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The Need for Effective Front-End Planning for Project Execution Success: HARC Sustainable Building

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Abstract

The era of continuous change has resulted in an evolution of society. As a consequence, there has been a negative impact on the environment. The rampant misuse of the natural resources can be observed across the globe. There is a need to follow early mechanisms such as front end planning to have zero damage at the final stage of any project. This paper is an attempt to analyze a case study of sustainable commercial building, Houston Advance Research Centre (HARC) that puts HARC building ahead of other buildings in terms of cost reduction and time savings. Qualitative research methodology has been used to understand and explore the concept of front end planning for successful project execution in case of HARC. It results in benefits such as more predictability of cost and schedule, reduction in probability of project failures and also improvement in operational performance.

Keywords: Front End Planning; Project Execution; Zero Energy Buildings; HARC

1 Introduction

The uncertain business environment has put the spotlight on the mechanisms that can alert the systems and generate best performance. There has been continuous evolution of society from traditional to modern one. Business environment in terms of technology, quality of life etc. has gone through a change (Uttlyer2021). The change can be seen in the form of better standard of living, sophisticated products, improvement in technology, better value. But in this journey of growth, somewhere the environment has been neglected. Especially the natural resources have been taken for granted. The impact of their rampant misuse is observable across the globe in the form of global warming or melting of glaciers (Chigbo et al. 2016) and has threatened their availability (Paulino & Pulsiri ,2022). Carbon dioxide levels in the air are the highest in the past 650,000 years. Out of the 19 warmest years on record, 18 years have been since 2001. The minimum level of arctic ice has decreased by 12.8% per decade (Uttlyer 2021). Further, China and the United States are considered the two largest energy-consuming countries. In 2009, China overtook the United States and became the largest energy consumer. From 1978-2010, the total energy consumption increased markedly from 0.57 to 3.25 billion tons of oil equivalent (International Energy Agency2010 ; Zhang et al. 2001; Okwoli and Ude 2011;Fanand Xia 2012; Ma et al. 2012; Danny et al. 2013).Burning fossil fuels is cheap and the most efficient way to produce energy, but it has pitfalls as well. Global resources are being abused in a vast way through human exploitation (Irons and Gibson2006; Hirokawa2009; Li et al.2014; Zuo and Zhao2014; Olubunmi et al. 2016) .There has been vast interest for zero energy buildings. There is a more focus on holistic approach for economic growth, protection of environment and social progress (Abdallah, 2021) that supports energy generation and conservation.

The building sector contributes to all energy related emissions by 38%. This also includes building construction industry emissions (Safa 2013; UNEP 2020).The UN report hints at halving direct building emissions by 2030 if we want to have net zero stock by 2050 (UNEP 2020). These challenges and probable impact calls for the new revolution of sustainable buildings (Kuchta and Mrzygłocka-Chojnacka 2020). Policy makers are stressing on the need to adopt sustainable initiatives in different sectors including port management (Gore, 2023).

There is a growing interest among researchers in various aspects such as developing insulation material using natural and recycled materials (CII2011;Liu et al. 2017) highlights the role of thermal insulation in contributing towards energy savings in buildings even though it has got less attention so far. Moreover, heating, ventilation, and air conditioning (HVAC) are the key aspects of a building's energy use (The Construction Industry Institute 2006; Atkinson 2009). In the past, buildings used energy-efficient methods such as natural and hybrid ventilation strategies, but these systems are not fully efficient and cause much burden on the energy use (Akadiriet al. 2012).Also looking at the correlation between ventilation and the occupants' health and productivity, past systems have never really accomplished the desired goals (HVAC-HESS2013).

The recent pandemic has raised alarm for all the sectors, including the construction sector. This increases the need for adopting early mechanisms to track and trace the errors, if any to rectify them with zero damage at later stages. It calls for application of mechanism such as Front End Planning with the focus on sustainability due to the constrained resources. Front end planning (FEP)is crucial for the successful accomplishment of the project (USDE 2019). It is vital and a relevant process that plays a key role in identifying risk at early stage of capital project planning phases. The mechanism has the power to mitigate the risk by developing detailed scope definition (Fageha&Aibinu 2013) and efficient application of resources in the project (Safa et al. 2013; Yun et al. 2012; USDE 2019).

FEP tool was developed by Construction Industry Institute (CII). Construction Industry Institute (CII), which explored different aspects of Front End Planning (FEP). Front End Planning is also called pre-project planning or front end loading. CII (2018a) total project design and construction cost can be reduced by 20 percent by focusing on front end planning. Even the project design and construction schedule gets lowered by 39 percent and also facilitates improvement in project predictability with respect to cost, schedule, and operating performance and enhances the chance of the alignment of project goals with the environmental and social goals (O'Donovan2002).Front end planning can accelerate an efficient completion of the design packages (Sindhu et al., 2018).

CII is a research group which consists of 126 organizations and holds mission to enhance cost efficiency in capital projects and increase competitiveness of its members (CII2018a).Furthermore, focal point of its research is alignment, benchmarking, change management, constructability, dispute prevention & resolution, front end planning (CII2018b). CII has identified front end planning as a critical element in the construction industry. Front end planning is described as a process of developing strategic information to identify risks and decide the resources needed to mitigate these risks (CII 2018b). The purpose behind the FEP process is to create an environment very early in the project lifecycle to effectively analyze potential projects risks (Gibson &Bosfield 2013).The desired result is to have a project that an organization can successfully manage. The front end planning being applied in this area is crucial for maintaining and successfully completing the project (Sherif& Price 1999; Gibson Wang Cho & Pappas 2006; Hensen et. al 2018).Also due to the need of balancing the economic, environmental and social objectives, application of sustainable practices (Kuchta&Mrzygłocka-Chojnacka 2020) is getting much attention (Martens &Carvalho 2017; Schröpfer 2017; Banihashemi et al. 2017).

Managing sustainability along with project attributes is quite challenging (Gareis et al. 2013; Marcelino-Sádaba et al. 2015). It takes optimization of resource allocation, strict schedule while focusing on sustainability objectives (Sfakianaki 2015; Chakraborty et al. 2017; Wu 2017). Sustainable projects follow practices ensure achieving sustainability objectives (Silvius &Schipper 2014). Development of sustainable goals required coupling of government, organizations and individuals(Godfrey 1993; GRI 2015).

Though large organizations have tried to echo with the sustainable objectives (Ionascu et al. 2020) but still a huge gap exists in these endeavors(Marcelinoet al. 2015).

Developing sustainable real estate is one of the important concerns in the modern time (Marcelino et al. 2015). Moreover, it is pertinent to consider stakeholder's opinion in the early phases of the project (Apanavičienė2015;Blasco and King 2017; PwC 2018).Further, it is utmost important that there is maximum degree of sustainability during the front-end of the projects (PMI 2010;Morris 2013; Brones et al. 2014; Armenia et al. 2019). The present project techniques do not imbibe the sustainability concepts fully (Marcelino et al. 2015; Apanavičienė 2015;Blasco and King 2017; PwC 2018) rather they focus on other related areas such as project stakeholders management and in many others it is totally invisible from the initial defining phase of the project (Marcelino et al. 2015; Apanavičienė 2015;Blasco and King 2017; PwC 2018).

2 Sustainable Building: Houston Advanced Research Center (HARC)

While new developments consider to implement new sustainable measures, Houston Advanced Research Center (HARC) is at the four fronts of sustainable buildings (Beydoun and Gonzalez 2017a; Beydoun 2019; Beydoun and Gonzalez 2019). With advanced front end planning, they managed to create a revolutionary zero-emission facility. Building designers, contractors, and owners are using few methods to control buildings' environmental aspects during the design phase, but this is where HARC acceded to other projects. Advanced and calculated front end planning put HARC a step ahead and made the dream of the building come true.

At the Houston Advanced Research Center (HARC), front-end planning and team collaboration contributed greatly to cost reduction, time savings, and the successful delivery of HARC's new headquarters building. The aim of this research paper is to present a case study of a sustainable commercial building that was so well planned as to be under budget and early in its handover(Beydoun and Gonzalez 2017b; Beydoun and Gonzalez 2018a). The vision of the company for the building to become a showcase of sustainable construction and design and net-zero energy operation was achieved.Since the HARC building is aimed to be part of the community which serves the mission of spreading awareness and educating on environmental issues in the area, it was the perfect example to use as a case study. It offers a real-world project with a proven track record in collaboration from the beginning of planning and design to construction and operation (Beydoun and Gonzalez 2016;2017b;2018b; 2018c;2019).

The paper is structured as follows : section1 sets the base for the paper while Section 2 explains research methodology followed. In section3, a case study has been presented. Section 4 contains the result analysis and discussion. The last section concludes and highlights limitations of the study and suggests areas of future research.

3 Methodology

In order to develop better insight into the area of front end planning for successful project execution, the paper dives into qualitative literature to present a roadmap towards understanding and explores the concept of front end planning for successful project execution.Total number of journals referred is 19 and the total number of research documents is 71. The research articles, books, reports, surveys related with subject and related areas have been analyzed.

Data for this paper is collected from different sources. Publications on HARC are available on the company's website in their archive section. Updates are published monthly in their newsletter and are available to the public. Two interviews are also conducted with Dr.MustaphaBeydoun, the VP &COO of HARC, at the HARC building in the Woodlands,Texas. Dr. Beydoun provided data on energy, financial, and LEED status(Leed 2020) at milestones throughout the critical phases of the project. The authors were given access to the documents, notes, and tables with data of the early collaboration stages, starting with the Gensler design team meetings with HARC leadership and staff all the way to contractor and project management selections. In addition to a field visit that provided the opportunity to observe the building in operation first hand, data was analyzed and compared to other non-sustainable and semi-sustainable projects. Since all these projects exist and are in operation, their level of success was assessed by comparing various metrics. For confidentiality reasons, some financial information has not been disclosed.

4 Case Study – The Houston Advanced Research Centre (HARC)

This section introduces the case of The Houston Advanced Research Centre (HARC) that is an apt example of well-planned and sustainable commercial building based on front end planning. Through sustainable construction and design, the building was also made through net-zero energy operations. The developed plan for the Houston Advanced Research Centre (HARC) headquarters office building in the Woodlands, Texas is an approximately 18,600 GSF two-story office building rectangle, that is 62' wide by 148' long and adjoining a 2,200 GSF laboratory.The vision for the 'build-to-suit structure' aimed to incorporate leading-edge sustainable technologies as well as serving as a showcase in the area.Thehigh-performance facility not only provides office and research space but also serves as an educational living lab. When choosing materials, mechanical and structural systems the embodied environmental impacts were heavily considered. To exemplify environmental stewardship, environmental, work culture, and financial considerations were considered (Beydoun and Gonzalez 2014; Beydoun 2019).

The design team's decision began by employing several elemental sustainable strategies aimed at minimizing the building's footprint (Beydoun and Gonzalez 2018c; Liu et al. 2017).To mention a few of them: designing bioswales to retain and filter water onsite; preserving the site's biodiversity by protecting and restoring native vegetation and minimizing impervious paving; a high efficiency building envelope; orienting the building to take full advantage of prevailing winds and optimizing daylight; onsite solar power generation; low-flow fixtures were installed to conserve water use; geothermal heat-exchange based mechanical systems were carefully designed for optimal indoor air quality and thermal comfort; interior spaces were designed and sized according to function. The first phase of the realization of the HARC building included the development of an Architectural Feasibility and Conceptual Design Study and Construction Cost Estimate (Liu et al. 2017).

The HARC and Gensler team compiled a feasibility study which provides vision and strategy, program validation and report, master site planning and landscape, along with the conceptual basis of design and feasibility cost implications. Building structural engineering was provided by Walter P Moore and the financial feasibility study by contractor Brookstone. Team alignment and collaboration was maintained throughout the process. Gensler supported HARC with the selection of the most suitable contractor for the job. To the end, Gensler ensured that HARC's needs were met during the building process and occupancy. Construction started in April 2016 and was completed in March 2017(HARC n.d.; Xu et al.,2018).

4.1 Front-End Planning, Visioning, and Strategy

The exceptional front-end planning in this project has provided ample information to point out risk and allocate resources in order to maximize the probability of success. As structures of organizations nowadays economize and out-source, project teams must self-direct during the planning process (Aarseth et al. 2017)

Team selection in preparation for the construction phase, along with collected data, assisted with choosing the right technology in preparation of scope and conceptual estimates and schedules.Alhassan& Adam (2021) emphasize on development information and communication technology for sustainable development.Studies show significant relation between information communication and technology and SDGs (Sustainable Development Goals) and it is going to speed up the achievement of 2030 targets (Adam &Alhassan, 2021).

Establishment of project guidelines and the execution plan, while measuring and reviewing performance and setting benchmarks, was invaluable to the project's success. Through facilitated discussions, the HARC leadership team gathered to identify an overall project potential while forming alignment on project process, scope, and mission. The objective of meetings was to form a sense of shared purpose and direction. The Construction Industry Institute advises strong leadership including executive, project owner and contractor throughout all levels of front-end planning. See figure-1 for a breakdown of the front-end planning schedule, all the way to hand over.

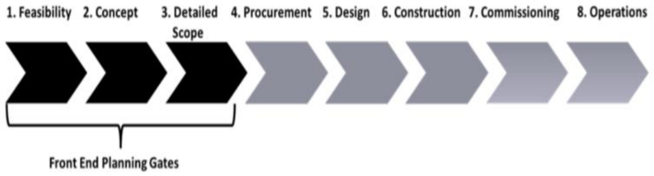


Figure.1. Front-End Planning Process Flow Chart

The Gensler-led HARC leadership and separate staff visioning sessions (a total of four and a half days) included three parts: setting the context, taking the organizational "snapshot" and identifying and confirming project goals, determining external and internal priority issues such as opportunities, threats, strengths and weaknesses.In this case, the collaboration didn't only mean leadership, the design company and contractors were also involved, but most importantly, the building's future occupants were included to ensure their ultimate comfort and needs were met. After the Visioning and Strategy process, the following were finalized: project location and the shaping of the physical facilities; the project schedule and budget; problem definition; HARC's current and future organizational needs were assessed; goals and expectations defined; organizational challenges explored and categorized, and building performance goals and evaluation criteria were established.

Using organizational "snapshots" created a clear picture of HARC by reviewing the organization's strengths, weaknesses, opportunities, and barriers. They also facilitated a better and thorough understanding of the organization's culture, values, operation and goals. During the strategy sessions, collaboration, culture and brand, workplace and sustainability metrics, and the value of human capital was discussed. The beginnings of the Owner's Program of Requirements (OPR) for the overall project were explored, created and documented. They were then aligned with HARC's vision. The design took into consideration of the brand creation that reflects the cultural and social goals of HARC. In addition to the OPR, the Campus Space Program identified factors not included in the pre-design programming phase such as goals, synergies, and means to measure the success of goals and strategies (see Table 1). The end goal was to achieve better optimization of design, building and operations approach beyond what could be realized by utilizing a single existing sustainability measuring tool such as LEED (Leed2020).

Table 1. Design Aspects of Campus Space Program.

Operational Can we handle it? Is it worthwhile? Will it improve the working conditions of employees?	**Economical** What will be the cost of the project? Is it affordable? When will the project start paying off?	**Educational** Will the project support education and research goals? Can it result in community education? Will the company be able to train and relocate the existing staff?
Technical Is it possible to achieve the performance goals? Do we have sufficient resources? What can we learn from the precedents?	**Social** How does it affect society and people? Will it result in growth of society and coomunity?	**Environment** What is the environmental impact ? How to build culture of awareness on environment and sustainability?

HARC looked to selectively optimize the building's functional approach through design tactics aligned with its goal to "help people thrive and nature flourish". Investment in each of these design aspects may have a greater initial cost, but they also have numerous operating paybacks and educational advantages that thus better align with HARC's research and community mission. While the energy, air and water alignment are self-evident with the conceptual facility design, the material focus also fits in.

4.2 Sustainable Energy at HARC

The goal of the design team is to reduce the energy usage of the building as much as possible through building siting, smart envelope solutions, efficient MEP systems, and optimized lighting and plug loads. To achieve optimum energy savings, the building was designed to minimize heat gain via a high-performance building envelope design, the use of a Dow Thermax insulation system and thermal venting that has heat from exterior metal panels transfer to air and vent upwards rather than to the enclosure. Fenestration on each elevation had specifically defined performance characteristics. Preliminary energy and daylight modeling were conducted to optimize the building's orientation-long axis along the east/west- and optimize window size and placement. The result is that wall and roof assemblies have an effective R-value to 50 . The careful selective use of high albedo and emissivity materials for cladding were purposefully placed. Cladding protects the slab from direct sunlight and eliminates the slab as an external heat sink.

The 252 solar panels installed on the roof are responsible for 88 kW of power generation (DC). The building's five inverters convert that energy from DC to AC power. A closed-loop geothermal heat exchange system consisting of 36 wells that run 300ft deep, where the ground temperature is a constant 70 degrees Fahrenheit, helps to maintain a comfortable interior temperature with the help of 15 high-efficiency heat pumps. In order to secure energy savings from the lighting, high efficiency LED fixtures were installed throughout, with task lights for controllable light levels, occupancy sensors for lighting shutoff, and most importantly, taking advantage of the 60' wide building to allow for improved day lighting. All the offices and 75% of the building's space have access to direct daylight. For operational purposes, building management systems including, energy metering and dashboards, allow for measurement, verification, and operational behavioral shifts to further maximize energy savings.

The reduction in water consumption is achieved by the installation of low-flow fixtures and native habitat that requires no watering. Bioswales and other permeable natural surfaces add to the management of the quality and quantity of storm water runoff. As part of the site's initial environmental assessment and analysis, an ecological survey of the 3.5-acre mixed pine-hardwood forested site was performed. The team assessed several landscape approaches for planting, water management, and hardscape. To create a minimum disturbance to the habitat around the building, a protection plan to preserve areas of high biodiversity was put in place. The plan included mimicking natural hydrology, site drainage and planning parking paving to avoid areas at drip lines of large caliper trees, all while minimizing impermeable materials to reduce water runoff. Over 70% of the site was left unpaved or in its natural state.

4.3 Building Materials and Life Cycle Analysis

'The HARC building was designed from a life cycle perspective' mentioned Dr.Beydoun. Life Cycle Assessment (LCA) offers a comprehensive approach to analyzing the many economic and environmental aspects of a product by considering its various life stages including raw material extraction, transportation, processing, service life, and disposal (see Figure 2).Evaluation of these stages and the inputs and outputs associated with these materials helped in creating the correct criteria for material selection and choice.

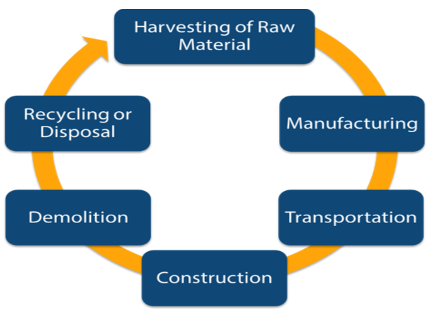


Figure. 2. Material Life Cycle Analysis

An engineering team from Walter P Moore performed a whole building life cycle assessment to evaluate the impacts of multiple materials, concentrating particularly on the enclosure and structural systems as these comprise a major portion of the building's materials.Because typical concrete — or more specifically, the cement in the concrete, which accounts for 90% of the concrete's carbon (CO_2) footprint — results in significant embodied carbon. Therefore, a steel-frame structural system was specified with low-carbon concrete elsewhere. These simple strategies saved 300,000 pounds of CO_2 emissions, which equaled a 20% reduction of embodied CO_2 from the structural and enclosure systems (compared to conventional construction), the equivalent of four years of operational CO_2 emissions before the building even opened. The LCA approach is imminent to the structure and way that HARC operates.

The design team investigated the embodied carbon of all materials. Figure 3 below is an infographic by the Materials Council that presents the amount of each material that can be produced for one ton of embodied carbon. Therefore, the larger the area, the less impact that the material has on an environment. The design team's goal was to maximize the use of the lower embodied carbon materials throughout the building while balancing cost, durability, and maintenance issues.

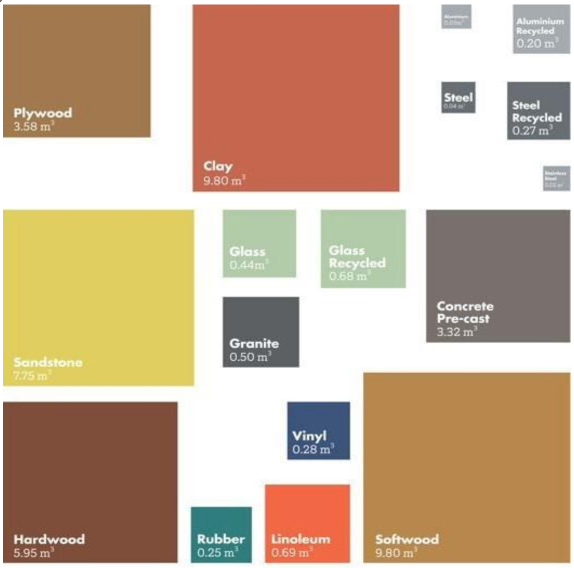


Figure. 3. Embodied Carbon of Various Materials (Gensler, 2020)

Enhancing air quality was at the top of HARC's priorities list. Putting their own research into practice, HARC set an example by utilizing a selection of materials with lower embodied carbon and smog-forming precursors. Materials transportation, with respect to reducing vehicle emissions, is a critical LCA component that the building team also focused on. Whenever possible, products that were manufactured and distributed regionally were selected.To improve indoor air quality and support building occupant wellbeing, a HARC priority, only materials, and finishes with no/low volatile organic compound (VOC) emissions were utilized. CO2 sensors and building indoor air quality monitors were installed and work with built-in technologies to optimize fresh air ventilation rates and return air filtration.

4.4 LEED

As HARC has a sustainability-focused mission, its certification target for the building was Leadership in Energy and Environmental Design (LEED) Platinum (Leed,2020) .This has given a potential challenge to the suburban nature of the site and LEED's emphasis on density and transit. Because energy, materials, and performance-related strategies have such a significant impact on LEED scores, assessing critical building systems and materials were early priorities in the design process. HARC was the first project in the region to require concrete suppliers to provide Environmental Product Declarations (EPDs), which are comparable to nutrition labels on packaged foods. 30.82% of the materials used in the building were obtained locally, and all building finishes were no or low VOC. 88.33% of the construction waste was recycled. As previously discussed, other advanced sustainable strategies include: a geothermal heat exchange system; an air-tight, high-performance building envelope and rain screen; and roof-mounted solar photovoltaics that provide over 100% (presently about 123%) of the HARC building's electricity usage. All excess power generated on-site is put back into the grid to be utilized by other users. Particularly impressive is the facility's 50% energy savings compared to LEED base targets for a facility of its size. The HARC building was certified as LEED Platinum by the U.S. Green Building Council (USSGBC) in September of 2017 (see Table 2 for the building's final LEED scorecard).

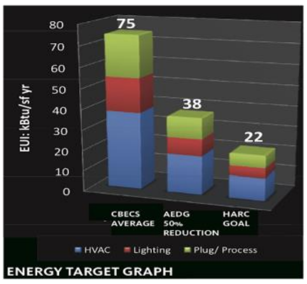
Table 2. Final HARC LEED Scorecard (provided by HARC)

HARC HQ LEED Facts for LEED DB+C: New Construction (v2009)	
Certification awarded September 2017	
Platinum	80 of 110
Sustainable sites	11 of 26
Water efficiency	6 of 10
Energy & atmosphere	35 of 35
Material & resources	6 of 14
Indoor environmental quality	12 of 15
Innovation	6 of 6
Regional priority credits	4 of 4

5 Results and Analysis

As a method of analysis, milestone dates track the project, as well as methods and materials used in construction and their environmental impact in comparison to traditional ways of construction and materials. The validity of this research is having a living example in operation.

By utilizing the correct design strategies, the team was able to meet its energy consumption goals.The average kBTU usage of an office building in Houston is 75 kBTU/sf/yr. HARC aimed to reach 22 kBTU/sf/yr (Figure 3). Quantifying the potential emissions reductions allows the impacts of the structure and enclosure to be put in terms of the savings associated with energy efficiency strategies. As of July 2019, the HARC building is at 18.4 kBTU/sf/yr stated Dr. Beydoun.



	kBTU/SF/YR	Price Per SF	Building SF	Annual Cost	Reduction %	Annual Saved
CBECS Average	75 kBTU	$1.71 / SF	20,000 SF	$34,200	-	-
AEDG 50% Reduction	38 kBTU	$0.86 / SF	20,000 SF	$18,000	46%	$13,900
HARC Goal	22 kBTU	$0.50 / SF	20,000 SF	$10,000	69%	$21,500

Figure. 4. Planned HARC Building Energy Usage (Gensler,2020)

The ASHRAE Advanced Energy Design Guidelines (AEDG) provide guidance to reach a 50% reduction in energy usage from the average. A 50% reduction would result in a goal of 38 kBTU/SF/YR (ASHRAE. (n.d.).

HARC had initiated an additional energy savings goal to reach a 70% reduction by utilizing the following key strategies; geothermal heating/cooling systems; an energy recovery unit for the outside air system; high-performance building envelope; and low lighting power densities and plug load control strategies.

Today, HARC is realizing a 75% reduction in energy usage as compared to an average office building in Houston. Furthermore, the building is currently on track to realize one of its other primary design goals, net-zero energy (NZE). This has become a reality only because of adoption of front end planning in the initial phases of development of building. As the first LEED Platinum BD+C in Montgomery County, Texas and the first commercial net-zero energy building in the Greater Houston Area, HARC has met their primary goals for the building.

Research has found that upfront investment in the front-end planning of a project, results in several savings. Front end planning (FEP) normally costs about 2.5% of the total project cost, while it will typically provide 10% cost savings, 7% faster schedule delivery, and 5% fewer changes will be faced. As shown in figure 4, a project executed on a Design-Build and Construction schedule will have an earlier point of delivering cost estimation and construction closeout.

Research also indicates that projects with better-aligned teams throughout the FEP process performed about 10% better in terms of cost and more than 16% better in terms of schedule. This truly exemplifies the direct relationship between the level of pre-project planning effort and project success.

Originally a separate structure serving as an Engine Lab was planned to be built to the west of the building. In the early phases of execution, this part of the project was dismissed due to cost consideration and owner's concerns regarding significant underutilization. There is currently no stipulation for future expansion of the structure. Based on the approved design narrative for the site and facility, the project feasibility cost estimator Brookstone developed the basic construction cost estimate for the Project. Their estimate document reflects a basic project package with careful site clearance and site stewardship. Brookstone's team also built-in price escalations for the subsequent 15 months of the anticipated construction period as a contingency for changes in the construction market. As seen in fig.5,total allocation and available budget tend to fluctuate depending on the construction industry market. The final project milestone shows the project ending under budget.

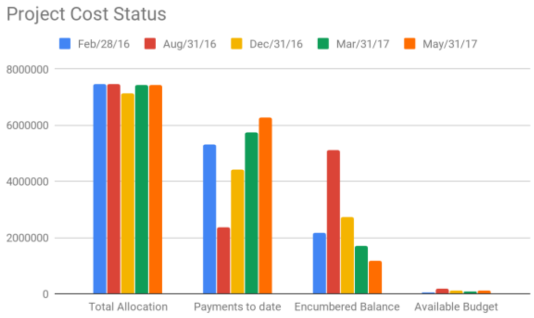


Figure. 5. HARC Building Cost Status

The Houston Advanced Research Centre has received several awards for its building. In October 2017 they received the Best Projects Award of Merit by Engineering News-Record (ENR) Texas and Louisiana. In 2018, HARC was chosen as a finalist in the Landmark Awards by the Houston Business Journal. Also, in 2018, the building won the Gold Level (highest level) Association of General Contractors (AGC) APEX Award in the Office Building Under $20M category. Most recently in January of 2019, the building was the winner of the prestigious Urban Land Institute (ULI) Development of Distinction award.

6 Conclusion

The paper has tried to examine a case study of sustainable commerce building, Houston Advance Research Centre (HARC) in terms of application of front end planning for successful execution of the project. Values such as increased predictability of cost and schedule, reduced probability of project failures, improved operational performance, the better achievement of business goals, better definition of risks and fewer scope changes; all evident in the HARC case. Through taking an in-depth look at HARC, authors are able to identify the details in preparation that lead to the success in delivering. The influence of motivation, a clear vision and a powerful message was communicated. Being completed ahead of its schedule and under budget, it is currently the only LEED Platinum BD+C in Montgomery County and is on track to become the first certified net-zero energy (NZE) commercial building in Texas. Today, it is averaging negative electric bills and water bills that run about $60/month. It is a validation of how proper planning, design, construction, and ultimately operations can lead to both supreme operational efficiency and occupant comfort and satisfaction. The study is limited by study of single building, i.e. HARC. The paper relies on the secondary data for case analysis. Further studies can be conducted on different buildings to understand how they are contributing towards conserving the environment. The paper provides future direction to study other similar buildings that can help in drawing a contrast and present further insights. Empirical survey on the related topic can improvise the topic further. The related studies can provide insight about the degree of conservation and sustainability initiatives take by the government and private players.

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