Solving the Energy Savings Puzzle in Commercial Buildings:

Lease Structures and Core & Shell Development

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ABSTRACT

It is an exciting time to be in the energy efficiency industry. Energy efficient technologies for the built environment are developing at a staggering rate. Net zero is no longer a pie in the sky, but an attainable goal. Yet, one after another, new, inefficient buildings are being designed, built and operated without care. Why? If we have the ability to build a Tesla, why do we see so many new Yugo's?

Through this paper we will explore the core-and-shell/tenant build-out construction strategy and its impact on the commercial building industry. We will examine how this development method and the lease structures that typically follow result in design priorities driven by first costs alone because operating costs are not paid by developers. We will also reflect on the difficulty in commissioning a core-and-shell building without a completed build-out and how this impacts building performance.

For too long our energy policy has been focused on setting a minimum threshold rather than realigning the motivations of the decision makers. Unfortunately, the more complicated our building code becomes, the more difficult it is to enforce. To address the issues with core-and-shell construction we must find a way to make the project developer accountable for the operating expenses of the building. We will present several methods to achieve this including restriction of specific lease structures, installation of sub-metering equipment and specific commissioning requirements for core-and-shell buildings. Through these methods we aim to make energy efficient design attractive to everyone.

Introduction

With the recently signed Paris Climate Agreement, reducing energy and carbon emissions has become a global imperative affecting not only governments, but business as well. Commercial buildings contribute to 40% of the world's greenhouse gas emissions and therefore play a key role in meeting climate reduction targets on local, national and international levels.

In order to understand the commercial building landscape we must also examine the ways in which new office buildings are developed. Office building development can be divided into two categories, built to suit and speculative. Buildings that are built to suit are designed for a particular occupant and are ready for occupant once construction is complete. Speculative buildings are often built in stages since the occupants are not usually known at the time of design.

The typical development approach for speculative buildings is known as core and shell. Core and shell (or base build) development is a popular approach for developers of rentable office buildings. Based on a survey conducted by Cushman & Wakefield 61% of all new construction on office buildings in the San Francisco Bay Area is core & shell. We estimate that electricity consumption in California increases by over 600 million kWh each year from new office buildings built through a core & shell development approach. This is equivalent to the construction of almost 90,000 new homes.

In a core and shell project a developer funds the design and construction of a building which includes the roads, paths, parking, foundation, structure, building envelop, completed common areas, and the base building plant (electrical and mechanical). In many cases this will include base building HVAC equipment such as air handling units or packaged rooftop air conditioning equipment. The occupied space within a core & shell development project is left more or less empty without lighting or zone level HVAC equipment. A blank canvas for a perspective tenant.

After a project has begun a developer will seek to find one or multiple tenants for the office space. The new tenants will be provided with some construction allowance to build-out the empty tenant spaces to meet their needs. Typically, this means tying in to the existing base building electrical and HVAC systems. The tenant buildout design may begin before the base building construction is completed or after, but in almost all cases it happens after the base building design is complete.

The primary benefit of this approach for the developer is time and money. The development process for a core and shell project is much faster than for full construction. This usually equates to lower construction costs as well. In addition, the core and shell model gives the developer more flexibility over potential tenants.

Lease Structures

One of inherent obstacles to overcome with reducing energy in commercial buildings relates to the structure of standard leases in which the incentives for energy savings are opposed between landlord and tenant. In short, the party that pays for energy upgrades does not always reap the full long-term savings, thus the incentive for initial upgrades is non-existent. As a result, energy reduction targets often fall short, even in the face of rising energy prices and global directives to reduce the resource consumption of buildings.

In order to fully understand the challenge with aligning energy savings with capital costs, it’s important to have a basic understanding of the three general types of lease structures: Gross lease, Triple Net lease and Gross Industrial Lease. Some lease types are more common than others, it depends largely on the market and type of building.

The **Gross lease** is the simplest lease form. In this format the tenant simply pays a stated amount each month. This rate covers all the basic ongoing expenses that the landlord incurs including utilities, trash, lawn care, snow removal, janitorial services, repairs, insurance and maintenance, etc. The landlord takes care of everything and the rate does not change. Any increase in the cost of these items is simply absorbed by the landlord.

The **Triple Net lease** is in many ways the opposite of the Gross lease. On top of a base rent, the tenant is responsible for all the costs incurred with the operation of the space including energy costs, maintenance, repairs, taxes, insurance, etc.

The **Gross Industrial lease** is similar to the Triple Net lease except the base lease rate includes the payment of taxes and insurance.

A major area of difference between the three types of leases is in regards to repairs and maintenance. In the Gross lease the landlord is responsible for repairs and maintenance and the estimated cost of these is included in the quoted rate. In a Triple Net or Gross Industrial lease the tenant is responsible for the repair and maintenance of their space.

Historically, tenants tend to prefer gross leases so their costs are fixed and predictable. Landlords tend to prefer Triple Net leases so that the fluctuating costs of energy, utilities and maintenance, etc are picked up by the tenant. This preference for one lease over another is shifting as tenants look to reap the benefits of energy cost savings under a Triple Net lease. Generally, the landlord decides which type of lease is used based on what they believe best fits their needs. When rental markets are weak, landlords often turn to gross leases to cater to potential tenants; once a building or space is structured on a gross lease, it becomes more difficult to change over to Triple Net or Gross Industrial, even if there are obvious advantages for doing so.

In a triple net lease, also called net lease, landlords are dis-incentivized from making energy efficiency improvements since they do not pay for monthly utility bills. In a gross lease, tenants are dis-incentivized from making efficiency improvements in their spaces since the savings are not directly reflected in monthly utility bills. This disconnect as described above is known as the ‘split incentive’ and continues to be one of the major barriers for reducing energy in commercial buildings.

‘Green leasing’ has gained momentum in recent years as a tool for addressing the split incentive; the goal being to reduce energy and carbon emissions from commercial buildings. In general terms, a green lease contains specific sustainability provisions as part of the landlord – tenant agreement, often centered on energy reduction strategies.

There are many examples of green leases on the market that can be used as templates for landlord-tenant agreements in commercial buildings. Regardless of the specifics, a successful green lease must be built around several key principles to be successful:

- Landlords and tenants should be incentivized to operate the spaces that are under their respective control as efficiently as possible.
- The party (landlord or tenant) that stands to reap the ongoing energy cost savings should cover all or most of the upfront cost of energy upgrades.
- Energy usage should be measurable and transparent to both Landlord and Tenant.

Examples of specific provisions that embody these principles include pass through & operations clauses as well as reporting requirements. Pass through clauses are lease amendments that allow the landlord to transfer all or a portion of the cost for energy upgrades to the tenant(s). Reporting mechanisms in leases require the measurement and sharing of energy data, often through submetering and benchmarking, and should also include goals for energy savings.

To this last point, accurately measuring energy data for landlords and especially tenants is fundamental to any serious effort to address resource efficiency. Progress toward any environmental goal is impossible without data to measure against.

The Challenges of Core & Shell Construction

Designing without Information

In every construction project, the design engineer must make assumptions about existing conditions and/or design intent in order to complete the mechanical, electrical and plumbing design. This is unavoidable. The design engineer will seek the best, most accurate information, so that the installed equipment and systems meet the needs of the owner and occupants while limiting project cost. When designing an HVAC system the design engineer will gather information about the buildings occupants, such as:

- Ventilation requirements
- Occupant density
- Occupancy schedules
- Receptacle Load
- Indoor design temperatures (allowable indoor temperatures)

In most core & shell projects, much of this information is unavailable. The design engineer must make assumptions for all design criteria based on a typical occupant. To illustrate this point, let's discuss a case study from a recent core & shell project. Table 1 below shows the design criteria for a recent core & shell project and the requirements of the occupant who moved in after the core & shell construction was complete.

Table 1. Design Criteria Assumptions for Core & Shell

Design Criteria	Core & Shell Assumption	Actual Occupant
Indoor Design Temperatures	70/75°F	70/75°F Occupants 68/78°F Data Center
Occupant Density	200 s.f./occupant	150 s.f./occupant
Minimum outside air rate	18,000 cfm	20,500 cfm
Receptacle load	1.5 W/s.f.	>> 1.5 W/s.f. (data center)
Tenant 24/7 Cooling	Concrete pad sized for air-cooled chiller, split-system condenser or small cooling tower	Central Utility Plant with water-cooled chiller and cooling tower located in a separate building

When the base building equipment is designed with insufficient information the efficiency and performance of the resulting system will suffer. If the AHU is undersized the fan will consistently operate at high speeds, increasing energy consumption. If the heating hot water system is undersized, the return water temperature will not be low enough for a condensing boiler to condense, decreasing thermal efficiency. If the ventilation system is undersized, the indoor air quality will suffer.

In the example above, the new tenant had to install several additional air handling units in addition to a central utility plant located outside of the building. An integrated design would have resulted in lower construction costs for both the owner and tenant as well as lower operating costs.

Design Priorities

In addition to the design criteria listed above, the basis of design is also a function of the design priorities. For instance, the allowable flow rate through the hot water pipes, the allowable face velocity within the ductwork, and the minimum HVAC system efficiency will all impact both the construction cost and the operating costs of the building. Even in owner occupied buildings it can be difficult to convince owners and developers to choose higher initial costs in order to reduce operating costs. Capital and operating budgets are often separate and distinct making savings in one unavailable to the other. However, when life-cycle costs are presented early enough in the design process the system with the lowest life-cycle cost often prevails.

Unfortunately, in core & shell construction it is typical that the designer's one priority is to minimize construction costs. No arguments or calculations will convince a developer to pay more when they won't realize any benefit.

We compared two similar office building construction projects; one core & shell office building and the other a complete new construction project where the owner will occupy the entire building. Both projects were around 100,000 s.f. with similar HVAC systems, packaged rooftop air conditioning units serving variable air volume reheat terminal boxes. Although the designs were very similar and typical for this size building, Table 2 below shows some key differences. While Design 2 was not revolutionary, the design team had clearly prioritized energy efficiency above first cost in some areas. As a result, Design 2 will have a significantly lower life-cycle cost.

Table 2. Difference in efficiencies between Core & Shell and Owner as Tenant

	Design 1	Design 2
	Core & Shell	Owner as Tenant
RTU Efficiency	EER = 10.7	EER = 13
Boiler Efficiency	85% (Non-condensing)	95% (Condensing)
Max Air Velocity in Duct Branches	2000 fpm	1500 fpm (results in lower pressure drop)

Commissioning

New construction commissioning continues to gain traction throughout the U.S. In California, all non-residential new construction projects greater than 10,000 s.f. must be commissioned under the energy code, Title 24 Part 6., commissioning core & shell projects has inherent challenges that severely limit its effectiveness. In most cases the HVAC systems are not fully functional when functional testing takes place. For instance, package rooftop units may be installed with a central duct shaft however, ductwork and VAV boxes on each floor will be missing. In this example, the commissioning agent will be asked to test the performance of a system without key pieces of equipment. The best the commissioning agent can do is ensure that the system startup and shutdown is functional. Testing is usually required after the tenant buildout is complete and by that time the installing contractor is long gone and sometimes, so is the commissioning agent.

Most tenant buildouts will also require commissioning, however, the base-building equipment is outside the scope of the installing contractor and therefore typically outside the scope of the commissioning agent.

An often neglected component of the turnover process is the training of onsite facility staff. The commissioning agent is often tasked with ensuring that facility staff receive proper training on the equipment and systems within their new building. However, under a core & shell model training is a particular challenge. Since much of the HVAC equipment cannot function normally without zone level equipment training will be limited. In addition, since there may be a long delay until the building is actually occupied, facility staff may not be available for training.

Existing Building Code

California's Title 24 is considered one of the more stringent energy codes in the U.S. The code covers a wide variety of topics from equipment efficiency to insulation. Let's examine a few examples to see how they pertain to core & shell projects.

Table 110.2-A provides minimum efficiency requirements for air conditioning equipment, preventing the installation of inefficient equipment. However, it does not guarantee the installed equipment is the right match for the load. The most efficient direct expansion (DX) rooftop unit (RTU) is still significantly less efficient than a water cooled chiller, cooling tower and air handling unit with chilled water coils. The code does not provide an upper load limit for less efficient equipment. The developer is free to find the least expensive equipment that will satisfactorily meet the building load. This almost always ends up being the less efficient option.

Section 140.4 C.2 covers variable air volume systems. It provides prescriptive requirements for both fan power and fan control. The code requires that fan power not exceed 1.25 W/CFM of supply air. The design engineer can show under assumed conditions, the selected AHU will meet this requirement, however, they have no way of knowing whether it will under normal operating conditions since the floor-by-floor ductwork and terminal boxes have not been installed.

The code also requires a duct static pressure and supply air temperature reset based on demand. However, programming a working demand based reset without the installed terminal boxes is impossible. Some of programming logic can be put in place, but it will need to be completed at the time of the tenant buildout. It is not uncommon for these required sequences to remain unfinished when the building turns over.

The code even goes so far as to specify how some equipment is zoned. However, it does not provide any direction on the AHUs. As a result, the least expensive approach is to design the building with the least number of AHUs, while still meeting the buildings loads. To save on ductwork, sometimes two or more AHUs serve the same ducts. As a result, the AHUs are not able to effectively reset the supply air temperature or duct static pressure because of the large disparity in zone loads.

Title 24 provides requirements for pipe insulation, duct insulation and duct sealing, but it does not provide requirements for pipe flow rates, duct velocities, and pressure drops. The larger the pipe or duct the lower the pressure drop and the lower the pump and fan energy requirements. This can be a complicated equation for a designer trying to balance first cost and operating costs, however it is made very simple when operating costs are not a consideration.

Summary of Challenges

So after all of this what do we have? In California, we have roughly 38.7 million more square feet of commercial real estate each year that was designed with insufficient information, utilizes the least expensive equipment and systems that still meet energy codes, has been inadequately commissioned, is run by a staff that may have never been trained.

Solution

Change Priorities with Codes and Standards

In order to have a significant impact on the energy efficiency of new core & shell office construction we need to change the priorities of the developers. This can be done by mandating the distribution of utility costs between tenants and owners as discussed above. It will not be as simple as requiring a gross lease type. Tenants must also be accountable for their energy consumption. We must codify the Green Lease type.

We recommend that each tenant be responsible for paying for all lighting and receptacle loads within their office space and the owner be responsible for paying for all other utility costs. In order to achieve this disaggregation of utility bills, submetering of tenant lighting and receptacles is required. At a minimum submetering could be done on a floor by floor basis. Advances in wireless submetering technologies make this a relatively low cost solution for both new and existing buildings. Tenants would then pay based on the percentage of floor area that they occupy. Additional fees for afterhours HVAC usage could still be charged directly to the tenant.

Through this strategy, the tenant still has a vested interest in keeping their energy bills low, but only where they can really make an impact. The owner would have a vested interest in installing, commissioning and maintaining an efficient HVAC system.

In addition, we must also specifically address the commissioning challenges of core & shell projects. The commissioning process must not be considered complete until the base building equipment is tested with a full tenant buildout. This can be accomplished with a simple change to the commissioning submittal requirements.

Finally, the only way to address the challenges of designing with incomplete or inaccurate information is to prevent it from happening. We must find ways to delay the design and construction of the base building HVAC systems until the majority of tenants have been identified.

Energy Efficiency Programs

There is a lot of potential for energy efficiency programs to tip the scale further toward efficient design. In order to be effective, these programs do not need to offer large incentives or technical assistance. Efficiency programs can significantly impact design by providing easy access to capital for developers. This can be accomplished through on-bill financing and a simple cost database for efficient equipment. For instance, the developer could easily finance the cost difference between a condensing boiler and a code compliant boiler or exceeding the code required efficiency of an RTU, or installing an oil-free magnetic bearing chiller over a code-compliant chiller. As long as the process is easy, deferring the cost of the equipment will be an easy decision for the developer since lower operating cost will result in a cash flow positive investment. In addition, the owner will get a higher value building for the same cost.

Conclusion

Potential Impact

As with all energy efficiency, it's best to start with the 'low hanging fruit'. Green Leases as well as properly design core & shell construction represents just that, easily achieved savings with minimal investment. We estimate the benefit from reducing the energy intensity of office buildings as described above would save California roughly 60 million kWh and 700,000 therms, each year.

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