2018 GCCA Global Cold Storage Capacity Report

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for the International Association
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Acknowledgements

The Global Cold Chain Alliance (GCCA) would like to recognize the author of this report:

Author

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Introduction

This report provides an update on refrigerated warehouse capacity using information collected from international offices of the Global Cold Chain Alliance (GCCA). The primary data source was a survey administered by GCCA staff in Spring 2018. In addition, official government reports were sources for information on the United States (U.S. Department of Agriculture) and India (India Ministry of Food Processing Industries).

Summary of the Findings

The total capacity of refrigerated warehouses worldwide was 616 million cubic meters in 2018, 2.67% greater than the capacity reported in 2016. India was the single largest country market, at 150 million cubic meters, followed by the United States at 131 million cubic meters, and China at 105 million cubic meters.

Refrigerated warehouse space was distributed unevenly across countries based on the index of market penetration developed by the Global Cold Chain Alliance (GCCA). The market development index is calculated as cold storage capacity per urban resident. The urban population is used in this benchmark because it is expected that urban centers are where the middle-class income population is concentrated. In developing country markets, the middle-class and high-income consumer segments support the demand for refrigerated and frozen foods, which ultimately drives the refrigerated warehouse service industry.

Refrigerated warehouses serve various needs in the food logistics process: storage of seasonally produced foods to allow them to be available year-round, short-term storage staged in strategic locations to meet retail distribution needs, and import-export logistics facilities along global transportation routes. There are two classifications of business models: warehouses available to multiple users on a for-hire basis and those operated by a food company exclusively for the company's sole use. In this report, as in industry practice, the warehouses available for-hire on a third-party basis are referred to as "public" refrigerated warehouses, although most of them are privately owned businesses. The term "private" warehouse is reserved for those warehouses operated by a food company exclusively for that company's use.

Limitations and Methodological Notes

The figures in this report are the most complete data available to document the global refrigerated warehouse industries. Certain limitations should be noted due to variations in units of measure and in defining the scope of the industry.

Units of measure. This report contains the potential for statistical error due to the required application of quantitative conversion factors. Most of the respondents to this survey collect information in cubic meters, which is the standard capacity unit adopted by the Global Cold Chain Alliance. Therefore, most of the units of measure are consistent throughout the report. However, a few nations customarily report in pallets, which presents a complication because the size of a standard pallet differs for European and American markets (see the Appendix for the applied conversion factors). Some responses were received in metric tonnage units. Tonnage units were converted to cubic meters on the basis of an assumption provided by food industry experts about the type of product stored.

Scope of the industry as a limitation on the data. Warehouses that do business with a number of customers are known as public refrigerated warehouse (PRWs) and are a part of the third-party logistics (3PL) business. The Global Cold Chain Alliance is a trade association of PRWs and therefore sources large amounts of information from the PRW industry. Warehouses that were operated privately may not have

been thoroughly covered by the information sources affiliated with the GCCA. For example, the data collected for Mexico over the past 10 years have included only the public for-hire warehousing capacity. In 2018, the total Mexican market size was notably substantially higher because privately operated space was included in the estimate for the first time.

Some national government agencies collect information on public, for-hire warehouses as well as privately operated space. Regardless of the source of information, every effort has been made to obtain a size estimate inclusive of both public space and private space, and to break out the market shares of the two types of business.

The definition of the industry used by some government statistics agencies also contributes to possible inconsistency in scope of the data. For example, the government of India reported on warehouse space used for vegetable and fruit products and therefore the national estimate may not include warehousing used for meat, dairy, and processed foods. In the United States, the national survey program targets those warehouses that typically store foods for more than one month. As a result, the estimate of the privately-operated warehouse space in the United States likely is understated because it does not include distribution centers used for storage over periods of less than one month.

Largest Country Markets

India has reported 150 million cubic meters of refrigerated warehousing in 2018, maintaining the position of the largest total capacity among the countries in the GCCA database. India had 7,645 cold storages in 2018, each averaging less than 20,000 cubic meters in size. Nearly all of the cold storage facilities were owned by private sector companies and the products stored were mainly potatoes and other vegetables.

The United States, with 131 million cubic meters of refrigerated warehouse capacity, was ranked second behind India. Refrigerated facilities in the United States averaged approximately 113,000 cubic meters each.

China was the third-ranked country market in 2018, at 105 million cubic meters. After several years of rapid expansion, growth in the Chinese refrigerated warehouse industry has leveled off, according to industry sources.

The country-by-country capacity data for 2018 and 2016 (most recent year available) are shown in Figure 1 for the top 20 countries. Table 1 shows refrigerated warehouse capacity for all the countries included in the GCCA global database, 2014-2018 as available.

Figure 1:

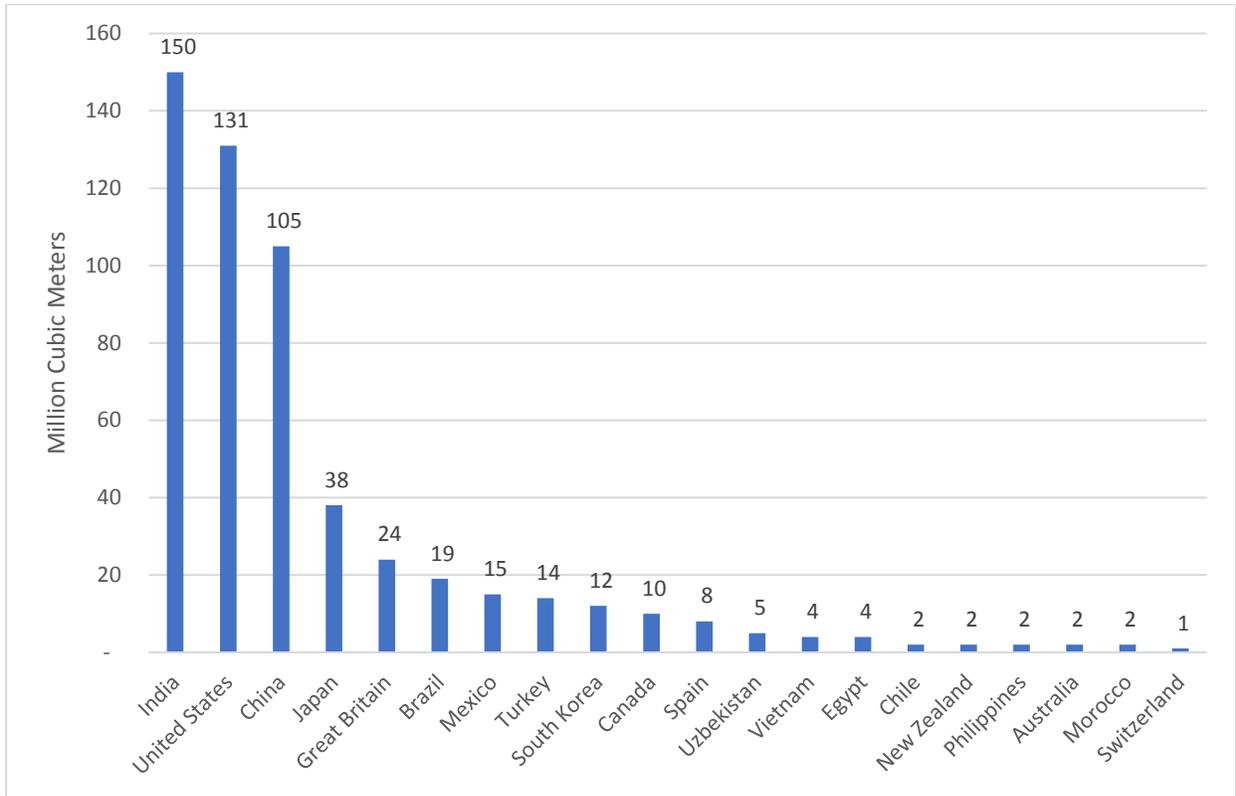**Capacity of Refrigerated Warehouses, Twenty Largest Country Markets, 2016 and 2018 as available, in Million Cubic Meters.**

Refrigerated Warehouse Capacity and Market Development Index, by Country, 2014-2018 as Available

Country	2014		2016		2018	
	Million m^3	m^3 per urban resident	Million m^3	m^3 per urban resident	Million m^3	m^3 per urban resident
Afghanistan	0.024	0.003	0.0181	0.002	-	-
Australia	5.083	0.245	6.04	0.281	1.865	0.085
Austria	1.000	0.174	-	-	-	-
Bangladesh	0.129	0.003	-	-	-	-
Belgium	2.720	0.250	2.70	0.245	0.10	0.009
Brazil	16.050	0.094	16.83	0.095	19.057	0.106
Canada	8.850	0.310	9.91	0.337	9.653	0.316
Chile	3.658	0.232	1.55	0.096	2.165	0.133
China	76.080	0.107	107	0.143	105	0.132
Colombia	0.100	0.003	-	-	-	-
Denmark	3.000	0.613	-	-	-	-
Dominican Republic	0.024	0.003	-	-	-	-
Ecuador	-	-	0.043	0.004	-	-
Egypt	3.25	0.089	-	-	3.5	0.085
El Salvador	0.042	0.010	0.02	0.005	-	-
Finland	1.000	0.216	.039	.085	-	-
France	15.500	0.282	6.29	0.111	-	-
Germany	23.950	0.395	16.00	0.265	-	-
Great Britain	24.646	0.490	32.37	0.624	24.117	0.441
Greece	1.200	0.171	0.7	0.102-	-	-
Guatemala	0.035	0.005	-	-	0.125	0.014
India	130.720	0.328	141.13	0.335	150.229	0.343
Indonesia	12.320	0.110	3.87	0.028	-	-
Iran	14.000	0.253	-	-	-	-
Italy	4.500	0.107	3.8	0.09	-	-
Japan	32.650	0.277	-	-	37.612	0.315
Kazakhstan[N]	-	-	-	-	0.002	0.00^2
Kenya	-	-	0.0215	0.002	-	-
Kuwait	0.281	0.069	0.33	0.082	-	-
Kyrgyzstan[N]	-	-	-	-	0.019	0.009
Libya	0.250	0.052	-	-	-	-
Mauritius	-	-	0.22	0.436	-	-
Mexico	4.869	0.053	6.5	0.065	15	0.152
Morocco	1.700	0.086	1.7	0.082	-	-
Namibia	0.150	0.165	-	-	-	-

Table 1--Continued:

Refrigerated Warehouse Capacity and Market Development Index, by Country, 2014-2018 as Available

Country	2014 Million m³	2014 m³ per urban resident	2016 Million m³	2016 m³ per urban resident	2018 Million m³	2018 m³ per urban resident
Netherlands	-	-	13.7	0.958	-	-
New Zealand	1.712	0.44	-	-	2.054	0.503
Nicaragua	0.00[1]	0.00[2]	-	-	-	-
Nigeria	0.04	0.00[2]	-	-	0.001	0.00[2]
Norway	-	-	-	-	-	-
Oman	0.021	0.008	-	-	-	-
Panama	0.137	0.046	-	-	-	-
Peru	-	-	2	0.081	0.100	.004
Philippines[N]	-	-	-	-	2	0.037
Portugal	-	-	0.42	0.064	-	-
Romania	0.292	0.027	0.5	0.046	-	-
Saudi Arabia	1.395	0.058	-	-	-	-
South Africa	0.323	0.010	0.47	0.013	-	-
South Korea	-	-	12.0	0.281	-	-
Spain	-	-	10.0	0.276	7.5	0.206
Sweden	-	-	2.0	0.239	-	-
Switzerland	-	-	1.5	0.248	0.62	0.100
Tajikistan[N]	-	-	-	-	0.10	0.041
Tunisia	1.310	0.179	-	-	-	-
Turkey	6.804	0.127	9.24	0.165	14.367	0.242
Turkmenistan	-	-	-	-	0.072	0.025
United States	114.851	0.438	118.07	0.440	130.965	0.490
Uzbekistan	1.075	0.102	3.54	0.327	4.5	0.385
Vietnam[N]	-	-	-	-	3.866	0.116
Yemen	0.057	0.007	-	-	-	-

-- Not available.

m³ -cubic meters.

N -Indicates countries that are new to the IARW database in 2018.

[1]-Less than 0.001 million m³.

[2]-Less than 0.005 m³ per capita.

Variation in Refrigerated Capacity Across Countries

Countries with larger populations, consumer incomes, and geographic areas likely have different needs for refrigerated warehousing services. To facilitate comparisons across countries, a market development index was calculated. The metric for service levels relative to the needs in the market is defined as cubic meters per population in urban areas. Table 1 contains the total market size and the market development index (MDI) for the 60 countries that reported to the GCCA in either 2018 or 2016.

As expected, many of the higher-income countries had higher presence of refrigerated warehousing capacity, relative to the urban population. Per-capita market penetration in the better-served markets typically ranged from 0.3 cubic meters to 0.5 cubic meters per urban resident (Figure 2). The highest market index levels were in New Zealand (0.5), the United States (0.49), and Great Britain (0.44). Among the developing countries, Uzbekistan and Mauritius reported the highest levels of market penetration with 0.38 and 0.43 cubic meters, respectively, of refrigerated storage per urban resident. Canada and Japan were at 0.31 cubic meters per urban resident.

India demonstrated continued progress in terms of cold storage capacity relative to urban population. The market development index for India rose to 0.34 in 2018, an improvement from 0.33 in 2016 and 0.30 in 2010. It should be noted that India's population is less urbanized than that of China, Brazil, and other emerging market economies. Later in this report, the state-by-state location of India's refrigerated warehouses is provided.

The middle-ranked countries in terms of refrigerated warehousing per urban population include the emerging market economies of Mexico, Brazil, Turkey, and China (Figure 3). The market development index levels for the mid-ranked countries ranged from 0.08 to 0.24 cubic meters of refrigerated warehouse capacity per urban resident. Based on these index levels, there is considerable unmet need in these markets.

Brazil reported the addition of 3 million cubic meters since 2016 (4.3% annualized rate of growth) in spite of its economic crisis. Later in this report, the state-by-state location of Brazil's refrigerated warehouses is provided.

In Mexico, GCCA sources reported a modest increase in the public for-hire warehousing capacity. The total market size in Mexico in 2018, at 15 million cubic meters, was significantly larger than in 2016 because privately operated space was included. The major change for Mexico was due to recording of privately operated space that was not disclosed in past reports.

The group of countries that have low refrigerated capacity, relative to potential needs, are at less than .05 cubic meters per urban resident (Figure 4). Several of these countries have predominantly low-income households and modest presence of modern grocery retail infrastructure.

Refrigerated Warehouse Market Development Index (Capacity in Cubic Meters per Urban Resident), for Countries in the High Range of the Index, 2016 or 2018.

Figure 3:
Refrigerated Warehouse Market Development Index (Capacity in Cubic Meters per Urban Resident), for Countries in the Medium Range of the Index, 2016 or 2018.

Figure 4:

Refrigerated Warehouse Market Development Index (Capacity in Cubic Meters per Urban Resident), for Countries in the Low Range of the Index, 2016 or 2018.
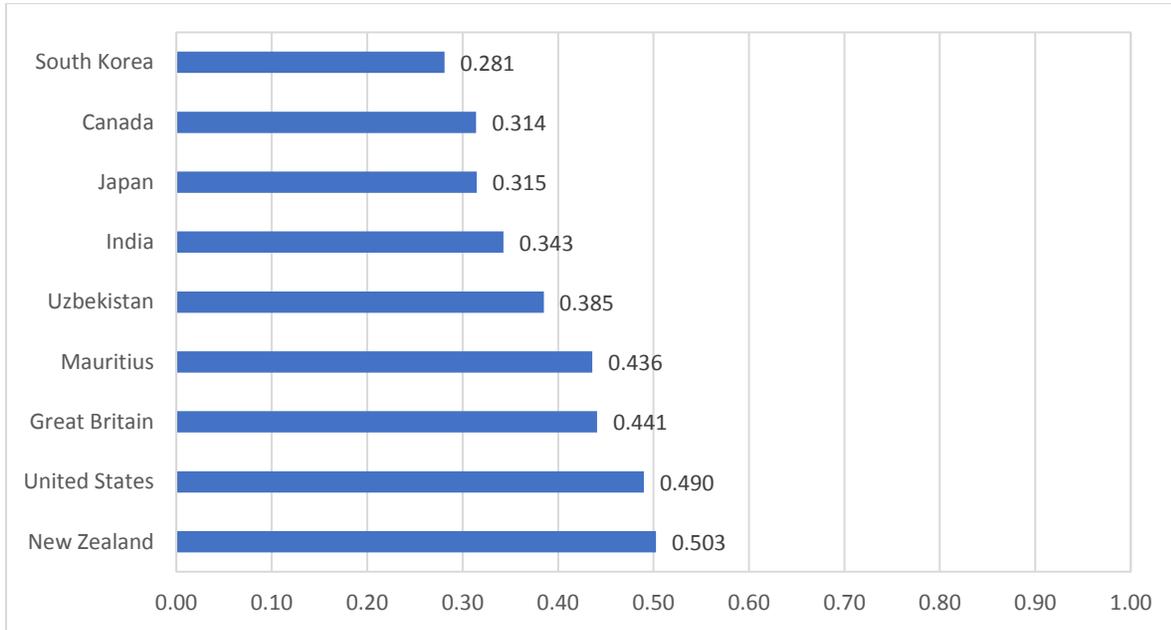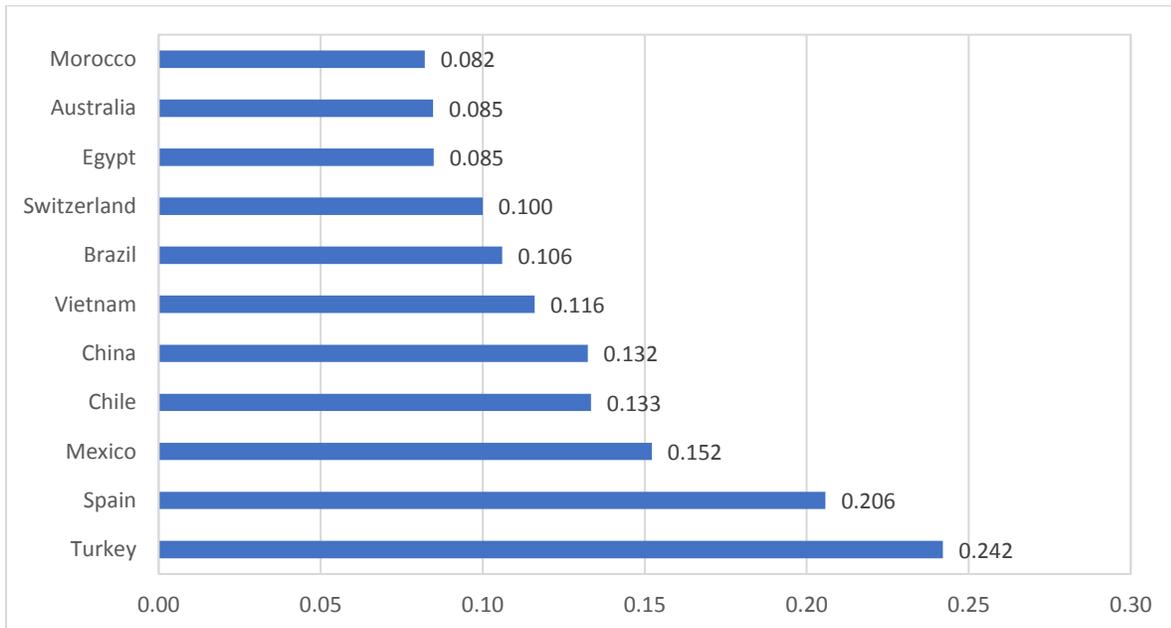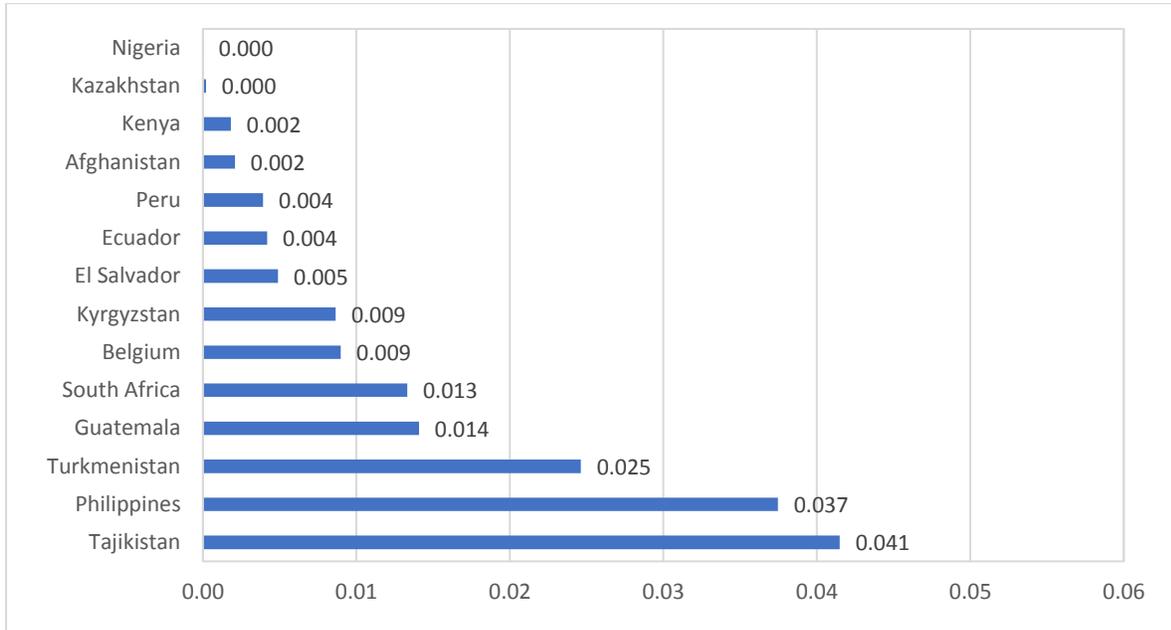

Size Ranges of Refrigerated Warehouses

Refrigerated warehouses are 100,000 cubic meters in size on average in developed market economies (Table 2). Japan is an exception, where the average size is under 13,000 cubic meters.

The largest companies that offer third-party logistic (3PL) refrigerated warehousing services operate in multiple countries, as shown in Table 3. The geographic footprint of the international companies has changed with merger and acquisition activity in the past few years.

Average Size of Refrigerated Warehouses, by Country, 2018 as Available.

Country	n facilities	Average size in m^3
Australia	13	143,478
Great Britain	204	118,220
United States	1,154	113,487
Canada	87	110,950
Belgium	1	100,000
Chile	45	48,116
Brazil	435	43,809
Spain	260	28,846
El Salvador	4	21,675
India	7,645	19,651
Philippines	120	16,667
Japan	2,926	12,854
Mexico	1,200	12,500
Guatemala	12	10,417
Kyrgyzstan	3	6,268
Turkmenistan	16	4,500
Uzbekistan	2,500	1,800
Turkey	19,700	729
Tajikistan	150	667
Kazakhstan	16	125
Total for the 2018 respondents	36,491	11,497

Trends in Grocery Expenditure by Country

The local population's preference for fresh or frozen foods is a key driver of the demand for refrigerated warehouse services. Food markets are dynamic and naturally vary around the world. A summary indicator

of the 5-year trend in food demand by country is provided in Table 4. The compound annual growth rate was calculated as:

$$CAGR = \left[\left(\frac{2017}{2012}\right)^{\frac{1}{5}} - 1\right].$$

The figures are based on grocery retail sales value in nominal terms, in local currency (Euromonitor), which is illustrative of food markets in most respects. However, it should be noted that price changes and the composition of the food basket might drive growth in retail sales without a corresponding change in demand for storage. For example, consumers might choose different quality levels, such as expensive meat cuts, over a cheaper item, thus increasing retail sales value without a change in storage space. Or, inflation and related macroeconomic shocks can explain extremely high growth rates such as those shown for Venezuela and Argentina in Table 4.

Table 3:
Largest Refrigerated Warehouse Companies, Locations, and Capacity, 2018.

Company	Locations	Million m³
Americold Logistics	Argentina, Australia, Canada, China, New Zealand, United States	27.07
Lineage Logistics	Belgium, Netherlands, United Kingdom, United States	21.72
Swire Cold Storage	China, Sri Lanka, United States	10.14
AGRO Merchants Group	Australia, Austria, Brazil, Chile, Ireland, the Netherlands, Poland, Portugal, Spain, United Kingdom, United States	7.45
Nichirei Logistics Group, Inc.	France, Japan, the Netherlands, Poland	4.93
Kloosbeheer B.V.	Canada, Germany, France, the Netherlands, Norway, South Africa, Sweden, United States	4.69
NewCold Advanced Cold Logistics	Australia, France, Germany, the Netherlands, Poland, Great Britain, United States	3.98
VersaCold Logistics Services	Canada	3.75
Interstate Warehousing, Inc.	United States	2.84
Frialsa Frigorificos S.A. De C.V.	Mexico	2.75
Cloverleaf Cold Storage Co.	United States	2.37
Emergent Cold Storage	Australia and Vietnam	2.16

Henningsen Cold Storage Co.	United States	1.83
Burris Logistics	United States	1.65
Gruppo Marconi Logistica Integrata	Italy	1.56
Congebec Logistics, Inc.	Canada	1.41
Hanson Logistics	United States	1.24
Conestoga Cold Storage	Canada	1.21
Oxford Logistics Group	Australia	1.09
Zero Mountain, Inc.	United States	1.08
Agri-Norcold A/S	Denmark	1.01
Montague Cold Storage Pty Ltd.	Australia	0.96
Bring Frigo	Norway and Sweden	0.90
Confederation Freezers	Canada	0.84
Friozem Armazens Frigorificos Ltda.	Brazil	0.82

Source: GCCA records.

Table 4:

Trend in Consumer Spending on Grocery Retail, by Country, Annualized Percent Change 2012-2017.

Country	CAGR in %	Country	CAGR in %
Venezuela	145.69	Hungary	4.13
Argentina	26.56	Australia	4.12
Belarus	17.77	United States	3.89
Uzbekistan	16.00	Thailand	3.77
Kazakhstan	15.02	Slovakia	3.52
Azerbaijan	14.56	Czech Republic	3.49
India	12.50	Malaysia	3.49
Pakistan	11.15	Canada	3.31
Ukraine	10.47	Norway	3.12
Cameroon	10.42	Latvia	2.86
/Indonesia	10.10	Tunisia	2.84
Kenya	9.93	Bulgaria	2.79
Saudi Arabia	9.55	Sweden	2.76
Egypt	8.71	Georgia	2.75
Algeria	8.49	Netherlands	2.71
China	8.32	Serbia	2.58
South Africa	8.29	New Zealand	2.39
Uruguay	7.85	Macedonia	2.22
Peru	7.59	Hong Kong	2.16
Bolivia	7.58	Spain	1.97
United Arab Emirates	7.42	Portugal	1.96
Romania	7.30	Germany	1.93

Russia	7.29	Israel	1.86
Colombia	7.16	France	1.85
Turkey	7.13	Great Britain	1.82
Dominican Republic	6.82	Austria	1.78
Costa Rica	6.80	Morocco	1.41
Guatemala	6.11	Denmark	1.34
Philippines	5.65	Ireland	1.20
Mexico	5.60	Japan	1.19
Estonia	5.43	Belgium	0.92
Brazil	5.05	Slovenia	0.88
South Korea	5.01	Switzerland	0.86
Lithuania	4.77	Croatia	0.69
Ecuador	4.62	Italy	0.58
Poland	4.35	Bosnia-Herzegovina	0.29
Chile	4.21	Finland	0.15

Source: Euromonitor, 2018.

Selected Country Reports

India

Population growth was slightly above 1% per year in India, where total population was 1.29 billion in 2016. Population growth slowed over in the 2012-2016 period, as shown in the bars in Figure 5, scaled on the left axis. Consumers' incomes in India grew, as marked by the line in Figure 5 (right axis scale). However, inflation has overtaken much of this nominal increase in personal expenditures.

In its forecasts published in March 2018, Euromonitor had a positive outlook for India. Overall economic growth was predicted to be 12% CAGR over 2016-2021. The retail market growth forecast is the same, at 12% annually for 2016-2021. This expectation is slightly above the annualized rate of grocery retail sales that occurred during 2012-2017 (Table 4). Inadequate roadway and warehouse infrastructure will be barriers to more rapid expansion of the freight transportation sector, including food distribution, according to Euromonitor.

In 2016-2017, the Indian government invested in roadway infrastructure and built 8,231 kilometers of new highways. An additional 14 billion US dollars for road construction was allocated for 2017-2018 (Euromonitor).

The locations of refrigerated warehouse capacity by state in India are illustrated in Figure 6 and Table 5.
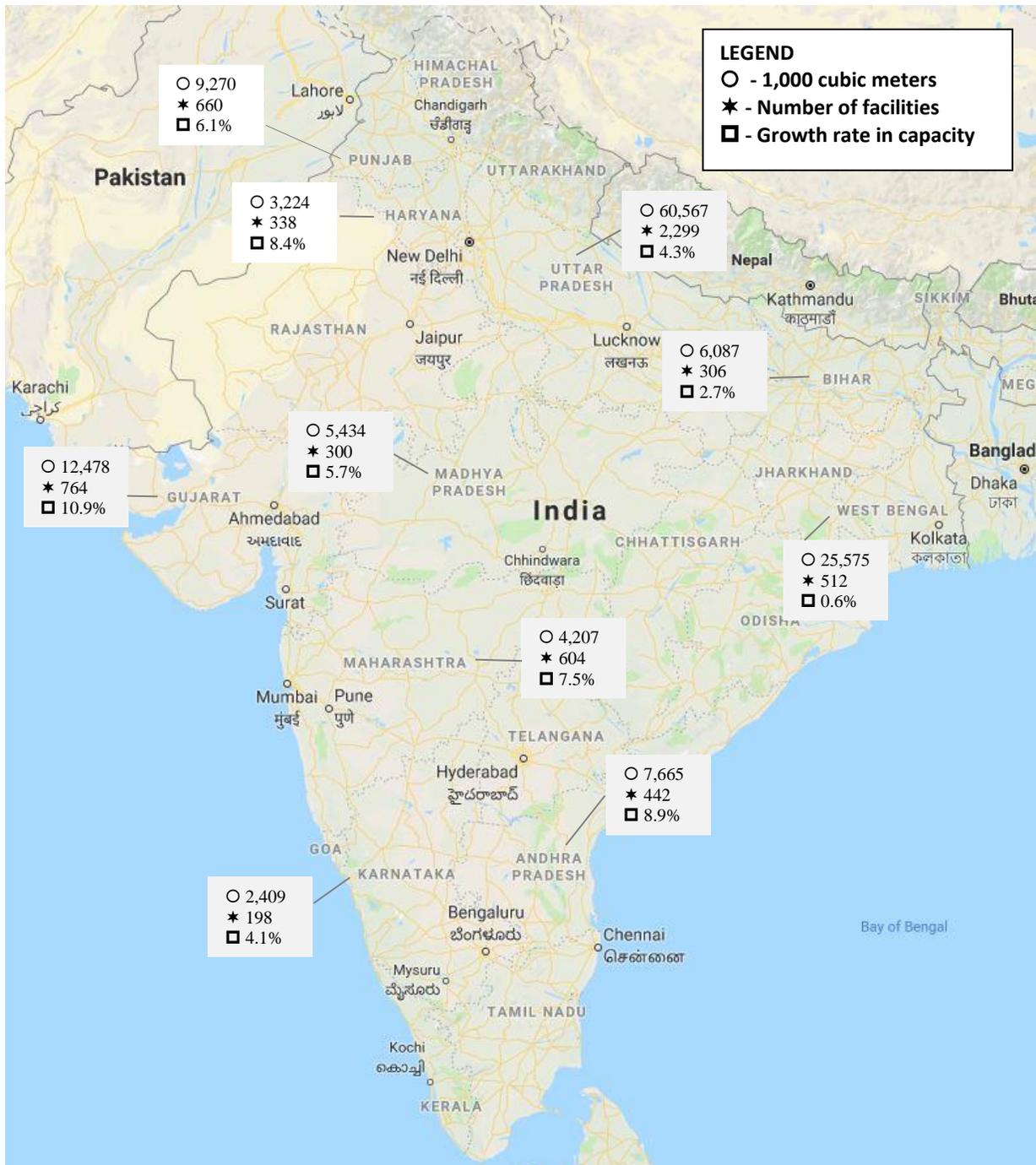
Figure 5:
Growth in Population and Per-Capita Consumer Spending in India, 2012-2016.
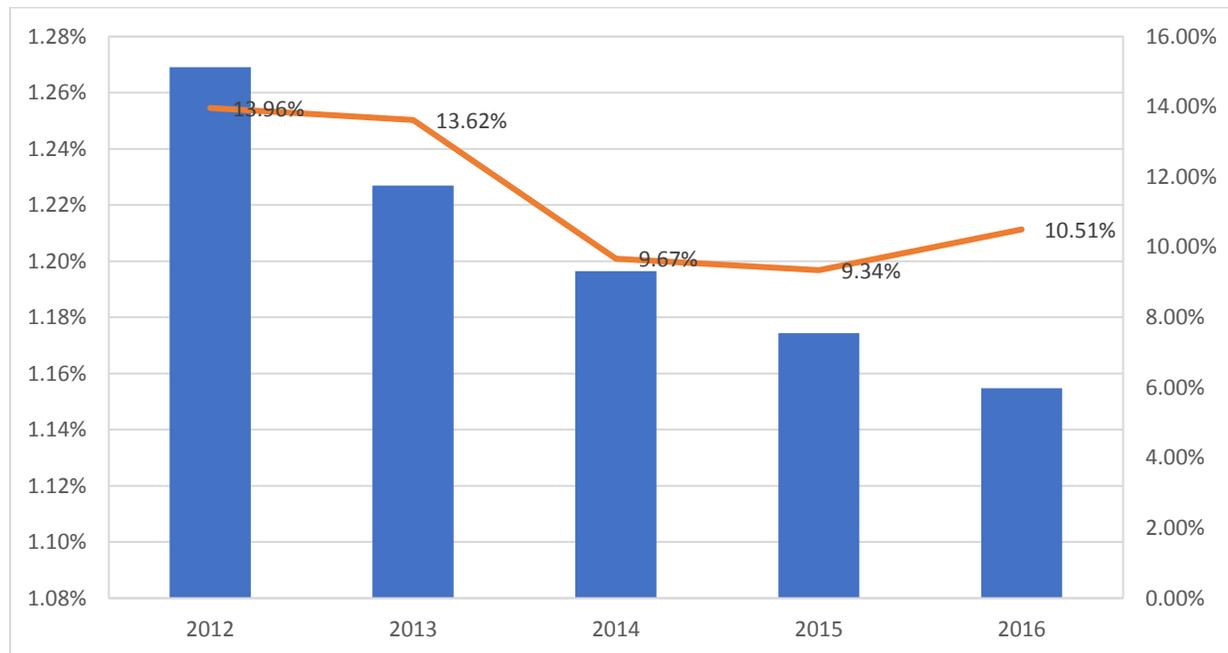
Source: Euromonitor, 2018. Population scale on the left axis and consumption spending on the right axis.

Figure 6:

Refrigerated Warehouse Capacity in India (top 10 states), Number of Facilities, 2017, and Annualized Capacity Growth Rate, 2009-2017.

Source: India Ministry of Food Processing Industries, 2017.

Table 5:

Refrigerated Warehouse Capacity in India, 2017, Number of Facilities, 2017, and Annualized Capacity Growth Rate, 2009-2017.

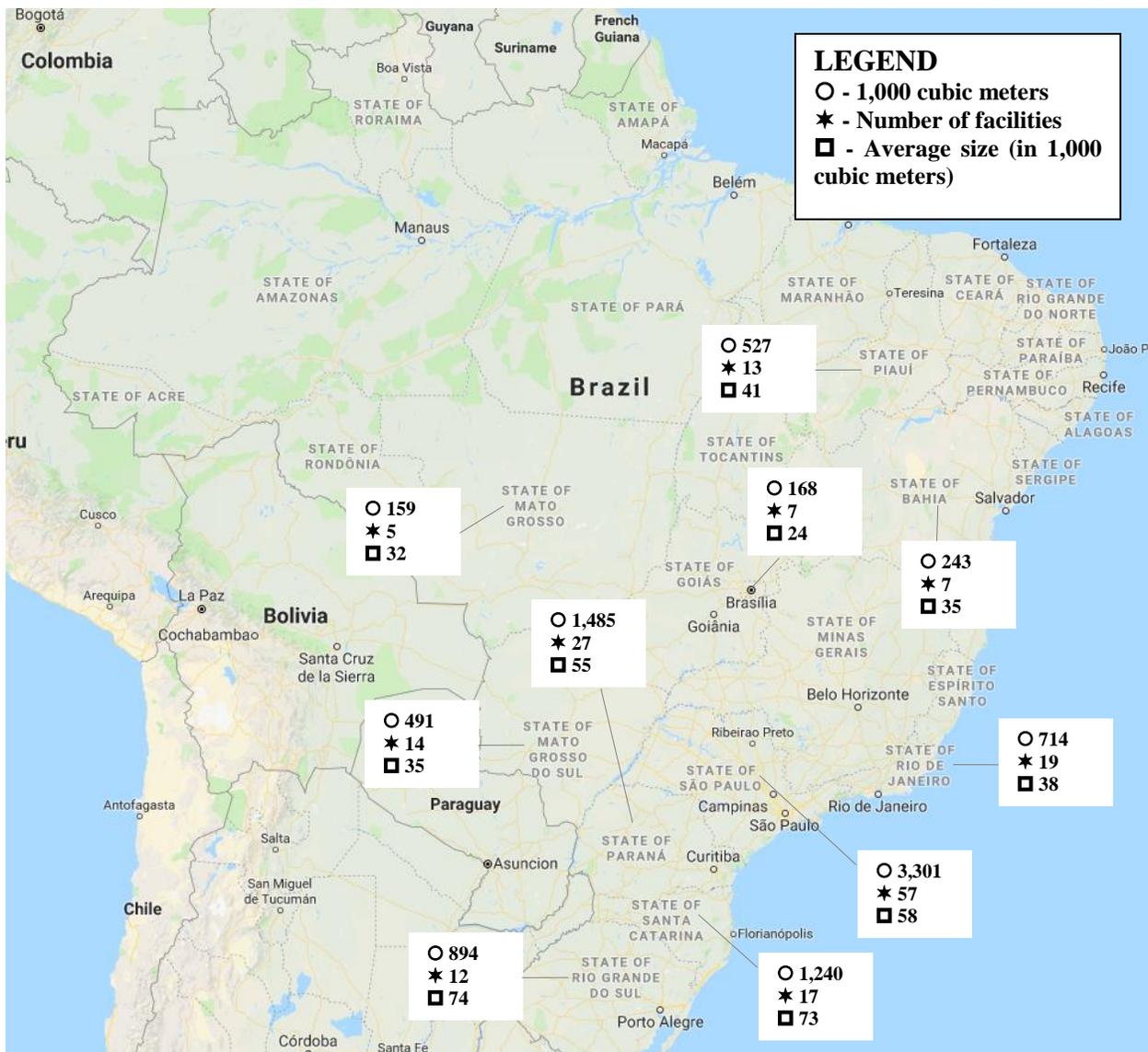| State	1,000 m^3	n facilities	CAGR 2009-2017
Uttar Pradesh	60,957	2299	4.3%
Gujarat	12,478	764	10.9%
Punjab	9,270	660	6.1%
Maharashtra	4,207	604	7.5%
West Bengal	25,575	512	0.6%
Andhra Pradesh & Telangana	7,665	442	8.9%
Haryana	3,224	338	8.4%
Bihar	6,087	306	2.7%
Madhya Pradesh	5,434	300	5.7%
Karnataka	2,409	198	4.1%
Kerala	346	198	4.1%
Tamil Nadu	1,452	174	4.4%
Orissa	2,323	171	8.0%
Rajasthan	2,388	166	7.0%
Chhattisgarh	2,082	98	4.4%
Delhi	558	97	0.4%
Himachal Pradesh	563	66	26.6%
Jharkhand	1,018	58	4.2%
Uttrakhand	690	46	11.2%
Jammu & Kashmir	484	38	12.8%
Assam	679	36	7.6%
Goa	33	29	0.0%
Tripura	196	14	5.6%

Chandigarh	54	7	0.2%
Meghalaya	35	4	12.5%
Nagaland	32	4	2.3%
Mizoram	17	3	-
Andaman & Nicobar Islands	3	3	18.4%
Pondicherry	-	3	0.0%
Manipur	24	2	-
Arunachal Pradesh	26	2	2.3%
Sikkim	9	2	0.6%
Lakshadweep	0.1	1	0.0%
Total	150,315	7,645	4.6%

Source: India Ministry of Food Processing Industries, 2017.

Brazil

The location and characteristics of refrigerated warehouses in Brazil are shown in Figure 7 and Table 6.

Figure 7:
Refrigerated Warehouse Capacity in Brazil (top 10 states), Number of Facilities, and Average Size of Facility, by State 2018.

○ 527
✱ 13
◻ 41

○ 159
✱ 5
◻ 32

○ 168
✱ 7
◻ 24

○ 243
✱ 7
◻ 35

○ 1,485
✱ 27
◻ 55

○ 491
✱ 14
◻ 35

○ 714
✱ 19
◻ 38

○ 3,301
✱ 57
◻ 58

○ 894
✱ 12
◻ 74

○ 1,240
✱ 17
◻ 73

LEGEND
○ - 1,000 cubic meters
✱ - Number of facilities
◻ - Average size (in 1,000 cubic meters)

Source: ABIAF (Associação Brasileira da Indústria de Armazenagem Frigorificada) Trabalho da Rede Brasileira de Armazéns Frigoríficos, 2018.

Table 6.
Refrigerated Warehouse Capacity in Brazil, Number of Facilities, and Average Size of Facility, by State 2018.

State	Capacity in 1,000 m³	n Facilities	Average size in 1,000 m³

Sao Paulo	3,301	57	58
Paraná	1,485	27	55
Santa Catarina	1,240	17	73
Rio Grande do Sul	894	12	74
Rio de Janeiro	714	19	38
Piaui	527	13	41
Mato Grosso do Sul	491	14	35
Bahia	243	7	35
Federal District	168	7	24
Mato Grosso	159	5	32
Ceara	111	4	28
Goias	94	3	31
Espirito Santo	67	2	34
Amapa	51	3	17
Parana	44	3	15
Alagoas	7	3	2
Rondonia	5	1	5
Paraiba	4	1	4
Acre	1	1	1
Maranhao	1	1	1
Total	9,607	200	48

Source: ABIAF (Associação Brasileira da Indústria de Armazenagem Frigorificada) Trabalho da Rede Brasileira de Armazéns Frigoríficos, 2018.
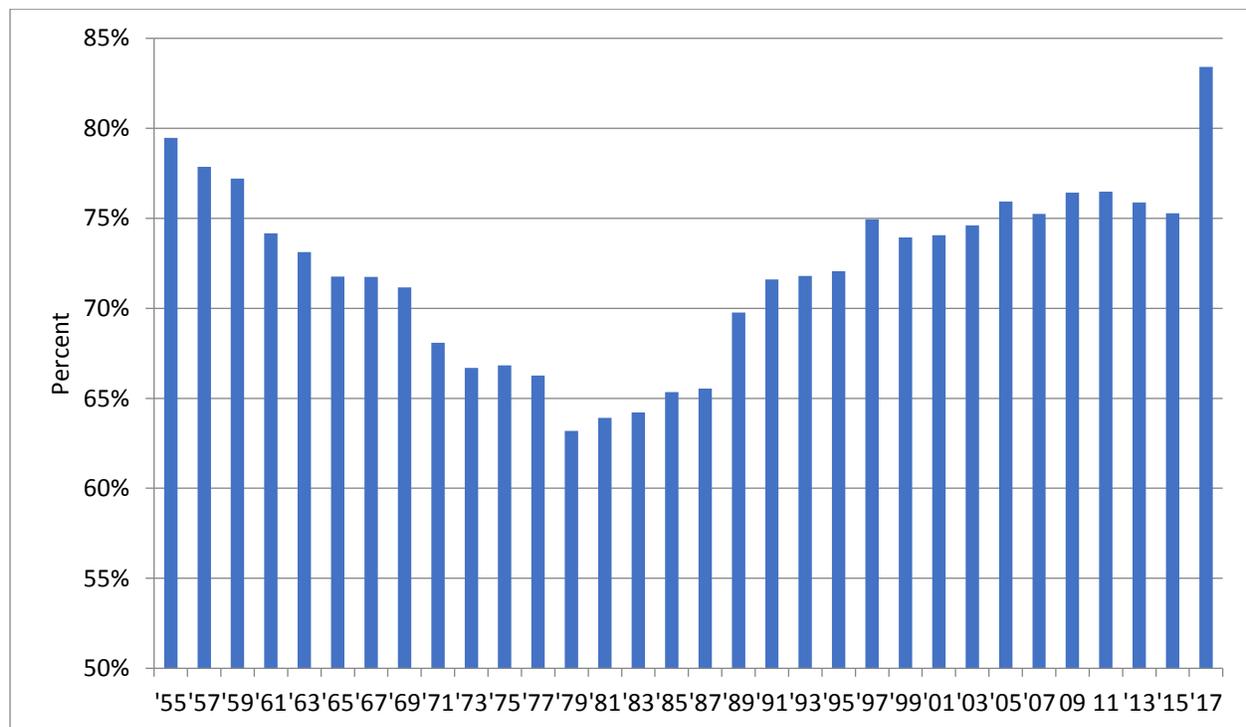
United States

The U.S. Department of Agriculture conducted its recent biennial national survey of refrigerated warehouses in October 2017 (U.S. Department of Agriculture). The survey coverage changed to include only those facilities in the United States that store product for 4 weeks. As a result of this change, there is a discontinuity in the U.S. industry capacity figures relative to prior years. In order to provide consistency across years to the extent possible, the data for the United States presented in this report were obtained largely from GCCA sources. The GCCA estimates cover public, for-hire warehouses regardless of the duration of product storage. The GCCA does not have an estimate for privately-operated warehouses and therefore the U.S. Department of Agriculture figures were used to represent privately-operated facilities. It should be noted that the U.S. Department of Agriculture had substantially fewer privately-operated warehouses reporting under the survey program in 2017 compared with 2015.

Consolidation of the U.S. industry into larger facilities continued in 2017, as it had in previous years (Table 7). The average size of a public, for-hire refrigerated warehouse in the United States was 113,487 cubic meters (approximately 5 million cubic feet). The number of U.S. refrigerated warehouses that were 5 million cubic feet or larger was nearly unchanged while a number of smaller warehouses dropped out of the national survey program.

Figure 8:
Share of U.S. Refrigerated Warehouse Capacity that is Public for-Hire, 1955-2017, in Percent.

Table 7:

Distribution of United States Refrigerated Warehouses by Size.

Size class in cubic feet	2017	Share of all warehouses in the size class
0-499,999	161	16.9%
500,000-999,999	103	10.8%
1,000,000-2,499,999	199	20.9%
2,500,000-4,999,999	233	24.5%
5,000,000 and over	254	26.7%
All sizes	950	100%

Note: Includes only the refrigerated warehouses that store product for 4 weeks or longer.
Source: US Department of Agriculture based on survey conducted October 1, 2017.

Conclusions

Globally, cold storage capacity reached 616 million cubic meters in 2018, an increase of 2.7% since 2016. The three largest country markets—India, the United States, and China— accounted for 60% of the global total of refrigerated space.

Total refrigerated warehouse capacity was compared with urban population to obtain a market development index that sheds light on the extent of unmet needs in a particular country. On average, there are approximately 0.2 cubic meters of refrigerated warehousing space per urban resident globally. Variation in the market development index across countries was significant, as a result of differences in consumers' buying power in the countries as well as differences in food production and trading patterns. Based on the findings for 2018, Mexico, Brazil, Turkey, and China had the largest unmet need for refrigerated warehouse space.

Sizes of refrigerated warehouses ranged from over 100,000 cubic meters in developed economies to 15,000-25,000 per facility in emerging market and lower-income economies. There may be corresponding differences in occupancy or inventory turnover rates that result in small facilities potentially generating services and income comparable to larger facilities. A number of smaller warehouses located across food production areas might also be used to serve farmers and food security needs in food production areas where transportation links are limited.

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Appendix: Conversion Factors

There are various ways to measure refrigerated warehouse capacity; the key difference is weight basis compared with volume basis. The conversion from weight-based units (metric tons) to volume units (cubic meters) depends on the product in storage, and we lack specific information on products for many countries. As a result, approximations of capacity in volume were made for certain countries. The conversions that were used in this report are:

1 Pallet = 6.65 cubic meters, for countries in the Americas. European pallets are converted at 1 Pallet = 1.944 cubic meters.

1 Metric ton = 4.3 cubic meters

1 Cubic meter = 35.31 cubic feet