Nonresidential Prototype Vintage Proposal

1. Vintage bins

Prototype models are intended to be average representations of the current building stock. Since the building stock consists of buildings ranging from 1 to over 100 years old built under their respective enacted regulations, the nonresidential building stock must be divided into several vintage bins for the prototype models to be representative. For this purpose, the following features of the building stock have been considered and investigated from the perspective of the building energy performance:

- Construction periods
- Major changes to the California building energy regulation (Title 24)
- Trend of window-to-wall ratio (WWR) over the past decades
- Building envelope material and insulation replacement timeframe, e.g., effective useful life.

1.1. Construction Periods

There are several factors that affect the nonresidential building construction intensity in California. Economic conditions, recession and boom periods, Proposition 13[1], land-use control and zoning policies, as well as laws changes are among the most influential. Instead of investigating these factors individually, the yearly construction rate was analyzed since it encompasses the actual effects of all the factors, including those mentioned earlier and others.

California-specific permit starts data from Dodge[2] (Dodge 2023) was used to study the construction rate. This data provides information about the residential and non-residential buildings on an annual basis beginning in 1967 and extending through 2022. It consists of real data gathered year by year to represent the new construction, alteration, and adding permits. It provides details such as the start year, type, floor area, total number of stories, value, and location (county) of each issued building permit in California. In order to extract the non-residential new construction rate, single-family houses and low-rise multifamily apartments[3] have been excluded from the data.

[1] Proposition 13 or Prop. 13 (officially named the People's Initiative to Limit Property Taxation) is an amendment of the Constitution of California enacted during 1978 (Wikipedia 2023-B). It limited the property tax rate to 1 percent plus the rate necessary and capped future property tax increases to a maximum of 2% per year (California State Board of Equalization 2018). Under Prop. 13, similar properties can have substantially different assessed values based solely on the dates the properties were purchased. This amendment has led to a huge tendency for people to stay in their existing homes because moving would result in a newly reset property tax rate. This situation has significantly affected the construction industry, especially in the residential buildings.

[2] Construction starts data by Dodge, 2023. It is a paid date which was provided to NORESCO by the CEC.

[3] Multifamily houses/apartments with number of stories below 4.

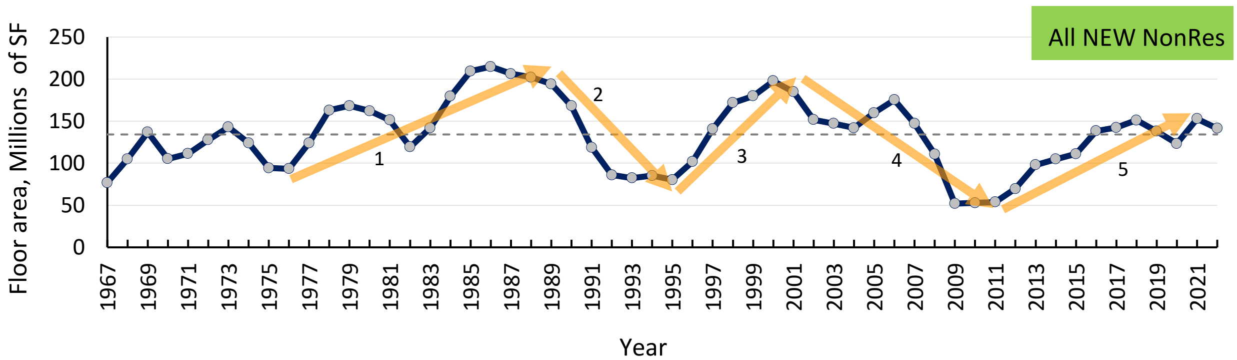


Figure NR-1: Yearly construction floor area of the new nonresidential buildings

Figure NR-1 shows the annual construction rate of new nonresidential buildings in the state of California. As can be seen in this figure, there are a series of growing and declining periods of construction. These trends are indicated by the transparent orange arrows, with approximate starting and ending dates. The construction rate began to rise in 1976 and, after a few years, it declined due to the early 1980s recession and the effectiveness of Proposition 13 in 1978. The occurrence of the 1982 economic boom[4] reversed the funding condition and consequently construction rate started to rise again, reaching its peak around 1986. Even with a gradual decrease, it maintained a high construction rate until 1989 (arrow1).

Starting in 1990, and as a consequence of the early 1990s recession[5], the construction rate sharply declined over the next three years and then remained stable during the subsequent three years (arrow 2). Around 1997 and in conjunction with the dot-com boom[6], the industry experienced rapid growth until around 2000 (arrow 3), after which it declined. It took 8 years for the construction industry to stabilize at the minimum construction rate around 2010 (arrow 4). The Great Recession in 2008[7] was one of the most significant factors that contributed to the decline in the construction rate in this period. The last growth phase began around 2012 and gradually increased until 2021 (arrow 5). Around 2020, in alignment with the COVID-19 pandemic, the construction industry experienced fluctuation, but it rose again.

Distribution of the "new" construction in California reveals that there are three high construction periods with an above-average construction rate. The average construction rate is indicated by the grayish horizontal line in Figure NR-1. These periods include:

[4] This boom is attributed to the economic program of President Ronald Reagan which began to take effect from 1982 (The New York Times 1990). His policies for tax cuts, reducing inflation rates, and deregulation had significant impacts on the U.S. economic condition.

[5] The 1990-91 downturn occurred at the end of the cold war. It was exacerbated by several external factors such as the Persian Gulf crisis, the savings and loan collapse, and continued job cutbacks due to lower defense spending (Singleton 1993). The aerospace industry collapsed in Southern California and the unemployment rate increased. As a consequence of all the factors, the construction industry entered a recession.

[6] The dot-com boom was a period of rapid growth in the value of technology companies in the late 1990s particularly in the Bay Area. The period coincided with massive growth in internet adoption, a proliferation of available venture capital, and the rapid valuation growth of new dot-com startups. (Wikipedia 2023-C)

[7] The Great Recession was a sharp decline in economic activity from late 2007 to 2009, also known as the Subprime mortgage collapse. During this period, the gross domestic product declined 4.3%, the unemployment rate doubled to more than 10%, home prices fell roughly 30% and at its worst point, the S&P 500 was down 57% from its highs (Forbes 2023-A). S&P 500 is a stock index that tracks the share prices of 500 of the largest public companies in the United States (Forbes 2023-B). The combination of banks unable to provide funds to businesses, and homeowners paying down debt rather than borrowing and spending resulted in the Great Recession (Wikipedia 2023-D)

- 1978 to 1990: The first period started around 1978 (a few years before the 1982 economic boom) and concluded with the 1990 recession. Almost 30% of the investigated nonresidential buildings' floor area was permitted during these 13 years.
- 1997 to 2007: The second prosperous construction period began around 1997, concurrent with the dot-com boom, and concluded after 10 years with the great recession around 2008. This period encompasses about 24% of the total investigated nonresidential buildings' floor area.
- 2016 until 2022: The construction industry went through the Great Recession and then gradually grew until it exceeded the average construction rate around 2016.

These periods are important for vintage selection due to the higher volume of nonresidential buildings constructed during these times in California. However, construction period is just one factor and there are some other important ones.

1.2. Major changes in Title 24 Part 6

Changes in the thermal characteristics of the building envelope is another feature. To track this feature, we looked at the energy regulations. We compared the prescriptive criteria of the nonresidential building envelope in each version of Title 24 Part 6 to the previous version. Among the factors influencing building energy consumption, the building envelope stands out as the most significant one with a lifespan considerably longer than other factors such as lighting and HVAC system. The lifespan of lighting is typically 10 years, and the average HVAC lifespan is approximately 15 years. Due to the short lifespan of other factors, the focus of this study was set on the building envelope elements.

Table NR-1 presents the changes applied to window thermal characteristics while Table NR-2 and Table NR-3 present the major changes applied to the wall and roof thermal characteristics. Tracking these changes provides us with insight into characterizing buildings based on their envelopes' energy properties.

1.2.1. Prescriptive Criteria for Windows

As observed in Table NR-1, 2001 stands out as a pivotal year in terms of glazing regulations. In this year, solar heat gain coefficient (SHGC) was categorized into four groups based on WWR, each with significantly lower assigned U-factors compared to the previous ones in 1998. Additionally, window U-factors were decreased notably (32-60%) and set to U-0.49 (Btu/h·ft2·F) for most of the nonresidential buildings' windows. These requirements could typically be passed by double-pane glazing systems.

Another significant milestone occurred in 2013. After several years of implementing more detailed energy regulations, in 2013, the requirements became less classified, and at the same time, stricter. Classification of SHGC based on the climate zones, WWR, and orientation was eliminated. However, U-factor and SHGC were separated into three groups of windows: fixed, portable, and curtainwall or storefront.

Table NR-1: Major Changes applied to the prescriptive criteria of the vertical fenestration in Title 24 Part 6

Year[8]	Reference	Nonresidential buildings except high-rise residential and hotel	Reference	High-rise residential buildings and hotels
2022	Table 140.3-B[9]	Max 20% changes in U-factors and RSHGC values in several climate zones.	Table 170.2-A[10] for high-rise residential Table 140.3-C[11] for hotel	No change in Hotel/Motel properties. High-rise residential has been separated from the nonresidential chapter and grouped with other multifamily buildings into a new chapter. For high-rise residential buildings: • Climate zones have been subcategorized into 16 climate zones. • Fenestration has a new structure with 3 subdivisions: NAFS 2017 Performance Class AW, curtain wall, and all other fenestrations. There are no fixed and operable window groups. • NAFS 2017 Performance Class AW has a U-factor and RSHGC values fall between those of the previous fixed windows and operable windows, except for RSHGC in climate zone 1 which is almost 50% higher than the previous RSHGC.
2019	Table 140.3-B[12]	No change	Table 140.3-C[13]	No change
2016	Table 140.3-B	No change	Table 140.3-C	No change
2013	Table 140.3-B	Window regulations became less detailed but stricter. 2-55% reduction in U-factor based on the window type. Up to 70% reduction in RSHGC based on the window type.	Table 140.3-C	Window regulations became less detailed but stricter. 13-23% reduction in U-factor based on the window type. Up to 63% reduction in RSHGC based on the window type.
2007	Table 143-A	No change	Table 143-B	Unchanged except for RSHGC in a few climate zones.
2005	Table 143-A	Almost unchanged (only a 4% reduction in U-factor).	Table 143-B	Almost unchanged (only a 4% reduction in U-factor).

[8] Each code edition incrementally describes the changes from the previous version.

[9] Prescriptive envelope criteria for nonresidential buildings (including relocatable public-school buildings (where manufacturer certifies use only in specific climate zones; not including high-rise residential buildings and guest rooms of hotel/motel buildings. This table is presented under Subchapter 5 of Title 24, part 6.

[10] Envelope component package-multifamily standard building design. This Table is presented under Subchapter 11 of Title 24, part 6.

[11] Prescriptive envelope criteria for guest rooms of hotel/motel buildings. This table is presented under Subchapter 5 of Title 24, part 6.

[12] Prescriptive envelope criteria for nonresidential buildings (including relocatable public-school buildings (where manufacturer certifies use only in specific climate zones; not including high-rise residential buildings and guest rooms of hotel/motel buildings. This table is presented under Subchapter 5 of Title 24, part 6.

[13] Prescriptive envelope criteria for high-rise residential buildings and guest rooms of hotel/motel buildings. This table is presented under Subchapter 5 of Title 24, part 6.

2001	Table 1-H	Became more structured with strict regulations. 32-60% reduction in U-factor. 16-50% reduction in RHSGC.	Table 1-I	Became more structured with strict regulations. 32-60% reduction in U-factor. Only a multi-pane glazing system could pass the new requirements. 11-68% reduction in RHSGC.
1998	Table 1-H	U-value unchanged 12% reduction in RSHGC	Table 1-I	U-value unchanged 12% reduction in RSHGC
1995	Table NO. 1-I	No change	Table NO. 1-J	No change

1.2.2. Prescriptive Criteria for Walls, Roofs, and Floors

Tracking the changes applied in Title 24 Part 6 over the years after 1990 reveals that envelope energy regulations became more classified in 2007. In this year, the U-factor was separately presented for each of the 16 climate zones of California and significant changes were applied to the building envelope thermal characteristic. Some of these changes are as follows:

- U-factors were reduced on average by 50% (+6% to -80%) for all nonresidential buildings' walls in almost all climate zones.
- Roof was a single envelope component in the 2005 edition of Title 24, but it was divided into two groups in 2007: "Metal buildings"[14] and "Wood framed" with new assigned U-factor values.
- New features for roofing products (low-sloped and steep-sloped) including aged reflectance and emittance features were added to the prescriptive criteria.
- New requirements for some of the roofing products were assigned.
- Floors U-factor were changed dramatically based on the climate zones.

The 2013 and 2016 editions of Title 24 Part 6 also applied strict regulations to the envelope energy properties. However, when comparing the amount of change each version applied to the previous one, 2007 is a landmark year from the prescriptive of envelope energy regulations.

[14] "METAL BUILDING" is a complete integrated set of mutually dependent components and assemblies that form a building, which consists of a steel-framed superstructure and metal skin. This does not include structural glass or metal panels such as in a curtainwall system (CEC 2022)

Table NR-2: Changes applied to the wall prescriptive criteria in Title 24 Part 6 (Max U-Factor)

Year[1]	Reference	Nonresidential buildings except high-rise and hotels	High-rise residential + Hotels
2022	Table 140.3-B	11-13% reduction in U-factor of the "metal framed" wall.	No change in Hotel/Motel. High-rise residential buildings have been joined to the new multifamily chapter. In high rise-res: • "Metal-framed" and "Wood-framed" have been merged and then categorized based on fire rating. U-factor of the new group, "Metal frame with fire rating <1 hr" is close to the values of the previous "Wood-framed group" (-13 to +21% change with an average of +2%). • U-factor of the new group, "Metal frame with fire rating >=1 hr" is close to the values of the previous "Metal frame" group (+6 to -38% change with average -16%).
2019	Table 140.3-B	No change	No change
2016	Table 140.3-B	30% reduction in "Metal Buildings" wall U-factor in 3 climate zones. 7% and 24% reduction in "Wood framed and other" wall in two climate zones.	30% reduction in the U-factor of "Metal Buildings" in almost all climate zones. 7% and 24% reduction in "Wood framed and other" wall in two climate zones.
2013	Table 140.3-B	No change	No change
2007	Table 143-A	Envelope energy regulations became more structured. Climate zones were separated into 16 zones instead of 5 zone groups. "Wood framed" wall and "Other" wall became one single group.	Envelope energy regulations became more structured. Climate zones were separated into 16 zones instead of 5 zone groups. "Wood framed" wall and "Other" wall became one single group.
2007	Table 143-A	Significant changes were applied to the wall energy requirement. U-factors were reduced by around 50% for all buildings in almost all climate zones. (+6% to -80% changes).	Significant changes were applied to the wall energy requirement. U-factors were reduced by around 50% for all buildings in almost all climate zones. (+6% to -80% changes).
2005	Table 143-A	The U-factor of the "Metal framed" wall was divided into two subgroups: "Metal Building" (with a 37% decrease in U-factor) and "Metal-framed" (with a 19% increase in U-factor). 20% increase was applied to the U-factor of "wood framed and others" wall	The U-factor of the "Metal framed" wall was divided into two subgroups: "Metal Building" (with about 32-56% decrease in U-factor) and "Metal-framed" (with around 24% increase in U-factor). 20% increase was applied to the U-factor of "wood framed and other" wall.
2001	Table 1-H	Zone classification was slightly changed, and as a result, the max U-factors in a few zones were reduced by about 9%.	Zone classification was slightly changed, and as a result, the max U-factors in a few zones were reduced by about 9%.
1998	Table 1-H	No change	No change
1995	Table NO. 1-I	No change	No change

[1] Each code edition incrementally describes the changes from the previous version

Table NR-3: Changes applied to the roof/floor prescriptive criteria in Title 24 Part 6

Year	Reference	Nonresidential buildings except high-rise and hotels	High-rise residential + Hotel
2022	Table 170.2-A for high-rise residential Table 140.3-C for hotel	High-rise residential has been separated from Nonresidential chapters and grouped with other multifamily buildings into a new chapter. 7% and 25% increase, respectively, in the aged solar reflectance and thermal emittance values of steep-sloped roofing products in most climate zones.	No change in Hotel/Motel. High-rise residential buildings have been joined to the new multifamily chapter. In high rise-res: • No change in roofs' value • The floor section has been restructured. Wood-framed has been added to the floors' division with a U-factor of 0.037 (close to the U-factor of the "other" group in the "Hotel" table) • The U-factor of the two other floor systems ("Raise mass" and other" floor) are similar to the values of "nonresidential buildings" except in 3 climate zones (12,15,16) that are 50% greater. However, in comparison with the values of the previous version, significant changes (-60 to +364%) can be observed. • Aged solar reflectance of low-sloped roof has been increased by 15%.
2019	Table 140.3-C	No change.	No change[1].
2016	Table 140.3-C	37% reduction in the U-factor of the "Metal Buildings" wall in all climate zones. And between 13-35% reduction in U-factor of "wood-framed and other" roof.	37% reduction in the U-factor of the "metal buildings" roof in all climate zones. And between 13-18% reduction in the U-factor of "Wood framed and other" roof in four climate zones.
2013	Table 140.3-C	Steep-sloped groups merged into one group. 200% increase in the value of the aged solar reflectance parameter for low-sloped roofing products and a 33% increase in the value of the aged solar reflectance parameter for steep-sloped (5lb/ft or more) roofing products.	Value was assigned to the aged solar reflectance and the thermal emittance parameters of low-sloped roofing products in one climate zone.
2007	Table 143-B	Envelope energy regulations became more structured. Climate zones were separated into 16 zones instead of 5 zone groups.so Roof's U-factor were subcategorized into two groups: "Metal building" and "wood framed and other".	Envelope energy regulations became more structured. Climate zones were separated into 16 zones instead of 5 zone groups Roof's U-factor were subcategorized into two groups: "Metal building" and "wood framed and other".
2007	Table 143-B	Roof was a single item with a U-factor of 0.051-0.076 in 2005, however in 2007, it was divided into two groups: "Metal buildings" with a U-factor equal to 0,065 and" wood frame" with a U-factor of 0.039-0.075 varies by climate zones.	Roof was a single item with a U-factor of 0.036-0.051 in 2005, however in 2007, it was divided into two groups: "Metal buildings" with a U-factor equal to 0,065 and "wood frame" with a U-factor of 0.028-0.039 varies by climate zones. Floors' U-factors were reduced between 0% to 59% depending on the material and climate zone.

[1] It appears that the floor U-factor of raised mass floors in climate zone 10 was mistakenly written as 0.669 instead of 0.069.

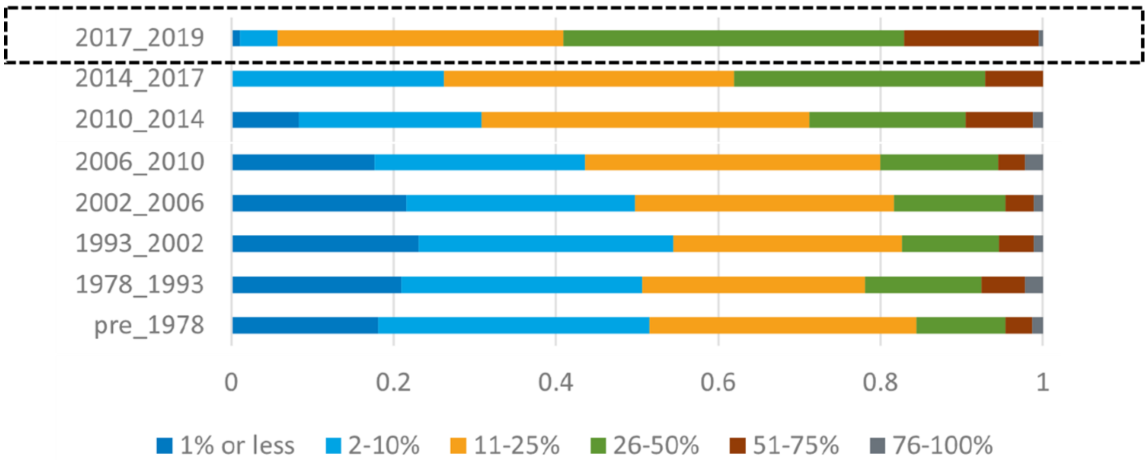
		-35% to +200% changes in U-factor of the mass floors and 0-45% increase in U-factor of the other floors. New features for roofing products (low-sloped and steep-sloped) including aged reflectance and emittance features were added to the prescriptive criteria.	New features for roofing products (just low-sloped) including aged reflectance and emittance features were added to the prescriptive criteria. "Raised concrete R-Value" was excluded from the floor criteria.
2005	Table 143-B	3-11% reduction to the roofs' U-factor in some climate zones. 4-12% reduction to the floors' U-factor.	3% reduction to the roofs' U-factor in some climate zones 4-12% reduction to the floors' U-factor.
2001	Table 1-I	Zone classification was slightly changed and consequently, the max U-factors in a few zones were reduced by 27,39%.	Zone classification was slightly changed and consequently, the max U-factors in a few zones were reduced by 27,39%.
1998	Table 1-I	No change	No change
1995	Table NO. 1-J	No change	No change

1.3. WWR Distribution

WWR is the proportion of the above-grade wall surface covered by fenestration. It is one of the essential elements of the building envelope that affects the total energy consumption of the building. Because WWR data specific to California is scarce, and WWR trends are not generally affected by geographic location[1], we can leverage WWR findings from studies outside California. National Renewable Energy Laboratory (NREL) recently published a reference documentation (NREL 2023) for the 2023 version of the Commercial Building Sector Stock Model (ComStock) and reported a WWR distribution by building vintage that is presented in Figure NR-2. This chart was developed based on 2020 Guidehouse[2] data for the national commercial window stock. As can be seen in this figure, new buildings are trending toward larger windows. A noticeable change in WWR is observed after 2010, especially after 2017.

Based on the results of the Comstock report, there are three periods for WWR in the United States: Pre 2010, 2010-2017, and after 2017. Almost 60% of the commercial buildings in the United States that were built after 2017 have WWR greater than 25%. This ratio is at least 20% greater than the window-to-wall ratio in the previous building vintages.

[1] [(NREL 2023), P-45]
[2] (Guidehouse 2021)



Comstock 2023-p46

Figure NR-2: WWR by building vintage [(NREL 2023), P-46]

1.4. Insulation Replacement Timeframes

The lifespan or replacement timeframe of the opaque building envelope is another key factor in the vintage section. According to CBECS 2018, almost 44% of the buildings constructed between 1980 to 1990 had their roofs replaced before 2018 (CBECS survey date). The roof renovation and replacement timeframe, in many cases, is around 30 years based on the results of the CBECS records.

We also reviewed other resources on building envelope replacement timeframes, including:

- Permits data.

  Through the website of the city of San Francisco, we had access to the issued permit archive from 2004 to 2017 and could search in their permit exploration engine, case by case, from 1983 to the present. Also, the website of the city of Los Angeles provides a case-by-case search option for recent years. These cities have milder climates and expect to allow for longer roof lifespan; however, because of the lack of statewide data, two cities with high population rate and yearly available data were investigated.

- Data in the sales market (available on the internet)
- Civil engineer and energy audit experts

Based on the information collected from the available resources, it has been found that roof insulation is typically replaced between 20 and 30 years, with an average estimate of 25 years. The replacement of roof insulation often comes with replacing the whole roof. In contrast, the wall insulation in nonresidential buildings typically remained unchanged. Although the permit review showed cases that renovated their roof insulation in 15 years or rebuilt some part of their exterior wall after 10-15 years, these cases do not constitute a significant proportion of the building stock.

1.5. Proposed Vintage Bins

Concluding the above-mentioned discussion and synthesizing all the information, our proposed vintage bins for nonresidential prototype models are shown below.

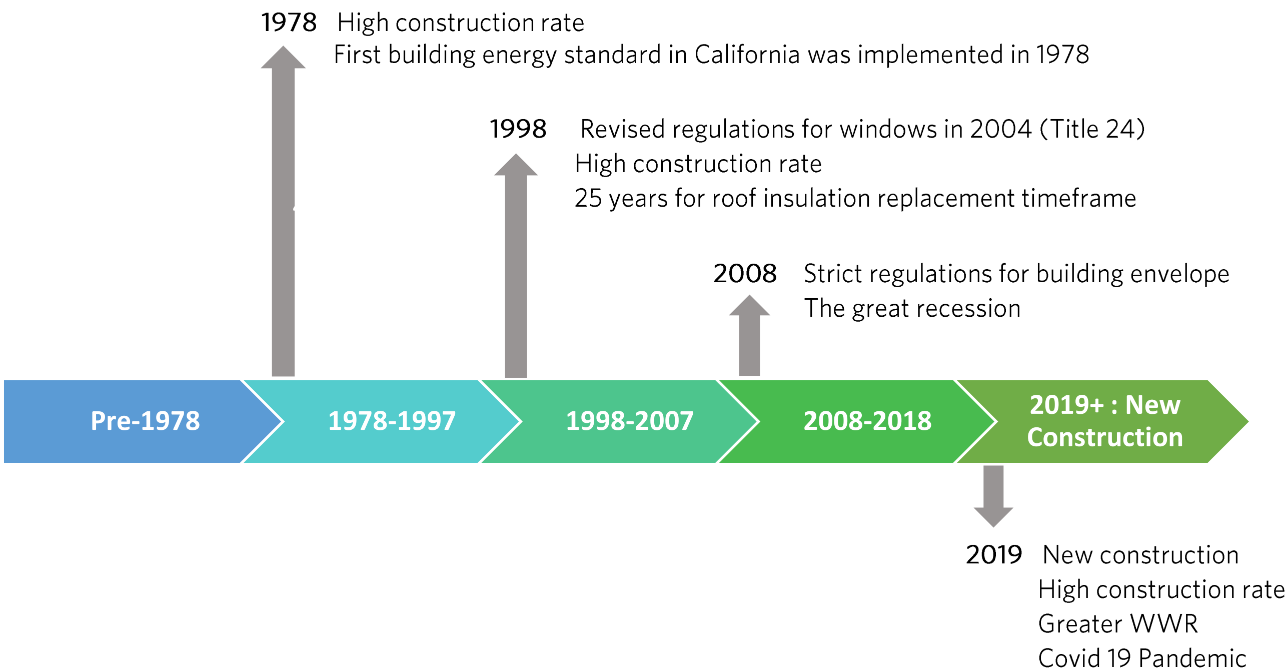


Figure NR-3: Proposed vintage bins for nonresidential buildings.

Pre-1978: The first vintage is pre-1978. It was in 1978 that the first energy standard for new buildings and alterations to the existing buildings (Title 24 Part 6) was adopted. Furthermore, the construction rate around 1978 was about 70% greater than a few years ago around 1975.

1978 to 1997: The second vintage bin is 1978 to 1997. The buildings' glazing system in this period was mainly single-pane windows. It was in 2001 that Title 24 Part 6 applied strict regulations for windows that could typically be passed by double-pane glazing systems. Figure NR-4 has been derived from CBECS 2018 and shows the percentages of the commercial buildings with multi-pane windows that were built in the Pacific region over the past years. As can be seen in this figure, almost all the buildings that were built after 2000 have multi-pane windows. Since a considerable percentage of the nonresidential buildings constructed before 2000 currently are equipped with single-pane windows, it has been decided to separate the buildings constructed before around the year 2000.

Due to the change in the building glazing system, and the occurrence of another prosperous construction period around 1998, it has been decided to set the end date of this period at the year 1997. It is expected that the buildings in this period currently feature roof insulation not older than 25 years.

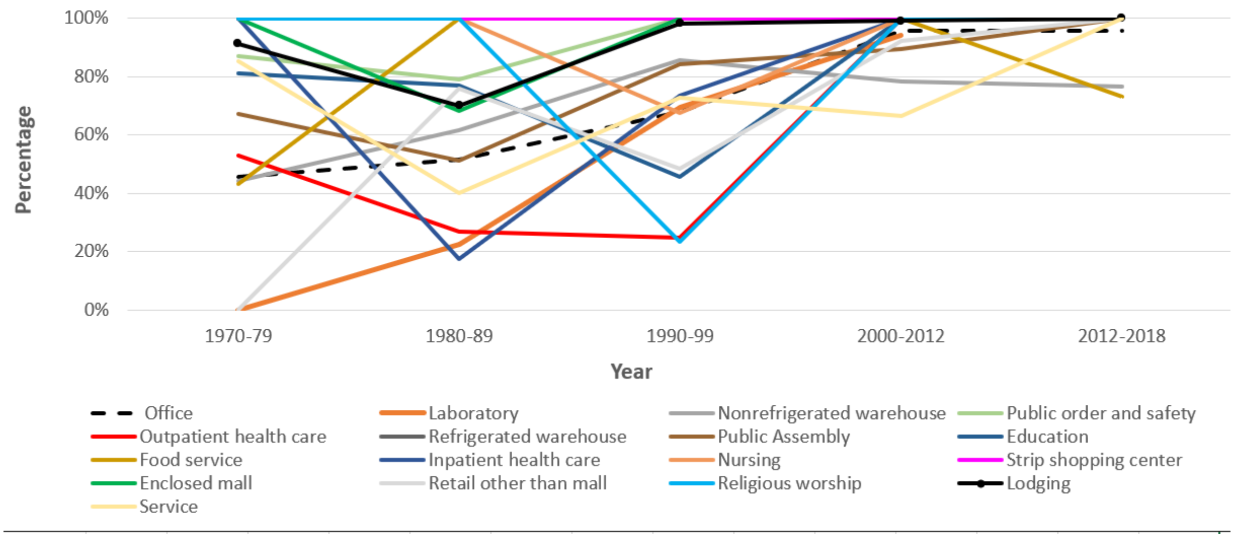


Figure NR-4: Percentage of the commercial buildings in the Pacific region that had multi-pane windows at the time of the survey (derived from CBECS 2018)

1998 to 2007: The third vintage bin starts from 1998 and ends in 2007 with the occurrence of the great recession. Buildings from this period are mainly equipped with multi-pane windows but feature less energy-efficient walls and roofs in comparison to the next vintage bin. Much stricter regulations for wall and roof insulation in new construction were required from 2007 Title 24.

It is expected that the buildings constructed in the first three vintage bins replaced their original HVAC system and are currently using HVAC systems not older than 20 years.

2008 to 2018: The fourth bin encompasses the years 2008 to 2018. Buildings in this period are equipped with almost the latest construction technology and meet strict energy regulations. They are tighter, equipped with almost energy-efficient windows, installed with better quality insulation, and additionally, their original HVAC system is still in operation. This bin ends with the occurrence of Covid 19 pandemic, allowing the recent years for the last bin, which is for buildings newly constructed in compliance with the most updated energy regulations and equipped with a greater WWR.

1.5.1. An Alternative Vintage Bins Selection

In addition to the previously mentioned proposal, vintage bins could be formulated differently, with the main distinction being the shift in the cutoff from 1997/98 to 1991/92.

This change better aligns with the early 1990s recession, resulting in two 15-year vintages, instead of a 20-year followed by a 10-year vintage. However, a significant issue is that a major change in performance resulting from the improvement in window performance, as required by the 1998 code, would be missed.

This approach categorizes buildings constructed from 1992 to 2008 into one group, while many buildings constructed before 2000 still have single-pane windows, a factor that should be reflected in the prototype models. Additionally, by moving the cutoff from 2018/2019 to 2021/2022, we distance the “New Construction” bin from 2017 which is a significant year from the point of WWR selection. As shown in Figure NR-2, buildings constructed after 2017 have larger window areas which should also be reflected in the prototype models.

Both scenarios are presented here for consideration. The final selection will be made after deliberation with the Prototypes TAG.

2. Floor Area Distribution by Vintage

The following tables and figure show the distribution of the nonresidential building stock by the proposed vintage based on the Dodge 2023 data.

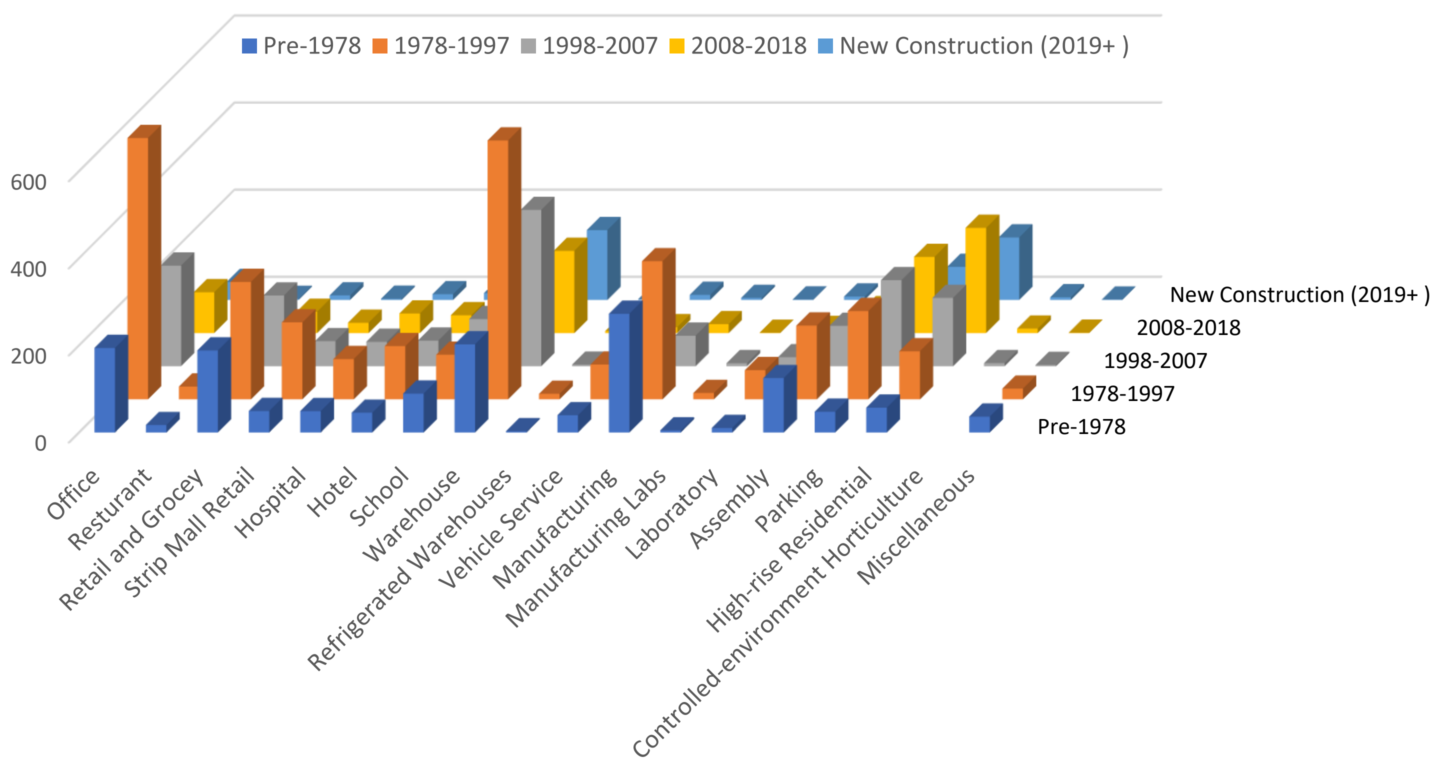


Figure NR-5: Distribution of “NEW” construction floor area (Millions of SF) by vintage

Tables NR-4: Distribution of “NEW” construction floor area by vintage

	Floor Area (Millions of SF)				
Building Type	Pre-1978	1978-1997	1998-2007	2008-2018	New Construction (2019+)
Office	194.0	606.2	231.0	93.8	41.3
Restaurant	16.9	29.3	13.4	5.7	2.5
Retail and Grocery	188.2	269.6	162.3	48.8	10.5
Strip Mall Retail	49.3	176.7	57.5	23.6	2.6
Hospital	49.0	92.4	55.9	45.0	13.3
Hotel	45.3	122.2	58.6	40.9	15.7
School	89.1	102.4	108.3	71.3	27.0
Warehouse	202.3	594.3	358.8	188.8	160.3
Refrigerated Warehouses	2.8	12.7	3.5	4.6	1.8
Vehicle Service	39.5	79.9	30.2	13.4	11.6
Manufacturing	272.5	317.1	70.0	20.5	4.7
Manufacturing Labs	4.6	14.6	6.9	0.7	1.0
Laboratory	10.2	67.0	20.5	9.3	7.8
Assembly	124.7	169.4	92.7	54.8	18.2
Parking	47.6	202.7	197.6	174.9	76.0
High-rise Residential	57.0	110.3	156.9	241.6	143.5
Controlled-environment Horticulture			7.1	10.3	6.2
Miscellaneous	36.4	24.5	2.8	0.8	0.9

	Percentage of each building type				
Building Type	Pre-1978	1978-1997	1998-2007	2008-2018	New Construction (2019+)
Office	17%	52%	20%	8%	4%
Restaurant	25%	43%	20%	8%	4%
Retail and Grocery	28%	40%	24%	7%	2%
Strip Mall Retail	16%	57%	19%	8%	1%
Hospital	19%	36%	22%	18%	5%
Hotel	16%	43%	21%	14%	6%
School	22%	26%	27%	18%	7%
Warehouse	13%	40%	24%	13%	11%
Refrigerated Warehouses	11%	50%	14%	18%	7%
Vehicle Service	23%	46%	17%	8%	7%
Manufacturing	40%	46%	10%	3%	1%
Manufacturing Labs	17%	52%	25%	2%	4%
Laboratory	9%	58%	18%	8%	7%
Assembly	27%	37%	20%	12%	4%
Parking	7%	29%	28%	25%	11%
High-rise Residential	8%	16%	22%	34%	20%
Controlled-environment Horticulture			31%	30%	44%
Miscellaneous	56%	37%	4%	1%	1%

3. References

California State Board of Equalization. 2018. "California Property Tax: An Overview." https://www.boe.ca.gov/proptaxes/pdf/pub29.pdf.

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