partially or completely assembled building constructed and designed to be reused multiple times and transported to different building sites” (International Code Council, 2018). The second, **permanent modular construction**, “is an innovative, sustainable construction delivery method utilizing off-site, lean manufacturing techniques to prefabricate single or multi-story whole building solutions in deliverable volumetric module sections” (Modular Building Institute, 2019).

The **degree of industrialization** in factories can also be used to categorize the activity. This can be done according to the usage of tools, technology and human interactions in factories during the four industrial revolutions. The 1<sup>st</sup> industrial revolution follows the introduction of water- and steam-powered mechanical facilities. The 2<sup>nd</sup> industrial revolution follows introduction of electrically powered mass production based on the division of labor. The 3<sup>rd</sup> industrial revolution uses electronics and IT to achieve further automation and manufacturing. And the 4<sup>th</sup> industrial revolution through the use of cyber-physical systems (Wahlster, 2016).

The **degree of prefabrication** of structures or its parts before the assembly on-site is also used to classify the construction activity. A percentage of prefabrication can be assigned to a structure, going from 0% to a fully on-site built structure, to 100% to a structure completely developed in a factory or in a different location than its final position. Under this classification, a highly planned single house has a degree of prefabrication between 25 and 35%, industrial buildings lie in the 20 to 30% band, standard turnkey houses are 40 to 60% prefabricated, modular units and sanitary pods can go from a 60 to a 90% degree of prefabrication. Relocatable modules can have the highest degree of prefabrication, with a degree falling between 95 and 100% (Staib et al., 2013).

### 2.1 History of offsite construction

Several approaches have been developed during human history to construct buildings that are fully or partially built in a different location than their final emplacement. In different

technological ages and latitudes, human beings have developed techniques and processes that differ to the traditional onsite building construction approach.

### 2.1.1 Early developments

#### 2.1.1.1 Yurt

One of the first offsite developments on earth have been found in Mongolia. A traditional *yurt* (or *ger*) is a portable tent used by nomad people from Central Asia. *Yurts* have been built for more than 2,000 years and can still be found nowadays. It consists of a round structure covered by animal skin or felt. The wall structure consists of a latticework of pieces of wood or bamboo, and the cone-shaped roof is an assembly of poles ending in a center ring (Kemery, B., 2006).

#### 2.1.1.2 The Japanese house

The Japanese house is famous for introducing the concept of standard measures in construction more than 1,000 years ago. Each element has a specific position, specification and dimension, where all of them are related to proportionality. For defining the interior spaces, the Japanese constructors considered the human dimension and the space to accommodate him (Matsushita, 2004).

#### 2.1.1.3 Chiloe's minga

In Chiloe, the biggest island in Chile, the tradition is when a family is moving to a new house, they are moving their actual house to its new emplacement. It can be seen as an early example of prefabricated modules transportation, that started after the arrival of the Spanish Empire to the island (Montandon, A., 1951).

### 2.1.2 Modern prefabrication buildings

The first attempts of modern prefabrication can be found after Lisbon earthquake of 1755 in *Baixa Pombalina* and during the construction of *Vila Real de Santo António* in *Algarve*, both in Portugal. These efforts were done following a decision made by the Prime Minister of Portugal of that time, *Marquês de Pombal*. The idea was to achieve shorter construction times by the standardization of repetitive elements, rationalization of production and systematization of construction (Fernandes, 2009).

In 1830, a prefabricated housing initiative was developed in the UK, called the *Manning Portable Colonial Cottage*. Designed to be easily put in place by inexpert personnel, John Manning developed a production line, quality control standards and a supply chain to deliver the units to the colonies overseas. This was one of a series of portable buildings sent from the UK to the colonies, mostly used to serve as protection from weather and theft (Herbert, 1972).

In North America, between the 1830s and the 1890s, the balloon frame construction was developed. Four main factors contributed to its origin. First, a high supply of saw milled standardized dimension lumber from Wisconsin, Michigan and Minnesota. Second, availability of iron nails at reasonable costs were produced in the eastern states industry. Third, transportation systems, water and overland, placed these items in states with high construction demand and pace for commercial and housing structures. Fourth, timber construction was possible mostly because of the availability of skilled workers and the possibility to build lightweight frames using standardized elements and structures (Peterson, 2000).

From the 1950s to the 1970s, concrete massive panel was the building block for prefabricated construction. The main idea was to develop low-cost, fast and repetitive concrete solutions. This approach did not consider the quality of life and other architectural drivers, such as architectural flexibility, producing massive structures, with hundreds or even thousands of units in the same location.

At the beginning of the 70s, the lack of flexibility and variety reduced the prefabricated construction housing market. The European Union markets started to demand quality, rather than just low-cost units. During this period, prefabricated systems reputation was put in dispute, and several building companies disappeared. The closed industrialization system became obsolete, and a brand-new open industrialization system appeared. It brought flexibility through the creation of construction elements and their compatibility between them. Nonetheless, these developments were mostly theoretical and only a few low-scale projects were developed.

By 1985, the market drivers changed, reducing prefabricated solutions competitiveness. The unit number per project decreased. There was a rise of the single family in detriment of the multi-family projects. The energy crisis forced the development of norms and standards to improve thermal performance. Open systems started to be used as parts of the whole building and lost the main role in construction that was achieved until the early 70s.

In the 90s, increase in the labor hand cost and a massive middle class demanding affordable housing fostered a new prefabrication wave. As an example, in Sweden, Ikea and Skanska in a joint venture created BoKlok houses to satisfy this emergent market segment. Nonetheless, this and other efforts could not defeat the predominant sectorial stigma of over-standardization.

By the 2000s, and due to the new and affordable technologies developed for construction, it was possible to develop projects with a high level of customization and flexibility, the prefabricated construction systems gained a new interest. Companies such as Lindbäcks Bygg, in Sweden, or Toyota houses and Mitsui houses, in Japan, developed a new paradigm for prefabricated construction, unveiling an unseen mix between high standards, design and standardization. By this time, prefabricated construction was mature enough to develop single family housing projects.

Since 2010, the rural to urban migration phenomenon was already started worldwide, and a growing middle-class demand for affordable construction rose to a maximum unseen in history. Worldwide, multi-family projects attracted prefabrication companies to develop new solutions. Development of new softwares supporting offsite construction started, so the experimental projects. Examples of this are the 57-story Ark Hotel in Changsha, China, and the 500-bed hospital built in Calicut, USA. Offsite construction systems started a race to dethrone onsite construction in the tall building construction segment (Guindos & Rodríguez, n.d.).

## 2.2 Industrialized construction methods and materials used

### 2.2.1 Construction methods

Industrialized construction is defined by Smith and Quale as planning, design, fabrication and assembly of building elements at a location other than their final installed location to support the rapid and efficient construction of a permanent structure (Smith & Quale, 2017).

Smith and Quale summarized all the basic existing construction systems in a sort of building system palette using ten different types. In real life, a project can either use only one or a combination of the different construction systems, and it is useful to analyze and define building construction projects (Smith & Quale, 2017):

- A. **Post and beam:** A structural skeleton requiring horizontal and vertical infill. Subdivided in segments, continuous posts and continuous beams.
- B. **Slab and column:** Simplification through the introduction of a single horizontal element. Subdivided in solid slab, ribbed slab, slab incorporating a perimeter beam.
- C. **Panels:** Load/-bearing flat components distributing loads and contributing to soundproofing. Subdivided in lightweight framed, lightweight solid, reinforced concrete, prestressed concrete, mixed.
- D. **Integrated joint:** Monolithic component simplifying connections by locating the joint outside in the geometrical meeting point. Subdivided in point to point, skeleton, planar.
- E. **Sectional module:** small and easy-to-transport modules but incomplete, as they need a complimentary component or process once they reach the site. Subdivided in by addition, checkerboard, by compaction.
- F. **Box:** Autonomous unit entirely completed at the plant. Subdivided in framed at the edges panelized, monolithic.
- G. **Load-bearing service core:** The service area is built at the plant within a module with structural capacity in order to support slabs and envelope panels generating the served area between them. Subdivided in point to point, linear.
- H. **Megastructure:** Framework to stack boxes in order to attain a high-rise status without piling them up. Subdivided in one story, two stories, three stories, four stories.
- I. **Site mechanization:** Bringing the factory and its tooling to the site as far as the structural sub-system is concerned. Subdivided in mobile factory, in situ factory, tunnel formwork, sliding formwork, permanent formwork.

### 2.2.2 Timber industrialized methods

The most used industrialized methods for timber buildings are building kits and finished modules. While building kits are defined as prefabricated elements or sections that are then delivered and assembled on-site, finished modules are distinguished as an entire building delivered and assembled on-site (Ross, 2010).

Building kits subtypes are based on both open structural panels and closed structural panels. Finished modules subtypes are either manufactured houses built over transportation chassis (EOS) or modular construction. The pros of building kits are an easier handling during construction, lower transportation costs and easy to setup factories. Regarding finished modules, their pros are shorter on-site time due to mounting and finishing, building quality and the delivery of higher value items from factory.

### 2.2.3 Structural materials

The main building materials used in the North American offsite construction market are wood, steel, concrete and aluminum. FPIinnovations presented back in 2015 a detailed analysis for Materials and Structures (Julien et al., 2015). Below you will find an abbreviated presentation of

structural materials in offsite construction, the offsite construction methods they relate to, and some usage examples found in literature.

**Timber based elements** have been developed for different structure dimensions and structural loads. Construction lumber is mostly used in frame and platform systems for buildings going from one story to four stories, in roofing structures for the housing sector or short span buildings and in modular systems such as panels, sectional modules and box units. Engineered wood materials are mostly used when either higher structure dimensions or structural loads are present, such as building diaphragms, long span buildings and mid- and high-rise buildings.

**Steel based construction** follows similar patterns for structures, where dimensions and loads define the quality and shape of elements. There are two kinds of steel that are used in building construction: hot laminated steel and cold rolled steel. Hot laminated steel is more expensive and more malleable, getting into different shapes. It is mostly used in bigger projects, such as industrial and commercial construction, like engineered wood elements. Cold rolled steel is limited to lesser type of shapes and smaller dimensions. This is mostly used in residential projects, modular construction and roofing structures, like construction lumber.

**Concrete based construction** is mostly used for durable and high vertical load construction, especially when reinforced with steel. High-rise construction and infrastructure projects are mostly made using concrete. Concrete is rarely used in small residential construction, except for foundations. Concrete offsite construction elements normally are slabs, columns, posts and beams, but can also be seen in modular construction and 3D printed buildings. Concrete also presents the possibility of hybrid construction system, being use along with wooden and steel elements.

**Aluminum** is a corrosion resistant material, lightweight and used in the form of alloys, extruded, laminated and shaped elements. Aluminum structures are rare in the construction market in general and are mostly used as construction elements to support the structural functions (connectors, nails and screws). Aluminum is mostly used in building envelopes, outdoor structural components, lighting equipment, signalization, among other).

### 3 International trade

In this section the world trade activity will be explored. The Harmonized Item Description and Coding System (HS) codes will be used to identify complete building exports and imports. The HS codes to be analyzed are HS940600<sup>2</sup>, HS940610<sup>3</sup> and 940690<sup>4</sup>. It is important to note that code HS940600 splits up into two new codes starting in 2017, and codes HS940610 and HS940690 replaced HS940600 in the ITC Trade map for bilateral trade. Code HS441890<sup>5</sup> will not be analyzed in this document because it has not been measured since 2016.

#### 3.1 Prefabricated Buildings Exports (HS940600)

In 2018 the global Prefabricated Buildings exports rose to 9.4 USD billion (Figure 1). The exports are now 3.3 times bigger than in 2001, and it has been growing at a yearly average pace of 8.5% since then. The 2008 crisis shrunk the global exports in 2009 and later between 2014 and 2015.

In a regional perspective, the 2008 crisis worked as an inflexion point for the different economies. In one hand, it helped the Asian, Baltics, Eastern Europe and Near East economies to keep a growing pace. In the other hand, the Northern American and Western Europe economies were the most negatively affected after recession. An interesting fact is that during recession an important overstock of buildings was held between 2012 and 2016 and were marked as being in Free Zones (marked as other in Figure 1).

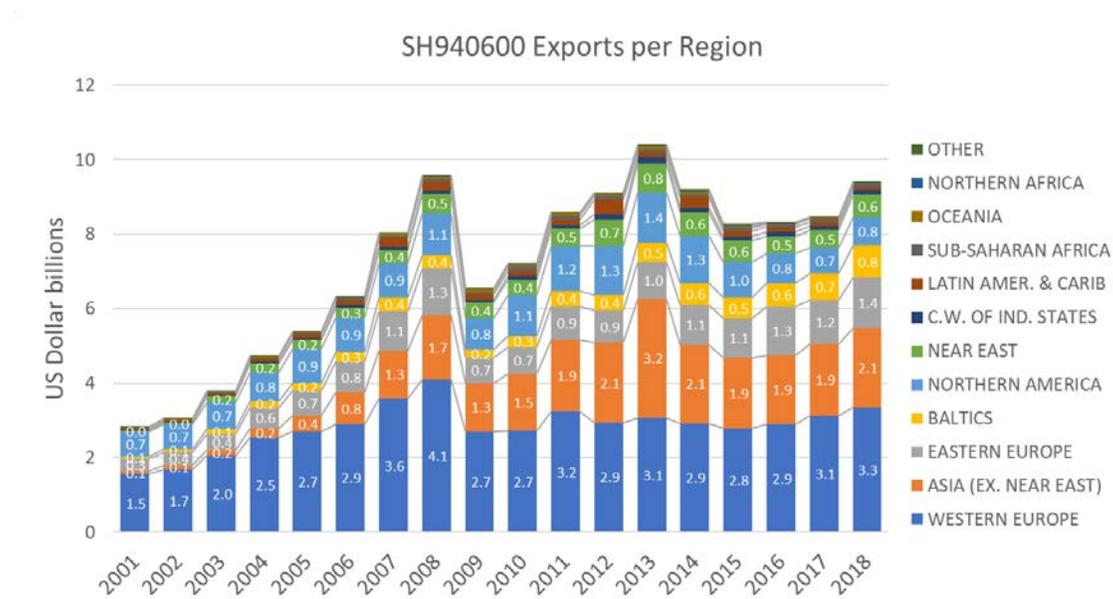


Figure 1: HS940600 Exports per Region in US Dollar billion. Source: ITC Trade Map.

<sup>2</sup> Prefabricated buildings, whether or not complete or already assembled

<sup>3</sup> Prefabricated buildings of wood, whether or not complete or already assembled

<sup>4</sup> Prefabricated buildings, whether or not complete or already assembled (excl. of wood)

<sup>5</sup> Builders' joinery and carpentry, of wood, incl. cellular wood panels (excluding windows, French windows and their frames, doors and their frames and thresholds, posts and beams, assembled flooring panels, wooden shuttering for concrete constructional work, shingles, shakes and prefabricated buildings)

In 2018, 20 countries were responsible for 80% of the exports. The list included China (16.4%), the Netherlands (7.4%), USA (5.7%), Estonia (5.4%), Germany (5.3%), Czech Republic (4.4%), Italy (4.0%), Sweden (3.7%), Poland (3.2%) and Slovenia (2.9%) at the top 10 positions. Canada stayed in the 14<sup>th</sup> position with 2.4% (Figure 2).

SH940600 World Exports Market Share per Country in 2018



Figure 2: HS940600 Exports share percentage per Country in 2018. Source: ITC Trade Map.

In 2001, 80% of the exports came from 15 countries. These countries have changed if compared to 2001's top 10 list, on which figured Canada (12.8%), USA (10.5%), Sweden (6.8%), Belgium (6.1%), Germany (5.8%), France (5.8%), Finland (5.5%), Czech Republic (5.0%) and Spain (4.5%) (Figure 3).

SH940600 World Exports Market Share per Country in 2001

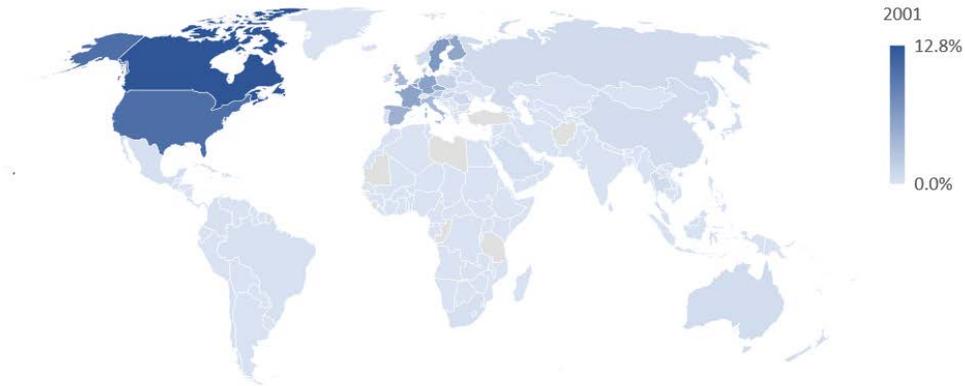


Figure 3: HS940600 Exports share percentage per Country in 2001. Source: ITC Trade Map.

China has shown the largest growth in the last two decades. The country passed from a 0.5% of the global exports to an impressive 16.4%, keeping a steady growing pace from 2001 to 2018. China is followed in performance by the Netherlands, passing from a 4.2% to a 7.4%, and Estonia, that passed from 1.5% to 5.4% in the same period.

Canada and the US presented the greatest losses. Canada, reduced its exports share from 12.8% to only 2.4% since 2001, and the US, decreased its exports share from 10.5% to 5.7% for the same period. Canada not only reduced its exports share in two decades but also its total export volume, passing from 363 USD million to 226 USD million. The US on its side increased its export volume from 297 USD million to 535 USD million.

The list of the top percentual export growth leading countries includes China (0.5% to 16.4%), Estonia (1.5% to 5.4%), the Netherlands (4.175% to 7.4%), Viet Nam (0.1% to 2.4%) and Israel (less than 0.1% to 2%). The list of the top percentual export reduction by country are Canada (12.8% to 2.4%), the USA (10.5% to 5.7%), Finland (5.5% to 1.4%), Belgium (6.1% to 2.6%), France (5.8% to 2.5%), Sweden (6.8% to 3.7%), the UK (3.9% to 1.7%), Spain (4.5% from to 2.4%), Luxembourg (2% from to 0.5%) and Denmark (1.9% from to 0.7%).

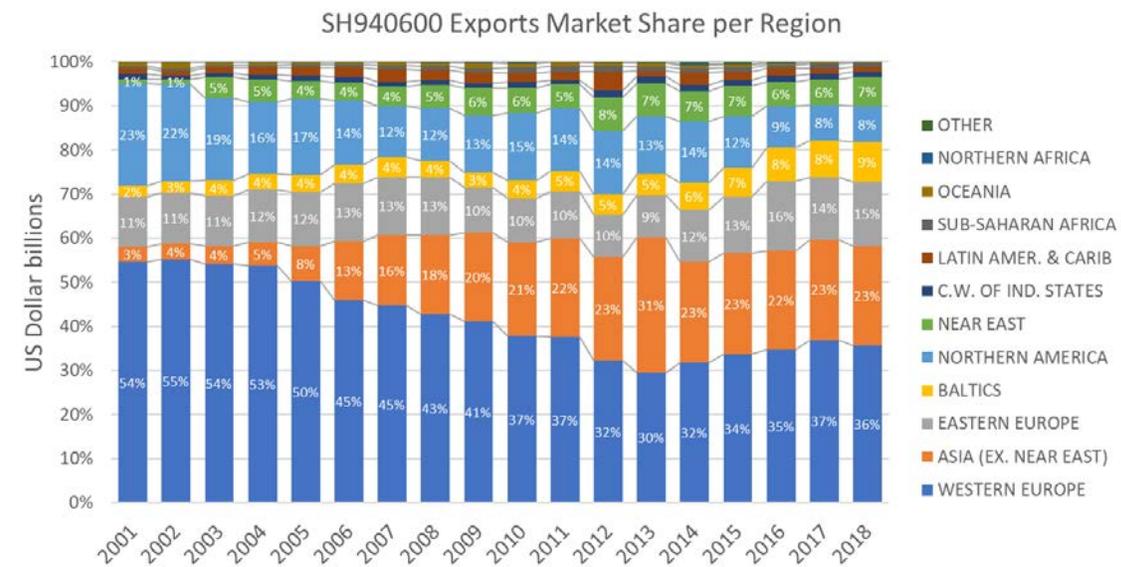


Figure 4: HS940600 Exports shares per Region. Source: ITC Trade Map.

When analyzing the exports share it is interesting to note that Eastern countries, except for the Netherlands, have been growing faster in the last two decades. Western countries, first North American then European, have been decreasing in the same period (Figure 4).

### 3.2 Prefabricated Buildings Imports (HS940600)

In 2018 the global Prefabricated Building Imports rose to 7.8 USD billion (Figure 5). Imports are now 3 times higher than in 2001 and have been growing at yearly average of 7.6% since then. Imports were affected similarly to Exports by the 2008 crisis, especially in 2009 and between 2014 and 2015.

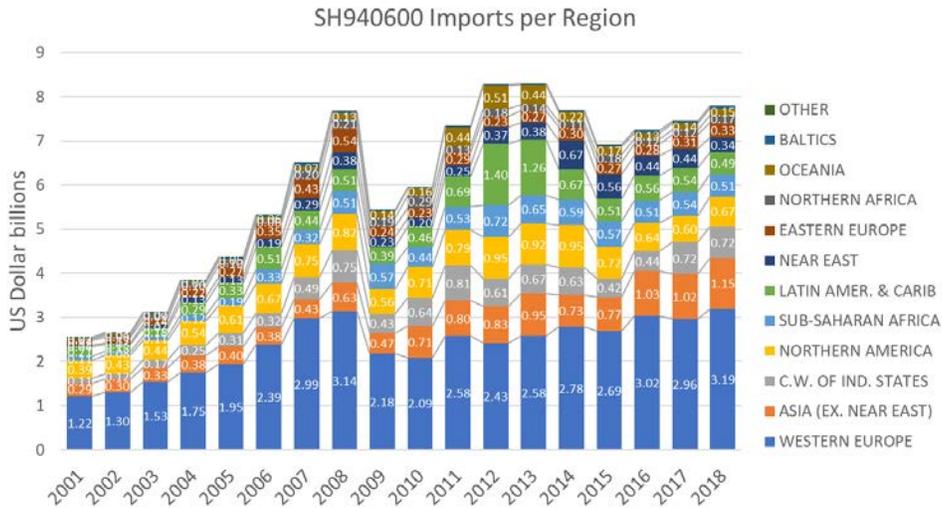


Figure 5: HS940600 Imports per Region. Source: ITC Trade Map.

When comparing global prefabricated buildings imports vs exports, there is evidence that a growing overstock (exports minus imports) may affect next-years market performance. During the last two market recessions (2008 and 2013) the ratio  $\frac{Exports - Imports}{Exports}$  overpassed 16% in both years (16.6% and 17.8% respectively). This behavior may be explained in part by the bullwhip effect caused by supply and demand differences, the lack of effective alliances between the component suppliers and the lack of prefabricated component standards, as warned by the Chinese government (Du et al., 2017).



Figure 6: HS940600 Global Imports, Exports and (Exports – Imports) over Exports. Source: ITC Trade Map.

In 2001, 49% of imports were concentrated in only 6 countries: Germany (14.4%), USA (11.9%), Japan (8.1%), France (6.6%), Mexico (4.3%) and Switzerland (3.9%). 25 countries concentrated more than 80% of the imports.

### SH940600 World Imports Market Share per Country in 2001



Figure 7: HS940600 Import shares per Country in 2001. Source: ITC Trade Map.

By 2018 imports grew and spread across the world. 50.8% of imports were held by 13 countries and 80.1% of imports were concentrated in 45 countries. Germany keeps playing the role of biggest importer and, despite of reducing their import share to 8.4%, the imports they made increased by 74% since 2001. From the top 80.1% importers, only Japan (-60% meaning -125.873 USD million) and Spain (-4% meaning -1.968 USD million) have a reduced their imports between 2002 and 2018.

### SH940600 World Imports Market Share per Country in 2018

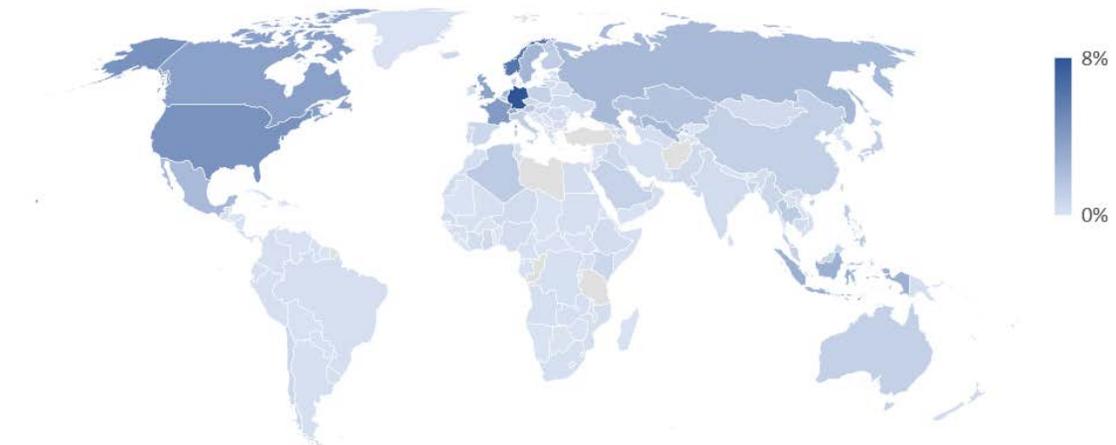


Figure 8: HS940600 Import shares per Country in 2018. Source: ITC Trade Map.

When reviewing the market share, it is interesting to note that imports worked differently between 2008 and 2012 for the developed and developing countries. Recession brought steady growing imports in developing countries while developed countries reduces their import pace.

Since 2012, the market dynamics have been different though. Only the Asian and Western Europe regions recovered while the rest of the regions kept shrinking their market share to these regions.

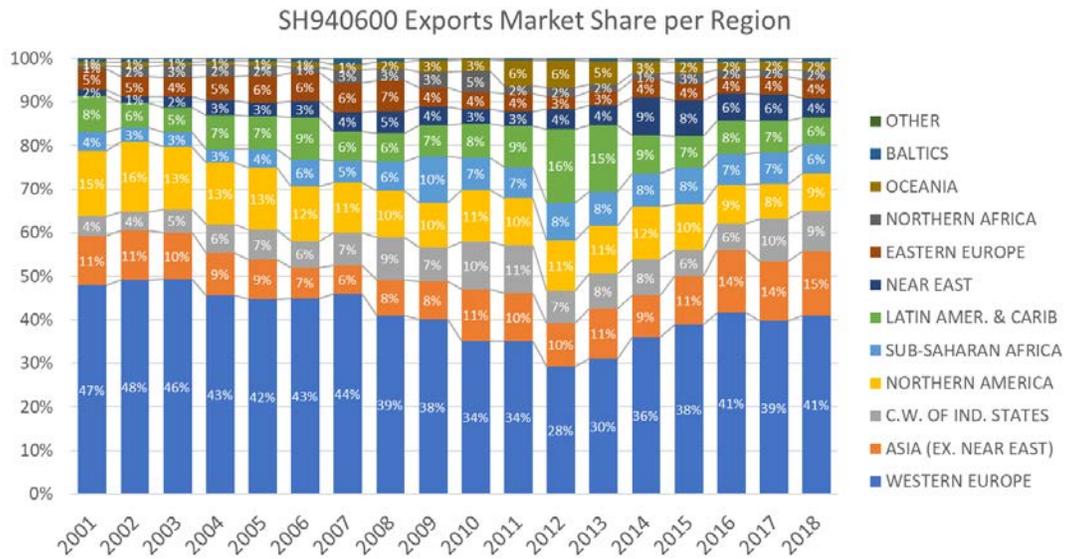


Figure 9: HS940600 Imports Market Share per Region. Source: ITC Trade Map.

### 3.3 Prefabricated Wood Buildings Exports (HS940610)

In 2018 the market size rose to 1.9 USD billion (+10% than 2017). Half of global exports (50,6%) were done by only five countries and 41.3% were done by only three countries. Both three and five-firm concentration ratios lie between 40% and 70%, indicating a medium concentration level in exports, looking like an oligopoly. The market has an Herfindahl-Hirschman index (HHI) of 916, indicating that it is an unconcentrated market (HHI below 1,500). In 2017, the three-firm ratio was 37.8%, the five-firm concentration ratio was 47.4% and the HHI was 791. All the three variables increased in one year, but it is too early to talk about a growing concentration trend in the market.

Table 1: HS940610 Exports, Market Share and HHI by Country. Source: ITC Trade Map.

Exporter	2017 Exports (MUSD)	2017 Exports Share	2017 HHI	2018 Exports (GUSD)	2018 Exports Share	2017 HHI
Estonia	362,750	21.1%	445	465,756	24.6%	605
Lithuania	162,400	9.4%	89	176,031	9.3%	86
Germany	125,713	7.3%	53	140,566	7.4%	55
Sweden	80,901	4.7%	22	88,731	4.7%	22
Belgium	83,279	4.8%	23	86,732	4.6%	21
Poland	79,948	4.6%	22	86,551	4.6%	21
Austria	59,300	3.4%	12	80,482	4.3%	18
Czech Republic	74,676	4.3%	19	72,521	3.8%	15
Latvia	78,012	4.5%	21	72,115	3.8%	15
Finland	76,873	4.5%	20	70,334	3.7%	14
Canada	56,272	3.3%	11	59,746	3.2%	10
Netherlands	58,953	3.4%	12	53,458	2.8%	8
United States of America	38,430	2.2%	5	37,664	2.0%	4
Slovenia	33,062	1.9%	4	32,817	1.7%	3
Russian Federation	23,814	1.4%	2	30,201	1.6%	3
China	77,841	4.5%	20	29,728	1.6%	2
Romania	23,739	1.4%	2	27,573	1.5%	2
Italy	28,482	1.7%	3	26,513	1.4%	2
Denmark	20,955	1.2%	1	23,251	1.2%	2
Kuwait	741	0.0%	0	21,867	1.2%	1

World exports can be segmented in four groups of countries. The top three groups cover an amazing 96.5% of total exports for this code. Group 1, or the leading countries exporting more than 5% of the exports share, includes Estonia (466 USD million, 24.6% of exports share), Lithuania (176 USD million, 9.3%) and Germany (141 USD million, 7.4%). Group 2, for established exporting countries, covering less than 5% but more than 2% of exports share. These countries are Sweden (89 USD million, 4.7%), Belgium and Poland (87 USD million, 4.6% of exports share), Austria (80 USD million, 4.3%), Czech Republic (73 USD million, 3.8%), Latvia (72 USD million, 3.8%), Finland (70 USD million, 3.7%), Canada (60 USD million, 3.2%), the Netherlands (53 USD million, 2.8%) and the US (38 USD million, 2%). Group 3 (between 2 and 0.1%) and group 4 (less than 0.1%) covered together 21.2% of the total exports done in 2018.

## 2017 vs 2018 Exports per Country in USD millions

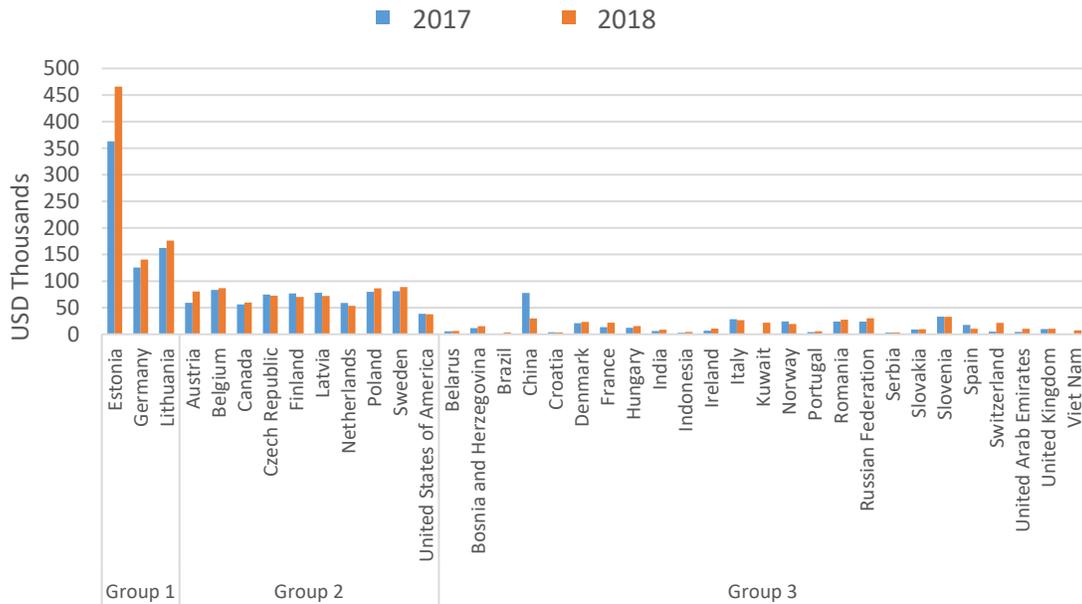


Figure 10: 2017 vs 2018 HS940610 Exports per Country in MUSD. Source: ITC Trade Map.

Regarding regional statistics, for 2017 the Three-Firm Ratio was 85.6%, The Five-Firm was 97.2% and the HHI was 2800. This means that the market was highly concentrated in the top three (or two) regions and ranges as an oligopoly (duopoly in this case as the top 2 regions cover more than 70%). In 2018 these numbers increased in favor to the top two regions: Three-Firm Ratio was 87.3%, Five-Firm Ratio was 95.7% and HHI was 2927. However, exports grew for almost every region between 2017 and 2018, the market share moved towards the Top 2 exporter regions.

Table 2: HS940610 Exports, Market Share and HHI by Region. Source: ITC Trade Map.

Region	2017 Exports (USD million)	Market Share	HHI	2018 Exports (USD million)	Market Share	HHI
Baltics	603.2	35.1%	1229	713.9	37.7%	1423
Western Europe	616.8	35.8%	1285	672.0	35.5%	1260
Eastern Europe	252.0	14.6%	215	267.5	14.1%	200
Northern America	94.7	5.5%	30	97.4	5.1%	26
Asia (Ex. Near East)	106.1	6.2%	38	61.1	3.2%	10
C.W. Of Ind. States	29.8	1.7%	3	36.9	1.9%	4
Near East	8.4	0.5%	0	35.1	1.9%	3
Latin Amer. & Carib	1.2	0.1%	0	4.8	0.3%	0
Sub-Saharan Africa	1.6	0.1%	0	2.4	0.1%	0
Oceania	5.2	0.3%	0	1.4	0.1%	0
Northern Africa	0.1	0.0%	0	0.4	0.0%	0
Other	1.5	0.1%	0	0.0	0.0%	0
<b>Grand Total</b>	<b>1720.5</b>	<b>100%</b>	<b>2800</b>	<b>1892.8</b>	<b>100%</b>	<b>2927</b>

### 3.4 Prefabricated Wood Buildings Imports (HS940610)

In 2018 the market size rose to 1.6 USD Billion (+6.5% than 2017). Comparing Imports vs Exports, there was a surplus of exports valued in 251 USD million (15.2% of total exports) in 2017, a difference that grew in 2018 meaning 331 USD million (17.5% of total exports). This rate is following the same pattern as H940600 (17.1%) (Table 3). Even though there is no proof that this index could predict any potential recession in the future, the *Conseil de l'industrie forestière du Québec* expects a recession soon, at least in the US. The US Consumer Confidence Index, the Construction ABC's Confidence Index and the US Treasury Bonds Index are following similar trends as before the last five American recessions (Vincent, 2019).

Table 3: HS940610 Global Imports, Exports and Export minus Imports. Source: ITC Trade Map.

Region	Imports (kUSD)		Exports (kUSD)		Exports – Imports (kUSD)	
	2017	2018	2017	2018	2017	2018
World	1,458,558	1,561,740	1,720,482	1,892,796	261,924	331,056

Regions have a different behavior and impact in the global trade activity. Baltics and Eastern Europe are dedicated to export activities. These regions have overpassed Western Europe as the biggest exporter in 2018 (37.7% Market Share). Northern America has a mixed activity between importing and exporting, although imports overcome exports of 37% in 2018. Western Europe is by far the biggest importer (77.6% Market Share in 2018) and a key exporter in the market (35.5% Market Share in 2018). Market concentration is high in the regional imports market. Western Europe cover more than 70% of Market Share, which can be considered as a monopsony, where one single buyer controls the buying-side of the market. HHI is over 2,500 for Europe alone, indicating a high concentration in the market (Table 4).

Table 4: HS940610 Imports, Market Share and HHI by Region. Source: ITC Trade Map.

Region	2017 Imports (kUSD)	2017 Market Share	2017 HHI	2018 Imports (kUSD)	2018 Market Share	2018 HHI
Western Europe	1,114,824	76.4%	5,842	1,211,188	77.6%	6,015
Northern America	131,519	9.0%	81	133,627	8.6%	73
Asia (Ex. Near East)	70,168	4.8%	23	74,084	4.7%	23
Near East	26,018	1.8%	3	15,782	1.0%	1
Eastern Europe	25,469	1.7%	3	31,127	2.0%	4
C.W. of Ind. States	23,468	1.6%	3	29,728	1.9%	4
Northern Africa	17,487	1.2%	1	3,346	0.2%	0
Latin Amer. & Carib	13,880	1.0%	1	14,476	0.9%	1
Sub-Saharan Africa	13,870	1.0%	1	18,887	1.2%	1
Baltics	11,339	0.8%	1	20,883	1.3%	2
Oceania	10,515	0.7%	1	8,605	0.6%	0
Other	1	0.0%	0	7	0.0%	0

Exports concentration was also measured for countries. Three-Firm Concentration Ratio was 42.6% in 2017, increasing to 43.1% in 2018. Five-Firm Concentration Ratio was 57.4% in 2017 and decrease to 56.8% in 2018. HHI moved from 921 in 2017 to 908 in 2018. HHI describes the market as unconcentrated, but the Concentration Ratio describes the market as an oligopsony, which is characterized by a small number of large buyers controlling the buying-side of a market (Table 5).

*Table 5: HS940610 Imports, Market Share and HHI by Country. Source: ITC Trade Map.*

Importers	2017 Imports (kUSD)	2017 Market Share	2017 HHI	2018 Imports (kUSD)	2018 Market Share	2018 HHI
Norway	319509	21.9%	479	325524	20.8%	434
Germany	192181	13.2%	173	230582	14.8%	218
United States of America	108607	7.4%	55	116410	7.5%	56
Switzerland	110546	7.6%	57	107908	6.9%	48
France	107222	7.3%	54	106629	6.8%	47
Sweden	101134	6.9%	48	89670	5.7%	33
United Kingdom	56253	3.9%	15	80134	5.1%	26
Netherlands	52265	3.6%	13	60275	3.9%	15
Finland	33777	2.3%	5	58919	3.8%	14
Austria	45764	3.1%	10	34783	2.2%	5
Italy	31679	2.2%	5	30940	2.0%	4
Russian Federation	14893	1.0%	1	22944	1.5%	2
Iceland	10067	0.7%	0	21057	1.3%	2
Japan	17012	1.2%	1	18551	1.2%	1
Denmark	12525	0.9%	1	17534	1.1%	1
Belgium	14716	1.0%	1	14725	0.9%	1
Canada	16976	1.2%	1	13397	0.9%	1

Even though the market itself is not driven by a small number of buying companies, this information is relevant as there is few alternatives available for selling counterparts, so competition is strong when selling in high demand countries. Also, competition for sellers is driven by the local codes and standards of these few dominating buying economies. Other barriers can be faced, such as start-up cost, brand name recognition and after-sales services.

Regional imports concentration seems to be determined by distance and historical relationships in this specific sector. The biggest importers maintain trades firstly with regional neighbors, then they look abroad. The withdrawal of the United Kingdom from the European Union in December 2020 could be a tangible opportunity for Quebec. The United Kingdom represented US 80.1 million in imports in 2018 and is set to overcome a growing building construction gap between new build completions and net additional dwellings (Goulding & Rahimian, 2019).

## 4 Canada Context

### 4.1 Canada Exports analysis

In 2019, Canadian wooden prefabricated buildings exports rose to 94.3 USD million, 36.3% of total prefabricated building exports from Canada in that year (Canadian exports of all materials were 259.8 USD million). In 2018 the ratio was 26.5% (60 USD million in wooden prefabricated buildings exports over 225.8 USD million of total prefabricated buildings). In 2017 the ratio was 27.6% (55.9 USD million in wooden prefabricated buildings exports over 202.8 USD million of total prefabricated buildings) (Figure 11).

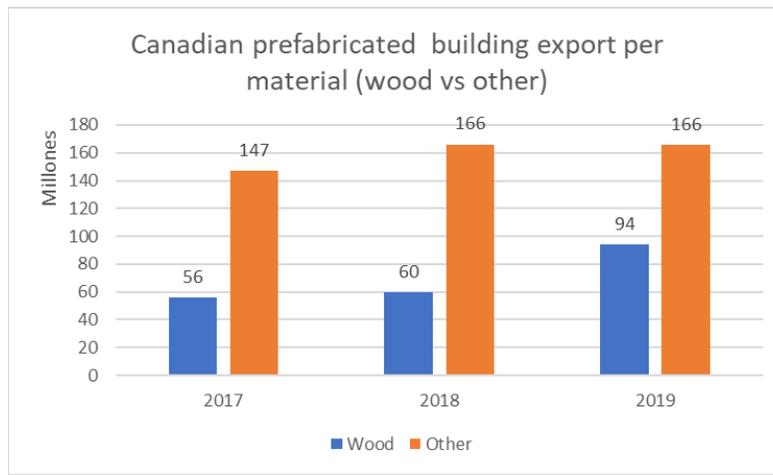


Figure 11: Canadian prefabricated buildings exports by materiality between 2017 and 2019. Source: ITC Trade Map.

The US is by far the most important destination for Canadian wooden prefabricated buildings; 95.3% of wooden prefabricated buildings exported from Canada went to the USA in 2019 (91.9% in 2018 and 87.3% in 2017). Regarding all prefabricated buildings exports from Canada, USA represented 83.5% in 2019, 78% in 2018 and 71.2% in 2017 (Figure 12).

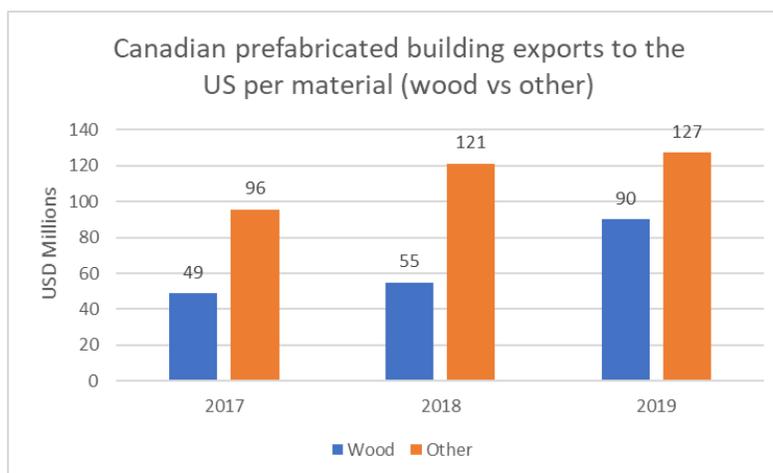


Figure 12: Canadian wooden prefabricated buildings exports by destination between 2017 and 2019. Source: ITC Trade Map.

Despite the US being the largest destination for Canadian exports and Canada being the biggest source of American imports, this situation does not apply on every state. China, Mexico and Vietnam are important providers for California, Texas and Kansas, respectively. In terms of the Northeastern region Germany and the UK have developed projects in the states of New York and Connecticut respectively, representing less than half a million of USD each (Figure 13).

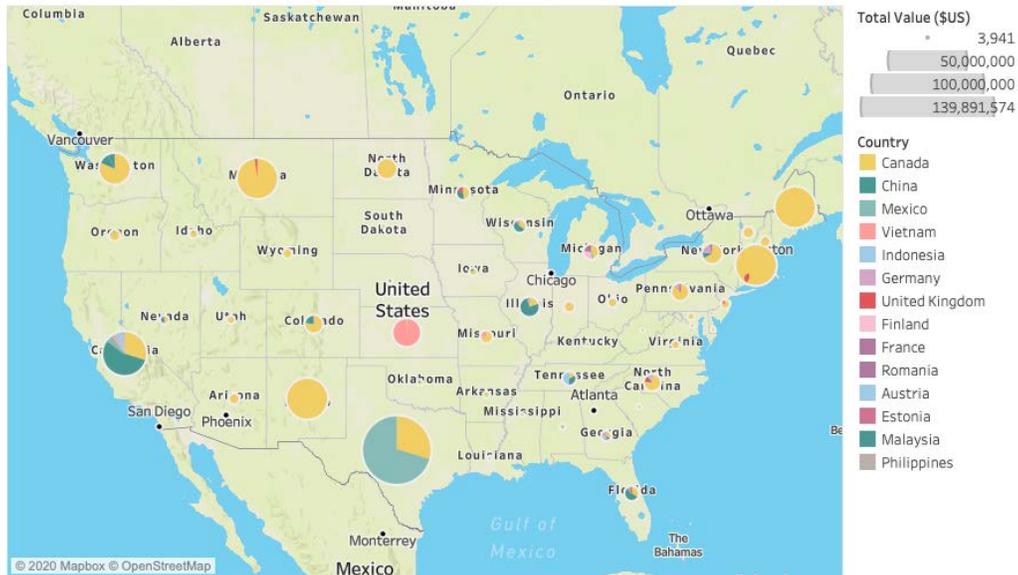


Figure 13: United States imports per exporting Country in 2019. Source: ITC Trade Map.

Other destinations for Canadian wooden prefabricated buildings in 2019 included Japan (USD 1.1 million), Germany (USD 774,501), and Antigua and Barbuda (USD 645,639). Numbers tend to change drastically for countries different than the US, Japan and Germany. This could be explained as punctual projects happening abroad, lacking business continuity (Figure 14).

### Canadian wooden prefabricated building exports by destination country (excluding the US)

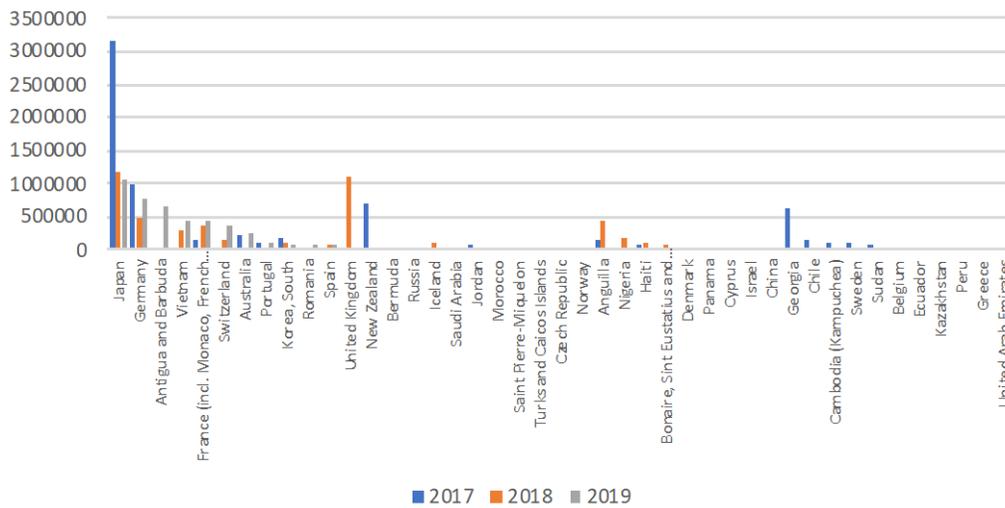


Figure 14: Canadian wooden prefabricated buildings exports by country (excluding the US). Source: ITC Trade Map.

## 4.2 Provincial export analysis

Quebec wooden prefabricated building exports accounted for 31.9% of Canadian exports in 2017, 31.2% in 2018 and 18.6% in 2019. Whilst Quebec kept similar values in the last three years, other provinces followed different trade patterns. Alberta accounted for 3.4% of Canadian exports in 2017, 6.3% in 2018 and 37.6% in 2019. Surrounding provinces as Ontario and New Brunswick have increased their global exports in the past three years as well (Figure 15).

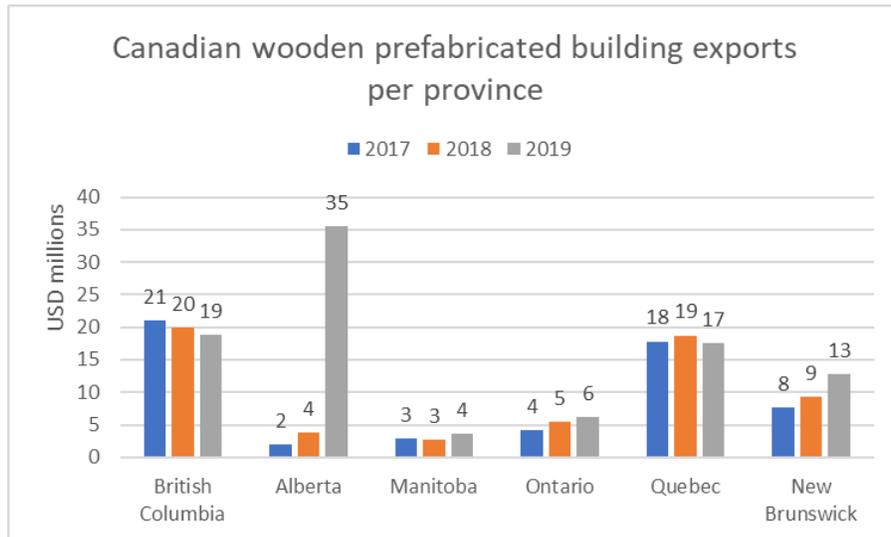


Figure 15: Canadian wooden prefabricated buildings exports by province. Source: Statistics Canada.

Even though surrounding Provinces have increased their numbers in the last three years, their destination markets were not the same as Quebec. Ontario's principal destinations in 2019 were New York (USD 1.1 million) and California (USD 1.1 million), Quebec's destinations were Massachusetts (USD 11.7 million) and North Carolina (USD 1.0 million) and New Brunswick's destinations were Maine (USD 12 million) and Colorado (USD 0.4 million). Alberta's destinations were New Mexico (USD 12.2 million), Montana (USD 11.0 million), Texas (USD 9.7 million) and California (USD 1.2 million) (Figure 16).

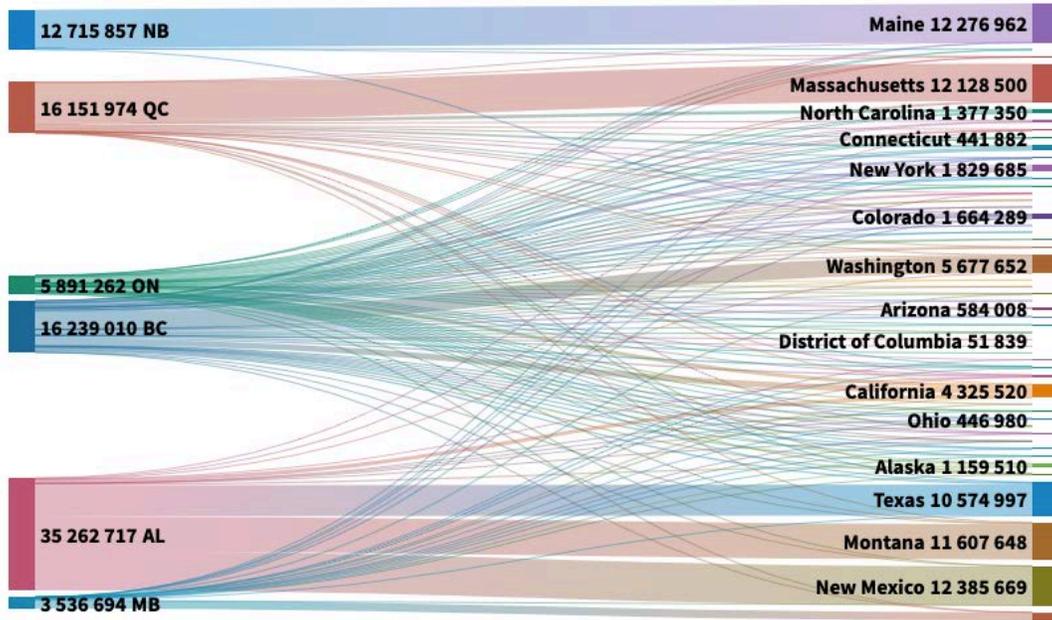


Figure 16: Canadian provinces exports to the US States, excluding provinces/territories with low volumes. Source: Statistics Canada.

### 4.3 Quebec’s export analysis

Quebec wooden prefabricated buildings exports reached 17.5 USD million in 2019, 18.7 USD million in 2018 and 17.8 USD million. The biggest destination for Quebec is are the US, with 16.2 USD million in 2019 (92.34% of total exports), 17.4 USD million in 2018 (92.90%) and 17 USD million in 2017 (95.38%) (Figure 17). Other destinations fluctuate from year to year. In 2019, the export activity was concentrated in only seven countries, 10 countries in 2018 and 11 countries in 2017.

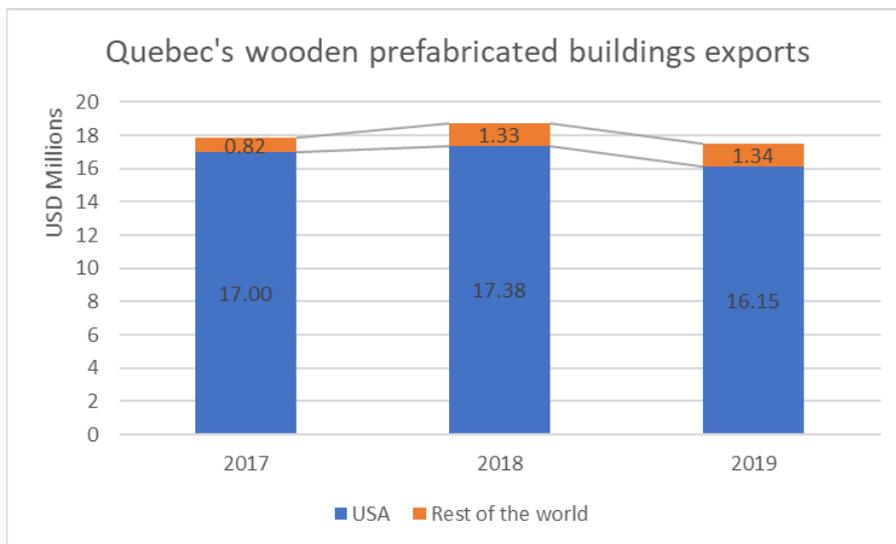


Figure 17: Quebec's wooden prefabricated buildings exports. Source: Statistics Canada.

Quebec exports to the US are basically done towards Massachusetts, totalling 11.7 USD million in 2019 (11.0 and 13.8 USD million in 2018 and 2017). Massachusetts represented 72.61% of total exports from Quebec to the world in 2019, 63.17% in 2018 and 81.17% in 2017 (Figure 18).

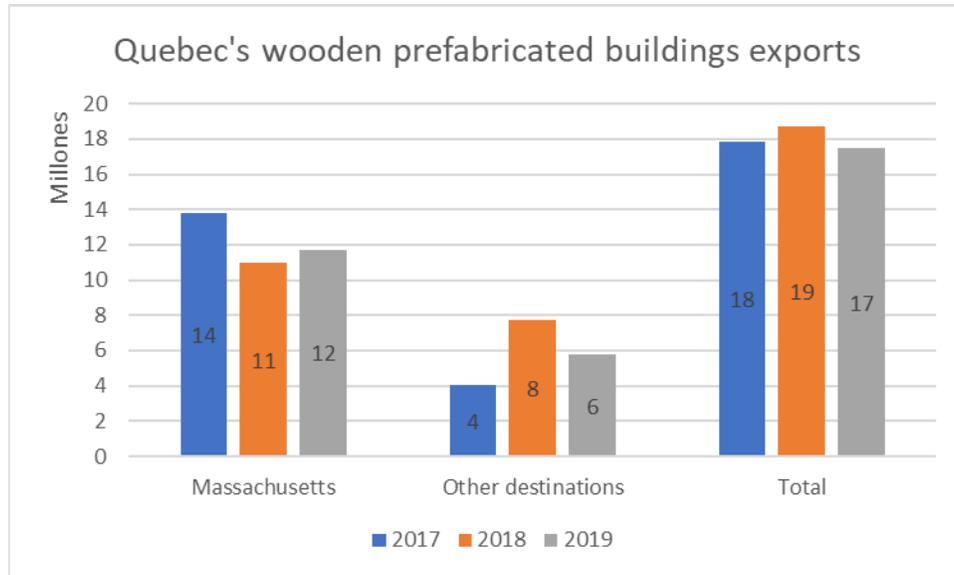


Figure 18: Quebec's wooden prefabricated buildings exports. Source: Statistics Canada.

Other important export destinations in 2019 included the US North-East region (2.4 USD million excluding Massachusetts) and North Carolina (1.0 USD million) (Figure 19). In 2018 and 2017 the export activity was also concentrated in the North-Eastern region (4.1 and 2.4 USD million respectively). North Carolina exports started to be important in 2018 (1.4 USD million) (Figure 19).

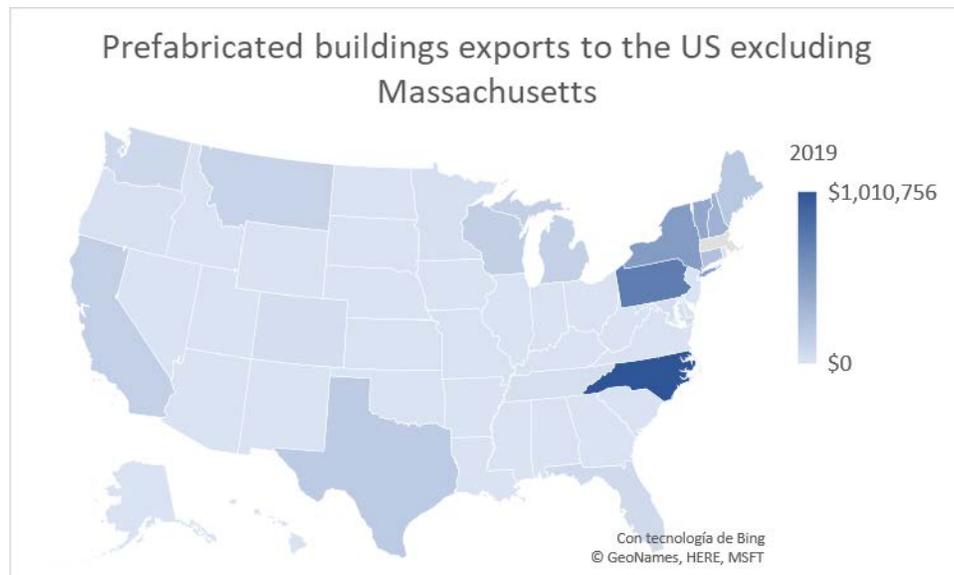


Figure 19: Prefabricated buildings exports to the US (excluding Massachusetts). Source: Statistics Canada.

Quebec exports to other countries than the US are occasional businesses and few of them keep a constant pace (Figure 20). However, the total exports to these destinations have been growing, passing from 823 USD thousands in 2017 to 1.33 USD million in 2018 and 1.34 USD million in 2019. Even though Quebecers do have a regional focus in the US Northeast, their building solutions can be cost competitive in different kinds of markets across the globe.

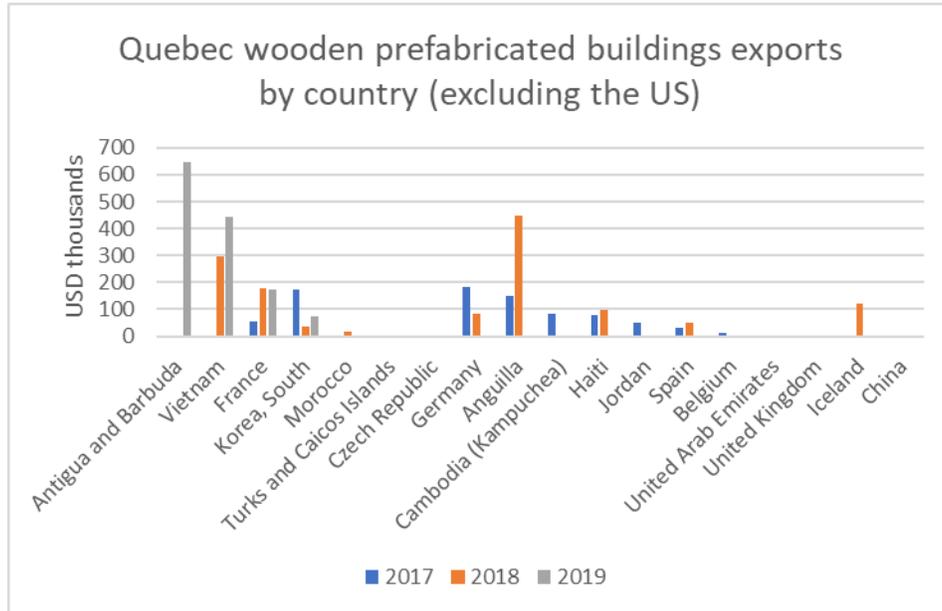


Figure 20: Quebec wooden prefabricated buildings exports by country (excluding the US). Source: Statistics Canada.

### 4.3.1 Production analysis

Production of wooden prefabricated buildings in Quebec<sup>6</sup> has been following a different growth trend in the last three decades. While in the production in the 90s almost doubled in a decade, the 2000's did not follow the same pattern, fixed at a 0.7% annual growth rate. The 2010's decade characteristic annual growth rate was 3.4%, and 2019 production rose to an historical maximum of CAD 170 million. Production differences throughout the year have been increasing. While production average throughout the year tends to the upper levels reached in that year, the production gap between the most and least productive months can be as high as CAD 2.3 million (Figure 21).

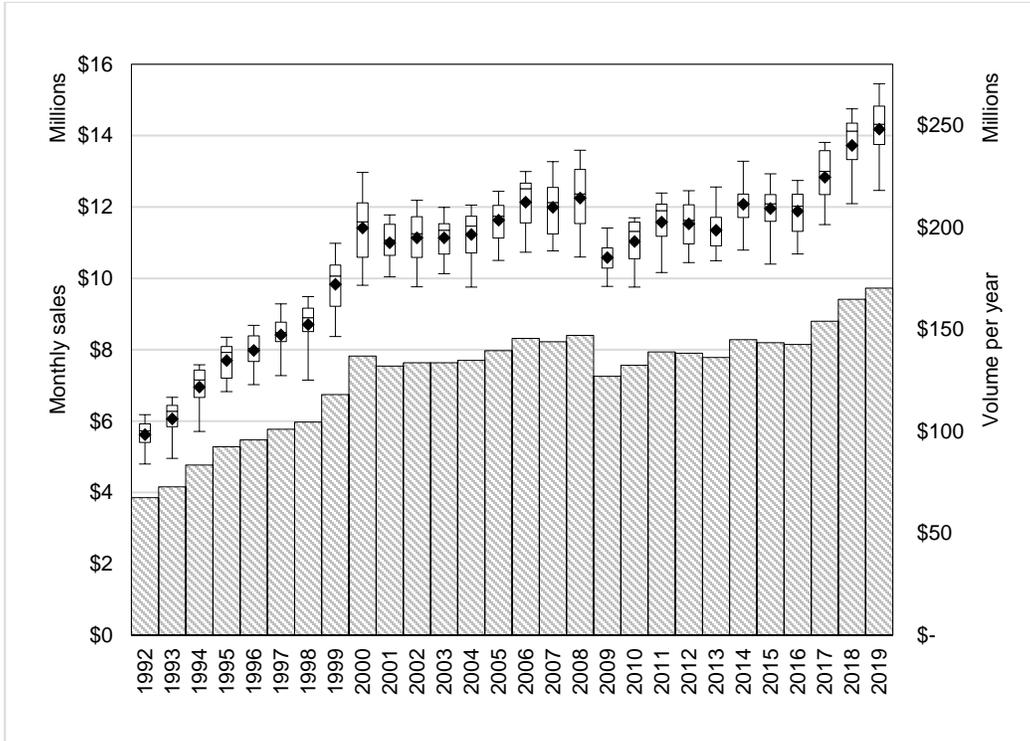


Figure 21: Quebec's wooden prefabricated building monthly sales statistics and total volume per year (1992-2019).  
Source : Statistics Canada.

Production is known to change seasonally in response to climate and personnel availability (Figure 22). Results suggest that climate, personnel availability linked to vacation and holidays must be considered when estimating capacity. Cold weather negatively affects production during the winter and labor scarcity negatively affects production in summertime.

<sup>6</sup> Wooden prefabricated building sales can be found at Statistics Canada under the North American Industry Classification System (NAICS) code 321992 and relate to HS940610.

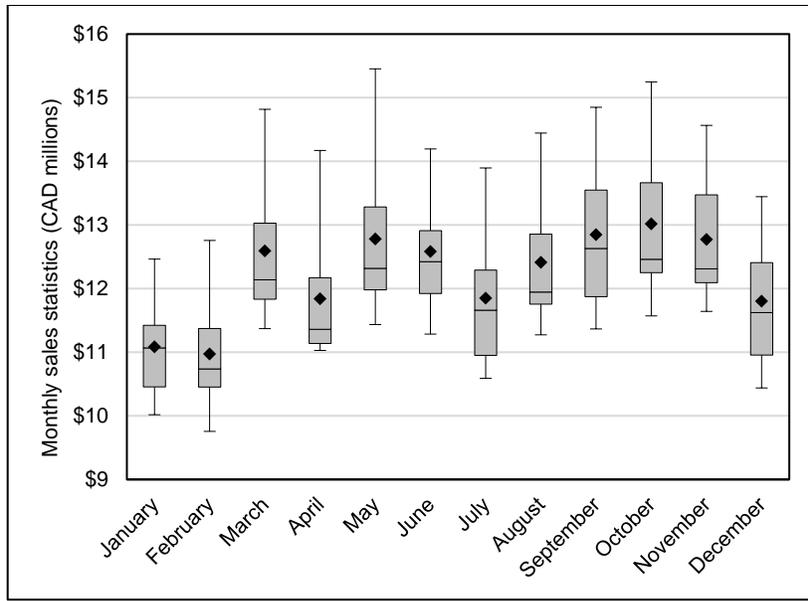


Figure 22: Quebec's wooden prefabricated building monthly sales seasonality (2010-2019). Source: Statistics Canada.

By assuming a flat production at the maximum historical level, it can increase to 8% (15.1 CAD million) yearly (Figure 23).

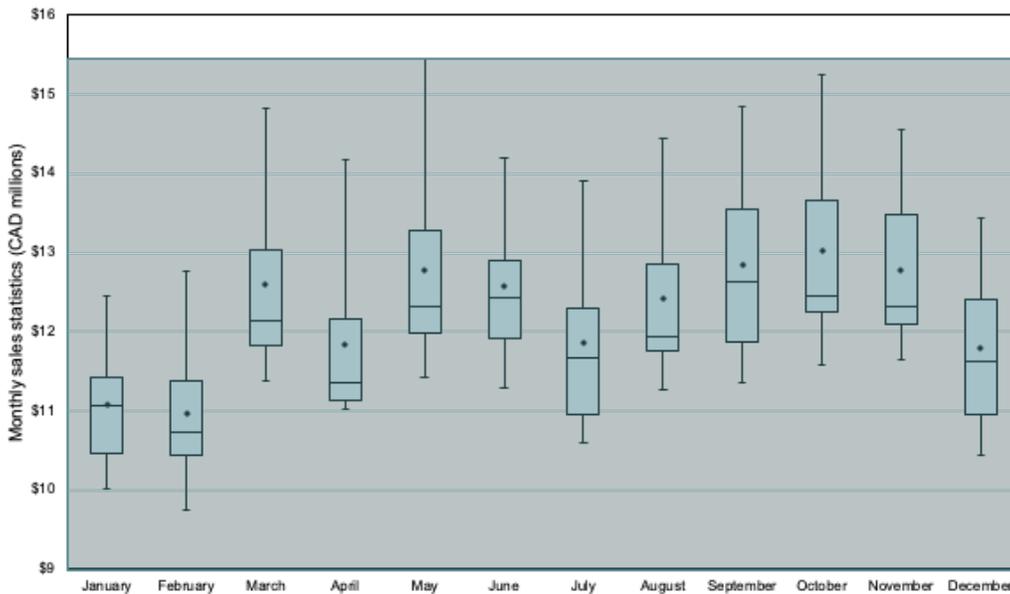


Figure 23: Quebec's wooden prefabricated building monthly sales without considering seasonality. Source: Statistics Canada.

Considering seasonality effects in offer as unavoidable, annual production can increase to 4% (6.3 CAD million). By enhancing the actual production capacity, the building export potential to the Northeastern United States can be 33% to 79% higher than current (Figure 24).

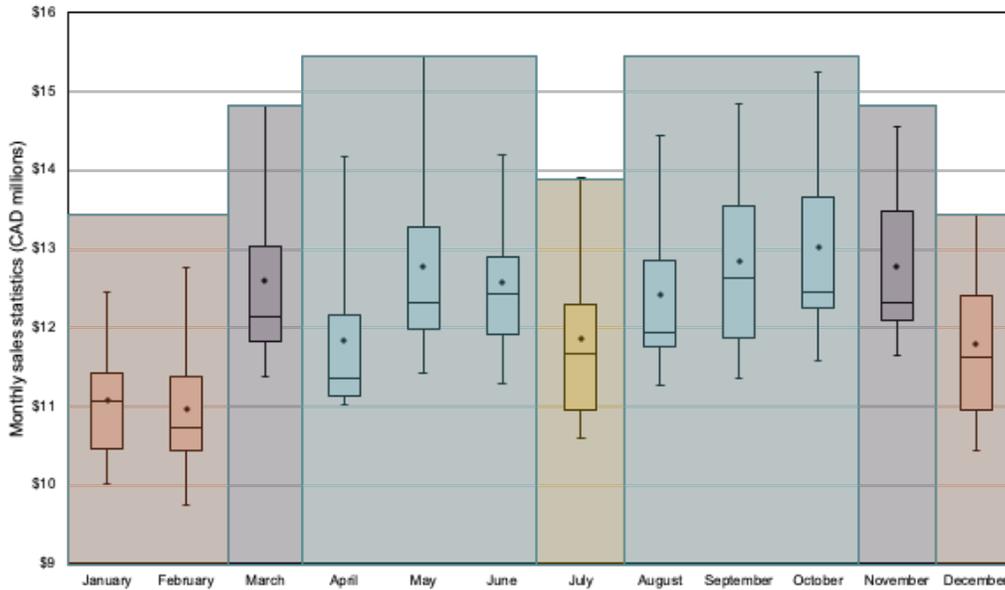


Figure 24: Quebec's wooden prefabricated building monthly sales considering seasonality. Source: Statistics Canada.

## 5 US context

### 5.1 Construction market

The United States construction market is divided in two segments: residential and non-residential construction. Residential construction is decomposed by in four subsegments, considering the number of units a building contains: one, two, three and four, and five units or more. Non-residential construction is divided in subsegments based on the final usage, which are: educational, commercial, power, highway and street, office, manufacturing, transportation, health care, lodging, amusement and recreation, communicational, sewage and waste disposal, water supply, public safety, conservation and development and religious (Figure 25). In this document Educational, Commercial, Office, Healthcare, Lodging, Amusement and recreation will be considered (US Census Bureau, 2018).

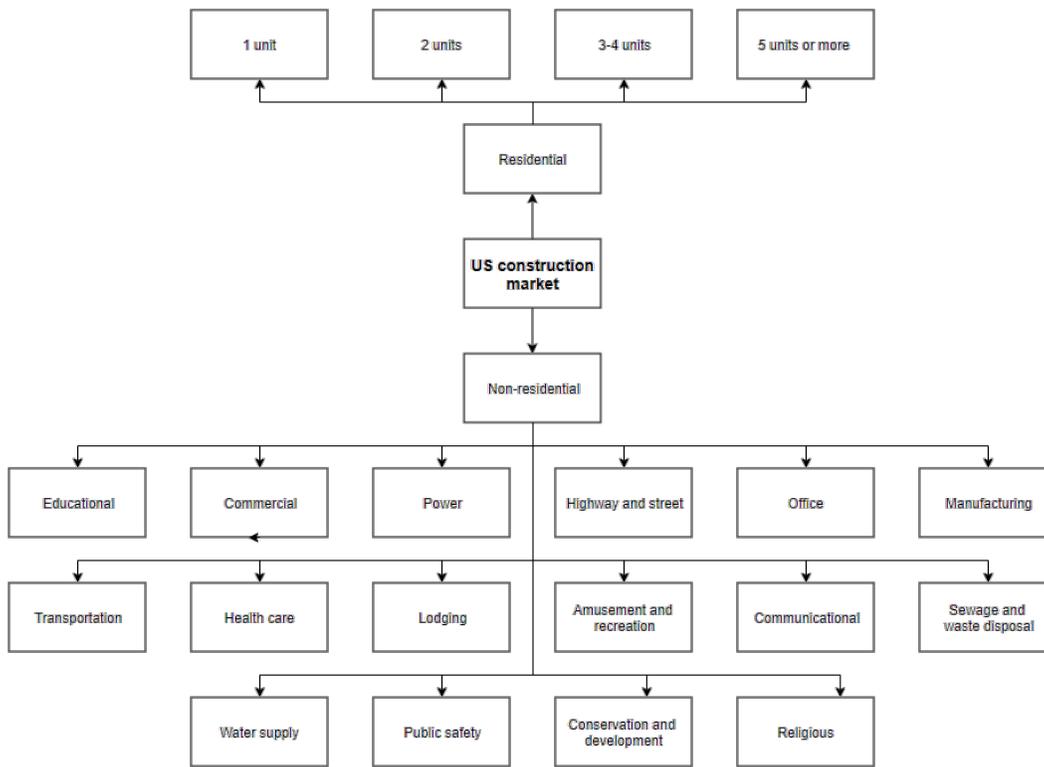


Figure 25: US construction market segments. Source: US Census Bureau.

## 5.2 Demand analysis

### 5.2.1 General outlook

The US construction market is one of the three biggest construction markets in the world, investing more than US\$ 1.3 trillion in 2018. In the last decade, and after the 2008 crisis effects vanished in 2011, the whole market recovered at an impressive 8% average rate per year.

This growth speed was mostly driven by the residential market that steadily grew 12% yearly, in average, since 2011. The non-residential market is also growing consistently since 2012 but at a lower 5% rate per year. Back in 2012, the market share was 32%/68% (residential/non-residential). Today, the market share is 42%/58% and the trend is to keep this momentum (Figure 26).

If the last decade's market movements from the public and private spending is analyzed, it is possible to see a stable public investment and a very volatile private market. Private construction absorbed all the effects the 2008 crisis brought, and is driving the total market changes since 2011, both at an average 10% rate per year.

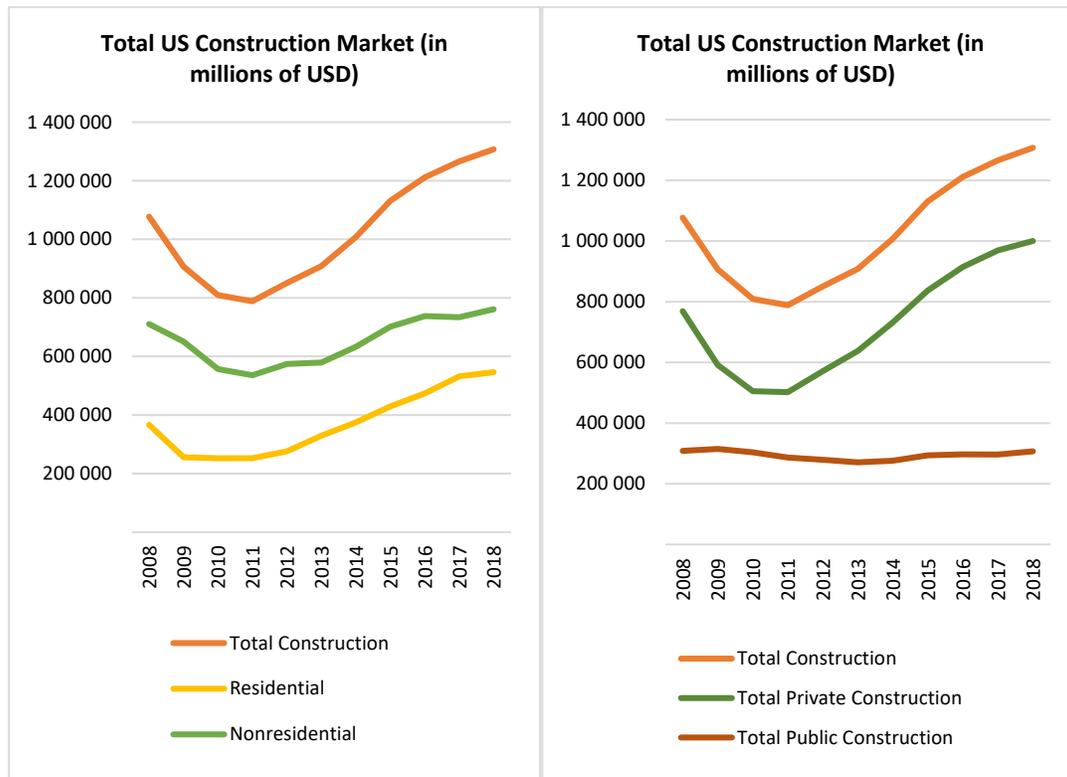


Figure 26: Total US construction market (in million of USD). Source: US Census Bureau.

According to FMI, 2018 was a strong and dynamic year for the North American market. In the US, average spending growth was expected to finish at 5% for the second consecutive year (FMI, 2019). FMI believes that growth will continue to rise in the future, mostly in the North East, South East and South West regions (Figure 27).

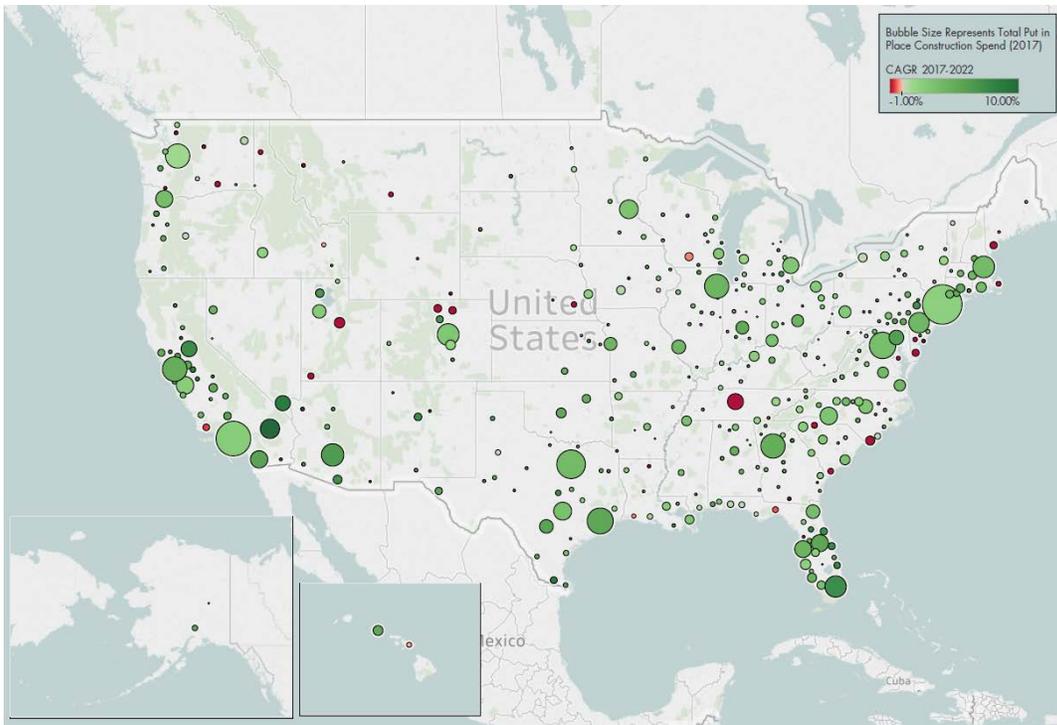


Figure 27: Total Construction Spending Put in Place 2017 and Forecast Growth (2017-2022 CAGR) by Metropolitan Statistical Area. Source: FMI forecast.

### 5.2.2 Residential market

US Residential market is almost completely driven by the private investment. While public residential projects exist, they represented only 2% in the last decade. Public residential investment averaged a yearly investment of 7 USD billion in the last decade, reaching its top in 2010 at 10 USD billion, around 4,25% of the total residential investment in that year. Since then it started to decrease and, in the last 5 years it represented 1.38% yearly, in average (Figure 28).

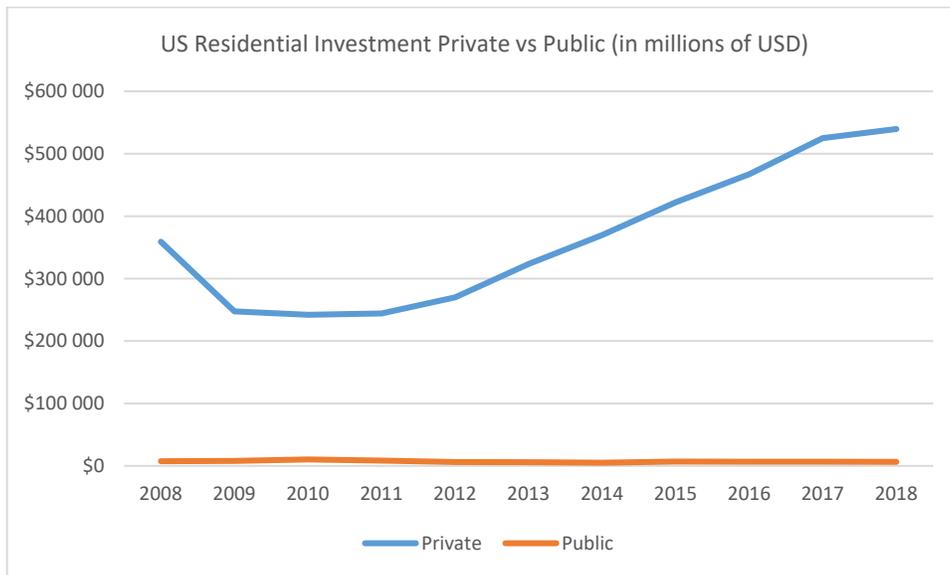
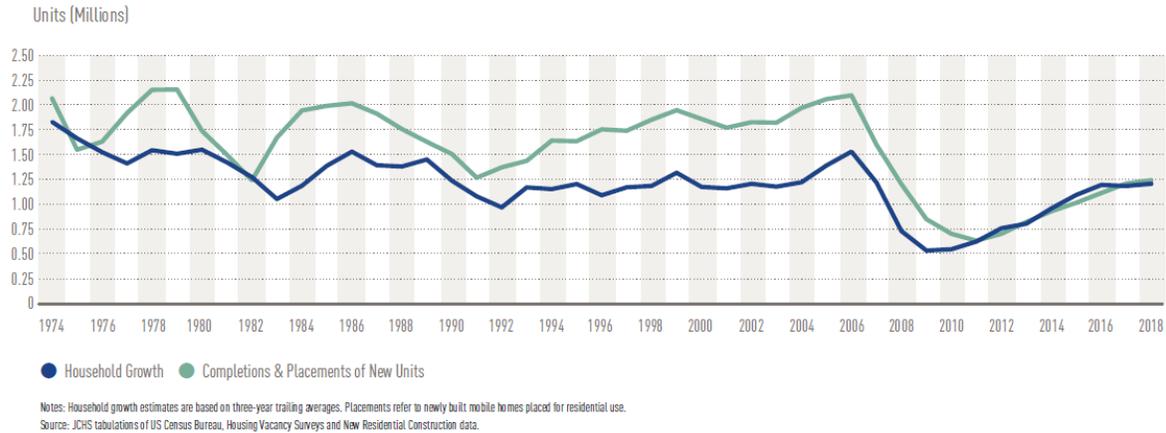


Figure 28: US Residential Investment Private vs Public (in million of USD). Source: US Census Bureau.

For the housing market sector, *Harvard's Joint Center for Housing Studies* stated that in 2019 there is a continue shortfall in supply. Demand grows at a 10% rate since the bottom reached in 2011 and struggles to be covered by the actual production (*Joint Center for Housing Studies of Harvard University, 2019*). To illustrate it, since 2011 household growth has kept the same pace as completions and placements of new units, a figure that has not been seen since 1982 (*Figure 29*).

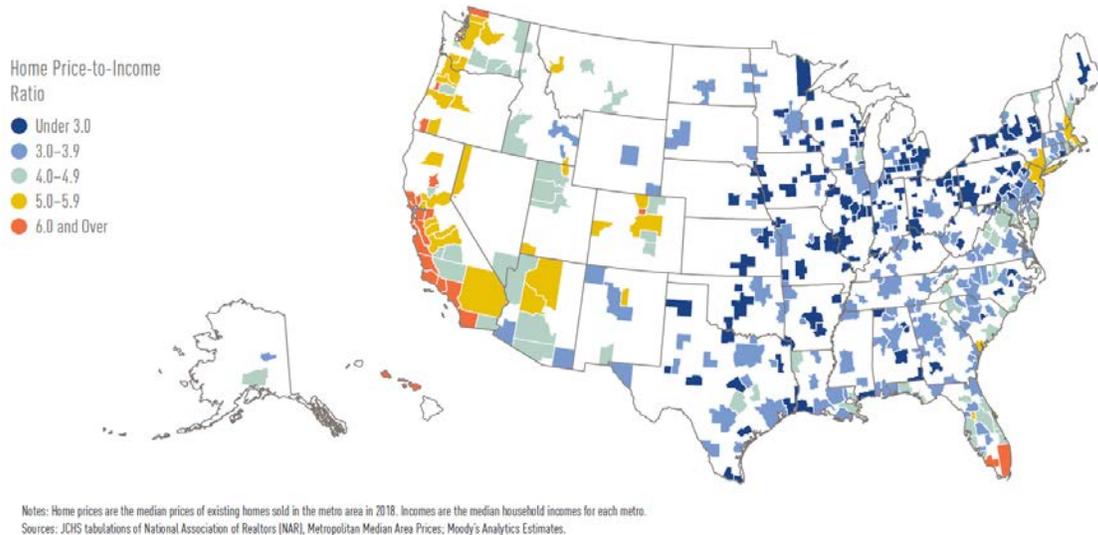
**Housing Construction Has Barely Kept Pace with Household Growth for an Unprecedented Eight Years**



*Figure 29: Household growth and Completions & placements of new units in the US. Source :Joint Center for Housing Studies of Harvard University, 2019.*

The housing shortfall brings higher prices as demand rises. This affects affordability, measured by the home price-to-income ratio, particularly in lower income households in high-income markets (*ibid*). The highest home price-to-income ratios were found in the west coast and part of Florida State, and the lowest ratios were found in the North Eastern States, mostly in rural counties (*Figure 30*).

**Although Homebuying Is Still Affordable in Many Markets, Price-to-Income Ratios Are Back Near Peak Levels**

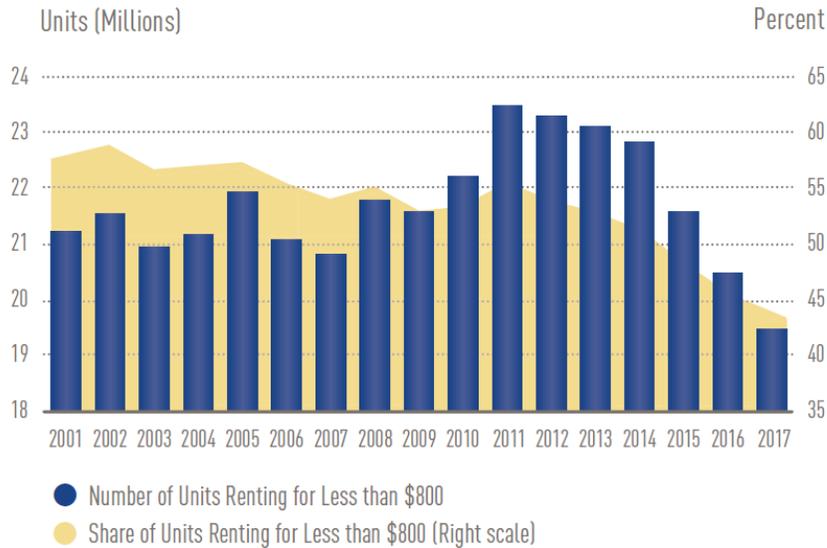


*Figure 30: Home price-to-income ratio (Source: Joint Center for Housing Studies of Harvard University, 2019).*

### 5.2.3 Residential rental market

The rental markets are also growing despite slackening demand. Overall rents grew at a 3.6% pace, twice the pace of overall inflation. Rental demand has been outpacing supply since 2016, leading to overall market rents rise and low-cost unit availability to drop substantially. By now, there is a lack of low-rent stock in general in the US, accentuated in big cities (Figure 31).

#### The Low-Rent Stock Has Shrunk by Four Million Units Since 2011



Note: Contract rents are adjusted to 2017 dollars using the CPI-U for All Items Less Shelter.  
 Source: JCHS tabulations of US Census Bureau, American Community Survey 1-Year Estimates.

Figure 31: Number of units renting for less than \$800 vs Share of units renting for less than \$800. Source: Joint Center for Housing Studies of Harvard University, 2019.

### 5.2.4 Non-residential market

US non-residential market fell after the 2008 crisis but started to grow again in 2010 in mostly every subsegment, totaling US\$ 761,113 million in 2018. While non-residential private investment rose in 2011 to US\$ 257,803 million (37% lower than in 2008), non-residential public investment touched bottom in 2013 to US\$ 264,846 million (12% lower than in 2008). Since then, both segments started to grow steadily in every subsegment (US Census Bureau, 2019).

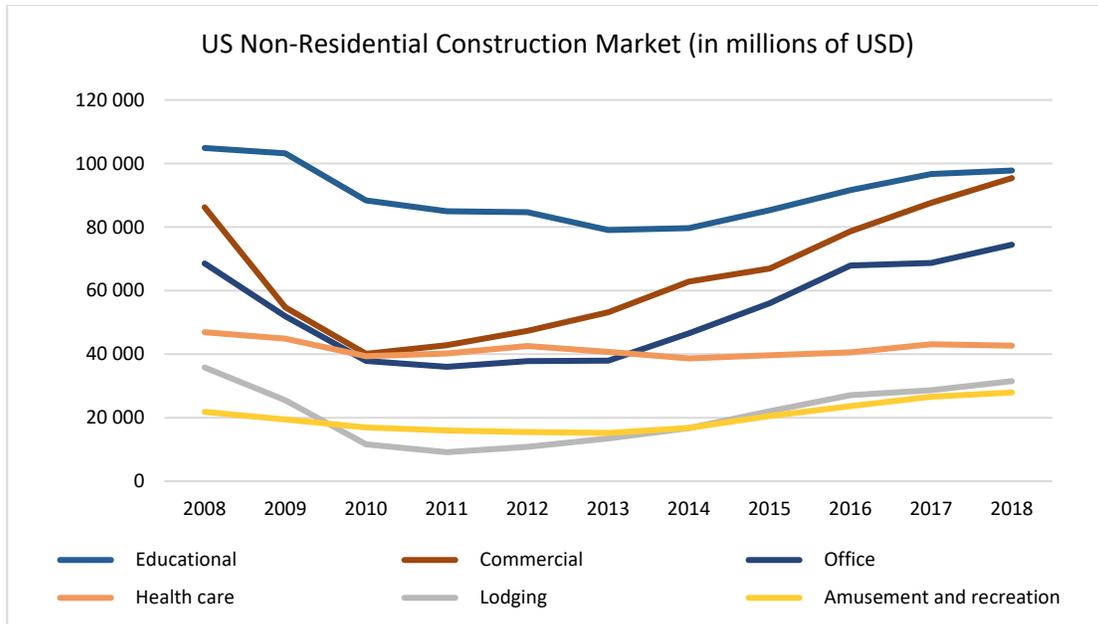


Figure 32: US Non-Residential Construction Market (in million of USD). Source: US Census Bureau.

#### 5.2.4.1 Private non-residential market

Private non-residential market is mainly driven by four subsegments: commercial (20%), power (19%), manufacturing (15%) and office construction (14%). Healthcare and lodging (7% each) complete the 82% of this segment.

Private commercial construction is back at the top since 2008, totaling US\$ 91,799 million by 2018, growing US\$ 6,831 million per year since 2010. Private energy construction has been the most regular market in the last decade, with an average growing rate of 3072 million per year, totaling US\$ 87,708 million by 2018 (US Census Bureau, 2019). Private manufacturing and office construction totaled US\$ 70,330 million and US\$ 64,591 million respectively, but while private manufacturing construction seems to have topped in 2015, private office construction keeps growing US\$ 5,836 million per year since 2010, similar to private commercial construction. Private healthcare and lodging construction are the only markets that have not attained a top since 2008. While private healthcare keeps a flat line since then, private lodging has been growing since 2011.

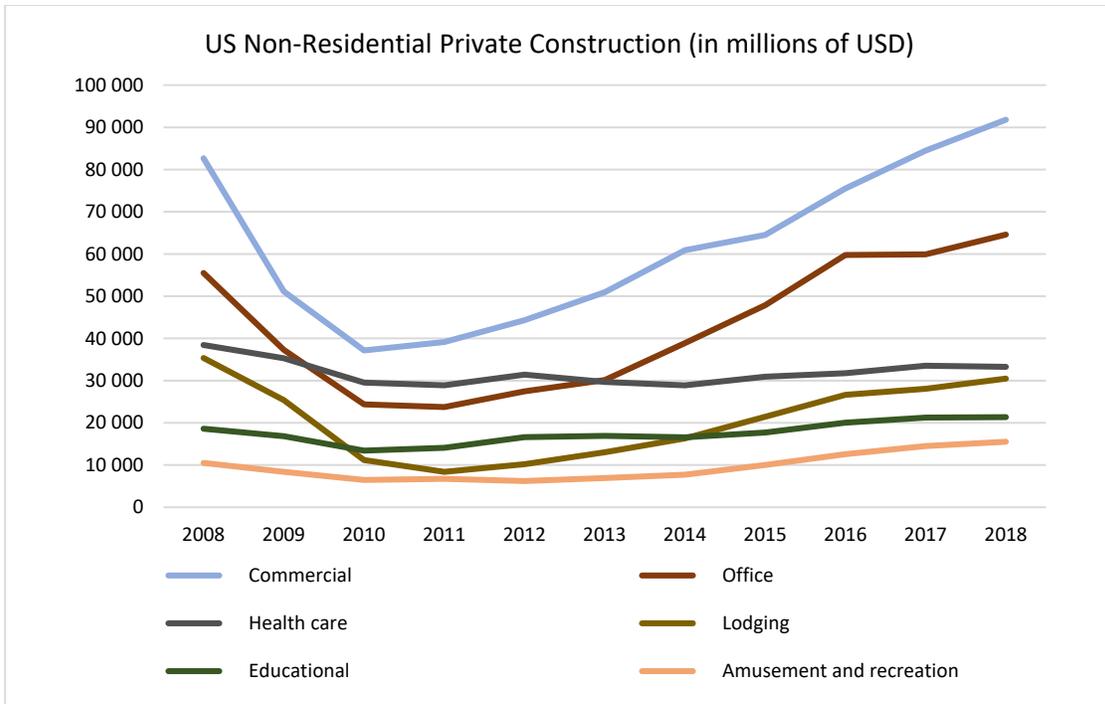


Figure 33: Non-Residential US Private Construction (in million of USD). Source: US Census Bureau.

#### 1.1.1.1.1 Northeast private non-residential market

The US northeastern private non-residential market has been actively rising since 2010. The market is ruled by New York with US\$ 30,373 million (46%), Pennsylvania with US\$ 12,345 million (19%), Massachusetts with US\$ 11,446 million (17%) and New Jersey with US\$ 6,915 million (10%). The four states together totalized 92% of the private non-residential investment in 2018 in the northeast region.

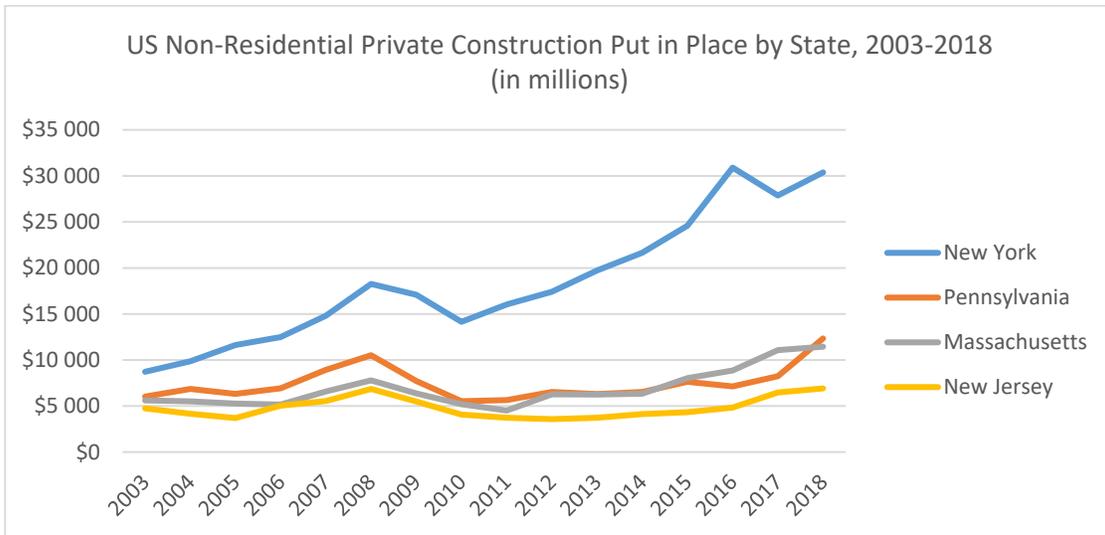


Figure 34: US Non-Residential Private Construction Put in Place by State, 2003-2018 (in million). Source: US Census Bureau.

The rest of the states totalized US\$ 5,297 million in 2018 and keep a regular pace of construction since 2010. Connecticut led with US\$ 2,361 million, Rhode Island follows with US\$ 1,216 then New Hampshire and Maine with US\$ 720 and 559 million respectively, ending with Vermont with investments over US\$ 441 million.

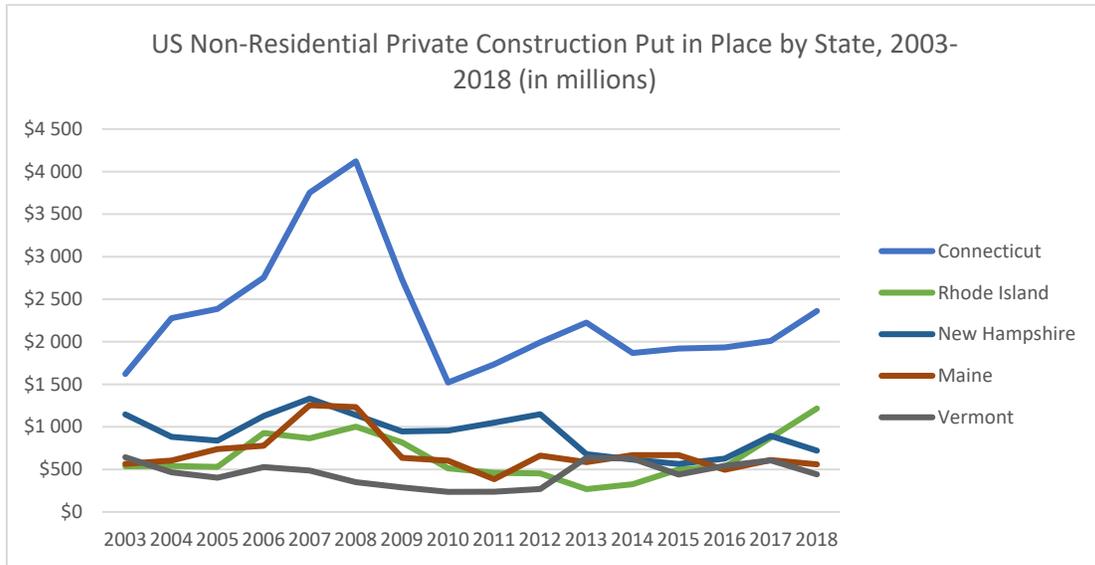


Figure 35: US Non-Residential Private Construction Put in Place by State, 2003-2018 (in million). Source: US Census Bureau.

#### 5.2.4.2 Public non-residential market

More than half the public non-residential market was driven by two subsegments in 2018: Highway and street (30%) and Educational (25%). Transportation (12%), Sewage and waste disposal (8%) and water supply (5%) complete the 80% of this segment (Figure 36).

Public educational construction (US\$ 76,426 million in 2018) is by far the most interesting market for offsite construction. It keeps growing US\$ 2,857 million per year since 2013 and have reached 89% of 2008 top value (US\$ 86,267 million).

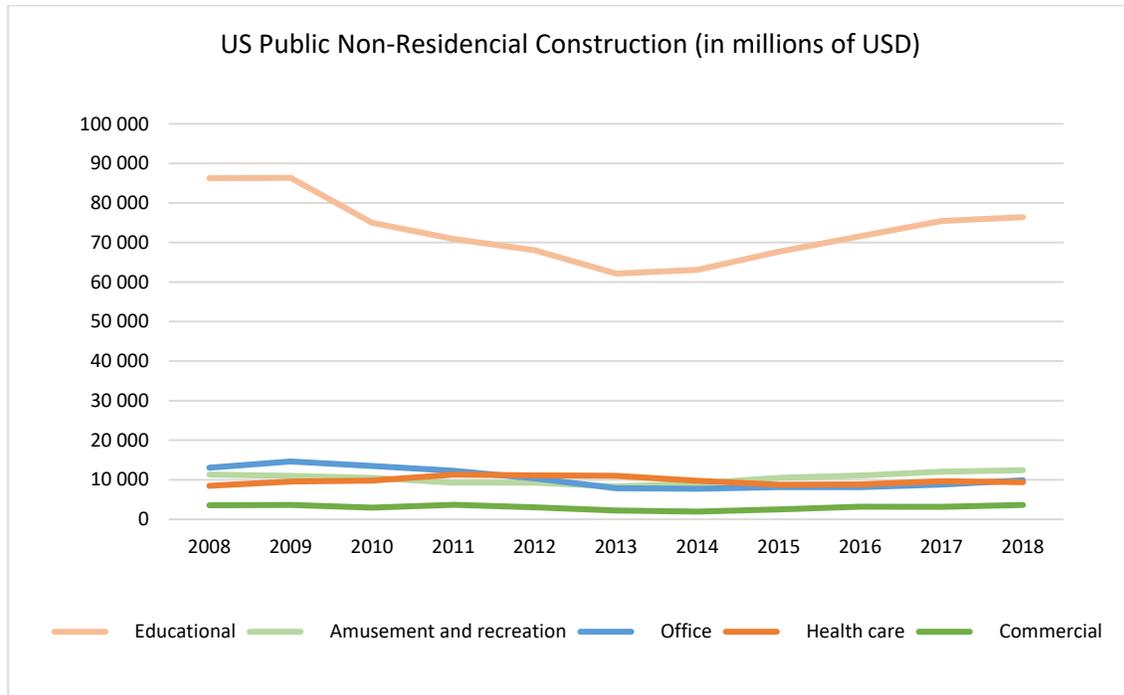


Figure 36: US Public Non-Residential Construction (in million of USD). Source: US Census Bureau.

## 5.3 Demographics

### 5.3.1 Population

US Northeast population is estimated to be 56,111,079 (+38,403 compared to 2017) people in 2018 (US Census Bureau, 2019). The Mid-Atlantic States counted a total of 41,257,789 (-11,920) people, where New York state leads the count with 19,542,209 (-48,510) people, followed by Pennsylvania with 12,807,060 (+16,613) people and New Jersey with 8,908,520 (+19,977) people. The New England states counted a total of 12,853,290 (+) people, like Pennsylvania's population alone. Most of the population in New England is based in Massachusetts with 6,902,149 (+38,903) people, followed by Connecticut with 3,572,665 (-1,215) people, New Hampshire with 1,356,458 (+6,691) people, Maine with 1,338,404 (+3,341) people, Rhode Island with 1,057,315 (+829) people and Vermont with 626,299 (-1,774) people (Table 6).

Table 6: US Northeast population by State. Source: US Census Bureau, 2019.

State	Population	Growth Rate per year
Connecticut	3 572 665	-1 215
Maine	1 338 404	3 341
Massachusetts	6 902 149	38 903
New Hampshire	1 356 458	6 691
New Jersey	8 908 520	19 977
New York	19 542 209	-48 510
Pennsylvania	12 807 060	16 613
Rhode Island	1 057 315	829
Vermont	626 299	1 774
<b>Total</b>	<b>56 111 079</b>	<b>38 403</b>

The *Joint Center for Housing Studies* projects that the next decade household demand will be driven by the generational fluctuations rather than population growth itself. While baby boomers (born 1946-1964) will lead to an astounding 11.1 million age 65 and over household increase, millennials (born 1985-2004) will demand 2.9 million more 35 to 44 year-old households. Generation X (born 1965-1984) will not be able to replace baby boomers' housing stock, leaving 1.9 million 45 to 64 year-old households vacancy (ibid). As a result, we will see a net 12.1 household increase in the US (Figure 37).

**Over the Next Decade, the Millennial and Baby-Boom Generations Will Swell the Populations in Key Age Groups**

US Population (Millions)

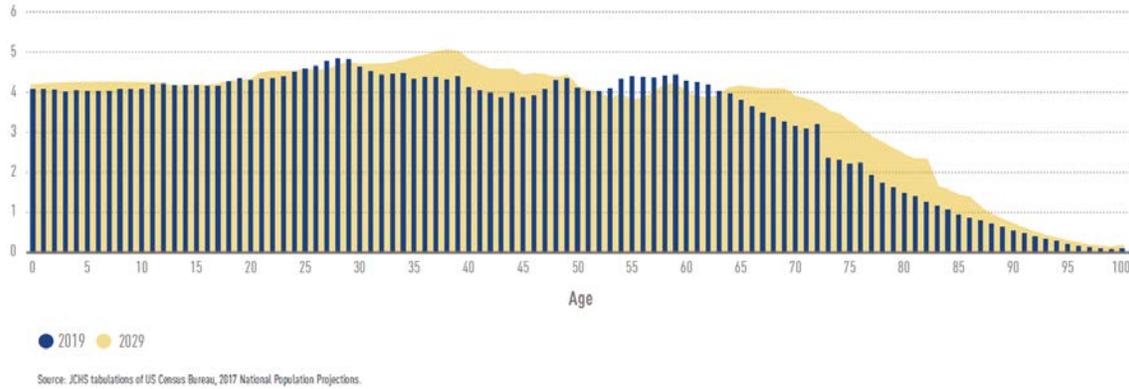


Figure 37: US population 2019 vs 2029 forecast (in million). Source: JDHS, 2019.

Applying the same analysis idea presented by the *Joint Center for Housing Studies* in the Northeastern States, we see a similar behavior in terms of generational fluctuations, with an estimated addition of 3,165,178 households. The baby boomer’s generation will add 3,366,766 households in the region, the millennial generation will add 1,343,256 households. The generation X will follow the national trend by reducing 1,544,845 households. We considered only a projection of the actual population in ten years, applying the average death rate to each age segment (Figure 38).

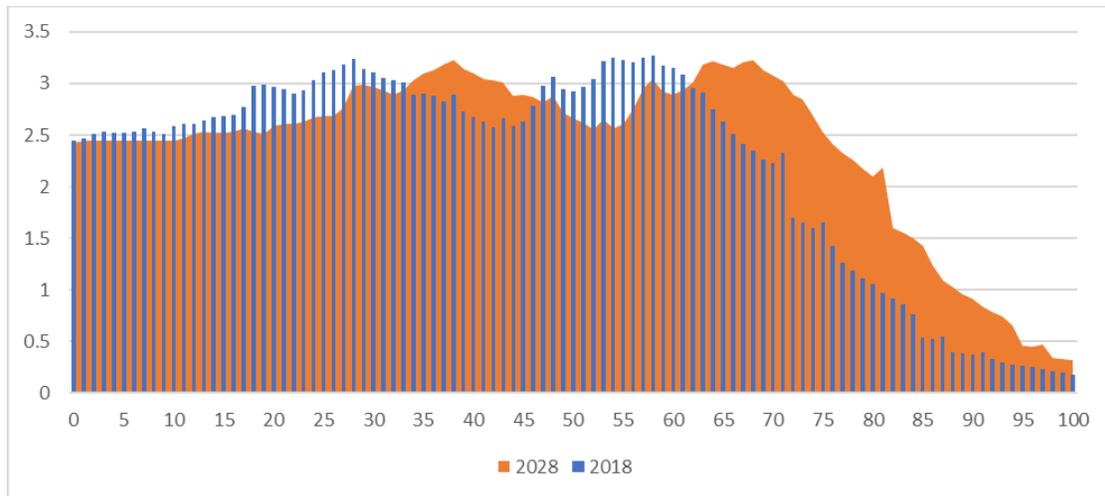


Figure 38: US Northeastern population 2018 vs 2028 forecast (million of people). Source: US Census Bureau, 2019.

## 6 Conclusions and recommendations

The United States construction investment in 2019 was over CAD 1.7 trillion, according to *the US Census Bureau*. The whole market has been growing at an 8% annual rate since 2011. Forecasts show that in the next 5 years demand will continue growing, accentuated in both coasts of the country. However, there is a continued shortfall in supply for the construction market to be overcome in the US. Additionally, home price-to-income ratio is rising in the region and low-rent stock is diminishing, emphasized in big cities.

To mitigate these effects, the US imported CAD 191 million in wooden prefabricated buildings in 2019. The Northeastern region imported a total of CAD 42 million in 2019 and CAD 19 million from Quebec. Northeastern imports are growing at a 5% annual rate since 2017. Canadian Federal and Provincial programs have been recently launched to foster productivity and exports. These facts propose a favorable environment for Quebec trade activity to Northeastern US.

The objective of this study was to estimate the export potential of wooden prefabricated buildings from Quebec to the Northeastern US in the next decade in relation to the actual trade activity and production capacity of the industry.

This study identified the actual export activity by analyzing the international trade of wooden prefabricated building from Quebec to the Northeastern US. Also, it measured the actual production capacity of Quebec by gathering production information from the local industry. Finally, it estimated the export activity potential by maximizing the production while keeping the infrastructure unaltered.

By assuming the production capacity to its historical maximum, the building export potential from Quebec to Northeastern US could be 79% higher than current (CAD 15.1 million). When considering seasonality effects in supply, the export potential can be 33% higher (CAD 6.3 million) (Figure 39).

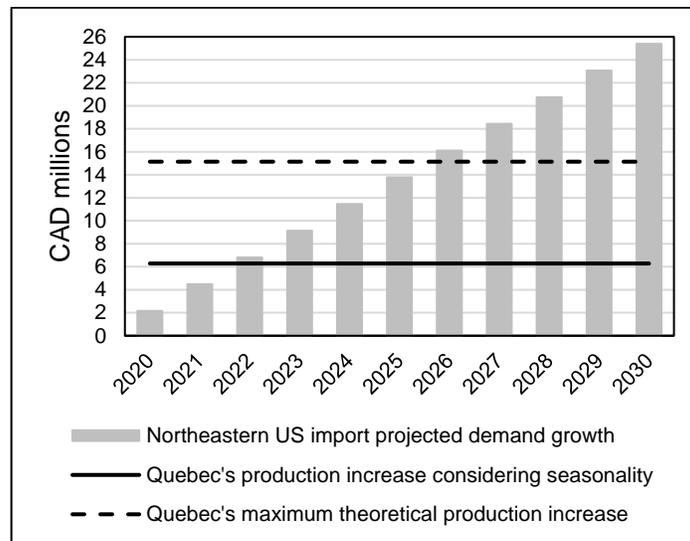


Figure 39: Export potential of wooden prefabricated buildings from Quebec to the Northeastern US under two production scenarios.

Results suggest that by drastically increasing the production capacity of the industry there is a chance that supply will overcome demand. Northeastern US import trend suggests the region would be able to import 14% to 34% of Quebec's potential production increase in 2020 (actual production capacity is CAD 170 million).

Results also suggest that seasonal differences that affect production can be as high as CAD 2.3 million between the most and least productive months. Variables such as climate, personnel availability linked to vacation and holidays must be considered when estimating real capacity.

The study has limits that could influence the results. The model used to forecast the Northeastern US imports does not consider the effects of new trade conditions between the US and Canada or the impact of the actual economic crisis in demand or supply.

The results of this study suggest that wooden prefabricated buildings production capacity in Quebec could be higher than Northeastern US import projected demand growth.

This highlights the need for Quebec to explore additional target markets and/or improving their export presence in the Northeastern region. This study will help to define future trade activity goals, investment targets and personnel requirement from the industry.

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