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Commercial New Construction Market Assessment

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Executive Summary

This report is intended to inform Northwest Energy Efficiency Alliance (NEEA) discussions on potential intervention strategies that will increase adoption of commercial new construction best practices. The report highlights trends, barriers, and opportunities for high-performance new construction projects, with a focus on Oregon, Washington, Idaho, and Montana (the Northwest).

CLEAResult led this project, with review and additional support from New Buildings Institute (NBI). Project tasks included:

- **Literature review.** CLEAResult reviewed nineteen publications to identify current practices, market penetration, market barriers, and opportunities relating to high-performance new construction. CLEAResult summarized key findings from each document in tabular form and synthesized overall themes and trends.
- **Market Data Analysis.** CLEAResult analyzed three resources to determine industry trends for commercial new construction. To determine trends in constructing high-performance new buildings, CLEAResult reviewed four public databases and gathered additional insights from several reports.
- **Stakeholder Interviews.** To gain perspectives from industry experts, CLEAResult interviewed twelve experienced professionals involved in new construction projects in the Northwest, including owner/developers; architects; mechanical, electrical, and plumbing (MEP) firms; and contractors.

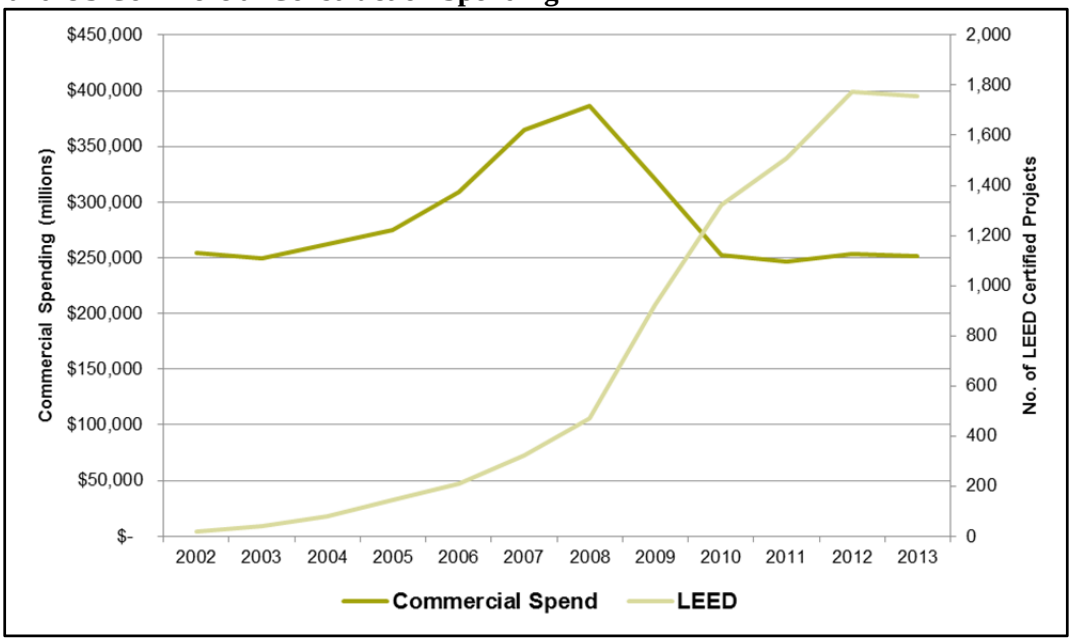
In addition to the project tasks listed above, CLEAResult and NBI incorporated insights from their own extensive experience in the field of commercial new construction.

Findings

Publicly-available sources of data on commercial construction activity are limited, and developing a comprehensive picture of new construction activity is hampered by inconsistencies among datasets. Finding reliable data on construction of high-performance buildings also provided challenges. Comprehensive data are available on the number of buildings certified under the U.S. Green Building Council's (USGBC's) Leadership in Energy & Environmental Design (LEED) Program, but beyond that, the available databases lacked standardized definitions and were incomplete.

Despite challenges with data quality and comprehensiveness, CLEAResult's market data analysis can provide a useful set of reference values for future studies, and has highlighted market data needs that could support future tracking of high-performance new construction. The most notable insight came from reviewing the trajectories of LEED certification and US commercial construction spending (Figure 1). This chart clearly shows acceleration in LEED certification from 2008 at a time when overall spending sharply declined.

Figure 1. Number of LEED-Certified Projects in the US by Year of Certification and US Commercial Construction Spending



Source: United States Green Building Council (LEED projects data); United States Census Bureau (U.S. Commercial Construction spending data).

The literature review and stakeholder interviews CLEAResult conducted under this project highlighted a range of themes, barriers, and opportunities relating to high-performance new construction. Three common themes persisted throughout the research:

- The business case for owner-occupiers to develop high-performance new construction is far stronger than for developers of leased properties
- Data on the benefits of high-performance properties do not meet the needs of leased property developers sufficiently to justify the risks and/or cost premiums
- An integrated design approach involving key stakeholders early in the process is critical for achieving high-performance building standards

Leased properties have the primary challenge of the financial value of high-performance not translating into the metrics that drive the initial investment decision by an owner/developer. Unlike owner-occupiers, owners of leased properties do not reap the long-term direct benefits from operational savings. The value of the building is the primary financial metric, and no established methods exist for factoring energy performance into property valuation at time of sale or refinancing. While other benefits have been reported (for example, lower vacancy rates and higher rents), available data are still insufficient on these benefits for investors to be willing to take on the risks involved.

Stakeholder interviews and the project team's experience strongly emphasized the need to involve key team members as early as possible in the design process to support a more integrated design approach. The design-bid-build (DBB) approach, whereby the general contractor is

involved only after the design is complete, is not conducive to high-performance new construction. CLEAResult's research for this project suggested a move toward other approaches in the Northwest, such as design-build and General Contractor/Construction Manager (GC/CM) approaches, which can both support high-performance new construction by involving more of the project team earlier.

Some interviewees for this project strongly recommended setting energy goals early in a project to keep team members focused on energy performance, and cited some examples of large owner-occupiers who are taking this approach. CLEAResult's research suggested a very low incidence of architects or contractors having contracts with energy performance targets or guarantees. While energy performance guarantees are attractive in theory, they raise several major challenges, such as:

- They change the nature of the already-complex relationships among the owner/developer, consultants/contractors, and their subcontractors
- Simulation modeling software is generally acknowledged as lacking in its ability to accurately predict energy use
- They may require stipulations regarding operation of the building, which may be hard for an owner to guarantee at the time of contracting
- They would necessitate rigorous, contentious, and potentially costly verification of performance, since performance would be directly linked with financial gain or loss

The complexity of these challenges necessitates a concerted effort to systematically remove market barriers and to achieve broad adoption of performance-driven contracting.

Besides the belief that more of the project stakeholders should be involved earlier in an integrated design process, the main point raised in the stakeholder interviews relative to design related to potential resistance to new technologies and strategies. Facility staffs in particular are responsible for maintaining equipment and will need to address occupant complaints related to building systems, so they are understandably wary of new practices.

CLEAResult's research findings placed a very strong emphasis on the early phases of projects: the owner/developer's initial decision to create a high-performance building, and the team-forming/contracting approach. While CLEAResult has summarized themes, barriers, and opportunities related to later project phases in this report, these appear to be less critical at this time for increasing adoption of new construction best practices.

Recommendations

CLEAResult and NBI have developed a series of recommendations and suggestions for follow-up activities that can support increased adoption of high-performance new construction best practices. In accordance with the research findings, the priority areas for action are to:

- Conduct research and develop resources to support the business case for developing high-performance leased properties
- Establish a clearer means of recognizing the energy performance of newly-constructed buildings

- Conduct research on new construction teaming/contracting approaches across the Northwest, to establish the prevalence of DBB approaches
- Support expansion of utility program approaches that incentivize and support the integrated design approach
- Develop post-occupancy energy monitoring protocols that can be used to improve performance assumptions for simulation models
- Develop best practice guidelines, training, and resources to support integration of plug load management into the design process (including verification protocols)

The research under this project reinforced a view that the Northwest is a leader in developing high-performance new commercial buildings. A growing number of case studies and a growing workforce of experienced individuals are part of these projects. NEEA's efforts to promote industry best practices through BetterBricks and other resources have played key roles in advancing new construction in the region. The integrated design approach has been refined over time, and a wide range of technology options is available to support high-performance designs. NEEA is well-positioned to accelerate high-performance new construction practices across the region through development of programs and resources that reinforce the value proposition and equip market actors to successfully implement projects.

1. Introduction

This Market Assessment Report is intended to inform a comprehensive market characterization study and internal Northwest Energy Efficiency Alliance (NEEA) discussions on potential intervention strategies for the commercial new construction industry. This report highlights trends, barriers, and opportunities for high-performance new construction projects, with a focus on Oregon, Washington, Idaho, and Montana (the Northwest).

CLEAResult and supported by New Buildings Institute (NBI) ("the team") led the research for this project, which included three areas of activity:

- **Literature review:** A review of nineteen documents relating to commercial new construction practices, barriers, and opportunities
- **Market Data Summary:** A review of available data on a) trends and forecasts in commercial new construction and b) trends in construction of high-performance buildings. CLEAResult collected data on national trends and highlighted data specific to the Northwest states (Idaho, Montana, Oregon, and Washington) where available
- **Stakeholder interviews:** Phone interviews with twelve representatives from firms participating in commercial new construction in the Northwest, including owner/developers; architects; mechanical, electrical, and plumbing (MEP) firms; and contractors

This report documents the research methodology, findings, conclusions, and recommendations based on the research, with additional insights provided by the team.

2. Methodology

The team conducted research for this project between July and December 2014. The research methodologies for each task are summarized below.

2.1. Literature Review

The team intended the literature review task to target ten to fifteen documents that highlighted current practices, market penetration, market barriers, and opportunities relating to high-performance new construction. The team further intended the research to address, but not be limited to, the following topics:

- High-performance/zero net energy (ZNE) trends, barriers, solutions
- Project management, teaming, contract arrangements
- Codes trajectory
- Evaluation reports
- Primary research on market trends

The team conducted web research to identify suitable documents for review, using key search terms based on topic or author, browsing well-known resources such as NBI's own website and conference proceedings from the American Council for an Energy-Efficient Economy (ACEEE), and pursuing suggestions of the team and NEEA contacts.

The team collected twenty-seven documents and prioritized them in terms of relevance to the project. Given time and budget limitations, the team reviewed a total of nineteen of these documents and developed a summary table of key findings from each of them (Appendix A). The team synthesized the key themes from the documents and produced a Literature Review Summary Memo incorporating the summary table and the findings and themes (which have been incorporated into this report).

2.2. Market Data Analysis

The team established objectives for the market data analysis of documenting data relating to new construction trends and forecasts by segment, and determining the proportion of new construction that is high-performance. The team focused wherever possible on the Northwest and incorporated national datasets where relevant.

The team identified three sources that provided historical data and some forecasting of commercial new construction trends in the United States, including breakdowns by state. These were:

- United States Census Bureau (through 2013)
- McGraw Hill Construction (through 2013; forecasts for 2014-2015)
- The American Institute of Architects (AIA) (through 2013; forecasts for 2014-2015)

The team could not identify sources of forecast data beyond 2015.

Identifying data sources for high-performance buildings proved challenging due to a lack of reliable, comprehensive data and lack of an industry-accepted definition of "high performance." The most suitable data sources identified were:

- U.S. Green Building Council's (USGBC's) LEED-certified projects list
- Voluntary databases of high-performance buildings, including US Department of Energy's (DOE's) Energy Efficiency and Renewable Energy (EERE) High Performance Buildings Database, New Building Institute's (NBI's) High Performance Buildings Database, and the AIA 2030 case study database[1]
- Reports and other studies that discuss "green building" trends in more general terms

The team collated the data available from each of these resources cross-checked it for consistency where possible, and developed charts to highlight key trends. Given the lack of consistency in how data were reported and the incompleteness of datasets, the team made only limited attempts to combine data from multiple data sources into single charts.

2.3. Stakeholder Interviews

The team established a key objective for the stakeholder interviews of gaining first-hand insights from professionals who can directly influence performance outcomes for new construction projects. The team targeted owner/developers, architects, engineers, and general contractors for the interviews.

The team developed a list of interviewee targets in collaboration with NEEA with a goal of interviewing ten to twelve individuals. The list of interviewee targets was biased toward individuals known as leaders in the field of high-performance new construction, as well as some individuals from less high-profile firms.

In parallel with development of the interviewee target list, the team developed two interview instruments: one for individuals working for firms recognized as leaders in high-performance new construction, and a variant for individuals working for less high-profile firms. The latter variant de-emphasized energy-related issues at the beginning of the interview instrument so that respondents would not presume that energy was the sole focus of the interviews. The interview instruments were designed for a sixty-minute "guided interview" approach, allowing for discussion and exploration of issues as opposed to a rigid questionnaire format.

The team prioritized an initial list of thirty-seven interviewee targets in collaboration with NEEA, and recruited interviewees by phone between September and November, 2014. Several targets did not respond, but the team was able to schedule twelve interviews for October and November, comprising:

- Four architects
- Two owner/developers

[1] The EERE, NBI and AIA 2030 databases had significant overlap (i.e., buildings appearing in more than one dataset), so these were combined into one dataset.

- Three engineers
- Three contractors

Among these, three architects, both owner/developers, two engineers, and two contractors represented firms recognized as leaders in high-performance new construction (names of individuals and firms are not reported here). The interviewees generally responded very positively when they learned that NEEA was funding the project, and were complimentary about NEEA's role in the Northwest and its resources.

A single interviewer conducted the phone interviews, averaging about sixty minutes each, in October and November 2014. The team collated notes from each interview and grouped them by topic, and summarized key findings, recurring themes, and opportunities. The team included additional insights in the summaries of findings based on team members' related research and field experience.

3. Findings

This section summarizes the key findings from the literature review, market data analysis, and stakeholder interviews.

3.1. Literature Review

The literature review highlighted a range of barriers and opportunities, described below, related to high-performance commercial new construction. Notable gaps in the literature's coverage of the initial topics of interest are also mentioned.

3.1.1. Barriers and Industry Challenges

The literature review identified a number of fundamental business-related barriers to achieving high-performance designs on a large scale, and cited some approaches either currently operational or in the process of implementation for addressing some of these barriers. In contrast to high-level business barriers, some resources highlighted specific targeted needs. The interconnectedness of many of the issues meant that addressing any single barrier might not have a major impact in isolation. Barriers and industry challenges are briefly summarized below.

3.1.1.1. Cost and Business Case Barriers

Several publications cited perceptions of high costs for high-performance designs, although this is an oversimplification. The core challenge is around risk and return; high cost is less of an issue if the return is high and the risk is manageable. The literature cited the following related barriers:

- Lack of benchmark cost data for low energy and passive design features. This is particularly critical when considering several combinations of design options at an early design phase. Data is also lacking on expected design costs vs. lifecycle impacts (in other words, designing high-performance buildings is typically more expensive but pays off in the long term).
- Inadequate valuation methods for recognizing the enhanced asset value of high-performance buildings.
- Lack of accepted industry data for quantifying investment risks, such as performance benchmark data, data on the persistence of high performance, and data on financial performance. This issue is compounded by a lack of accepted measurement standards.
- In the absence of hard data, investing in high-performance designs requires a leap of faith, and many investors/owners are skeptical about the persistence of high-performance designs.
- Disconnect in expressing the financial benefits of more energy efficient designs. The energy efficiency industry typically uses percent savings relative to a reference value (such as twenty percent beyond code), whereas the commercial real estate community uses costs on a per-square-foot basis.
- The return on investment timeline may not align with investors' timelines for holding a property, as the payback period on many investments in energy efficiency is longer than the holding period for many development investors.
- The "split incentive" problem, in which the party that invests in the high-performance design does not directly benefit from the ongoing energy savings (where the tenant pays the energy bills). This issue may be resolved if the owner sees the return in the form of

higher rents, higher occupancy, shorter lease turnover time, and higher asset value, but data are not yet available to reliably quantify those benefits.

- Energy is not the primary concern for the owner during the design process. It may be part of an overall sustainability agenda which itself is a sub-part of the owner's overall project requirements.
- Adding to owners' concerns over financial risks is the additional risk in departing from the norm in terms of procuring design/construction services and managing projects. Departing from familiar practices can increase risk that the project will not meet budget, timeline, or performance targets.

3.1.1.2. Technical Barriers

The literature recognized zero net energy (ZNE) new construction as better-suited to some types of buildings than to others (considering factors such as climate or footprint-to-height ratio). The main technical barriers cited in the literature review centered on simulation modeling:

- Disconnect between modeled and actual performance. This could have several causes:
  - Suboptimal operations during occupancy
  - Inadequate modeling approach, for example using erroneous assumptions for plug load usage due to lack of industry data
  - Modeling tools do not adequately model certain low-energy or passive features (the literature review yielded no specific examples)
- Lack of skills and/or tools and/or budget to assess design options at the early design phase. Iterative modeling from an early phase is considered highly beneficial for a successful integrated design approach.

While modeling challenges may appear technical in nature, they can fundamentally affect the design and construction process in two ways:

- By modeling too late in the design process, the design team loses the ability to assess multiple configurations at an early stage of the process (in many cases simulation is only created once the design is completed, as a verification exercise)
- Model inaccuracy limits the ability of the owner to hold the designer (and others on the project team) accountable for actual building performance; the designer cannot reasonably guarantee energy performance for cases in which simulation tools/approaches are lacking.

The team also noted gaps in the lack of standard commissioning approaches and methods for successfully transitioning to the occupancy phase, despite the fact that energy codes have begun to address these issues in earnest in recent code cycles.

3.1.1.3. Barriers and Challenges Related to Codes and Policy

The literature often referenced codes and policies as means to drive higher-performance buildings. Many cities and states have implemented (or are in the process of implementing) energy-focused policies and are incrementally increasing the stringency of building codes. Similar to the business case barriers noted above, policy development is hampered somewhat by

a lack of reliable industry data to shape and justify policies. The literature review revealed the inconsistency of regulations and policies across the US.

A fundamental related barrier is the lack of industry-accepted definitions around high-performance buildings. Efforts are underway to define "zero net energy" (with some agencies using the term "net zero energy"), and ZNE-ready or ZNE-capable, but the literature review revealed no proposed timeline for developing universally-accepted definitions. The industry often uses the terms "high performance," "sustainable," and "green" with no specific definitions, although it often uses standards such as American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 as a reference point; for example, a design might be said to target fifty percent of the energy consumption of a building that meets ASHRAE's standard 90.1.

The literature review noted two barriers related to codes: First, that plug loads are typically unregulated by codes, and are becoming an ever-larger proportion of whole building energy use; and second, that codes are typically structured in a fairly prescriptive way that a) can inhibit design freedom and b) does not verify actual performance.

3.1.2. Opportunities

The literature review also identified a number of opportunities, briefly described below:

- Several publications mentioned integrated design as a means to "tunnel through the cost barrier." An approach that takes a baseline building design and adds isolated energy efficient features can see each added feature result in incremental added cost; in contrast, the integrated design approach takes a holistic view from the outset, considering the building as a whole, and can result in an optimized design that is more cost-effective overall.
- 18,600 new architecture jobs are forecasted between 2012 and 2022, a greater-than-average growth rate of seventeen percent annually. This provides an opportunity to intervene with students and junior architects to foster an integrated design ethos from the outset.
- One AIA publication suggested that innovation and entrepreneurship are typically being driven by small and mid-sized firms who can exert influence on the industry as a whole. This may offer the opportunity to program administrators to work with smaller, more agile firms to support shifts in the industry.
- The Energy Trust of Oregon's New Buildings program has been successfully implementing a Path to Net Zero pilot, which can serve as a replicable model for other utilities seeking to achieve deeper savings with their new construction programs.
- Owner feedback has indicated that tax deductions/credits and expedited permitting are attractive incentives for pursuing higher-performance designs.
- Although not yet industry-accepted, some data are emerging around financial returns related to higher-performance buildings, in terms of lower interest loans and pension fund investment interest. This is motivating a high proportion of Fortune 500 companies to give preference to certified buildings over non-certified buildings. Several research projects have indicated links between certified buildings and higher rents, occupancy rates, and tenant retention (based on LEED certification or Energy Star labeling).

- One publication stressed the importance of utilizing new contract arrangements that focus on accountability and shared benefits at the same time as creating standardized performance metrics that define and measure success.
- Some are exploring outcome-based codes as a way to allow more design freedom and to ensure performance after handoff to occupancy.
- AIA provides the "2030 Palette" toolkit for design professionals.
- AIA 2030 Commitment, Architecture 2030 Challenge, and the Living Building Challenge provide opportunities to further increase market awareness and provide market recognition for owners of high-performance buildings.
- Climate Action Plans such as those in Seattle and Portland can provide models for regional leadership to promote higher-performance buildings. This is particularly relevant for commercial real estate markets, where asset value is often strongly influenced by local market activity and tenant demands.
- The Economics of Change Project is developing an open source "Integrated Valuation Tool" that will account for the lifecycle impact of a building in a more holistic way.
- The literature cited a key success factor of setting an energy use goal early and to maintain focus on that goal throughout the design and construction process.

3.1.3. Literature Review Gaps

Although the following topics fit within the scope of the literature search, the team identified limited or no useful information on them within the task timeline:

- Trends in how projects are managed for high-performance buildings, compared with "typical" approaches
- Trends in design and construction contracting arrangements for high-performance buildings
- Long-term expectations of code stringency increases
- Prevalence of building information modeling (BIM) and expectations around whether it will grow in importance

Appendix A provides a summary table of findings related to each of the reviewed documents.

3.2. Market Data Analysis

Results from the market data analysis are summarized below.

3.2.1. Data Availability, Consistency, and Comprehensiveness

Publicly available sources of data on total construction spending are limited, and developing a reliable picture of new construction activity is hampered by several factors, including:

- Data most commonly being reported in dollars of construction activity rather than in square footage or number of buildings
- Lack of distinction in reporting dollars spent on new construction, renovation, or additions

- Lack of consistency between datasets regarding the building types included, such as private vs. public, nonresidential vs. commercial, and inclusion/exclusion of specific sub-sectors
- Limited data on a state-by-state basis
- No suitable construction forecasts beyond 2015 (the team identified one data source, but it was cost-prohibitive)

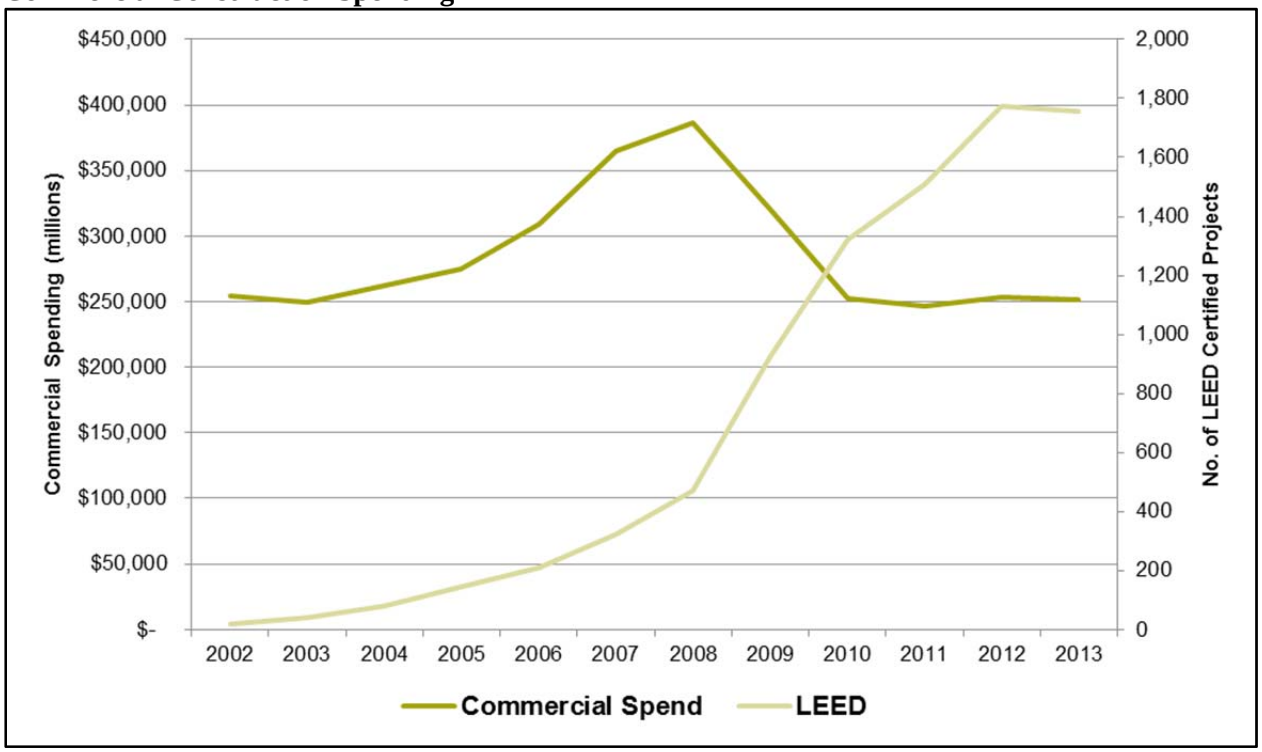
Finding reliable data on construction of high-performance buildings also proved to be a challenge. Reliable and comprehensive data are available for LEED-certified buildings, but beyond that, the available data lacked standard definitions and/or was incomplete. The team used reports from McGraw-Hill Construction, combined with analyses of three high-performance building databases and a database of LEED-certified buildings, to document high-performance building construction for this research.

3.2.2. Summary of Findings

The market data analysis identified the following key points:

- Following the decline that started with the Great Recession in 2008, commercial construction spending nationwide flattened out in 2010 and is forecast to increase for all building types through 2014 and 2015. In the Northwest states, Washington and Oregon have seen some year-on-year volatility since 2010 but all four states are generally trending upwards.
- The number of LEED-certified buildings nationwide has increased steadily for the last decade despite the major industry-wide impact of the Great Recession (Figure 2). Data for the Northwest shows LEED certifications relatively flat since 2010, suggesting that the Great Recession has had a greater impact regionally than nationally.
- Construction spending is highest in the education category, which is also projected to have the highest percentage of green construction projects.
- In the Northwest, construction spending is also high for government service buildings.
- The percentage of green construction nationally has increased from approximately ten percent in 2007 to fifty percent in 2013; this trend is likely to continue.

Figure 2. Number of LEED-Certified Projects in the US by Year of Certification and US Commercial Construction Spending



Source: United States Green Building Council (LEED projects data); United States Census Bureau (U.S. Commercial Construction spending data).

3.3. Stakeholder Interviews and Team Experience

The twelve stakeholder interviews yielded a diverse set of viewpoints and experiences related to commercial new construction. Perspectives from the design and construction experts interviewed encompassed the complete new-construction process from initial decision to build through to occupancy. The key findings from the stakeholder interviews are summarized below. Perspectives and experiences of the team are included where applicable.

3.3.1. Definition of "High Performance"

The interviewees had no consensus on the definition of a "high-performance building." The range of responses included the following:

- With regard to defining a high-performance building as achieving energy performance at a percentage value beyond building code or ASHRAE standard: three interviewees stated fifty percent beyond code/standard, one said thirty percent, and another said "twenty five percent is a good start."
- Some interviewees mentioned zero net energy (ZNE), ZNE-Ready (ZNER), and net positive energy as high-performance targets.
- Two respondents stated that energy use intensity (EUI) targets were irrelevant given that different building types would have different target EUIs, although in theory reference values could be established for different building types. One architect mentioned that an

EUI "in the low twenties" (referring to kBtu) can be considered high-performance; this value would equate to ZNER for a commercial office building.

- Some would consider certification from the International Living Future Institute (ILFI) as recognition of high performance, as long as the certification included the "Energy Petal."[2]

All interviewees who mentioned either building codes or LEED certification as high-performance characteristics noted that they were alone insufficient to designate high performance. While each has increased in terms of energy performance stringency over recent cycles of updates, the interviewees considered them a lower threshold and/or "a place to start" as opposed to a true high-performance benchmark. Notably, none of the interviewees mentioned the influence or potential impact of reach codes.

Several of the interviewees noted that the term "high-performance" should not be restricted to a measure of energy performance, and mentioned water and waste efficiency as two examples of additional metrics. In the team's experience, most new construction projects aiming for ZNE will be considering water, waste, and other factors in addition to energy.

One interviewee raised the subject of "healthy buildings" as a rising trend among building owners and managers.[3] The interviewee noted indoor air quality (IAQ) as the main performance aspect related to healthy buildings, and further noted the inherent tension between sealing buildings for energy efficiency and allowing sufficient ventilation for optimal IAQ. The interviewee cited Google as an example of an owner who has funded research on healthy buildings, including a three-million-dollar grant to the USGBC for healthy building materials research.[4] The interviewee perceived a risk that the energy efficiency industry might lose credibility among owners if it did not acknowledge the healthy buildings trend.

Interviewees also cited productivity and comfort as important to owners, although they mentioned no specific standards, data, or metrics in connection with those two factors.

Two interviewees noted that successful high-performance buildings should be achievable at little or no cost premium over typical building construction. One engineer referenced the report *Cost of Green Revisited* (Davis Langdon. 2007) as an example of research that concluded there is "no significant difference in average costs for green buildings as compared to non-green buildings." One interviewee recommended that industry awards programs (such as those of the AIA) provide greater recognition to projects delivered at a more reasonable cost, to help address the widely-held perception that high performance is available only at a significant cost premium.

3.3.2. Project Initiation

When discussing the motivators that drive initial decision-making for a new construction project, several interviewees highlighted the differences between owner-occupied and leased properties.

[2] More details on the International Living Future Institute certification is available at: http://living-future.org/node/91/#living

[3] McGraw Hill 2014 is an example publication on this topic

[4] Google-funded research is most prominent in the area of materials toxicity, which can have energy implications since higher toxicity drives demand for higher ventilation levels.

The value proposition of high-performance buildings is much greater for owner-occupied properties, as they directly benefit from the long-term operational savings. Public buildings are often guided by top-down mandates, as in the case with the General Services Administration (GSA). [5] One architect mentioned that issues can still exist in justifying high-performance designs for public buildings due to separation of capital and operational budgets. The team has also experienced this barrier, although it can often be overcome when the owner is excited about a project and/or has mandates. For developers of leased properties and any related investors, energy efficiency is often a lower priority than other core business needs such as:

- Achieving full occupancy as soon as possible
- Lease rate
- Market differentiation
- Asset disposition

One architect acknowledged that the industry has not found an effective way to reach developers of leased properties with high-performance design approaches. While numerous case studies on leased properties exist that highlight the benefits of high performance in terms of occupancy and lease rates, they lack high-quality data that can be used in the upfront planning process for an individual project.

Interviewees indicated that the majority of owner/developers express concern regarding energy efficiency and sustainability in general; the challenges are due less to a lack of concern than to a lack of willingness to invest additional first cost (where required) or to manage the risks associated with implementing a new design approach and newer technologies. Risk management is a critical factor for owner/developers, such as the risk that implementing innovative strategies and technologies increases the possibility of project delays. Making the financial case for high performance is currently receiving much emphasis; addressing risk management as a whole is important for driving greater market demand from owner/developers.

In terms of specifying performance levels for a building, one interviewee mentioned the Veterans' Administration (VA) and a major healthcare system (the name was kept confidential) as two rare examples of owners that have detailed performance specifications. GSA has also set guidelines. Most interviewees said that owners rarely have energy performance goals and will leave the detailed specifications to the architect; the owner's initial high-level requirement may be for LEED certification, and the architect is then responsible for defining the details. One architect gave an example in which the owner required LEED Gold and offered a bonus for achieving Platinum, and the architect intended to go even higher in terms of energy performance. Another architect mentioned that the City of Portland sets general a requirement for LEED Gold but sets specific targets on some individual LEED credits, thereby ensuring emphasis on those elements it deems most important. The interviewees generally felt that architects can have a strong influence on the performance of a design, but that in the absence of a strong vision and a champion on the owner side, achieving truly high-performance buildings can be difficult. A

[5] Further details on GSA's policies regarding new construction is available at http://www.gsa.gov/portal/content/104462

general contractor mentioned that the State of Washington was considering a policy that sets an EUI target for public buildings (State of Washington Department of Commerce 2011).

Interviewees acknowledged that some owners only want to meet code and nothing beyond; some may want LEED certification just to have the plaque for marketing purposes; and some may want "LEED-like" performance without having to pay for formal certification.

Several interviewees noted that establishing lifecycle cost analysis (LCCA) and other methods that encourage consideration of the total cost of ownership can strongly support any additional first cost for high-performance buildings, as these methods fully capture the long-term operational savings. This reinforces the earlier point that owner-occupiers are more likely able to justify a high-performance building compared with leased property developers. An architect suggested that leased property developers are unfairly cast as "bad guys" for not developing high-performance buildings. He urged the industry to provide a suite of energy efficient options that developers could justify using their own financial processes and metrics. Market research on local tenant demands constitutes another driving factor for leased property development; stimulating demand for higher-performance properties among tenants could therefore support commercial property developers in justifying their construction.

Two interviewees mentioned the new construction pro forma as a key component in justifying high-performance new construction, but only in general terms. For commercial properties, the pro forma[6] is a key document that can influence the design, and hence performance, of a new building. Although the interviewees did not clarify how building performance translates onto the pro forma, one developer talked of evaluating energy-efficient building features using the pro forma and another mentioned that increased occupancy and lower maintenance costs of high-performance buildings can be input to the pro forma (s/he gave an example that assumed maintenance costs for a multi-family property to be twenty-five percent lower than for a standard design). The same developer noted that high-performance buildings are more likely to sustain occupancy and lease rates during harder economic times given their greater attractiveness to tenants due to low energy costs and prestige.

The interviewees stated differing experiences with cost comparisons between high-performance new construction projects and projects using standard methods. Those who considered high performance to come at a higher first cost felt that developers needed to understand the additional value and long-term gains that would justify the additional cost. Others stated that the integrated design process can appear high-cost but results in fewer costly design changes later in the process. One architect noted that while some energy-efficient features can increase construction cost, these can be offset by downsizing or eliminating some pieces of equipment through the integrated design approach. One architect stated that owners will not pay architects more for high-performance design, but that architects could offset additional costs through utility and tax incentives.

[6] A pro forma documents the financial case for a new construction project. It is used as a communication tool among developers, equity partners, lenders, and other parties to the early decision-making processes. A pro forma has no single standard format, but in general they will encompass the key assumptions for the project, cash flow, and financial returns.

3.3.3. Contracting and Team Composition

All interviewees felt strongly that the "design-bid-build" (DBB) approach is not conducive to developing high-performance buildings, noting that it does not allow contractors to be involved at an early stage, and it splits accountability for project delivery. Interviewees suggested multiple potential approaches that can better support higher performance, such as design-build (DB) and the General Contractor/Construction Manager (GC/CM)[7] approach. One contractor noted a trend toward DB in the Seattle market and more GC/CM and "IPD-ish" (integrated project delivery) approaches in the Portland market, adding that each of the varied approaches can support the construction of a high-performance building. This aligns with the team's experience – the critical factor is to get the contractor, engineers, commissioning authority, and other key project stakeholders involved in the project from the early stages, which can be achieved via several different contracting and project management approaches.

An engineer discussed the challenge of shifting some large and/or institutional owners away from the DBB approach. While some individuals in the organization may support more collaborative approaches, the organization's culture may be deeply rooted in the belief that obtaining multiple bids is the lowest-cost approach, and this may be written into formal procedures (or even laws) that are difficult to change. One architect noted that addressing this challenge necessitates demonstrating through rigorous research that the full lifecycle cost impact of the DBB approach is higher than more integrated approaches. The team's experience in Oregon suggests that many institutions are already shifting away from a DBB approach toward DB, and that the trend may continue in the absence of research on cost-benefit analysis. Some institutions, such as healthcare facilities, avoid DBB in favor of integrated approaches so that they have the freedom to work with preferred MEP firms with specialized knowledge of their building systems and applications. In addition, some owners may continue to see DBB as an ideal option, for example retail owners who have developed a prototype store design intended to be replicated nationwide as cost-efficiently as possible using local construction firms.

Many of the interviewees emphasized the importance of getting as many of the project participants involved as early as possible, including the contractors, MEP firm, and commissioning authorities. Ideally these stakeholders should be involved at the schematic design (SD) phase or even earlier. The team selected the majority of interviewees for their experience working on high-performance building projects; they reported seeing more stakeholders being pulled into projects earlier. Several of the interviewees mentioned that commissioning authorities are typical on their projects. Two architects said that commissioning authorities are brought into the project at the design development (DD) phase, which helps to reduce costly fixes to designs later in the project. Another architect noted the value of the commissioning authority in verifying performance during the occupancy phase, but acknowledged that getting owners to pay for commissioning services can sometimes be challenging since the value proposition is not fully understood. The team's experience confirms this, more for leased buildings than for owner-occupied: developers feel that they are already paying for a building that works, so they are reluctant to pay an additional fee for commissioning.

[7] The terms "GC/CM" and "CM/GC" are used interchangeably. The former is typically used in Washington and the latter in Oregon.

Architect interviewees described owners' typical selection process for an architect. Larger organizations may have the capability to create a request for qualifications (RFQ) in-house, while other organizations may achieve this with the help of a consultant. Owner/developers often issue an RFQ without specific criteria related to building performance, except perhaps to request a "sustainable" building or a certain LEED rating; one interviewee mentioned that this creates challenges for high-end architects to differentiate themselves. A qualifications package may include the number of LEED-accredited professionals and/or a listing of LEED-certified projects, but as noted earlier, this is not considered a reliable metric for true high-performance buildings.

Three interviewees mentioned prior involvement with projects in which the contracts incorporated a performance target/guarantee. One architect said that his experience with performance targets indicated that they are a powerful tool for maintaining focus throughout design iterations, to ensure that energy-efficient features aren't eliminated through value engineering or other priorities taking precedence. An engineer noted the contractual difficulties of working with performance clauses, and that the performance contracting approach had gone in and out of fashion over the years. One of the biggest challenges of performance-based clauses is that the designer has no direct control over operations once the building is occupied. A general contractor reiterated the challenge with contracting in describing a project in which the firm guaranteed an EUI target for the building, saying that the contract had many "loopholes" and restricted how the building could be operated, making it potentially impractical for occupants. He also noted that, because his firm had a significant portion of its fee at risk due to the performance guarantee, it had to incorporate similar performance guarantees into agreements with its subcontractors to share that risk. As building codes and disclosure policies focus more on measured performance, the team expects performance targets to become more common.

3.3.4. Design Phase

Interviewee responses varied in terms of how energy performance is addressed through the design phase of a new construction project. As noted earlier, an EUI target is rarely set during the early specification or contracting phase, although interviewees cited Google and the GSA as examples of organizations that do take an outcome-based approach. Among those interviewees who had seen energy targets set during the design phase:

- An engineer said that energy-related issues can be raised from concept through to construction documents (CD) phase, and that late SD phase is common.
- An architect with a DB firm stated that a target EUI may appear on the Basis of Design, and as the design evolves it would be evaluated against that target.
- An engineer noted examples in which energy targets are developed based on the first round of simulation modeling.

The most significant design-related barrier, cited by several interviewees, is resistance among facility staff to incorporating new technologies and strategies (applicable to owner-occupied buildings where facility staff are known up front). Facility staffs are responsible for maintaining equipment and will need to address occupant complaints relating to building systems, so they are understandably wary of new practices. One interviewee cited air conditioning systems with

variable refrigerant flow (VRF) as an example of a system around which apprehension exists. Another interviewee mentioned naturally-ventilated buildings with no mechanical cooling; this case has a strong association between mechanically-controlled cooling and occupant comfort, and a high level of concern about eliminating cooling equipment from a design. One architect explained that as a result, a building may be designed for natural ventilation but still have mechanical cooling as a backup, thereby negating a potential source of construction cost savings. MEP firms are well-positioned to provide support and to ease concerns of facility staff around selecting newer technologies and approaches, as they communicate closely during a new construction project.

One engineer said that his firm uses non-energy benefits to help persuade owners to adopt energy efficient features, using the example of the better acoustic properties of naturally-ventilated buildings, which can be a strong selling point for owners. An architect made a similar point, noting that removing air conditioning ductwork can allow for a different floor-to-floor pitch and greater rentable area from a reduced-size mechanical room – both of which can be significant benefits to the owner.

Several interviewees mentioned that selecting new technologies and strategies in a design can artificially inflate construction costs. They said that installing contractors unfamiliar with new technologies such as radiant systems are more likely to inflate their costs in order to mitigate any risks from installation problems. One engineer suggested the greater prominence of this issue with contractors in areas away from major metropolitan areas such Portland and Seattle, given their more limited experience with high-performance buildings.

Building codes constituted a minor component of the interviews because it was noted early on by interviewers that building codes fall short of typical high-performance measures, although two interviewees did briefly discuss the impact of building codes on high-performance building design. A developer said that zone temperature specifications in code are too restrictive, making it harder to create designs with no mechanical cooling; he stated that code specifications based on handling extreme temperature conditions that may occur only a few hours in a year are overly restrictive. A general contractor noted that a code requirement for continuous rigid insulation means that the industry has had to move away from concrete sandwich panels to a less cost-efficient solution.

Other interviewee comments relative to the design phase included:

- Schedule is a big driver and can be a challenge for fully evaluating optimal design options.
- The SD phase typically involves narrowing down options from approximately twenty-five HVAC equipment options to three.
- While improving the building skin is often not cost-effective due to the Northwest climate, doing so can make the whole design cost-effective through an interactive effect on downsizing or eliminating equipment.
- By the fifty percent DD phase, a design team has set the fundamental design and made the majority of design decisions, with plug load circuits/management as an exception.

- Utility energy efficiency programs typically provide incentives for choosing higher-efficiency equipment, but not for eliminating equipment altogether through improved design approaches.

3.3.5. Construction Phase

The depth of discussion on the early phases of a project in many cases limited the remaining interview time for discussing the construction phase in detail. Most of the interviewees made the key point that early involvement in the project by construction contractors (through a DB or CM/GC approach) can mitigate many of the potential problems with construction.

Three of the interviewees raised the particular construction issue of infiltration. One noted that infiltration requirements were recently added to building codes, and that specifying and verifying infiltration can be challenging. One gave the example of enclosure construction touching on many trades; elements such as roofing, exterior walls, and glazing may be handled by different firms. As a result, responsibility for ensuring the air-tightness of the transitions between these enclosure elements may be unclear or omitted. Sealing responsibility must be clarified in contracts and drawing specifications. In the team's experience, this is critical; complete and detailed drawings and specifications will allow contractors to clearly understand their responsibilities.

3.3.6. Occupancy Phase

As with the construction phase, the interviews similarly allowed little time for discussion of the occupancy phase.

Several interviewees described their experiences with energy monitoring after occupancy. An architect felt that owners and architects' interest in energy monitoring is increasing, but that getting owners to invest in the necessary metering and software can be difficult. Adding to the cost perception barrier, the many current metering and monitoring options and the lack of standardization complicate the tool selection process for the interviewees. The complexity of this topic leads many interviewees to believe that energy monitoring can be obtained only at a high cost; in actuality, the team has seen solutions for approximately $1,500, a small amount compared to the overall construction cost. An architect experienced in verifying energy performance after occupancy said that his firm included the facility staff early in the development process to establish the metering and data needs.

A developer described how her firm has installed monitoring in buildings it has developed, and has successfully used that data to update its modeling assumptions for subsequent projects. She noted that on a recent project, the simulation model significantly over-estimated plug loads and lighting, and under-estimated heating load.

An engineer highlighted plug loads as an end use that needs focused attention. He commented that plug loads can constitute more than fifty percent of total building load for high-performance buildings. In his experience, plug loads have been absent from the scopes of work for any of the design/development team members. He acknowledged that this topic can be sensitive for leased

property developers since any plug load reduction measures built into the new construction process may impact future tenants' operations.

3.3.7. Promising Technologies and Approaches

The interviewer asked all interviewees what they considered to be promising technologies and strategies for high-performance buildings. The responses are listed below, divided into the broad categories of proven and more forward-looking technologies and approaches. Only one interviewee suggested each of these responses.

- Proven technologies and approaches:
  - Electro-chromatic glass
  - Energy submetering and monitoring
  - Controllable outlets
  - Hydronic/radiant systems (especially for mixed-use buildings)
  - Enclosure improvements to a level with no need for mechanical heating
  - Variable refrigerant flow (VRF) systems
  - High efficiency heat recovery units
  - Optimized building orientation
  - Heat recovery chillers
  - Natural ventilation

- Forward-looking technologies and approaches:
  - Dynamic facades, and tailoring facades to differing microclimates on different sides of a building
  - Photovoltaics integrated into facades
  - Phase-change materials
  - Heating and cooling people rather than spaces (heated chairs, for example)
  - Comfort bands

A contractor and an engineer mentioned ground source heat pumps (GSHPs) as promising, but only in limited cases (for example, some locations might be too rocky or have a high water table). Some interviewees highlighted the challenge presented by the lack of skills and funding for performing conductivity tests to assess the technical feasibility of using a GSHP.

3.3.8. Training and Education Needs

The interviewees' responses yielded no recurring themes related to training and education needed within their professions. Their identified training and education needs (each mentioned by only one interviewee) included the following:

- Training suggested by architects
  - Training for engineers on designing buildings with no mechanical air conditioning
- Training suggested by developers
  - Guidance and training on simulation model quality control
  - Education on new technologies, including cost and design implications
- Training suggested by engineers

  - Training on "comfort modeling," factoring in and evaluating design parameters that can improve occupant comfort
  - Training for building operators to manage high-performance buildings and new technologies
  - Education on plug load management for property owners and managers
  - Training for engineers and contractors on designing and verifying infiltration levels

Interviewees generally perceived that the Northwest has a high number of qualified individuals who can lead and support high-performance building projects.

3.3.9. Opportunities

The interviewer asked interviewees to suggest actions that would help to expand adoption of high-performance new construction best practices. Their suggestions generally focused on project initiation and the design phase, as summarized below.

- Project initiation
  - Offer tax incentives and bridging loans to lessen the impact of higher first costs for high-performance new construction projects
  - Address the owner/tenant split incentive problem for leased properties and encourage greater adoption of green leases
  - Conduct long-term research on twenty to thirty high-performance buildings, collect five years of data including qualitative surveys on health and comfort, and use the findings to demonstrate the full range of benefits. In particular, use these data to demonstrate that an integrated approach is the least cost long-term
  - Employ behavioral scientists to shift misconceptions around high-performance buildings, for example addressing the concern that removing mechanical heating/cooling equipment makes it harder to ensure occupant comfort
  - Collect data to demonstrate higher asset value, reduced cap rate, and other financial benefits that could be input into a project pro forma or other form of financial justification
  - Provide educational materials to owners/developers when permit is pulled
  - Develop educational materials and resources to support pro forma development for high-performance buildings

- Design-focused
  - Provide incentives for daylight modeling, LCCA, and early design charrettes
  - Evaluate the design process and drive out waste, for example through the use of BIM as a development and communication tool
  - Develop approaches and language for outcome-based contracts. Take a collaborative approach that also addresses the behavioral impact of taking additional risk on a new construction project
  - Enable wider sharing of tools and resources for design charrettes, and encourage their adoption by more programs
  - Evaluate code requirements to identify and address clauses that act as barriers for greater adoption of high-performance technologies and strategies

In addition to these specific suggestions, earlier interviewee comments may be used to infer opportunities and gaps that can be addressed to increase adoption of high-performance new construction best practices, such as early goal-setting and involving all key stakeholders early in the development process.

4. Conclusions and Recommendations

4.1. Conclusions

The literature review, market data analysis, and stakeholder interviews conducted for this project each provided a window into themes, barriers, and opportunities related to commercial new construction. Together these activities built an overall nationwide picture and created a deeper dive into practices and trends in the Northwest.

The diversity of issues raised through the research activities is noteworthy; they highlight the complexity of the overall picture and suggest the difficulty of finding approaches to increasing adoption of high-performance new construction best practices. The following three themes persisted throughout the research:

- Owner-occupied properties are far better positioned to accelerate high-performance new construction than are leased properties, primarily because the owner making the investment is in a position to reap the long-term operational savings for owner-occupied buildings.
- Data on the benefits of high-performance properties do not meet the needs of leased property developers sufficiently to justify the risks and/or cost premium.
- An integrated design approach involving key stakeholders (such as contractors, engineers, and commissioning authorities) early in the process is critical for achieving high-performance buildings.

The following sections summarize more detailed conclusions.

4.1.1. Definition of High Performance

Viewing the topic of high-performance building definition as a whole, the main points made by interviewees were:

- High performance is not restricted to energy use, and may include water and waste efficiency, health, comfort, and productivity.
- In terms of certification, a gap exists between LEED certification (acknowledged as only partially related to energy use) and ZNE building rating (such as from the Living Building Challenge). Many shades of high performance exist between those extremes with no industry-accepted means for recognizing them.
- Interviewees want to achieve and recognize high-performance designs developed with little or no cost premium over typical new construction practices.

At the high end of the performance scale, the Living Building Challenge appears to meet a need for a certification that a) encompasses more than just energy performance, and b) sets a ZNE target for energy performance. While LEED is the most widely-recognized commercial building rating for new construction, leading firms in the Northwest do not consider its highest certification level (Platinum) representative of high performance (the new release of LEED may shift that perception). A need clearly exists for a means to recognize those increments of high

performance between code compliance and ZNE. Interestingly, neither the literature review nor the stakeholder interviews addressed the topic of energy asset rating,[8] which is intended as a tool for recognizing energy performance increments in an industry-normalized fashion (similar to the way in which Energy Star's 1-100 scale has gained market traction over the last decade). Stretch codes and outcome-based codes were also virtually absent from the research findings.

4.1.2. Motivation: Owner-Occupied vs. Leased Properties

As noted above as one of the primary general conclusions, while sustainability is a common concern for many owner/developers, the propensity to act is distinctly different for owner-occupied and leased properties. Three main reasons explain the difference:

- For an owner-occupied building, the owner will reap the direct operational savings long-term (often twenty years or more), making the investment decisions more attractive and any risks more acceptable
- Public buildings experience a higher likelihood of top-down mandates to achieve high performance (as with the General Services Administration example)
- An owner-occupier is more likely to reap the benefits of enhanced branding and reputation than is the owner of a leased building, again making the investment more attractive

Owner-occupied buildings do, however, have their own challenges, as described below.

Leased properties have a primary challenge in that the financial value of high performance does not translate into the metrics that drive the initial investment decision by an owner/developer (and any third-party investors providing upfront capital). Past studies clearly document that the triple net lease structure, which is still dominant, gives rise to a "split incentive" because owners of leased properties do not reap the direct benefits from operational savings. The value of the asset (building) is the primary financial metric, and energy performance is not factored into property valuation at time of sale. While the literature reviewed has reported other benefits (such as lower vacancy rates and higher rents), the insufficiency of available data on these benefits impede investors' willingness to take on the risks involved.

Although the literature review and stakeholder interviews did not suggest that high-performance buildings consistently incur a higher first cost, owner/developers appear to consistently maintain that perception. A better understanding of the factors that drive first costs for high-performance new construction is crucial. Given that cases will occur with unavoidable cost premiums for high performance, financial data will be necessary to justify the additional investment.

4.1.3. Contracting and Teaming Approach

Stakeholder interviews and the team's experience strongly underscore the need to involve key team members (such as contractors, MEP firms, and commissioning authorities) as early as possible in the design phase. Doing so supports a more integrated design approach that can produce a more energy-efficient design and minimize costly late design changes and construction

[8] More information on the US Department of Energy's Building Energy Asset Score is available at http://energy.gov/eere/buildings/building-energy-asset-score.

problems. The team's experience is consistent with that of the stakeholders view that the design-bid-build (DBB) approach is not supportive of high-performance building development (with retail chains as a possible exception). Multiple alternatives to DBB, including the design-build (DB) and General Contractor/Construction Manager (GC/CM) approaches, can support high-performance new construction. The team did not find data regarding the prevalence of various contracting approaches; stakeholder interviews and the team's experience suggested a strong trend away from DBB in the Northwest, noting that the research sample set's bias toward high-performance new construction in major metropolitan areas. Some interviewees suggested that the DBB approach is still deeply ingrained in some organizations and may be written into organization procedures or even law. To continue the shift away from DBB, some interviewees recommended research to gather long-term data on lifecycle costs and non-financial data (such as occupant comfort and productivity) to demonstrate the benefits of more integrated approaches.

The research findings for this project suggest a very low incidence of contracts currently incorporating energy performance targets or guarantees. The literature review yielded no market data, and only one interviewee cited experience with performance guarantees. While this approach is attractive in theory, it raises several major challenges, including the following:

- It would change the nature of the already-complex relationships among the owner/developer, consultants, contractors, and their subcontractors.
- Simulation modeling software is currently unable to accurately predict energy use.
- It may require stipulations around operational parameters, which may be hard to fix at the pre-design stage.
- It would necessitate rigorous, contentious, and potentially costly verification of performance, since performance would be directly linked with financial gain or loss.

The complexity of these challenges necessitates a concerted effort to systematically remove market barriers and to achieve broad adoption of performance-driven contracting.

4.1.4. Design Phase

Aside from the earlier-noted belief that more project stakeholders should be involved earlier in an integrated design process, the interviews unearthed the main design-related issue of potential resistance to new technologies and strategies. The facility staff for owner-occupied properties, if involved in early design, may be very concerned about a) higher maintenance requirements and b) dealing with occupant complaints if performance problems arise. Interviewees also noted the perception that installing contractors may inflate their pricing for unfamiliar technologies and approaches in order to manage the risks they face, which may lead to the removal of promising technologies and approaches from a design.

The main design-related issues from the literature review centered on simulation modeling:

- Differences between modeled and actual performance due to either suboptimal operations, erroneous modeling assumptions, or inadequacy of modeling software for modeling certain low-energy systems
- Lack of skills and/or tools for assessing many different options at the early design phase

For the first issue, one interviewee cited successful efforts to monitor energy use during occupancy to continuously improve assumptions used in modeling.

Utility programs did not feature prominently in the research. One interviewee noted that utility programs typically provide incentives for higher-efficiency equipment, but not for integrated design approaches that might result in downsized or eliminated equipment. Several interviewees mentioned the benefits received from Energy Trust's New Buildings Program, particularly through design charrettes.

4.1.5. Construction and Occupancy

While the construction and occupancy phases also present challenges, the team's research very strongly indicated that owner motivation, project management/contracting approach, and design are much stronger determinants of building performance.

4.1.6. Workforce Development

While the research highlighted owner education as a means to help initiate and manage successful high-performance building projects, it did not feature workforce training as a strong area of need. While several of the interviewees made suggestions for training needs, no consistent themes emerged. This may indicate that the current supply of qualified firms is sufficient for current levels of demand – hence future growth in demand may dictate increased future workforce training needs.

4.1.7. Promising Technologies

Project teams have successfully demonstrated a variety of technologies and approaches in high-performance buildings; however, none of the approaches emerged from the research as the most promising. One theme in the stakeholder interviews addressed the linkage between improving enclosure sealing and the elimination of mechanical air conditioning and/or heating. They cited three barriers to naturally-ventilated buildings:

- Some climates in the Northwest are not suitable for eliminating mechanical heating or cooling
- Some building types , such as healthcare facilities, have tight restrictions on air quality
- Code requirements for space temperatures may be too restrictive to allow for natural ventilation

Several interviewees highlighted the increasing proportion of building energy use tied to plug loads, given that lighting and HVAC have traditionally been greater areas of focus. As a result, designers may need to increase focus on plug load management to support continued increases in building performance.

4.2. Recommendations

The team has developed a series of recommendations and suggestions for follow-up activities that can support increased adoption of high-performance new construction best practices. To the extent possible, the following suggestions are limited to activities that align with NEEA's resources and typical areas of activity.

4.2.1. The Business Case

The following are suggested as potential activities that would strengthen the business case for developers of leased properties:

- Support or lead a regional working group (or workshop) with participation from commercial real estate developers and investors, policymakers, architects, contractors, and other related stakeholders to establish specific, measurable goals that would make high performance an attractive investment for developers of leased properties.
- Conduct research to quantify long-term performance of high-performance buildings, both financial (market value, lease rates, tenant retention, vacancy rates, EUI and energy costs) and non-financial (productivity, occupant comfort and satisfaction, other health-related metrics). Focus on the metrics that:
    - Factor into the initial investment decision, including pro forma inputs
    - Can positively impact attractiveness of a property to a prospective tenant
- Conduct research to document cost metrics specific to high-performance projects in the Northwest, broken down by project phase and technology.
- Provide support to national and state-specific efforts to incorporate energy performance into commercial property valuation protocols, for example by supporting pilots, training, and outreach efforts in the Northwest.
- Deploy behavioral science-driven outreach/marketing approaches to address misperceptions such as:
    - High-performance buildings are significantly higher-cost than standard buildings
    - Eliminating mechanical heating/cooling would make it harder to ensure occupant comfort

While energy asset rating did not directly appear in the research, it may help to address some of the barriers through development of an industry-recognized performance scale based on building design, which in turn can support policies, programs, and market valuation approaches. NEEA should maintain communication with US DOE as its energy asset rating is deployed and provide support through pilots and outreach where applicable to NEEA's own objectives in the region.

Both leased and owner-occupied property development need to understand that LEED certification is not synonymous with high-energy performance, especially away from the major metropolitan areas in the Northwest. This may be addressed through outreach and greater recognition of projects that are truly high-performance, and could potentially be packaged with other resources that support regional approaches to promote high performance, such as local climate action plans, expedited permitting, and provision of educational materials when permits are pulled.

The research indicated a strong need to move away from the design-bid-build approach; some stakeholder interviews suggested that this trend is already happening. This issue may necessitate further research to determine whether specific actions are needed to accelerate the trend.

4.2.2. Contracting

The team recommends further research on performance-based contracting approaches, to determine the potential reach of the approach relative to the level of effort required to address the

many complex barriers. In the short term, greater benefits may be achievable through stimulating greater market demand and the encouragement of non-binding energy targets that support greater collaboration between design and development team members (see other recommendations in this report).

4.2.3. Design

NEEA's focus for over a decade on promoting integrated design has provided significant benefits, and it should continue its leadership in this area. Other recommendations relating to design are:

- Provide resources such as RFQ/RFP templates and training to support owner/developers in procuring high-quality design services, for example by emphasizing the value of past projects that have surpassed LEED Platinum and incorporated advanced features
- Conduct field research and building monitoring at the end-use level to help refine model assumptions for high-performance buildings
- Support Northwest utilities in developing program approaches that support some or all of the following:
    - Integrated design/design charrettes
    - Energy performance goal-setting early in the design (or pre-design) phase
    - Daylight modeling
    - Comfort modeling
    - Standardized project data collection protocols (such as cost and performance data) that can support region-wide data analysis and reporting
- Develop best practice guidelines, training, and resources to support integration of plug load management into the design process (including verification protocols)

4.2.4. Other Recommendations

The team suggests further study to identify barriers and recommendations related to the construction and occupancy phases, since the research under this project uncovered findings and recommendations strongly focused on project initiation and design. The following topics may be worthy of deeper exploration:

- Commissioning approaches for high-performance buildings, highlighting best practice protocols for the most common and/or problematic systems
- Verification of plug load management strategies and occupant needs
- Sub-metering and energy monitoring best practices
- Training needs for installing contractors regarding systems commonly used in high-performance buildings, such as radiant systems, VRF, air sealing, advanced lighting controls, and plug load controls
- Region-wide data needs to support development and long-term tracking of programs and policies that promote higher-performance new construction

The research under this project reinforced a view that the Northwest is a leader in developing high-performance new commercial buildings. A growing number of case studies and a growing workforce of experienced individuals are part of these projects. NEEA's efforts promoting industry best practices through BetterBricks and other resources have played key roles in

advancing new construction in the region. The integrated design approach has been refined over time, and a wide range of technology options is available. NEEA is well-positioned to accelerate high-performance new construction practices across the region through development of programs and resources that reinforce the value proposition and equip market actors to successfully implement projects.

5. References

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Appendix A – Literature Review Summary Table

Doc #	Title, Lead Author, Organization, Year	Overview of Study
1	AIA Foresight Report: The Changing Context, Business, and Practice of Architecture 2014. AIA. 2013	• After six years of recession the economy seems poised for a significant rebound, with unemployment falling and stocks, construction, and demand all returning to pre-crisis levels. • Among the market trends noted in this report, one references the Bullitt Center in Seattle as raising standards for improved environmental impact and promoting healthy lifestyles. • In the US, 53.6% of design firm leaders had a positive outlook on growth potential for 2014-2015. 42.9% expressed a neutral opinion, and 3.5% felt negatively. • Bernard Markstein, US Chief Economist at Reed Construction Data, stated "The combination of a growing economy and low long term interest rates will spur an increase in nonresidential building starts." • Technology is changing consumer expectations of access to information and options, putting pressure on businesses to find new ways of communicating and delivering value. Some firms are focusing more effort on marketing and new media to strengthen their value proposition and market awareness. • The bureau of labor statistics anticipates approximately 18,600 architecture jobs will be added to the US economy between 2012 and 2022, representing a greater-than-average growth rate of seventeen percent. • According to the AIA's 2013 Compensation Report, voluntary turnover rates at firms increased from 4.5 to 5.6 percent from 2010 to 2012 (higher for the largest organizations). • As part of an effort to attract talent, some firms are developing closer relationships with schools of architecture and design. • Much of the innovation and entrepreneurship is coming from small and mid-sized firms. Entrepreneurial firms are taking advantage of blogs, podcasts, and social media networks in order to provide knowledge, resources, and community for fellow small-firm architects and designers. AIA offers the Architect's professional Primer app and the Small Firm Exchange (SFx) convention track for small firms to network, collaborate, and provide useful resources. • The number of firms using performance analysis to inform design is set to increase. • ZNE design is mentioned in the report, but as a part of an overall movement toward sustainability, social responsibility, resiliency, and waste reduction.
2	The Economics of Change: Integrated Policy Approaches to Unlocking the Value of a Restorative Built Environment. Wright Chappell, Theddi. International Living Future Institute. 2013	• Our understanding and ability to fully capture the full economic value of an ecologically and socially responsible built environment has not kept pace with our knowledge and ability to design and construct it. Uptake has been hindered by the idea that building green means paying more without a corresponding increase in asset value. • Economics of Change project established in 2011 as an inter-disciplinary market transformation project under the leadership of the International Living Future Institute (ILFI, publishers of this report). • The Economics of Change Project is currently developing an "Integrated Valuation Tool" based on open-source software. The tool will be targeted for use by investors, lenders, valuation professionals, underwriters, policymakers, public and private project developers. • Market dynamics and financial accounting processes do not adequately account for externalities (such as environmental impact).

Doc #	Title, Lead Author, Organization, Year	Overview of Study
		• Anticipate that externalities will be aggressively addressed at local, national, and international levels through pricing (taxes and subsidies); regulation; performance standards; and other policy tools. • Critical point is that we can't decouple what we build from *where* and *how* we build. • Report presents the concept of "integrated value" which incorporates market value and net externalities. This is presented as a basis for valuation and appraisal approaches. Integrated value incorporate social, human, natural, built/manufactured, and financial capital. • Report recommends policies that have the following characteristics: o Transparency; o Foster a broader concept of value and evaluation; o Covering the full building lifecycle; o Unlocking value, e.g., Tying to tax incentives; o Work at multiple scales; and o Break down silos between social/health/ecological aspects. • Climate Action Plan (2009) co-developed by the city of Portland, OR and Multnomah County. Plan covers eight primary areas, of which Buildings and Energy is one. 2010 carbon emissions fell below 1990 levels. The Plan includes a goal to achieve ZNE in all new buildings and homes by 2030. • Seattle's Climate Action Plan first released 2006, updated twice (most recently in 2013). "Building Energy Plans" is one of four main target areas within the overall Climate Action Plan. • Joint report by AIA and the National Association of Counties (NACo) found that the preferred incentives for supporting green building and other sustainability efforts were: o Tax incentives; o Density bonuses; and o Expedited permitting. • The Economics of Change Project is looking at the Integrated Design Process (IDP) holistically so as to eliminate the perception of higher cost for sustainable new construction. The connection between upfront capital cost efficiency of sustainable features to the increased asset value of those features is a key component. Useful references cited: ANSI Integrative Process Standard for Design and Construction of Sustainable Building and Communities (2011), and the Integrative Design Guide to Green Building (2009). The ANSI standard features as a credit in USGBC's LEED Rating (V4). ULI has developed education modules on the ANSI standard. • Seattle permit applicants may opt for accelerated permitting program if they commit to utilizing the Integrated Design Process. • To overcome limitations in cost estimation for high-performance buildings (e.g., Evaluating benefits in isolation and ignoring the synergistic benefits from multiple interactive features), Weidt Group 2009 study proposed an integrated estimation method to arrive at lower perceived incremental cost for improved energy performance.
3	High Performance Buildings – Value,	• Defining the audience: o Owner/users: corporate, institutional, government;

Doc #	Title, Lead Author, Organization, Year	Overview of Study
	Messaging, Financial and Policy Mechanisms. McCabe, M.J. Pacific Northwest National Laboratory. 2011	o Investors: institutional, private, core, opportunistic, large, small; and o Large properties (>50,000 sq. ft.) are generally owned by institutional investors. • For real estate investors, owners, and financiers, investment analysis and decision-making are led by traditional bottom-line factors such as revenue, expenses, risk, and return, rather than by the narrower life-cycle cost analysis. • If the goal is to engage property owners in a way that motivates them to invest in the construction and retrofit of high-performance buildings, the message needs to be centered on the financial impact to the property and/or portfolio, focused on risk and return. • Broadly speaking, the industry judges the market risks associated with high-performance attributes to be greater than potential benefits. This judgment is based partly in reality and partly on cultural barriers, business norms, and competing stakeholder interests. The perception of value depends on the stakeholders, investment objectives, access to and cost of capital, property type, and lease structure. • To monetize energy savings, the savings must be bankable. To be bankable, the investment community must believe the efficiency is meaningful and will be persistent over time, or else they will not invest in or finance the improvements. • To forge common understanding and shared objectives, language needs to be broadened to incorporate financial and energy metrics in the same medium; for example, cost per kilowatt-hour needs to be translated easily to cost per square foot. • It is not just first costs or even a simple payback analysis that drives investment decisions. In fact, the process encompasses a complex set of variables, unique to each type of stakeholder and each decision maker individually. • What is a meaningful level of efficiency that will cause investors to stand up and take notice because they see an obvious impact on value? … ten percent efficiency gain is insufficient—there is too much room for volatility, and the absolute financial impact is not compelling enough. At twenty percent savings, investors will take notice, but they need to be convinced the efficiency and savings are durable. • If the goal is to align everyone's interests, then we must utilize new contracts that focus on accountability and shared benefits at the same time we create standardized performance metrics that define and measure success. • Integrated solutions start with a whole-building (or even district-wide) approach that incorporates advanced technology, ongoing commissioning, education, and training (operations staff and occupants), along with universally agreed-upon benchmarks, measurement standards, and mandated improvements in efficiency. When supported by financial incentives, modified lease structures, and cost/benefit-sharing that align stakeholder interests, these integrated solutions result in more rapid deployment of measures and in meaningful and persistent performance, thereby facilitating investment decisions. No single lever alone can rapidly drive meaningful change. • The inflection point that will enable efficiency to scale beyond the earlier adopters in the private sector is the intersection of tenants defining high-performance as industry best practice and an owner who believes they will receive enhanced leasing interest if they have a resource-efficient building. This point is further defined when owners recognize there is inherent risk due to the potential for competitive obsolescence, energy and resource price volatility, and pending regulation. • Industry is short on benchmarks and feedback mechanisms for the designers and builders. Without these tools, it is difficult to hold designers and builders accountable for ongoing building performance. And when we cannot measure

Doc #	Title, Lead Author, Organization, Year	Overview of Study
		overall building performance or hold people accountable, the entire design/construction process is likely to be driven by short-term economic considerations and local building codes. • Market linkage: There is a need to link high-performance and energy efficiency to the value of the property beyond that which can be achieved in operating savings (benchmark disclosure cited as an example, and energy asset ratings mentioned).
4	Industry Research and Recommendations for New Commercial Buildings. Hendron, Bob. NREL. 2014.	• Authors evaluated industry needs and developed logic models to support possible future commercial new construction research and deployment efforts that could be led or supported by DOE's Commercial Building Integration program or other national initiatives. Report was the outcome of a collaborative industry effort and comprehensive literature review. • Recommendations emphasize the energy efficiency component of NZE, or net-zero energy ready (NZER) buildings. • Definitions: o NZER: A building that includes all efficiency measures that are more cost-effective than renewable energy; o NZE: A building that generates as much source energy using renewable energy sources as it consumes on an annual basis, and complies with one or more of the class definitions in Pless and Torcellini (2010); and o Cost-effective NZE: A building that meets the definition of NZE. • Gap analysis resulted in five recommended high-priority focus areas and near term strategies that could be pursued at federal level: o Developing consistent, climate- and sector-specific energy benchmark data, at the whole building and system level. Whole-building targets for high-performance and NZER buildings may be derived from these data; o Enhanced modeling tools to support financial decision-making, whole building design, new technology analysis, model calibration, operational and behavioral factors; o Better cost data, at component and system level, to support ROI analysis; o Effective commissioning and operational strategies to ensure performance is attained and that it persists; and o Integrated resources, to include case studies, best practice guides, datasets, and tools in an easily accessible format.
5	Notes from the Trail: Checking in on the Path to Net Zero. Walker, Becky. PECI. 2012.	• Energy Trust's Path to Net Zero pilot (PTNZ), launched in 2009, was one of the first in the country to offer structured incentives to ZNE buildings to push innovative design and offset costs. The pilot sparked a lot of interest in professional design support and funding for technical studies, energy-efficient designs and technologies, and monitoring systems. • Plug loads become a more significant energy end use in high-performance buildings, due to the greater emphasis on HVAC and lighting in designs. • Costs will continue to decline for efficient technologies and contractors and designers will gain more experience with efficient systems, such as radiant heating and cooling, bringing the success of these projects within reach for an even wider array of buildings. At the same time, cutting-edge projects will continue to test emerging technologies and inventive occupant engagement strategies to reach net-zero and even net-positive energy use. Utilities and other entities should continue to encourage net zero and net-zero ready design aspirations through incentives, awards,

Doc #	Title, Lead Author, Organization, Year	Overview of Study
		design support, and information sharing. • Based on findings from the PTNZ pilot, early design and technical assistance has been expanded to encourage integrated design, iterative modeling, and additional energy-related studies. The program is exploring ways to integrate solar further into efficiency projects and promote solar-readiness. Program staff has gained experience with the development, modeling, and installation of innovative design ideas, such as radiant heating systems that are supplemented by solar thermal or geothermal preheating. Energy Trust is exploring offerings to encourage post-occupancy monitoring and building optimization, as well as supporting burgeoning net-zero and net-zero-ready initiatives in the market. • Energy Trust provided assistance and financial support for the installation of monitoring and reporting systems. • This paper concludes that project in this pilot program have demonstrated what is being discovered nationally- that net zero is within reach for a variety of building types, particularly small buildings. • The paper also includes four success factors that contributed to project success: o Established energy goals early and remained committed to those goals throughout design and construction; o Identified and successfully implemented design strategies that are not common in typical building designs in the United States by using an integrated design approach; o Found deeper savings by altering the requirements for space use, scheduling, temperature ranges, and occupant interaction; and o Installed technologies that are, for the most part, cost-effective and market ready. • Solutions provided in the PTNZ pilot benefited from the region's temperate climate.
6	Evaluation of the Path to Net Zero Pilot. Dethman, Linda. Cadmus. 2012.	• Participants of the PTNZ Pilot reported the highest satisfaction with the phase that focused their attention on energy efficiency and energy reduction targets. Program implementers agreed that setting targets, and finding out if they met them, helped nudge participants through the program. • Most participants said the Early Design and Technical Assistance incentives were essential for their participation and cited the financial incentive package as a particularly valuable aspect of PTNZ. • Challenges exist in meeting program requirements for cost- effectiveness on a measure-by-measure basis. Report recommends considering basing incentives on energy savings performance, and providing incentives in a way that helps building owners afford the package of measures to meet their energy goal. • Monitoring and reporting in PTNZ holds value for the broader high-performance building market, including building operators, but the requirements can be challenging for participants. Recommendation that program offers more prescriptive guidance. • Occupant and building operating behavior are likely to be a more important part of building performance in high-performance buildings than in other buildings, especially concerning plug loads. • Challenges exist in how to get highly efficient buildings financed and marketed, since they may be perceived as more expensive and risky to operate. • The popularity of more stringent approaches already in the northwest market, such as LEED certified designs, both aids and complicates the progress to net zero buildings.

Doc #	Title, Lead Author, Organization, Year	Overview of Study
		• While interest in net zero energy buildings continues to grow, the design and construction techniques needed to achieve net zero buildings are not widespread. For instance, these buildings require an integrated design process where the owner, design teams and other stakeholders evolve and agree on crucial aspects of the approach, and where expert energy modeling can show how efficiency can be maximized. Integrated design, however, is not standard practice for most new commercial buildings and especially not smaller ones. • Decision to participate in PTNZ pilot predominantly driven by the owner. • Main barriers to developing ZNE buildings: o Increased costs – real or perceived; o Reluctance to try new design techniques, systems, or technologies; o Perception of risk among developers that the public is not receptive; o Skepticism about reaching lofty goals or that "Net zero" can really be done; and o Lack of available data in the marketplace to justify risks.
7	Getting to Zero: Policies and Programs Presentation Slides. Hewitt, David. NBI. 2014	• California: California Public Utility Commissions ordered Big Bold Goals for New Construction; California Energy Commission sets path to ZNE codes in their bi-annual Energy Plan; Savings by Design Path to Zero program produced at least 30 ZNE or ultra-low energy buildings in four years; CalGreen (stretch code) supports ZNE code path; Executive order for new state buildings to be ZNE by 2025. • Vermont: Comprehensive Energy Plan says Vermont should establish a "…clear path to achieve a goal of having all new buildings built to net zero design by 2030." ▪ Washington State: Residential and nonresidential construction permitted under the 2031 state energy code must achieve a seventy percent reduction in annual net energy consumption (2006 code baseline). • Tucson and Pima County: Net zero certification will be issued after one year of performance demonstrates net-zero achievement. Meeting the requirements in either the prescriptive path or performance path shall be deemed to be in compliance. • Minnesota: Sustainable Buildings (SB) 2030. The purpose of SB2030 is to establish cost-effective energy efficiency performance standards for new and substantially reconstructed commercial and institutional buildings, meeting the goals of the Architecture 2030 program to achieve Net Zero Energy Buildings. • Minnesota's journey to NZE has been a long and winding road, called B3 which stands for "Buildings, Benchmarks & Beyond" — mapped by Legislature — financed through utility assessments $500,000/yr. for Guideline and Benchmarking tool maintenance and improvements. $500,000/yr. for SB2030 development and continued training and education. Utilities are also required to integrate their conservation programs (Energy Design Assistance) with these programs. • Impact of B3 Programs: 258 projects (including SB2030 projects). • SB2030 Program: o Forty buildings from 2009-2012 (over seventy as of 2014); o Savings of 250 million kBtus/year ($3.25 million); o B3 Benchmarking since 2004;

Doc #	Title, Lead Author, Organization, Year	Overview of Study
		▪ Over 7,500 buildings representing over 300 million SF in program; ▪ Identified over 1,500 building candidates for improvement; and ▪ Potential savings of 23 million dollars per year identified.
8	*Zero Carbon: Onward to Zero (ppt).* Eijadi, David. The Weidt Group. 2010.	• The "cost tunnel effect" theorizes that the cost of adding energy efficient equipment to a building increases as the design team tries to squeeze in more technologies. However, if your team can shape the architecture holistically while achieving efficiencies of at least seventy percent, the overall cost begins to go down. • Before beginning design, the "Net Zero Court" project team evaluated energy use data for similar buildings to set an energy efficiency target of eighty percent compared to a benchmark office building in the St. Louis climate region. Quantitative comparative analyses guided all decisions, major or minor, by explicating emissions data. Subsequent iterations refined the initial decisions and defined a solution that reached seventy-three percent energy use reduction with energy efficiency. • What did the project team learn? o Iterative analysis and commitment to performance-driven solution resulted in eighty percent savings with low added costs; o All-glass buildings are not the future of low-energy solutions; and o Future tenants will need to understand potential benefits of open offices and plug load limits… but high-ceilings and emissions story enhance PR/Marketability. • What did the project team learn about the design process: o Model, Measure, Manage; o Cost Trading; o Every BTU counts: No silver bullet; and o Integrated role of team players is essential. • Different results require a new formula: performance-based process is the future.
9	*Spatial penetration and performance of LEED ratings & certification levels among office buildings.* Dermisi, Sofia. W. E. Heller College of Business, Roosevelt University. Date unknown (2010 or later).	• Some key driving forces behind LEED construction are i) lower interest rates for construction & permanent loans; ii) increased likelihood of financing by certain banks; iii) pension funds investment interest; and iv) policies of the vast majority of fortune 500 companies, which show an increasing preference toward LEED over non-LEED buildings. An increasing number of senior executives are embracing sustainability as one of their priorities even for leasing space - something lacking three to five years ago. • The adoption of green strategies and LEED for office buildings has also some financial challenges for both new and existing facilities: o Although a high-quality LEED certified project can be developed with nominal cost it won't save money in the long-term operation of the facility. Only the adoption of base building systems controls (such as heat-exchangers, displacement air systems, double wall systems, active shading systems, motion sensors for lighting etc.) can save money in the long-run but they come with an upfront premium; o In cases where structures need to be demolished/rebuilt and/or the site needs to be mitigated, disposing the various material in an environmentally friendly way can also be costly;

Doc #	Title, Lead Author, Organization, Year	Overview of Study
		o From an operating budget standpoint the upfront capital required for the LEED certification might take more than three years to pay back, which can possibly exceed the developer's holding period and create a disincentive; o The cost savings cannot be determined yet because of the lack of: ▪ Significant number of LEED buildings with historical information and documentation; ▪ Documentation on the cost savings received separately by the tenants and the building; ▪ Documentation on the changes of employee sickness patterns in LEED compared to non-LEED buildings; and ▪ The disparity between who pays for most of the LEED certification and who reaps the benefits is a major influence on decisions. • A series of other recent studies focused on comparing "green" buildings (LEED and Energy Star rated) with a control group of buildings with similar but "non-green" characteristics in the US. Results indicated that rents/sf and sales prices were roughly three percent and sixteen percent, respectively, higher for the "green" group, while earlier studies by Miller et al. and Fuerst and McAllister indicated larger differences between the two groups. • The paper indicates the penetration of LEED in the overall market at about nine percent over a ten-year span (the first property certified in the dataset was in October, 2000). • The application of various financial incentives (by state, utility and local government) on energy efficiency indicates that green building incentives among others increase rent levels both before and after a property becomes certified.
10	Net Zero and Living Building Challenge Financial Study. Cortese, Amy. NBI. 2013.	• The purpose of the *Net Zero and Living Building Challenge Financial Study: A Cost Comparison Report for Buildings in the District of Columbia* was twofold. First, to investigate costs, benefits and approaches necessary to improve building performance in the District of Columbia from LEED Platinum to zero energy, zero water and Living Building status. Second, to advise District government on policy drivers related to deep green buildings and to analyze the opportunities for the District to offer incentives to advance most rapidly toward zero energy, zero water and Living Buildings. • A new policy framework is required if the building industry is to embrace net zero and Living Buildings at scale. To accelerate adoption, this research suggests the District develop a comprehensive roadmap that addresses all of the following issues over time and illustrates a clear pathway to the District's aggressive 2032 goals. The roadmap should consider these key recommendations from the study: o Define net zero. Develop a clear and achievable definition of net zero in the District. In any net zero energy definition, policy makers should focus on energy efficiency and include a healthy balance of renewable energy production. Energy use and production should be verified with measured performance results; o Consider community-level approaches. Boundaries that move beyond the building to multiple buildings or communities should be considered. Community approaches to energy and water (sometimes referred to as "district systems") are an effective way to address the challenges uncovered in this research. Individual buildings can benefit from economies of scale associated with community-based solutions. By connecting buildings, waste energy and water in one building can be utilized by another; and o Encourage transition to outcome-based energy codes. Use benchmarking and disclosure data to set outcome-based energy targets set within a scaled framework to encourage and focus designers, owners, operators and

Doc #	Title, Lead Author, Organization, Year	Overview of Study
		occupants toward an end result of ultra-low energy use. Future green building policies and incentives can be aligned and directly tied to this outcome-based energy target. Despite advancements in energy codes, without fundamental alterations, current codes may not facilitate net zero energy for a number of reasons. First, codes do not regulate all energy use in a building and the unregulated loads are becoming an increasingly large portion of total energy consumption. Additionally, as NBI's Sensitivity Analysis suggests, codes only regulate the design aspect of buildings, yet operations, maintenance and occupants have a significant impact on ongoing energy use. Also, code compliance can be established by prescriptive measures such as insulation levels, window performance and equipment efficiency. However these elements may omit many elements of building design that have a significant impact on energy use, such as orientation and massing. Finally, current codes allow the use of energy modeling to demonstrate compliance, however, varying assumptions lead to different results and may not accurately predict net zero outcomes. While it may seem counterintuitive, codes do not always encourage the most efficient building possible. For example, buildings with an efficient air conditioning system may perform much "better than code" compared to a passive building designed to eliminate the need for air conditioning through the use of thermal mass, shading and natural ventilation. This is because in code modeling, a passive building is compared to a hypothetical building with no air conditioning, while a building with an efficient air conditioning system is compared to a building with the least efficient system that can legally be installed under the code.
11	Roadmap to zero emissions. Architecture 2030. 2014	• Between 2011 and 2030 population growth in urban areas is forecast to absorb total global population growth. • Action items call for new buildings and renovations to meet EUI targets below the regional average for each building type. Targets: o 2016: 70% below average; o 2020: 80% below average; o 2025: 90% below average; and o 2030: Carbon neutral. • Roadmap calls for a "Building Sector Financing Facility" to be established through the Green Climate Fund, green infrastructure bonds, and other initiatives. • The US Energy Independence and Security Act calls for new federal buildings and renovations to be carbon neutral by 2030. • The "2030 Palette" has been developed as a toolkit for design professionals, providing guidance at a range of levels, from regional planning to individual buildings. • To date, the 2030 Challenge and the AIA 2030 commitment have been adopted and implemented by: o Eighty percent of the top ten, and seventy percent of the top twenty A/E/P firms in the world; o Fifty-two percent of all US architecture firms; and o Government agencies at all levels. • "Urbanism + 2030" is implementing the 2030 Challenge for Planning, a set of performance targets. • AIA + 2030 Professional Series is a ten-part training program providing design and technology applications (ten, 4-hour sessions).

Doc #	Title, Lead Author, Organization, Year	Overview of Study
12	Achieving scale in the US: A view from the construction and real estate sectors. The Economist Intelligence Unit. 2013.	• Barriers: Energy efficiency regulation in the US is patchy, confusing and inconsistent. Building codes and other policies often differ between states—and sometimes within them. This leads to a suboptimal situation in which the vast majority of US companies manage energy efficiency at the building level rather than at the portfolio level. • Attractive: Innovative financing offers opportunities to achieve greater scale. Aggregating projects across and within sectors through green banks and large mortgage financing organizations allows for a more efficient allocation of capital and would likely attract large institutional investors. • Challenge: Both the public and the private sectors must work to address the data challenge. Data on energy efficiency performance are limited, unshared and often inconsistent between measurements. Creating a supply of standardized data on the energy and financial performance of projects will help institutional investors to choose investments based on risk profiles and will also facilitate comparison of the energy efficiency performance of investments. • Benefits of energy efficiency beyond cost savings include higher occupancy rates and higher tenant retention.
13	Evaluating Direct Energy Savings and Market Transformation Effects: A Decade of Technical Design Assistance in the Northwestern USA. Val Den Wymelenberg. Idaho Integrated Design Lab. 2012.	• Documents impacts of multi-state design assistance program 2001-2010. Direct energy savings: 626 buildings, 51,262,000 sq. ft., 45.3aMW, and 265,738 therms. • Evaluation started from a pool of 722 buildings. Note: due to changes to project database in 2005-2006, data from many earlier projects was lost. • Defined seven distinct aspects of integrated design (ID), and used these to describe the “level of integrated design” (in percent) that each of the projects went through. 1. Design team established performance goals and compared them to building design; 2. Design team worked outside of normal disciplines to exploit synergies between climate, use, building and site design, system selection/design; 3. Energy efficiency related analyses were completed to inform design decisions; 4. Design team considered climate as a resource; 5. Design team considered whether occupancy schedules and comfort criteria were malleable; 6. Building was designed to create small loads; and 7. System design matched to actual loads o Savings estimates were analyzed vs. the “level of integrated design,” ie. How many of the seven ID aspects were included in the project. Savings ranged from 8.1% to 32.5%, but report’s conclusions note low correlation coefficients between percent ID and savings, and recommend more research in this area. • University of Oregon and University of Idaho labs consulted on over 230 projects, resulting in an estimated 9,700+ contact hours of project-based education. In addition 146 presentations resulted in over 8,700 contact hours of professional education.
14	Integrated cost estimation methodology to support high-	• Breaking Barriers: Using energy modeling to drive design decisions earlier in the design process has long been recognized as an effective way to increase the energy performance of building design. With this in mind, several utility sponsored Design Assistance programs in the Midwest region expanded their scope to provide comparative energy analysis of design options as early as the building programming portion of the design process. These utility programs

Doc #	Title, Lead Author, Organization, Year	Overview of Study
	performance building design. Vaidya, Prasad. The Weidt Group. 2007.	attempt to influence decisions that significantly impact the energy performance of the designed building. To be effective for market transformation, these programs need to provide incentives for more energy-efficiency decisions that occur in the conceptual stages of design. To calculate savings in a utility program and provide incentives that can be defensible, a fair and consistent baseline protocol is needed. Appendix G to ASHRAE/IESNA Standard 90.1-2007 is currently the most robust energy modeling protocol that can be used by such incentive programs and rating systems. However, this protocol does not provide adequate baseline criteria to evaluate early design decisions, such as building shape, glazing and skylight area and programmatic efficiency. To enable the calculation of savings and incentives, Appendix G needs to be expanded to provide additional baseline criteria. • Utility sponsored energy efficiency programs can promote lower-energy options through equipment incentives and consulting investments, if a consistent, fair and industry-standard baseline can be used for the calculation of savings. • This paper proposes the following modifications to Appendix G (ASHRAE/IESNA Standard 90.1-2007) based upon multiple project studies: o Baseline building shape parameters should be set for the 32 building types of Standard 90.1, so that architectural designs can be compared against a common baseline. Shape parameters include number of floors, floor to floor height, maximum floor plate depth and a method to create an orientation neutral shape for any given floor area. This paper gives an example of such a method; o This adjustment to the Appendix G protocol will allow utility incentive programs and other rating systems to recognize and provide incentives to a broader range of architectural energy conservation measures. These architectural measures often demonstrate savings that persist longer in the building than many engineered system strategies. In addition, market transformation; and o Programs that use a robust industry-standard protocol tuned to promote low energy consuming architectural design.
15	*Effective intervention Points for the Building Sector*. Architecture 2030. 2010. 2-page brief on Architecture 2030 website	• "Intervention points" means the points where major transformations can most easily take place. • Beyond energy code policy, design tools and financial incentives are key for effecting change. • Financial incentives for the commercial sector are best implemented through tax deductions and tax credits.
16	High Performance Buildings Measured Performance and Key Performance Indicators. Cortese, Amy. NBI. 2013	• Research on twenty-two high-performance buildings in California found they performed much better than the national average per building type. Of those eligible for an Energy Star score, over seventy percent were in the top ten percent of like-type buildings nationally. But the research found little correlation between a building's actual measured energy performance (EUI and Energy Star score) and ratings such as LEED energy points that represent estimated energy performance. Compared to similar buildings in the CEUS database, many failed to achieve their original *estimated* high-performance design goals. These findings further demonstrate that there is often a discrepancy between expected energy performance and actual measured outcomes.

Doc #	Title, Lead Author, Organization, Year	Overview of Study
17	Final Program Report: Evidence-Based Design and Operations PIER Program: Improving the Real World Performance of Commercial Buildings. Higgins, Cathy. 2013.	• The California Energy Commission Energy Research and Development Division supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace. • *Evidence-based Design and Operations Final Program Report* is the final report for the Evidence-based Design and Operations PIER Program (contract number 500-08-049) conducted by New Buildings Institute (NBI). The information from this project contributes to PIER's Buildings End-Use Energy Efficiency Program.
18	Data Needs for Achieving High Performance Buildings. National Institute of Building Sciences. 2011.	• Purpose of study: Despite the push to achieve high-performance by building community leaders, policymakers and building owners, such attempts will stall unless all members of the building team trust the data demonstrating achievement of the intended results or identification of problems identifying necessary adjustments. This trust is built on the availability of credible data.
19	Building Energy Codes Program National Benefits Assessment, 1992-2040. Livingston, OV. Pacific Northwest National Laboratory. 2014.	• No insights relative to this literature review

Appendix B: Phone Interview Guide

Interviewees with high performance buildings experience

Introduction
Thank you for agreeing to be interviewed for this project. The goal of this call is to document your experiences and perceptions of commercial new construction as they relate to high performance buildings. We are looking for your input from two angles: firstly to gain from your specific experiences, and secondly to get your thoughts on general industry practices.

This call is intended to last 45 minutes, and will follow a guided interview format that allows us freedom to hone in on specific areas rather than following a prescriptive questionnaire approach. This is one of many interviews we are conducting on behalf of NEEA to help inform their future initiatives around commercial new construction. We are not recording this interview, and will not be using any direct quotations in any published documents.

The following sections provide an outline discussion structure. The general approach is to ask open questions and explore more deeply based on initial responses.

Interview

What would you consider a "High Performance Building"?

Can you please give an example of what you consider a HPB
Possible follow-up: what level of performance is required? Performance relative to what (code baseline, absolute metric, EUI, etc.)?

Initial decision-making, planning & contracting phase

1. Which individuals (roles) do you see as most instrumental in making the initial decision to build a high performance building?
2. On what basis is that decision made?
    a. May include discussion of specific financial decision-making tools / practices, and motivating factors for decision-makers
3. Who else provides input to the upfront decision-making process?
4. What are the most critical obstacles in making the initial decision to build a high performance building?
5. What opportunities do you see for overcoming those obstacles? For each of these topic areas, what are the key factors that can encourage high performance building?
    a. Contracting
    b. Financing and proforma development
    c. Development of Owner's Project Requirements

Design phase

6. At what point in the design phase are the energy aspects of the design typically first addressed?

7. What skills in high performance design are the hardest to find or most expensive to obtain, either as staff to hire or as subcontractors?
8. What are the key decision points in the design process that drive a building's performance?
    a. What are the decision makers and advisors at those points?
        i. Involvement of MEP firms, construction firms, commissioning providers, technology providers?
    b. On what basis are decisions made?
9. What are the most promising high performance strategies & technologies, and what is holding back broader adoption?
10. It has been reported that high performance designs are more costly during the design phase, and that this is a barrier for owners –
    a. Would you agree?
    b. How could this barrier be addressed?
11. What skills and education gaps exist for architects and designers to be able to design HPBs?
12. What do you see as the best ways for addressing those gaps?

Construction phase

13. Once a high performance building has been designed, what are the major barriers in constructing that building to meet the design requirements? (while avoiding excess cost)

Occupancy phase

14. What do you see as the main barriers to achieving and maintaining energy performance goals once the building is turned over to occupancy?
15. What strategies do you think can overcome those barriers?
16. Have you been involved in measurement and verification of performance goals, and if so do you have any best practice recommendations?

General

17. What market sectors do you think are most ready to ramp up adoption of high performance design?

18. Other than those already stated, what tools and resources would most benefit the industry in adopting high performance buildings?
19. Other than those already stated, what training and education gaps to you see in the industry?
20. How do you foresee codes and policies (such as energy performance disclosure mandates) influencing broader adoption of high performance buildings?
21. What one or two changes to the market would make the most difference in increasing demand for HPBs?

Interviewees without known high performance buildings experience

Introduction

Thank you for agreeing to be interviewed for this project. The goal of this call is to document your experiences and perceptions of commercial new construction. We are looking for your input from two angles: firstly to gain from your specific experiences, and secondly to get your thoughts on general industry practices.

This call is intended to last 45 minutes, and will follow a guided interview format that allows us freedom to hone in on specific areas rather than following a prescriptive questionnaire approach. This is one of many interviews we are conducting on behalf of NEEA to help inform their future initiatives around commercial new construction. We are not recording this interview, and will not be using any direct quotations in any published documents.

The following sections provide an outline discussion structure. The general approach is to ask open questions and explore more deeply based on initial responses.

The initial decision-making processes

1. Which individuals (roles) do you see as most instrumental in making the initial decisions that will influence a building's design?
2. On what basis are those decisions made?
    a. May include discussion of specific financial decision-making tools / practices, and motivating factors for decision-makers
3. Who else provides input to the upfront decision-making process?
4. What are the most critical trade-offs that are made during the pre-design phase?
    a. Can follow up to talk about relative priority levels given to design cost vs. construction cost vs. innovation-related risks vs. eventual operating costs, etc.

Planning & Contracting Phase

5. For each of these topic areas, can you describe what you consider to be standard industry practice?
    a. Contracting
    b. Financing and proforma development
    c. Development of Owner's Project Requirements

Design Phase

6. What design skills are the hardest to find or most expensive to obtain, either as staff members or as subcontractors?
    a. If response doesn't mention energy-related skills, ask them about that
7. What are the key decision points during the design process, and what are the priorities and trade-offs that arise when those decisions are being made?
    a. Who are the decision makers and advisors at those points?

        i. Involvement of MEP firms, construction firms, commissioning providers, technology providers?
    b. On what basis are decisions made?
8. What are the most promising technologies for commercial buildings, and what is holding back broader adoption?
9. At what point in the design phase are the energy aspects of the design typically first addressed?
10. How often, if at all, are you given energy targets?
11. What would you consider a “high performance building”?
12. When choosing design firms and design approaches, what is the typical approach to determining design cost vs. value?
13. What skills and education gaps exist for architects and designers?
14. What do you see as the greatest opportunities for addressing those gaps?

Construction Phase

15. Once a building has been designed, what are the major barriers in constructing that building to meet the design requirements? (while avoiding excess cost)

Occupancy phase

16. Have you been involved in projects where energy performance was verified at the point of handoff to occupancy or during the occupancy phase?

General

17. Other than those already stated, what tools and resources would most benefit the industry for constructing new commercial buildings?
18. Other than those already stated, what training and education gaps to you see in the industry?
19. What one or two changes to the market would make the most difference in increasing demand for high performance buildings?

Appendix C: Data Analysis Summary Memo

CLEAResult

Commercial New Construction Market Data Analysis

August 15, 2014

PREPARED BY Cindy Strecker, Eliot Crowe, Becky Walker, Jay Olson

PREPARED FOR NEEA

Overview

PECI is developing a Commercial New Construction Market Assessment Report for NEEA that will help inform a comprehensive market characterization study and internal NEEA discussions on potential intervention strategies for the new construction industry. The Report will highlight trends, barriers, and opportunities for high performance new construction projects.

Task 1 for the Market Assessment project involves background research in the form of a literature review, analysis of market data, and documenting insights from first hand experiences of PECI and New Buildings Institute (a subcontractor on this project). This memo summarizes the outcomes of PECI's market data analysis activities, which were focused on how trends in constructing high performance buildings compare with new construction overall.

The Market Data Summary is the outcome of a review of available data on [a] trends and forecasts in commercial new construction, and [b] trends in construction of high performance buildings. We collected data on national trends and highlighted data specific to the Pacific Northwest states (Idaho, Montana, Oregon, and Washington) where available.

Data Availability, Consistency, and Comprehensiveness

There are limited publicly-available sources of data on total construction spending, and developing a reliable picture of new construction activity is hampered by several factors, including:

- Data being reported most commonly in dollars of construction activity rather than square footage or number of buildings;
- Lack of distinction in reporting dollars spent on new construction, renovation, or additions;
- Lack of consistency between data sets regarding what building types are included, e.g. Private vs. public, nonresidential vs. commercial, and inclusion/exclusion of specific sub-sectors;
- Limited data on a state-by-state basis; and
- No suitable construction forecasts beyond 2015 (one data source was identified but was cost-prohibitive).

Reliable data on construction of high performance buildings also provided challenges. Reliable and comprehensive data is available for LEED-certified buildings, but beyond that the available data lacked standard definitions and/or was incomplete. Reports from McGraw-Hill Construction, combined with analysis of three high performance buildings databases[1] and a database of LEED-certified buildings were the sources used to document high performance building construction for this research.

Summary of Findings

The following key points were identified through the market data analysis:

- Following the decline that started in 2008 due to the Great Recession, commercial construction spending nationwide flattened out in 2010 and is forecast to increase for all building types through 2014 and 2015. In the Pacific Northwest states, Washington and Oregon have seen some year-on-year volatility since 2010 but all four states are generally trending upwards.
- The number of LEED certified buildings nationwide has increased steadily for the last decade despite the major industry-wide impact of the Great Recession that started in 2008. Data for the Pacific Northwest shows LEED certifications relatively flat since 2010, suggesting that the Great Recession has had a greater impact in the region than nationally.
- Construction spending is highest in the Educational category and is also projected to have the highest percentage of green construction projects.

[1] Published and maintained by the U.S. DOE, the American Institute of Architects, and New Buildings Institute

- In the Pacific Northwest, the building types with the most construction spending include education and government service.
- The percentage of construction that is green nationally has increased from approximately 10% in 2007 to 50% in 2013 and this trend is expected to continue[2].

[2] It should be noted that the data on percentage of construction that is green may not use a definition of "green building" that is aligned with NEEA's definition of "High Performance"

National Construction Trends and Forecasts

Three data sources were identified that provided historical and some forecasting of commercial new construction trends in the United States. These are[3]:

1. United States Census Bureau;
2. McGraw Hill Construction; and
3. The American Institute of Architects.

Each of these is discussed in the following sections. For the purposes of this report, commercial construction is assumed to include public and privately funded nonresidential building construction that includes: lodging, office, commercial (grocery, restaurants, retail, etc.), health care, education, religious, public safety, and amusement and recreation. Excluded construction types include transportation (such as runways and passenger terminals), communication (television buildings and structures), water and waste water treatment plants, and manufacturing. See Table 2 for additional information on building types included in this research.

United States Census Bureau

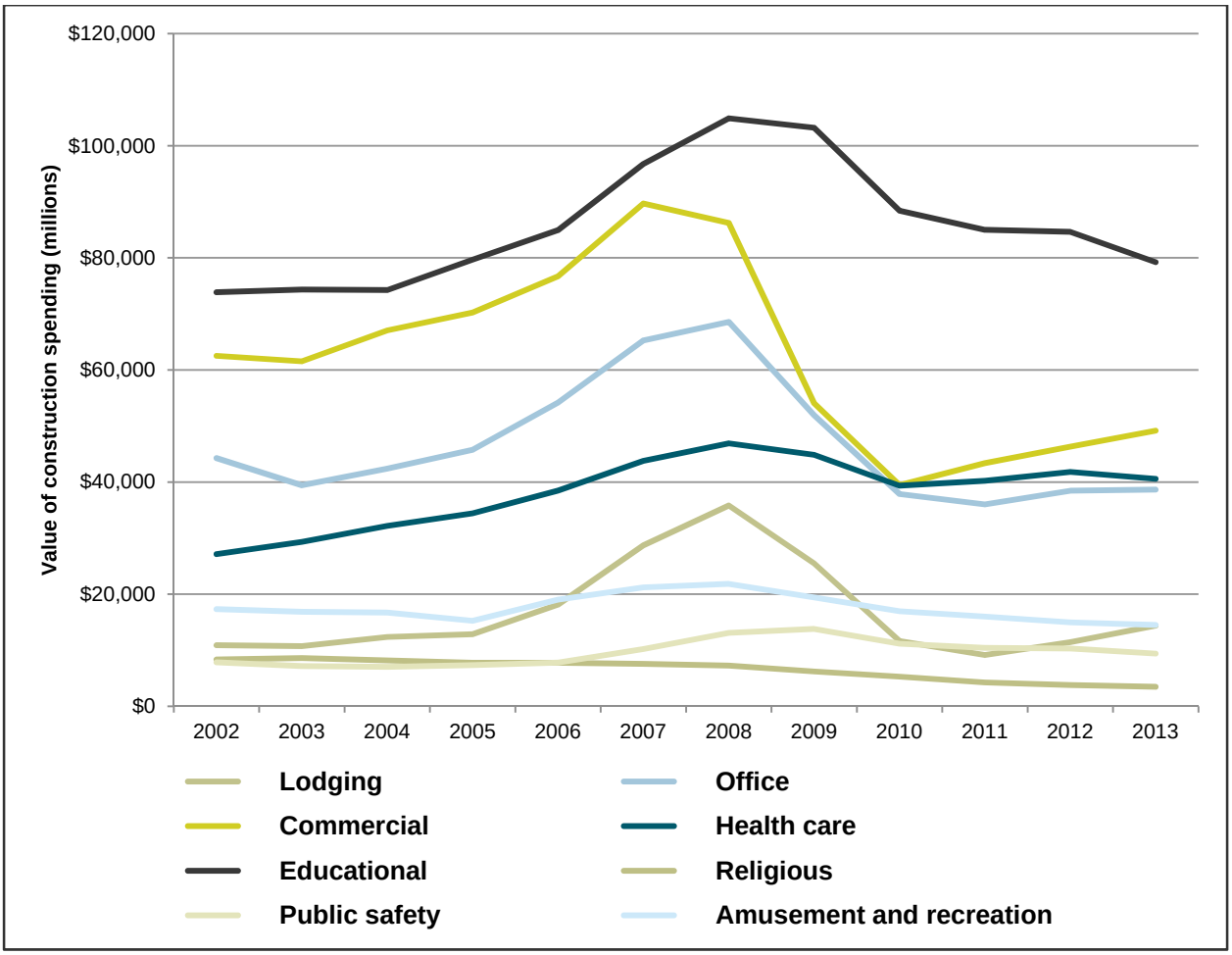
The most comprehensive data set identified that is accessible for free is the U.S. Census Bureau ("Census") data on construction spending. From this source, data as far back as 1993 is available by commercial sector. This memo includes data from 2002 to 2013 because it provides a representative picture of the construction market and encompasses the period in which additional data were available for comparison. While monthly data is available, annual figures only are included in this analysis to capture overall trends.

Census data includes both private and public construction work on new structures or improvements to existing structures, reported in dollars. In addition, data is broken down into nonresidential and residential subcategories. Within the nonresidential category, there are market sectors that include commercial buildings as well as other sectors such as manufacturing, transportation, and communication. Only the commercial building sectors within the nonresidential grouping are included in this analysis. This is discussed further in the Comparison of Data Sources section below.

Figure 1 shows trends for the commercial building sectors analyzed. The chart illustrates that for all sectors, the value of construction spending was increasing through to 2007/2008, at which point the Great Recession caused a significant decline. Certain sectors saw more significant declines to levels below those seen in 2002 (commercial, office and lodging) while others saw more modest declines (educational, healthcare and amusement/recreation). Commercial, office and lodging are all showing signs of recovery, with spending increasing in 2012 and 2013. Other sectors appear to have stabilized after seeing a major drop in activity between 2008 and 2010.

[3] See bibliography for more detail on data sources

Figure 1. Annual Value of Commercial Construction, by Sector (Source: U.S. Census Bureau)

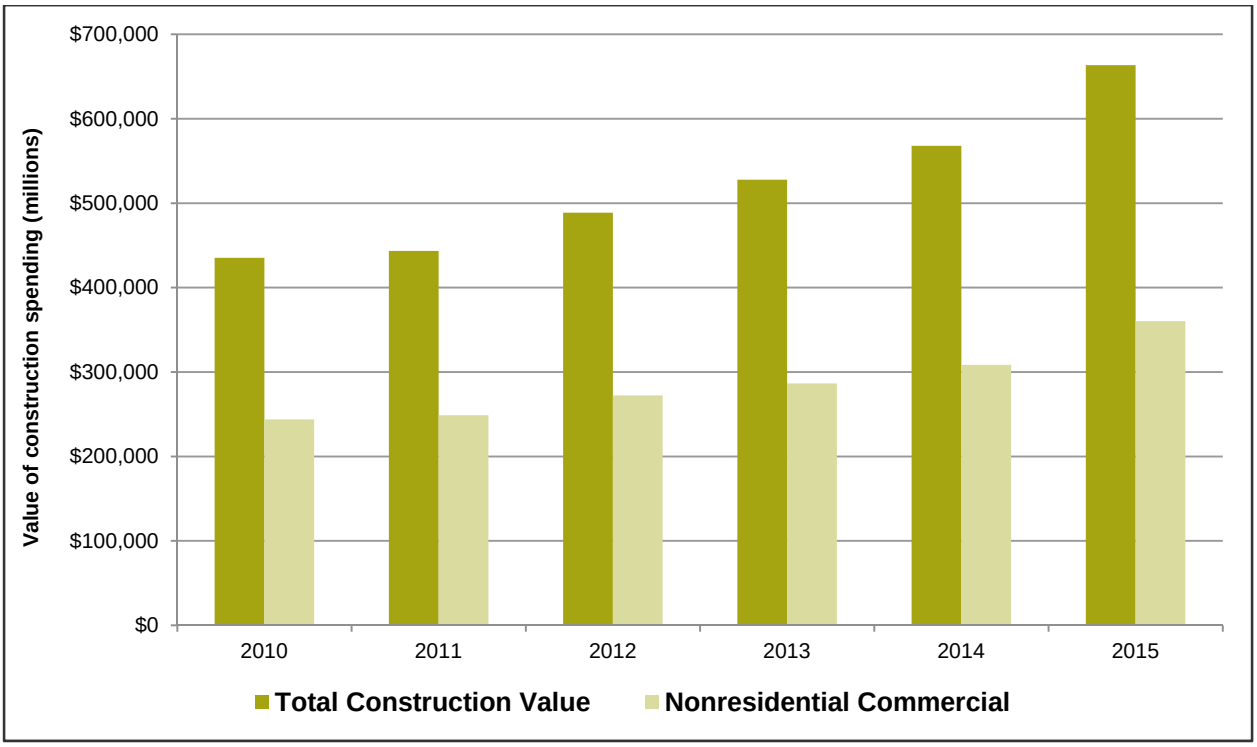


McGraw Hill Construction – Dodge Report

McGraw-Hill Construction is one of the leading construction data providers, providing their “Dodge” construction data nationwide and at the state level. The market sectors falling under the “nonresidential” category for Dodge data do not correspond to those in the “commercial” category for the Census (Table 2). Commercial buildings spending comprises 56% of total nonresidential spending for the for the Census data, and so this percentage was applied to the Dodge nonresidential data to produce an estimate of commercial spending that could be compared to the Census data. Figure 2 shows the total nonresidential construction spending from Dodge alongside an estimate of commercial spending derived from this data.

Dodge data was available from 2010 through 2013, with 2014 and 2015 being forecasted. 2015 is forecast to show significant increases in construction spending over the previous year, at about 17%. Further comparison of Census and Dodge data can be found in Table 1.

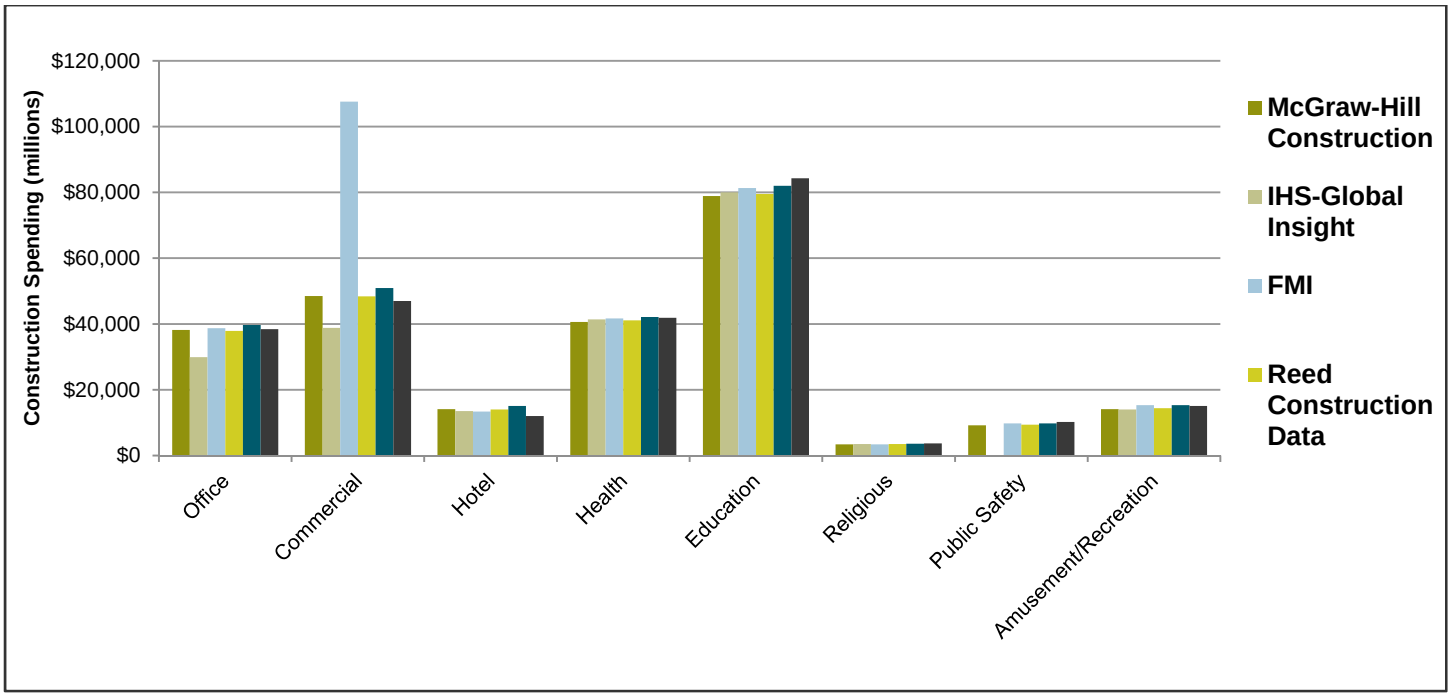
Figure 2. Total Construction Spend (Source: Dodge) and Estimated Nonresidential Commercial Spend



AIA Consensus

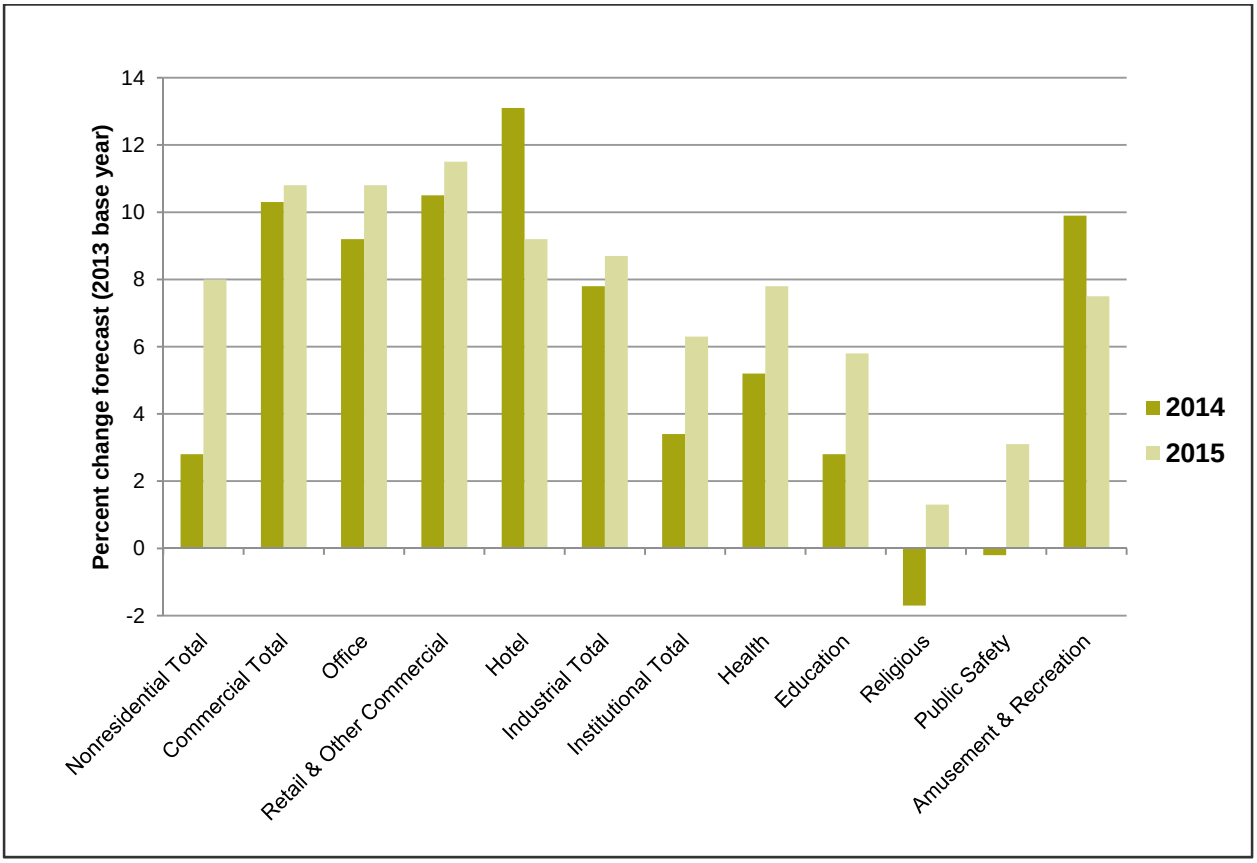
The third data source reviewed – the AIA Consensus - includes reported data for 2013 and forecasts for 2014 and 2015 construction spending. The AIA Consensus forecast is based on data from seven individual sources, which include: McGraw Hill Construction, IHS-Global Insight, Moody's Economy.com, FMI, Reed Construction Data, Associated Builders and Contractors, and Wells Fargo Securities. Moody's Economy.com data was not included in this data analysis as the figures include only total *private* nonresidential spending. Figure 3 includes the 2013 construction spending by market sector as estimated by each of the six data sources. The only sector that includes significant variation is the retail/other commercial sector, where FMI estimated spending to be more than twice that of the other sources.

Figure 3. 2013 Construction Spending by Commercial Sector and Data Source (Source: AIA Consensus)



Also of interest from the AIA Consensus reporting is the variation in forecast growth by market sector. Figure 4 below shows the greatest increases in office, retail and other commercial, and hotel markets (although it is noted that hotels growth is forecast to decline in 2015). Growth is significantly lower (or negative) in the religious and public safety sectors.

Figure 4. Forecast Growth in Construction Values, by Market Sector (Source: AIA Consensus)



Comparison of Data Sources

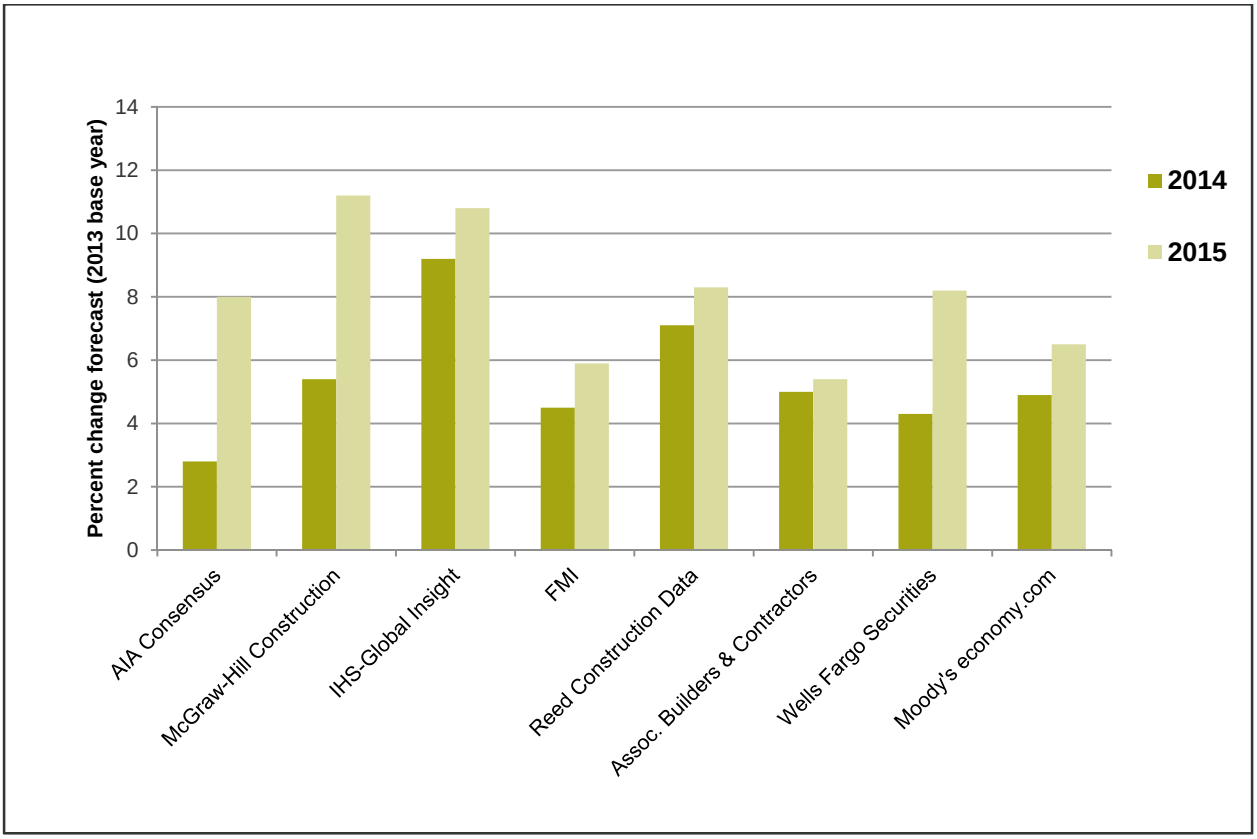
Table 1 summarizes data on US construction spending for commercial market sectors. Census data is available for 2010 through 2013. Dodge data was included for 2010 through 2013, with 2014 and 2015 included as forecasts. AIA Consensus data includes actuals for 2013, with the projections for 2014 and 2015 based on estimates of percent increase over 2013 spending.

Table 1. Value of US Nonresidential New Construction (millions of dollars)

	2010	2011	2012	2013	2014	2015
Census	250,068	244,356	251,614	249,331		
Dodge	243,878	248,810	272,249	286,638	308,473	360,259
AIA Consensus				260,717	277,012	281,988

The variation in construction values between the Census and Dodge data ranges from +2% in 2010 to -15% in 2013. There is higher variation between the forecasts of the AIA Consensus and the Dodge data, which might be expected as [a] they are projected values that may factor different driving variables, and [b] Dodge data is an individual source while AIA Consensus is a blended value based on seven different data sources. Figure 5 shows the variation in forecasts for the seven data sources included in the AIA Consensus reporting. Based on Table 1 we conclude that the data for 2010 to 2013 is fairly consistent and reliable, and that growth may be expected for 2014 and 2015 at a rate somewhere between the Dodge and AIA Consensus estimates.

Figure 5. Percent Change in Forecast Construction Value, by Data Source (Source: AIA Consensus)



Nonresidential Data Subcategories

Table 2 shows the categories of nonresidential construction included in the Census, AIA Consensus, and Dodge data sets, distinguishing between those included in this analysis and those that were excluded.

Table 2. Nonresidential sectors considered "commercial" for purposes of this market assessment

	Census	AIA Consensus	Dodge
Nonresidential Commercial – Included in analysis	Lodging	Hotel	Hotels & Motels
	Office	Office	Office & Bank Buildings
	Commercial	Retail & Other Commercial	Stores & Restaurants
	Includes auto sales		Parking Garages & Auto Service
	Includes warehouse		Warehouse (excl. manufacturing owned)
	Health Care	Health	Hospitals & Other Health Treatment
	Educational	Education	Schools, Libraries and Labs
			Dormitories
	Religious	Religious	Religious Buildings
	Public Safety	Public Safety	Government Services Buildings
	Amusement & Recreation	Amusement & Recreation	Amusement, Social, Recreational
			Misc. Nonresidential Buildings
Nonresidential Other- Not included in analysis	Manufacturing	Industrial Total	Manufacturing Plants, Warehouses, Labs
	Transportation, Communication, Power, Highway & Streets, Sewage & Waste Disposal, Water Supply, Conservation & Development		

Pacific Northwest Construction Trends

In order to gain more insight into construction spending in the four Pacific Northwest states, the Dodge MarketLook Q1 2014 reports for each of the four states were reviewed. Total new construction spending for nonresidential commercial buildings is summarized in Figure 6, and total square footage is shown in Figure 7.

Figure 6. Annual Value of Nonresidential Commercial Construction Spend (Source: Dodge)

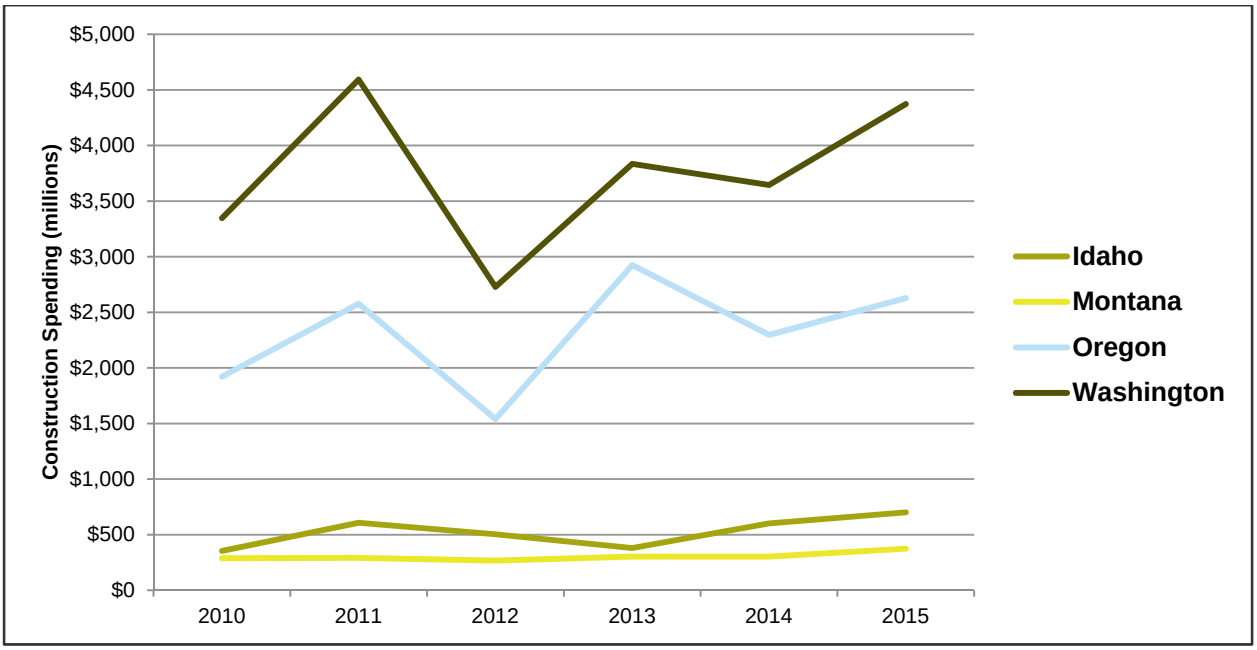
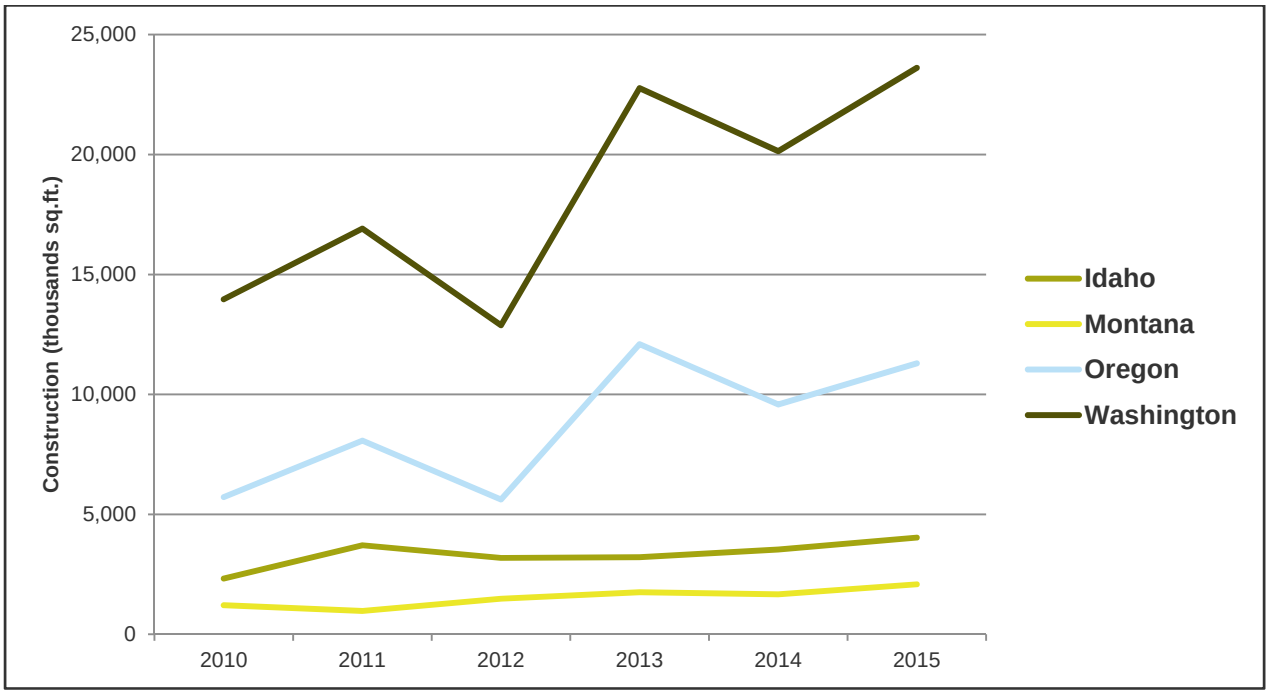


Figure 7. Annual Area of Nonresidential Commercial Construction (Source: Dodge)



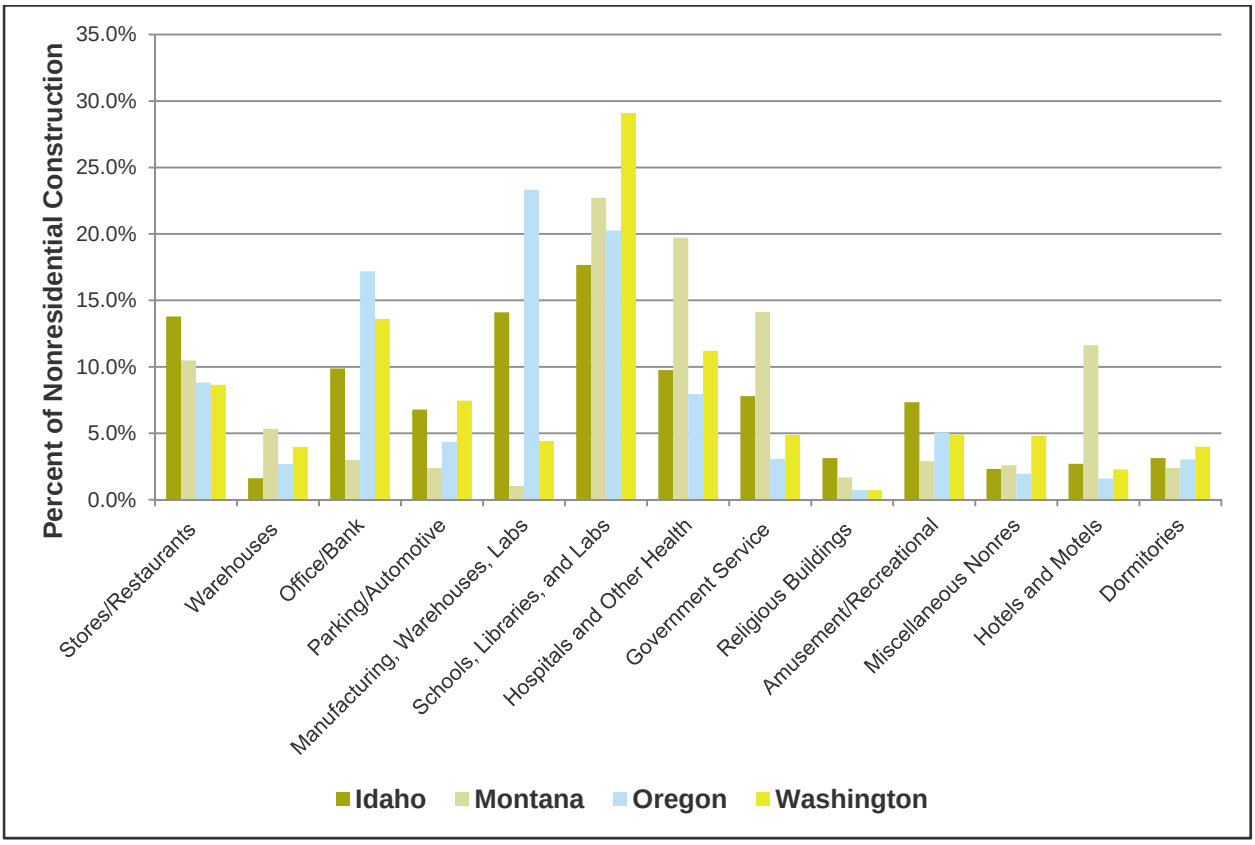
Figures 6 and 7 indicate that:

- Oregon and Washington are experiencing a similar pattern of commercial construction spending, generally trending toward increased spending but with some year-on-year volatility.
- Montana and Idaho has experienced relatively low and flat levels of commercial construction spending compared to Oregon and Washington, although trending slightly higher.

- While spending in Idaho is significantly lower than Oregon and Washington, the expected increase in 2015 over 2010 levels is nearly double, while Oregon, Washington and Montana are expected to be only around 33% higher than 2010 levels.

Dodge data also provides insight into the types of buildings being constructed in the Pacific Northwest. Figure 8 below shows the percentage of construction that falls within each building type as reported in the MarketLook report.

Figure 8. Nonresidential Construction Breakdown by Building Type, 2010-2013 (Source: Dodge)



It should be noted that Figure 8 indicates average values for 2010-2013, while the industry was in or recovering from the Great Recession. This might explain the relatively high percent values for public/institutional building types, as investment in these building types is more likely to be supported by legislative/bond measures and government stimulus funding.

High Performance Building Trends

There is no single accepted definition for a 'high performance building,' and little data is available for buildings adopting that term. In order to build a general picture for this memo we reviewed three types of data:

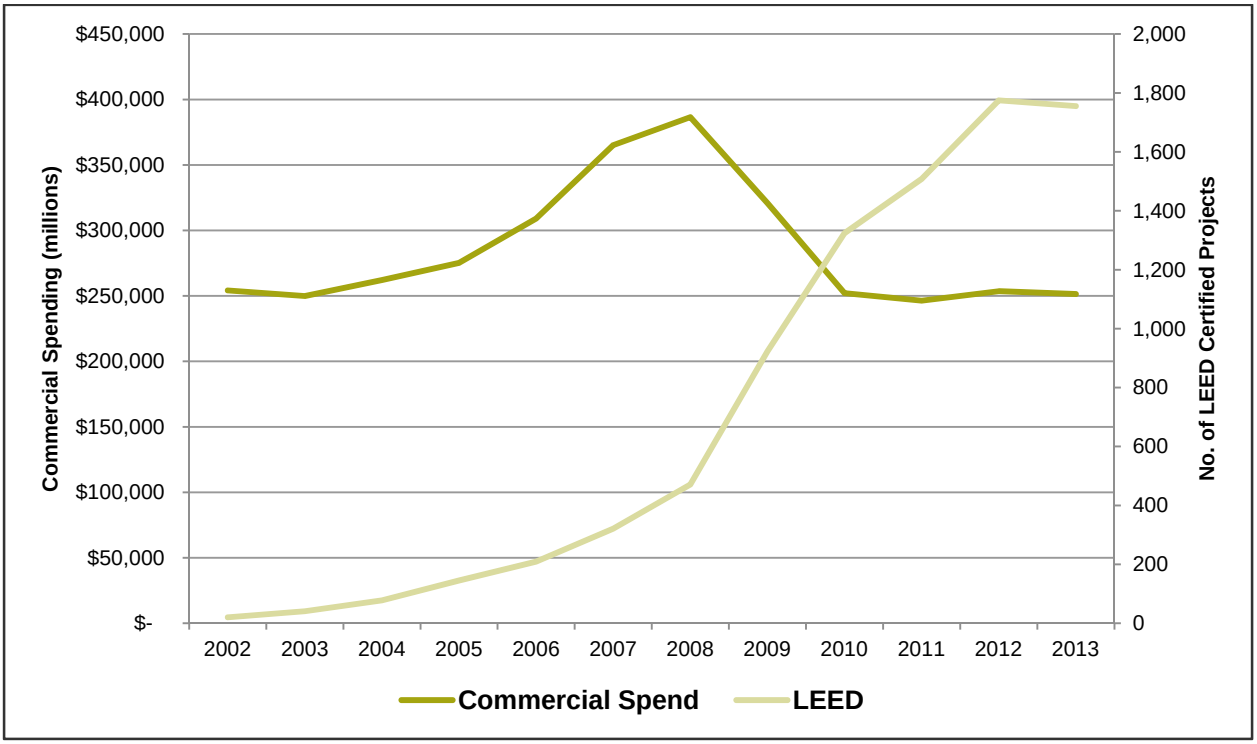
- USGBC's LEED-certified projects list.
- Voluntary databases of high performance buildings, including U.S. DOE's Energy Efficiency and Renewable Energy (EERE) High Performance Buildings Database, New Building Institute's (NBI) High Performance Buildings Database, and the AIA's 2030 case study database. There was significant overlap between the EERE, NBI and AIA 2030 databases (i.e. Buildings appearing more than one dataset), so these were combined into one data set.
- Reports and other studies that discuss "green building" trends in more general terms.

The most commonly used definition of "green building" found in the identified data sources is from McGraw Hill Construction's Green Construction Outlook Report: *"We define green building as one built to LEED standards, an equivalent green building certification program, or one that incorporates numerous green building elements across five category areas: energy efficiency, water efficiency, resource efficiency, responsible site management and improved indoor air quality. Projects that only feature a few green building products (e.g. HVAC systems, waterless urinals) or that only address one aspect of a green building, such as energy efficiency, are not included."*

LEED-Certified Projects

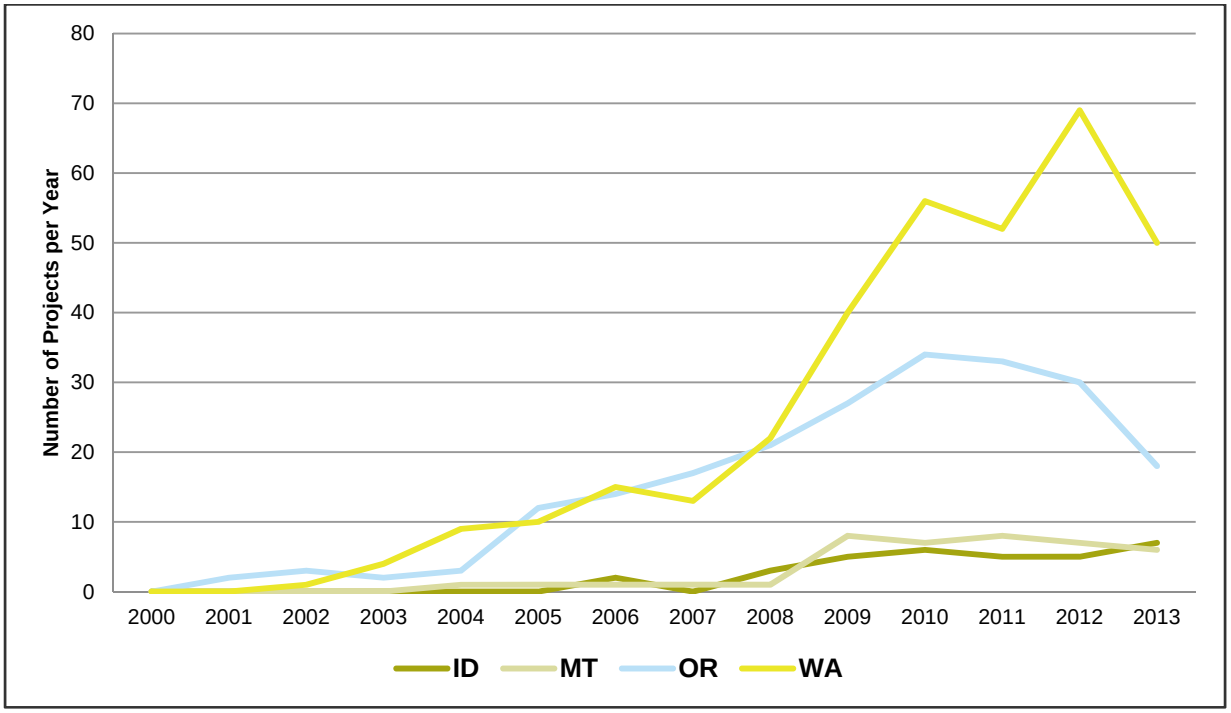
The following figures summarize the data from the USGBC's LEED project database, a comprehensive online summary of all LEED-certified buildings. Data were sorted to include only new construction projects in the United States (Figure 9). Despite the economic downturn, the number of LEED-certified projects has steadily been increasing although this was not the case for 2013 which was flat relative to 2012. This may be due in part to the length of time required to obtain certification, with the slowdown in investment that occurred during 2009/2010 affecting the number of projects where certification was obtained in 2012 and 2013 upon project completion.

Figure 9. Number of LEED-Certified Projects in the U.S. by Year of Certification (Source: USGBC) and U.S. Commercial Construction Spending (Source: Census)



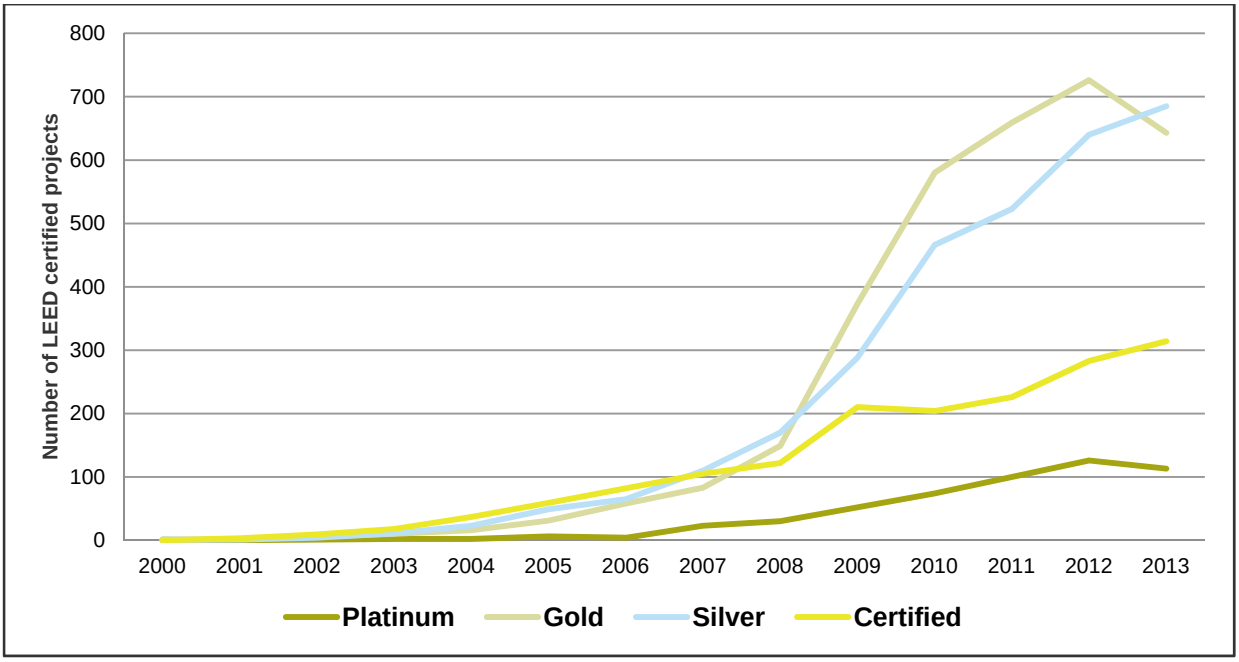
When reviewing data for the Pacific Northwest states greater variation is observed in the number of buildings attaining LEED certification, as illustrated in Figure 10. 2011 marked a plateau in growth, and Oregon has since dropped significantly. The drop in LEED certified projects in 2013 was more significant in the Pacific Northwest than for the US as a whole (a 27% decrease as compared to a 1% decrease for the US). The LEED database does not include any data on building size, so it is not possible to compare LEED certification activity with construction activity as a whole.

Figure 10. Number of LEED Certified Projects by Year and State (Source: USGBC)



Certification levels were compared for all U.S. LEED certified projects (Figure 11). Fewer projects are earning platinum and certified-level certifications (6% and 20% respectively), while the greatest number of projects are certified at the gold level (39%).

Figure 11. LEED Certified Projects by Certification Level – U.S. Projects (Source: USGBC)



In the Pacific Northwest, the highest percentage of projects is gold certified, with nearly half of all projects reaching this level (Figure 12). Only 14% of projects achieved the minimum LEED Certified level. In the Pacific Northwest, 56% of projects are earning the highest two levels of certification (Gold and Platinum) compared with 45% for the U.S. as a whole, as shown in Table 3.

Figure 12. LEED Certified Projects by Certification Level – Pacific Northwest Projects (Source: USGBC)

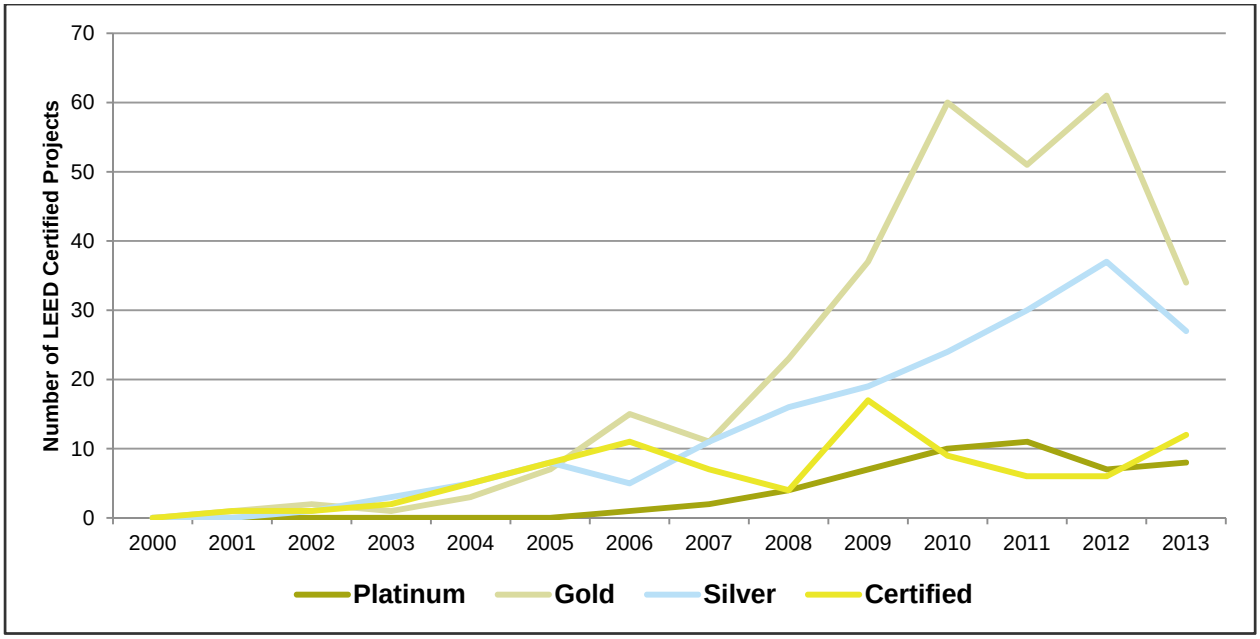


Table 3. LEED Certification Level, U.S. and combined Pacific Northwest states

LEED Certification Level	U.S. Total		Pacific Northwest	
	Projects	% of Total	Projects	% of Total
Platinum	567	6%	50	8%
Gold	3581	39%	319	48%
Silver	3278	35%	199	30%
Certified	1816	20%	94	14%
TOTAL	9,242	100%	662	100%

Other High Performance Building Databases

Three high performance buildings databases were reviewed:

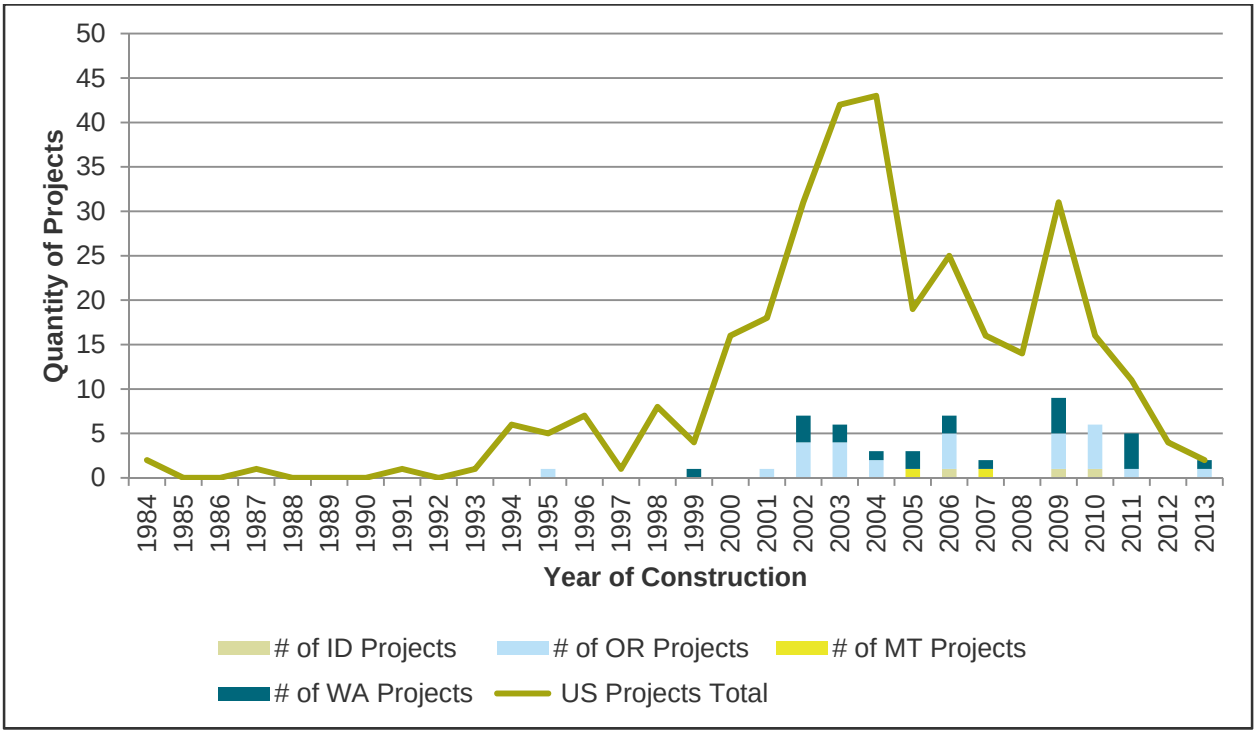
- US Department of Energy's Building Database
    - Shared resource with in-depth information and data on high-performance, green building projects developed by US Department of Energy and National Renewable Energy Laboratory
    - Anyone may enter information about a building project in the database
    - Includes 193 buildings
- AIA 2030 Case Studies (http://architecture2030.org/2030_challenge/case_studies)

- Project firms may submit projects to AIA for inclusion in the database
- Information includes Energy Use Intensity, however, no indication is made if this is operating or predicted
- Includes 155 buildings

- New Building Institute's Buildings Database (http://buildings.newbuildings.org/)
  - Projects that have demonstrated or predicted performance that is 30% better than the Commercial Building Energy Consumption Survey (CBECS) average for their building
  - NBI attempted to gather measured energy data to confirm actual performance
  - Includes 135 buildings

Three hundred and twenty four unique buildings are included in the combined three databases. Of those, 53 projects are in the Pacific Northwest states. Nearly half of all projects were constructed between 2000 and 2004. Figure 13 presents an overview of construction dates for high performance buildings nationwide and in the four Pacific Northwest states. This data does not appear to correlate with construction spending or with LEED certification trends.

Figure 13. Total Number of Projects Entered into High Performance Building databases (Sources: U.S. DOE, AIA, NBI)



Combined, these databases show a general decreasing trend in the number of projects since 2004, as opposed to LEED which saw an increase through 2012. However, data are voluntarily entered in two cases and in the third there is no indication if the database is continually being expanded (No projects in the US DOE database are constructed after 2012). Thus, there may be other explanations for the decreasing trend seen in all three databases. Analyzing these databases for building type was more complicated, given the variety of classifications used. The NBI data included multiple building types, making classification difficult, while AIA includes only five classifications. The two largest building types do appear to be office and education (including both K-12 and higher education).

The total building square footage for projects with available data in the United States is 34,801,054 square feet. Table 4 below shows the square footage for Pacific Northwest states. Oregon has by far the greatest total square

footage of high performance buildings in the Pacific Northwest, more than double that of Washington State. This is in contrast with USGBC data showing that Washington has more LEED-certified buildings.

Table 4. Square footage for High Performance Buildings in Pacific Northwest states (Sources: U.S. DOE, AIA, NBI)

	Building Square Footage
Total in US	34,801,054
Montana	46,276
Idaho	291,520
Washington	1,646,567
Oregon	4,636,879

Other Data Sources Reviewed

Dodge Green Construction Outlook 2013

The Dodge Green Construction Outlook report (2013) identifies the following key datapoints regarding the green building market:

- Green building is expected to represent as much as 44% of the total commercial and institutional construction market in 2012, increasing to 55% by 2016. Commercial includes office, retail, hotel and other. Institutional includes education, health care and other.
- The following sectors represent the largest growth areas for green construction: education, health care, office and retail/hotel. The office sector has the greatest percentage of projects that are green at 54% of construction starts by value, with a value of about $9 billion for 2012. Education has the largest value of green construction at $16 billion, although this is expected to be only about 44% of starts by value. Health care is increasing to about 44% with a value of $9 billion. Retail and hotel are expected to reach 35% and 38% respectively, with a combined value of starts of $7 billion.
- The nonresidential green construction market is expected to have reached $60 billion by 2012, with total construction valued at $136 billion. This compares to the US Census value for nonresidential, commercial construction spending valued at $252 billion.

The report also provides some insight into the differences between new construction and renovation. It is reported that total square footage of new construction dropped 41% between 2007 and 2010, with renovations increasing from 46% of the total number of projects in 2006 to 64% in 2011. With new construction having a higher dollar value, the value of new construction is about 60% of total construction spend, down from a peak of 68%.

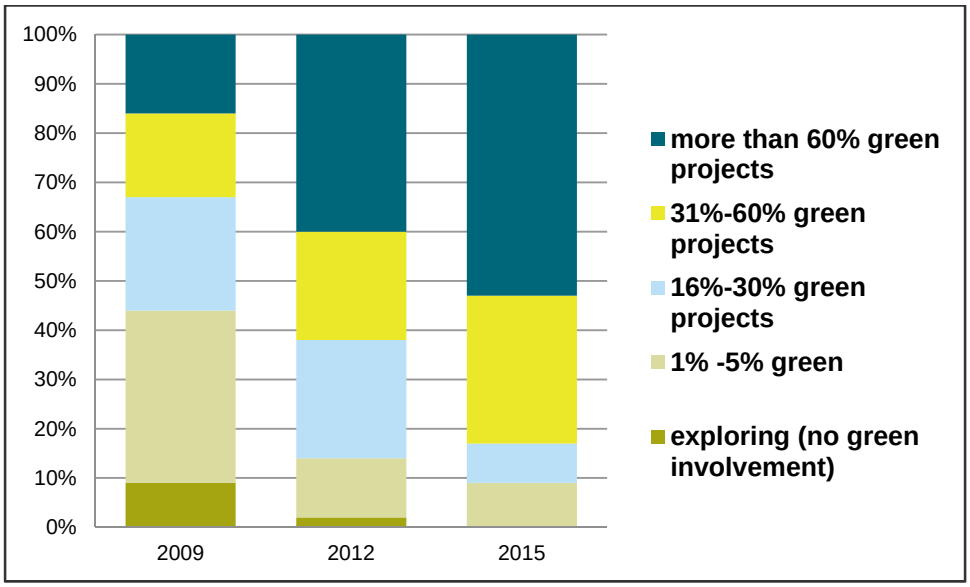
McGraw-Hill Construction World Green Building Trends Smart Market Report, 2013

McGraw-Hill Construction conducted a survey of green building trends worldwide. Much of the data was reported by country. The following discussion focuses on trends specifically for the United States. For respondents (architect, engineers and contractors, consultants and owners), engagement in green building activities is increasing, with green building defined as a construction project that is either certified under any global green building rating system (such as LEED or Green Globes) or built to qualify for certification under such a system (see earlier definition of green building). In 2015, it is projected that 57% of firms are planning for more than 60% of their work to be green.

Based on this report, In the US *“the most dramatic increases occurred between 2008 and 2011, which was during the economic downturn and time of transition for the US economy, government and construction marketplace.”*

Sectors with the most expected growth include new commercial buildings (e.g. office, retail, hotel) with 57% of firms reporting planned green projects in next three years, retrofit of existing buildings at 56%, and new institutional buildings (e.g. schools, hospitals) at 52%.

Figure 14. Green Building Activity as Reported by Survey Respondents (2009-2015 expected)

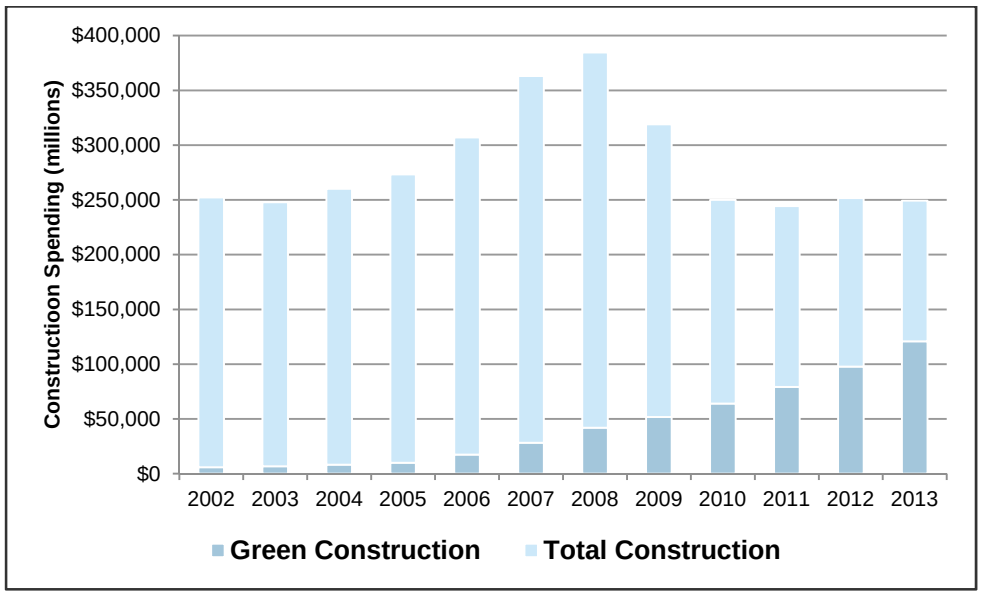


USGBC Green Jobs Study

In 2009 the USGBC asked Booz Allen Hamilton to study the economic impact – specifically related to workforce – of the green building market. One of the methods used was to estimate jobs supported by green construction expenditures. Information on the green construction market was thus generated and is presented here.

In Figure 15, the green construction data from the Green Jobs Study was plotted against the US Census Bureau data on total commercial construction spend. Using this data, it is shown that the percentage of total commercial construction spending that is for green projects has grown from just over 2% in 2002 to nearly 50% in 2013.

Figure 15. Green Construction Estimates (Source: Booz Allen Hamilton) and Total Commercial Construction Spend (Source: U.S. Census)



Energy Star for Buildings

Does not include enough detail on buildings to be valuable for this study. While data is available on the breakdown of ENERGY STAR Certified buildings by building type, it does not provide information on the building score or date of construction for the building.

Dodge Research and Analytics: Construction Market Forecast Service

Five year forecast by market type (for example, commercial warehouses, stores and shopping centers, public buildings, etc.) for US and 9 major regions. Cost is $1,900 per building type, which was considered prohibitively expensive for the purposes of this summary but may be justifiable for a more comprehensive market characterization study. Data contained in Construction Market Forecast Service reports are proprietary information on construction starts presented in terms of dollar value and building square footage.

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