FROST & SULLIVAN

Attn. Greg Walker

Continental Automated Buildings Association

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Ottawa, ON, K1J 7S6

Intelligent Buildings Council (IBC) Research 2020

"Intelligent Building and COVID-19"

Closing Date: July 3, 2020, 4:00 PM ET

"Technical Proposal"

Submitted To:

Continental Automated Buildings Association (CABA)

From: Frost & Sullivan

3 July 2020

Table of Contents

1 CHECKLIST - RFP SECTION 12 - MANDATORY REQUIREMENTS REFERENCE

RFP Reference	Requirement (Bidder's proposal should repeat exactly as defined in the RFP)	Referenced Section/Page In Bidder's Proposal
12.1	Technical Proposal Page Limits Acknowledgement Technical Proposal – Introduction/Legal/Other (Include statements from Section 1.2) Max Pages 1 Technical Proposal – Personnel Biographies; Max Pages 2 Technical Proposal – About Research Organization (Experience, sample research, clients, etc.); Max Pages 2 Technical Proposal – Methodology (Sample size, target groups, timeline, etc.); Max Pages 2 Technical Proposal – Appendix A: Signed RFP; N/A Technical Proposal – Appendix B: Sample Research (Whole or partial research) Financial Proposal (Provided as a separate document, include statements from Section 1.2, reference Technical Proposal); Max Pages 2	Provided Below: Page #4: 1 page Section 6; Page 14 & 15 Section 4; Page 7 & 8 Section 5; Page 9 to 13 Attached Attached Provided separately
12.2	Evidence of knowledge and experience of personnel of current theory and practice in the connected home research discipline by providing relevant biographies of all personnel who it is proposed will participate in the project. The vender's project leader must have a minimum of 10 years relevant experience.	Page 14; 19-24
12.3	Evidence of previous experience in the intelligent building discipline by providing examples of relevant projects prepared for three (3) separate clients within the preceding 48 months. References will be required from these three (3) clients, if requested by CABA.	Page 7
12.4	A summary of how the vendor proposes to perform the project and the relevant experience of the proposed Staff.	Pages 9 to 13
12.5	Identify the sample size of both the interviews and surveys	Page 12
12.6	Acceptance of deliverables as identified in the Terms of Reference/Prospectus and proposed schedule.	Pages 4, 13
12.7	**The vendor must be a member of CABA or agree to become a member of CABA (US$850) (before the RFP is reviewed).**	Already Member of CABA
12.8	**RFP Signature** - Bidders must complete, sign (end of Section 18) and return this RFP form prior to the closing date.	Signed and attached with proposal delivery email
12.9	**Costs must be in $USD.** A fixed price including a full cost breakdown as per Section 17, "Financial Proposal" must be provided.	Provided in Financial Proposal
12.10	The Financial Proposal must be submitted as a separate package (PDF document) to the technical proposal **(NO FINANCIAL INFORMATION MAY APPEAR IN THE TECHNICAL PROPOSAL).**	Submitted Separately

2 Certifications

Frost & Sullivan hereby provides the following certifications:

- Certification items Nos. I to III – These are provided as requested by CABA in the RFP.

CERTIFICATION

I As per the RFP point # 1, sub point 1.2 (on page 2 of the RFP), Frost & Sullivan hereby agrees to the following:

1.) We hereby offer to sell and/or supply to the Continental Automated Buildings Association (CABA), for terms and conditions set out herein, the supplies and/or services listed herein and/or any attached sheets at the price(s) set out therefore.
2.) We hereby certify that the price quoted is not in excess of the lowest price charged anyone else, including our most favored customer, for like services.

II Frost & Sullivan confirms acceptance of the deliverables and associated timeline as identified in the Terms of Reference and schedule outlined in Section 12 of the RFP (Please refer to page 10, Section 12 – Mandatory Requirements, Item # 12.6).

III As per RPF point # 9, sub points 9.1 & 9.2 (on page 5 of the RPF), Frost & Sullivan certifies the following:

9.1 We hereby certify that all the information provided in all the attached biographies/resumes, particularly as this information pertains to education achievements, experience and work history, has been verified by us to be true and accurate. Furthermore we hereby certify that, should we be awarded a contract and unless CABA is notified in writing to the contrary, the personnel offered in our proposal shall be available to perform the tasks described herein, as and when required by the project authority. CABA and the Steering Committee must approve all new personnel working on the research that were not listed in the RFP submission.

9.2 We hereby recognize and certify that CABA will be the owner of the final deliverables and that no revenue-sharing arrangements on subsequent report

Signature…….....
(Authorized Representative of Frost & Sullivan)

Name – Konkana Khaund

Date – July 3, 2020

3 Introduction and Background

The Continental Automated Buildings Association (CABA) is an industry association dedicated to the advancement of intelligent home and building technologies. CABA's collaborative research program, undertaken annually, is funded and performed under the aegis of its leading industry councils focused at home and building technologies. The Intelligent Buildings Council (IBC), instituted to lead the advancement of smart technologies, industry initiatives and thought leadership within the large buildings space, has expressed interest in pursuing a research project looking into the impact of COVID-19 on the intelligent buildings (IB) industry and the new challenges and opportunities it represents for the IB value chain.

COVID-19 and Intelligent Buildings: An unprecedented transformation for the industry

The COVID-19 pandemic has impacted nearly every industry and transformed the way business will be conducted going forward. Beyond health, safety and environmental risks, the impact of COVID-19 has already forced various industries to consider business transformation initiatives to deal with the "new normal" circumstances that this pandemic will lead to. The intelligent buildings industry is no exception. In many ways, the IB industry and it value chain could be reeling in recovery challenges for a much longer time, given the fact that buildings and their occupants poses significant restraints to rolling out reset and recovery measures correctly. For the operators, building staff, city and municipal authorities and technology solution providers this calls for tremendous recalibration and reorganization of initiatives to handle reentry IB operation measures in the post COVID-19 scenario.

Frost & Sullivan's proactive COVID-19 initiatives: Rebound Strategy Framework

Frost & Sullivan has been proactively involved in evaluating reset and rebound strategies for various industries that have been impacted by COVID-19. Our econometric forecasts projecting recovery for various industries, carried out as early as February 2020, has been already hailed as commendable and a highly dependable scenario planning tool by government authorities, corporations and think tanks.

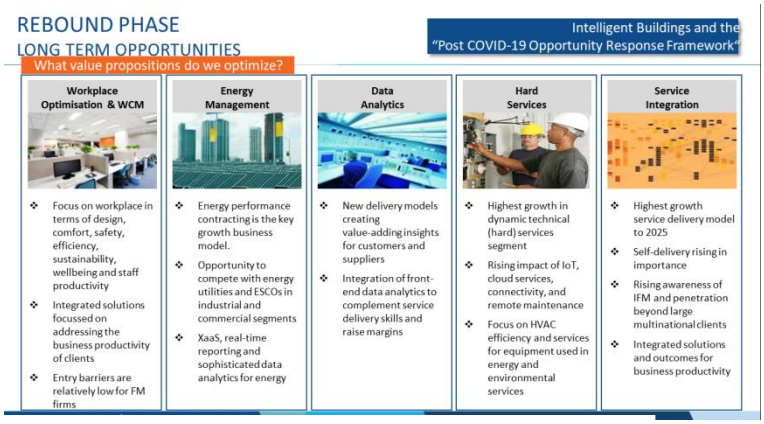
A key aspect of our COVID-19 recovery planning initiatives has been working closely with our global clients to support strategic decision making initiatives, support recovery frameworks and collaborating on identifying opportunities to respond to for business sustenance. This includes working closely with several IB industry representatives to create recommendations on reset and rebound initiatives for their businesses. This hands-on engagement that we are already leading will offer CABA members a great head start and strategic advantage to partner with Frost & Sullivan on this pertinent project.

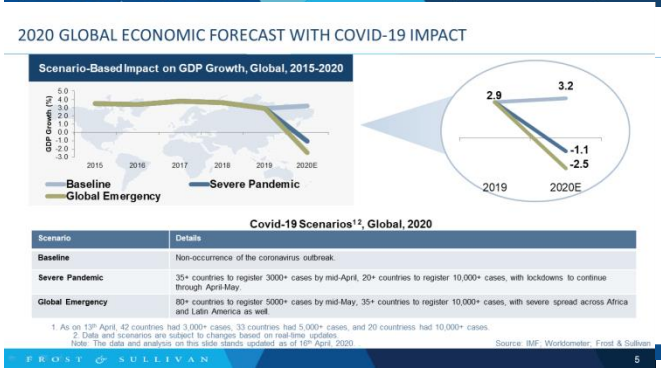
Our global position and local market insights will be particularly helpful in offering a variety of perspectives to deal with COVID-19 challenges, learning from the globally successful reset and rebound measures that we have been supporting our clients with. This, combined with our scale of operations, pool of knowledge and strategy experts, and solid all-rounded industry expertise will offer a differentiating edge for CABA members to work with Frost & Sullivan.

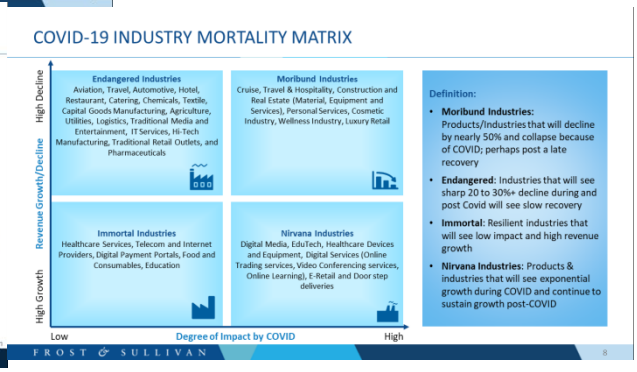
Frost & Sullivan is pleased to put forward this proposal and project design to assist IBC in this endeavor. We believe our project's outcomes will help IBC members in formulating an actionable intelligent building post COVID opportunity roadmap, and offer strategic guidance on successfully navigating its future trajectory.

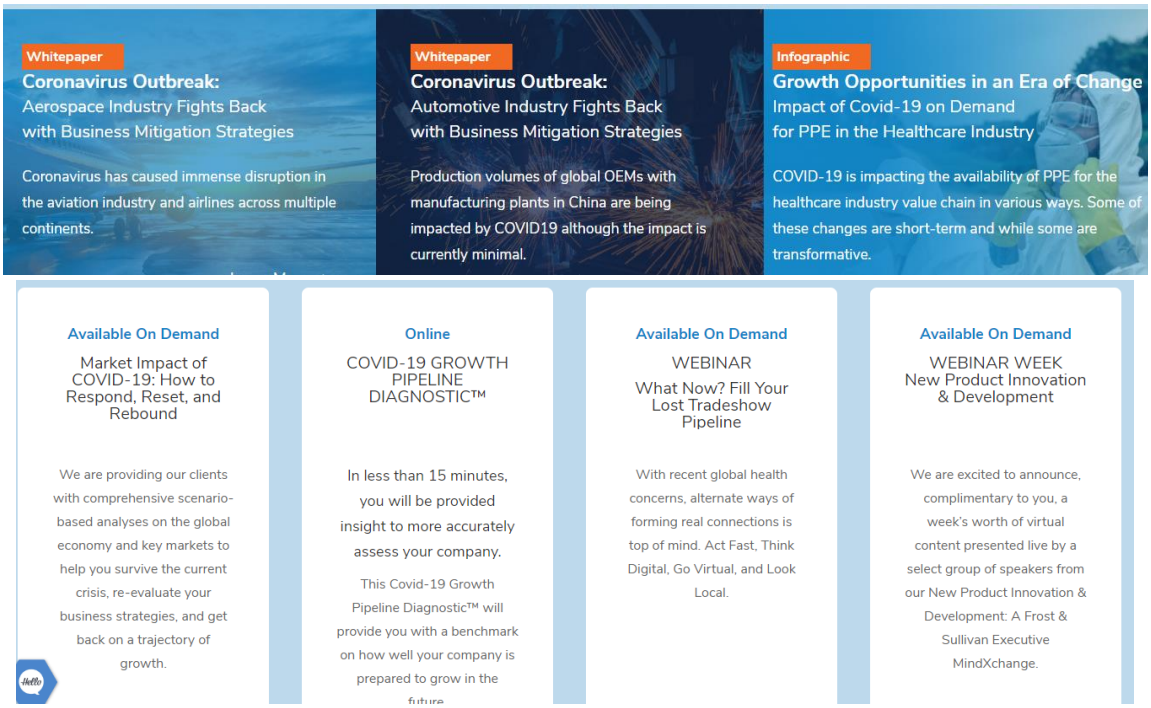
A Quick Snapshot of Frost & Sullvian's Proactive Engagement with Industry to Support Post CoVID-19 Rebound Strategies

Our active research, scenario projections, opportuntty framework development exercises









4 About Frost & Sullivan

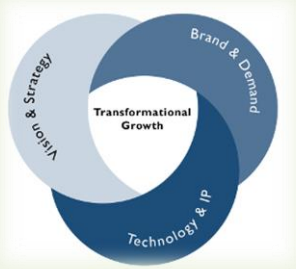
Frost & Sullivan, a global research and consulting organization, is uniquely positioned to not only identify growth opportunities but to also empower and inspire our clients to create visionary growth strategies for their future, enabled by our extraordinary depth and breadth of thought leadership, research, tools, events and experience that assist our clients by making their goals into a reality. Our understanding of the interplay between industry convergence, mega trends, technologies and market trends provides our clients with new business models and expansion opportunities. We are organized, positioned and trained to assist our clients in the development of their transformational growth strategies. We work with clients to not only help them survive the present, but adapt and thrive for the future. Our unparalleled breadth of services combines collaborative growth partnership research and consulting, technology and IP solutions, strategy, brand and demand solutions.

Frost & Sullivan's Global Presence, Coverage and Perspectives

More than 1,800 Consultants and Analysts in 40+ Offices Provide Perspective, Coverage & Service

Our Industry and Market Coverage

- Comprehensive understanding of all industry and market opportunities
- Analysis of potential competition from outside Client's industry
- Identification of growth opportunities in areas other than Client's current industry



10,000 active clients globally in more than 300 industry sectors and markets

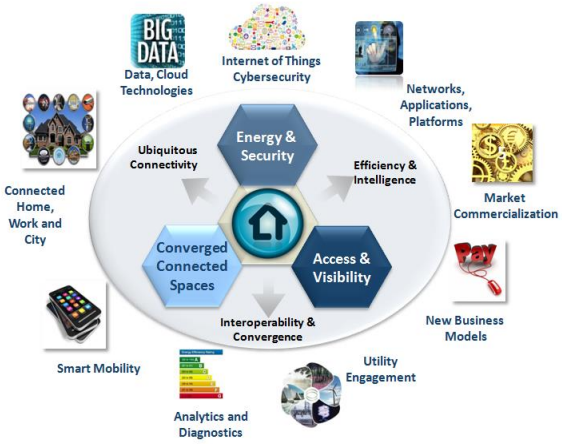
Our Clientele

- Emerging and Global 1000 companies
- Leading industry associations
- Universities, business and tech schools
- The investment community

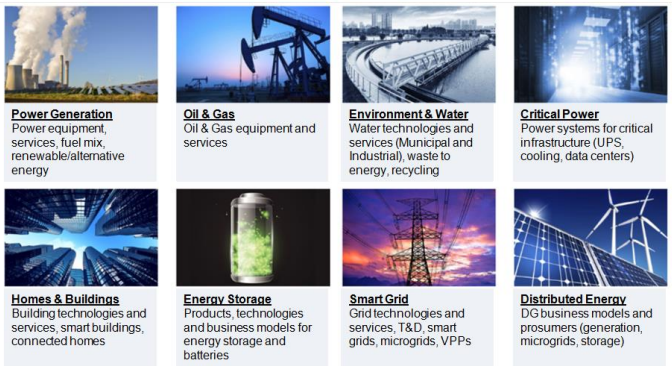
Frost & Sullivan's Expertise in Intelligent Buildings

The intelligent buildings industry is undergoing rapid transformation. Evolving quickly from basic automation and controls-aided intelligence, prevalent through the tail end of the last decade, IBs today is a complex proposition, revolutionized by new entrants on the technology and platforms side, with sophisticated management and monitoring solutions, offering self-learning, monitoring and optimization capabilities. The intelligent building environment is increasingly becoming dynamic with the expanding impact of IoT. While comfort, air quality, and smart energy management and energy efficiency gains importance inside the building, at the same time renewables and sustainable energy concepts for the building are showing a rapid growth in the last decade spurring advanced solutions in grid technologies and energy storage. The need for more smart and autonomous building management solutions is creating opportunities for the value chain. In keeping with the changing trends Frost & Sullivan's research focuses holistically on in-building systems and the broader smart and IoT technology domains, encompassing all key aspects of the value chain. From exploring market commercialization, new business models, buildings and energy industry convergence, and initiatives to disseminating though leadership–our experience and brand equity gives us a distinct edge in supporting this IBC research.

Our Domain Expertise in Intelligent Building



Frost & Sullivan's extensive IB and related industry coverage



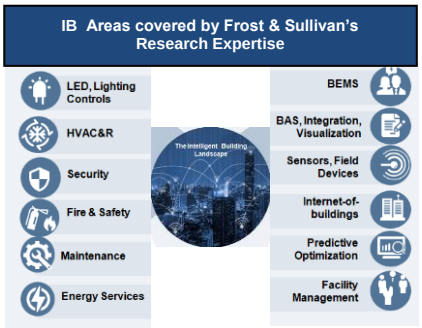
Sample of Past Experience

Provided below is a representative list of our expertise in the intelligent buildings that would directly benefit CABA in working with Frost & Sullivan.

Project	Project Highlights and Outcome
Intelligent Buildings: Design & Implementation Client: CABA, IBC, 2017	• This project was commissioned by the IBC, CABA, to help establish the benefits of adopting proper design to drive the growth in intelligent building solutions, and justify investments based on design-linked long term ROI of buildings. • The research tabled before the steering committee provided an understanding of the various prevalent design processes and the value drivers associated with them, including the role of energy performance and monitoring. • Through detailed industry perception based research the project addressed issues and challenges propagated by professional end users, owners and occupiers. • It evaluated the role of energy efficiency technologies and EMS systems, energy efficiency mandates, utility rebates, specification formats, rating tools and incentives to help promote design approaches in this industry. • Recommendations were made on ways to help incorporate design and implementation methods early on in a project life cycle to obtain maximum value.
Life Cycle Costing and Intelligent Buildings Client: CABA, IBC, 2013	• The project was undertaken to help CABA and the IBC in their ongoing endeavors in promoting the benefits of life cycle costing (LCC), uncovering pertinent issues around LCC adoption, and to address the complexities associated with making LCC and similar design and cost justification tools a necessary component of the industry. • The project revealed the need to logically approve capital investments by making design and specification tools a necessary part of the project flow for intelligent buildings. • Recommendations were made to the industry participants to organize initiatives to work together and create structural frameworks for joint collaboration in technology deployment as well as propagating LCC adoption.
Intelligent Buildings and the Bid Spec Process Client: CABA, IBC, 2012	• The project was undertaken to uncover the issues and complexities associated with bid and spec processes in pursuing intelligent building design and implementation. • The research proved that present bid and spec processes followed in the industry lack transparency, are price driven, and do not offer adequate impetus to the incorporation of intelligent technologies. • It critically examined the role and challenges associated with leading industry design and implementation processes such as bid and spec, design build, and construction management for intelligent buildings. • The recommendations included action items to address immediate needs for industry participants such as organization initiatives to work together and create structural frameworks for joint collaboration in developing design and spec development practices.
EMS Value Proposition Optimization and Strategic Business Roadmap for global markets Client: Tier 1 Japanese Conglomerate in EMS and Smart Infrastructure with major presence in NA, Europe & APAC, 2018	• The project involved designing and market testing an optimal EMS value proposition with value added services that the Client can offer for competitive advantages to commercial and institutional end users in North America, Europe and APAC countries • As part of the project competitive solutions were evaluated and benchmarked for gaps and niches to develop a minimum viable product value proposition that the client can launch for growing its business in these geographies • Significant end user research was undertaken globally to establish features and attributes that would resonate for best value, including pricing and revenue models that the Client should target in various end user segments • Frost & Sullivan also conducted a series strategy workshops with the Client to develop mutually the right implementation roadmap for market launch and mass roll out • After successful completion of phase 1 of the project Frost & Sullivan is now engaged by the client to help monitor and track implementation performance and identify adjunct growth areas for the client to pursue.
North America and European market partner strategy for EMS services for C&I Facilities Client: Global Market leader in Automation & Controls, BEMS, 2019	• Client had a need to understand the landscape for value added services in distributed energy controls for buildings and BEMS through strategic collaboration with software service providers and energy analytics providers to the C&I industry in North America, Europe and APAC markets. • The project entailed opportunity quantification in regional markets and identification of strategic partners to collaborate in their go-to-market strategy. • Frost & Sullivan undertook a detailed market research exercise globally to understand the demand for such services, the incremental revenue streams, and the ability to introduce the services early on in these regional markets to secure first mover advantage. • The client is implementing the strategic recommendations of the project delivered by Frost & Sullivan.

Sample of Relevant Research Expertise

Bright Green Building: Convergence of Green and Intelligent Buildings, CABA, IBC (2008)
Intelligent Buildings Roadmap, CABA, IBC, 2011
Global BEMS and HEMS market, Annual Report
New and Emerging Entrants in the EMS industry, Global Report Published Annually
DC power distribution markets for home and building energy management, Annual Report
Analysis of Energy Management and Performance Contracting Services Markets, Annual Report
Analysis of Building Automation Systems and Services Markets, Annual Report
Cybersecurity and Intelligent Buildings, 2015, 2017, 2019
Analysis of Building Installation and Services Market in North America and Europe, Bi Annual Report
Global Fire and Life Safety Market Analysis, Annual Report
Smart Buildings IoT enabled Market, 2016, 2018, 2020
Analysis of Lighting Equipment and Controls Market, Annual Report
Analysis of Demand Response Market North America, 2011, 2015, 2019
Opportunities for Internet of Things (IoT) in Connected Homes and Buildings, 2015, 2017, 2019
Technology Convergence with IoT; Impact on Urbanization, Construction and Mega Cities, Annual Report



5 Technical Proposal Methodology and Deliverables

The objective of this engagement is to help industry participants navigate the aftermath of the pandemic, target opportunities and implement the right measures to successfully grow their business in a post COVID-19 environment. As our industries deal with the imminent slowdown and fundamental shifts brought about by COVID-19, there are distinct pockets of opportunity that the emerging future scenario could deliver. The project outcomes will provide tangible and descriptive profiles of opportunities across your relevant industry segments, and provide a prescriptive timeline for prioritizing response strategies.

Frost & Sullivan proposes to address this project scope via the fulfillment of three distinct modules of research. The scope and deliverables of each module will be contained succinctly within each module to allow the project to progress in a timely manner, and more importantly to help industry participants to act upon findings and initiate their COVID-19 response strategy promptly. The three modules are:

PROJECT DESIGN & OUTCOMES: MODULE 1

Scope

- COVID-19 and Intelligent Buildings: Impact Overview
- Regulatory Environment & Guidelines Review

Deliverables

- IB Impact overview : buildings of the future dictated by the "new normal": technology, service and occupant changes
- CRE and asset management changing trends and impact review: IEQ, health and sanitation, reentry implications, change requirements to CRE services , system recalibration needs, worker safety, capital shortages
- Scientific literature review for COVID-19 and associated transmission vectors , scientific research and opinions on dealing with COVID-19 aftermath, influence on new building solutions
- Overview of knowledge and recommendations of other authorities such as Centers for Disease Control and Prevention (CDC), ASHRAE, and global though leaders
- Analysis of the above components, implications and top takeaways for IB industry participants
- Assimilation into a report to submit to the steering committee; Presentation of findings

Methodology & Report Layout

- Research output will be largely secondary based, supplemented with detailed discussion with steering committee members, regulators, and industry influencer bodies to develop final report and recommendations
- Report layout: ~30-35 page deliverable in word with PowerPoint supplement for presentation of findings

Timeline

- 5 working weeks from commencement of Module 1 to report delivery and presentation

Top Takeaways:

- Which areas need prioritizing for response?
- What does the science tell us?
- What combined intelligence can we leverage?

PROJECT DESIGN & OUTCOMES: MODULE 2

Scope

- IB technology impact assessment of COVID-19
- Technology innovation and potential evaluation to support post COVID-19 opportunities

Deliverables

- Technology landscape review and impact mitigation potential assessment: ultraviolet light sources, thermal imaging, sensors, touchless devices for calling, elevators, operating lights and doors, faucets, hand dyers, others; in-home preemptive temperature and health detection technologies to regulate building entry, occupant behavior management, facial recognition and people flow management, crowd analytics technology solutions, contact tracing and contactless maintenance, among others; cybersecurity concerns and mitigation measures to consider
- Service innovations to support post COVID-19 building needs: building & workspace technology and design
- Technology and data analytics to support post COVID-19 mitigation measures: incorporate solutions to monetize data
- Analysis of the above components, implications and top takeaways for IB industry participants
- Assimilation into a report to submit to the steering committee; Creation of a ***technology implementation radar*** over a 5 year horizon; Presentation of findings

Methodology & Report Layout

- Research output will based on structured primary discussions with industry participants, technology innovators and incubators, supplemented with desk research and interactions with steering committee members to develop final report and recommendations
- Report layout: ~40-50 page deliverable in word with PowerPoint supplement for presentation of findings

Timeline

- 8 working weeks from commencement of Module 2 to report delivery and presentation

Top Takeaways:

- Which innovations hold the key?
- Which technologies offer maximum potential?
- Where can we add incremental value?

PROJECT DESIGN & OUTCOMES: MODULE 3

Scope

- Future readiness of the IB industry after COVID-19
- Resiliency Requirements & Recommendations

Deliverables

- New technology implications on the IB environment and occupants
- Future of work and integration of work-from-home (WFH) in designing and planning for IB infrastructure
- Planning for pandemic preparedness: considerations for future indoor environmental: HVAC systems, advanced air and IEQ management, monitoring, crowd management, occupant monitoring and security planning
- Use cases of the future - recalibration and augmentation of systems and buildings for post-pandemic use such as:
  - IB with alternative built in usages for "pop-up" hospitals; Design simulation to facilitate "open office" reversals
  - Emergency health, safety and sanitation scenario simulations
  - EMS synchronization with emergency response support, IEQ resets to support "pandemic-ready" needs
  - Disaster mitigation and rebound services in a non human supported environment
- Analysis of the above components, implications and top takeaways for IB industry participants
- Assimilation into a report summarizing the future ready roadmap for IBs to submit to the steering committee; Presentation of findings

Methodology & Report Layout

- Research output will be largely secondary based, supplemented with detailed discussion with steering committee members, regulators, and industry influencer bodies to develop final report and recommendations
- Report layout: ~30-35 page deliverable in word with PowerPoint supplement for presentation of findings

Timeline

- 5 working weeks from project commencement to report delivery and presentation

Top Takeaways:

- How do we plan for future IB infrastructure?
- What will dictate our customer engagement process?
- Which innovations are best suited for our organizations to respond to?

Frost & Sullivan's Approach & Project Fulfillment Plan

FROST & SULLIVAN'S APPROACH

Following our past history of successful landmark research projects with CABA, we propose the following approach:

Engage & Organize — Deploy a consensus-based approach to lay out engagement processes and extract best value by mobilizing both, the project team, and the steering committee.

Evaluate & Affirm — Apply proven research and investigative methodologies to affirm and corroborate fact-based analysis.

Collaborate & Deliver — Mutually collaborate with the steering committee, CABA and external industry experts to deliver best-in-class outcomes.

PROJECT FULFILLMENT PLAN ACROSS 3 MODULES

PROJECT INITIATION	PROJECT PLANNING; SURVEY AND RESEARCH DESIGN COLLABORATION; PROJECT MANAGEMENT PLAN
RESEARCH PHASE	INTERVIEWS; SURVEY; SECONDARY RESEARCH; PANEL DISCUSSIONS; ANALYSIS & REVIEWS; INDUSTRY STAKEHOLDERS' GUIDANCE
REPORT CREATION	COLLABORATIVELY DESIGN AND DEVELOP FORM FACTOR OF FINAL DELIVERABLES; MILESTONE PLANNING; RECOMMENDATIONS REVIEW
FINAL DELIVERY	DRAFT & FINAL REPORT DELIVERY; EDITORIAL AND PAGINATION SUPPORT; WEBINARS; PROMOTION AT INDUSTRY EVENTS

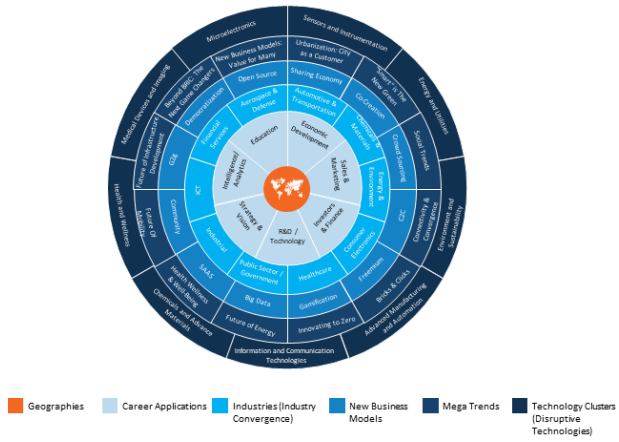
Examples of Proprietary Analysis Tools Frost & Sullivan will leverage for these modules

INTELLECTUAL PROPERTY FOCUSED ON GROWTH

Our team has developed world-class IP to empower our clients' growth zone journey

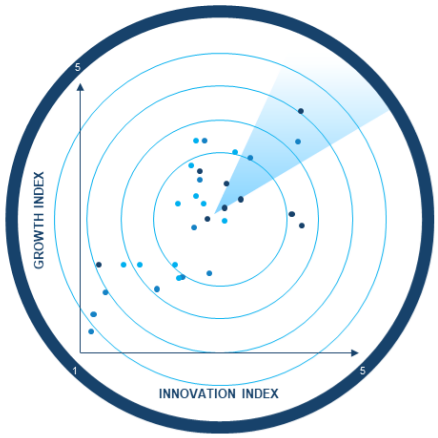
The Innovation System™

A tool that allows clients to see how trends, technologies, markets and careers collide in an ever-complex world of opportunity generation



The Frost Technology Radar™

A benchmarking tool that allows you to understand your position, your competition, and areas of growth (i.e., trends)



INDUSTRY ENVIRONMENT: KEY POST COVID-19 PREDICTIONS

Building EMS' Expanding Role, Beyond Efficiency & Comfort

Building managers will look for EMS solutions that are powered by AI and completely leverage the full potential of IoT devices to optimize building performance. Beyond occupant comfort and sustainability, synchronization with emergency response support and ability to recalibrate environmental quality is critical from the EMS to support "pandemic-ready" needs.

Connected Security & Safety Preparedness Plugs into EMS

Frost & Sullivan predicts the implementation of stringent safety standards and increased penetration of IoT-enabled cybersecurity and compliance detection systems to improve emergency response and reduce risks during pandemics. City surveillance projects will increasingly link with the built environment for input sharing and planning response strategies.

Pandemic-ready Use Case Mandatory for Real Estate Developments

Buildings will feature new use cases driven by government mandates. The ability to support pandemic-ready "pop up" medical infrastructure, either as a dedicated wing or a standalone unit in the campus, complete with environmental calibration, will be necessary to maintain their accreditations. Suppliers will tailor solutions to meet these changing requirements.

Keeping 5-G Rollout on Track for Broader Benefits

Frost & Sullivan predicts, while economic headwinds will delay enterprise 5G rollout, its larger benefits will keep 5G implementation on track. Trends in favor include the spike in bandwidth demand due to growth in teleworking and remote operations, post COVID-19, including 5G's support in Singapore's and China's monitoring and controlling efforts to triage the pandemic.

AI-powered Smart Buildings Delivered by A Digitally Mature Ecosystem

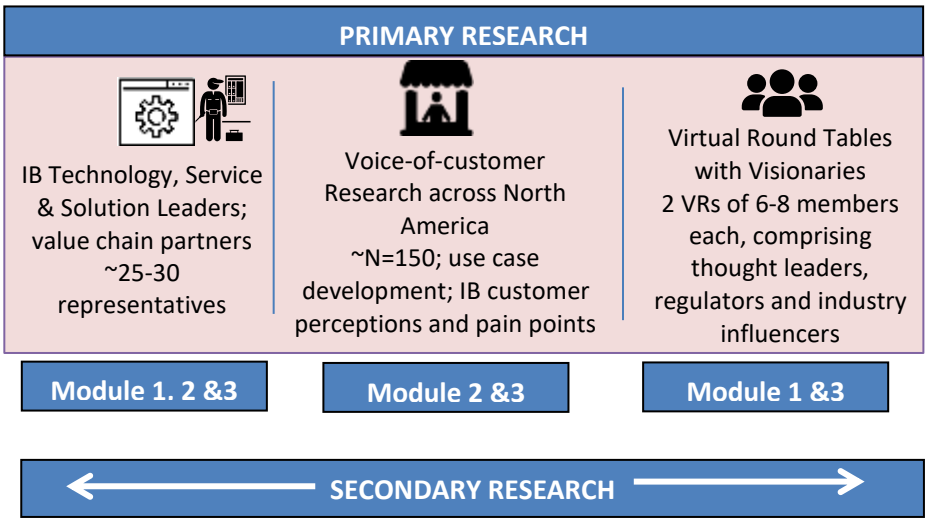
Leading building technology companies such as IBM and Siemens will integrate disparate building automation and management systems under one AI powered platform. Operating and maintaining buildings with such solutions will be further supported by a digitally advanced ecosystem that can integrate disaster mitigation and rebound services in a non human supported environment.

Integrated Vertical Building Solution Bundled with Disaster Response

Lighting solution providers like Acuity and Signify will lead on the momentum for connected lighting and push for integrated vertical building solutions, including integrated LED luminaires, building energy management, and digital lighting services. Bundling disaster response capabilities in their solution portfolio will characterize value propositions and branding.

Research Methodology Explained

To accomplish this goal, Frost & Sullivan will create the engagement vision with the steering committee, solidify objectives, goals and deliverables and carry out the fulfillment plan that will deliver this project. The below methodology identifies the consulting process flow, participants and milestones that will contribute to the development of the final reports of the three modules. The blue boxes below indicate the modules that will utilize the output of these primary research components.



Timeline: Activity Schedule

The proposed timeline for this project is depicted below. Actual milestones may vary based on progress and discussion with CABA and steering committee members. Total time frame is expected to be 18 working weeks.

Milestones	**Activity**	**Timeframe: 20 to 24 working weeks**
Project Kickoff and Steering Committee (SC) Launch	Kickoff Meeting; Set goals and objectives; establish update schedule; Set dates for completions of Module 1	Week 1
Module 1		
Introductory meeting and Module 1 planning session	SC discussions Research Launch Literature review launch Primary research and analysis Report development	Week 2, 3, 4, 5
Module 1 Submission	Report submission	Week 6
Module 1 report review by SC	Report review Feedback and questions from SC Incorporation of feedback and submission of updated Module 1 report to SC	Week 7, 8
Module 1 presentation	Presentation of Module 1 report to SC	End of Week 8
Module 2	Detailed work plans for Modules 2 and 3 will follow the above process as shown for Module 1	Week 9-16
Module 3		Week 17-24

Deliverables

Frost & Sullivan will provide CABA with the following deliverables and webinars as requested in the RFP. The outline of report and content will be created once the steering committee is formed and the project is formally kicked off.

Reports, Presentations and Data	Webinars
Frost & Sullivan will provide one consolidated report combining outcomes of Modules 1, 2 and 3 at the end of completion and submission of all 3 modules to CABA. The following deliverables pertains to this 1 consolidated deliverable only. These do not apply to the deliverables of each successive model. Delivery of six (6) draft documents in a format that CABA will provide, including the following: (1) Full report (Microsoft Word format) (2) Executive summary (Microsoft Word format) (3) Full report presentation (Microsoft PowerPoint format) (4) Executive summary presentation (Microsoft PowerPoint format (5) Raw Data where applicable (6) Four (4) or more infographics of key data from the research Delivery of six (6) final documents, including the following: (1) Full report (Microsoft Word and PDF format) (2) Executive summary (Microsoft Word and PDF format) (3) Full report presentation (Microsoft PowerPoint format) (4) Executive summary presentation (Microsoft PowerPoint format) (5) Raw Data where applicable (6) Four (4) or more infographics of key data from the research ***Additionally, Frost & Sullivan will be happy to support CABA members with a white paper developed from the outcomes of the 3 modules to use as an educational tool with the industry.***	• One (1) introductory webinar (1 hour) for prospective funders • Kick-off webinar (1 hour) to the Steering Committee to outline the research purpose, scope, objectives, approach, and timelines. The webinar will be hosted and recorded, with contact information of attendees to be shared with CABA. • Regular Steering Committee webinar meetings (1 hour), when deemed necessary through each of the 3 modules, to communicate; progress, preliminary findings, approvals of research methodologies, and next steps. The webinar will be hosted and recorded, with contact information of attendees to be shared with CABA. • Respond to requests by individual Steering Committee members for additional information via conference or webinar calls. Any new CABA contacts that join Steering Committee meetings or any of the webinars will be provided to CABA (name, email, etc.). • " 1 Final Webinar" (2 hours) at the conclusion of all 3 modules: Modules 1, 2 and 3, provided by the vendor, will be presented to all the funders (unlimited attendance) after the final documents have been delivered. This webinar will be hosted and recorded by the vendor. Contact information of webinar attendees will be recorded by vendor and shared with CABA. Vendor must use the PowerPoint template provided by CABA. This webinar will encapsulate the consolidated findings through Modules 1, 2 and 3. • "Organization Webinars" (1 hour) for each organization on the Steering Committee after completion of all 3 modules: Modules 1, 2 and 3, unlimited attendance per organization. These webinars will be presented after the final documents of all 3 modules have been delivered to the funders. Steering Committee members have one (1) month to arrange for these presentations with the vendor. These webinars will be hosted and recorded by the vendor. Contact information of webinar attendees will be recorded by vendor and shared with CABA. • "Industry Webinar" (1 hour), after completion of all 3 modules: Modules 1, 2 and 3, will be provided following the embargo period ending. The embargo period ends four (4) months after the Final Webinar. This webinar will be recorded and all contact info (name, email, etc.) of those registered will be shared with CABA. • Approximately three (3) "Industry Webinars" (1 hour each) will be provided throughout the project. These webinars will correspond to the release of the modules 1, 2 and 3. Each webinar will present high level findings from the module. These webinars will be recorded and all contact info (name, email, etc.) of those registered will be shared with CABA. • A special half day presentation provided to a select number of steering committee contacts (approx. 10) led by a minimum of one analyst of the vendor to lead a discussion on industry trends. All costs to be borne by the vendor.
• Frost & Sullivan will provide a fully paginated final report to CABA as per CABA's guidelines • All webinar costs will be borne by Frost & Sullivan.	

6 Personnel Biographies

Frost & Sullivan proposes the following project team structure and responsibilities for success of this project.

Project Team Organization		Responsibilities (both for CABA and Frost & Sullivan)
Client Project Steering Committee	Frost & Sullivan Mark Simoncelli, Partner Konkana Khaund, Director of Consulting	• Provide supervision for the engagement • Approve initiatives • Eliminate roadblocks, facilitate client organization buy-in • Make decisions for engagement progress
Project Lead		
Client Project Steering Committee	Frost & Sullivan Konkana Khaund, Director of Consulting	• Manage day-to-day tasks • Lead creation of deliverables • Monitor progress against plan • Review weekly status
Project Team		
Client Project Steering Committee	Frost & Sullivan Core team Konkana Khaund, Director of Consulting Dr Romualdo Rodrigues, Director of Consulting Lucrecia Gomez, Principal Consultant Pratik Paul, Sr Consultant Anirudh Bhaskaran, Sr Consultant Other consultants and analysts to be added as required	• Provide deep industry expertise • Offer strategic insights into project planning and conduct research • Produce deliverables and recommendations

Brief Team Member Profiles

The exhibit below provides brief profile highlights of each team member. Detailed bios are provided in the appendix.

Team Member Credentials	Profile Highlights
Mark Simoncelli, Partner & VP Role in this project: Project Supervisor and Quality Assurance Executive	• Over 19 years of consulting experience in business process consulting, digital transformation, energy, home and buildings and power sectors • Extensively involved in industry framework developments, digital transformation strategies, growth implementation and convergent industry solutions • Extensive work experience in business advisory with major IB sector clients
Konkana Khaund, Director of Consulting Role in this project: Project Manager and Team Lead	• Over 18 years of experience in research and consulting in home and building technologies, environmental technologies, and urban infrastructure sectors • Extensively involved in smart homes and building solutions, urban infrastructure development, energy management, Internet-of-Things (IoT) and cybersecurity, building automation and control, smart cities, sustainable solutions, energy efficient technologies and solutions, climate technologies, HVACR and lighting
Lucrecia Gomez, Principal Consultant, Frost & Sullivan Role in this project: Project Team Member	• More than 16 years of energy and urban infrastructure consulting expertise, which includes particular knowledge of market entry and expansion strategies, new product development and launch strategies, process mapping and analysis, third-party business plan verification • Industry expertise includes extensive professional experience in the buildings and energy sector, with a focus on energy transmission, distribution and generation technologies, demand response and grid optimization technologies, microgrids and energy services, technology contracting processes and procurement evaluations, controls, automation, lighting, HVACR and performance contracting • Additional focus on backup power, generator sets and other distributed generation solutions, oil and gas (upstream, midstream and downstream), renewables (wind, solar, biomass), fuel cells (stationary, portable)
Dr Romualdo Rodrigues, Director of Consulting, Consumer Research Role in this project: Team Member, Professional End User Research Specialist	• Over 15 years of experience as a quantitative market research and marketing strategy consultant, including hand-on experience on six CABA projects delivered to IBC and CHC • Experience covers consumer and professional industry end user research; brand research – consumer and B2B; advertising and message optimization; product features configuration and pricing optimization; market segmentation and positioning research; predictive modeling; advanced multivariate analysis; choice modeling using various methods (ACBC, CBC, MaxDiff, etc); marketing strategy formulation based on quantitative research insights
Pratik Paul, Sr Consultant Role in this project: Team Member	• Over 10 years of professional expertise, which include market research, advisory, and project management; particular expertise in technology penetration evaluations, sourcing strategy recommendations, intelligent buildings and connected home, BEMS and HEMS, smart cities research; visionary innovation research, analytics and business process implementation • Extensive track-record of leading flagship consulting projects, with in-depth knowledge of key trends and issues affecting the connected industry segments
Anirudh Bhaskaran, Sr Consultant Role in this project: Team Member	• Sr Consultant in the Energy and Environment team covering Home and Building Management Technologies, with over 10 years of industry experience • Extensive expertise in smart buildings, urbanization and infrastructure sectors; disruptive technologies and business models; energy efficiency technologies; water and wastewater process and reuse technologies; sustainable developments • Experience in the homes and buildings sector with primary focus on HVACR, building controls and automation, lighting and energy efficiency, energy services and performance contracting, building and homes energy management systems, smart and connected homes

Appendix

- **Appendix A – Signed RFP**
- **Appendix B – Team Member Bios**
- **Appendix C – Sample of Past Research**

Appendix A – Signed RFP

The complete signed RFP is send to CABA via email. A snapshot of the signature page is provided here.

Intelligent Buildings and COVID-19: RFP – June 19, 2020

16. AWARDING OF CONTRACT

As this project is based on a competitive bidding process, only one (1) contract will be awarded, and it will be offered to the bidder whose proposal is deemed by the Steering Committee, Council Executive Committee and CABA to provide the best value. More than one (1) vendor can be selected if a joint proposal is submitted and selected.

Should the total cost of the selected vendor's proposal exceed the available total project budget, CABA and the Steering Committee may work with the vendor to achieve optimization of project scope, research objectives and methodology in accordance with the available project budget.

Once the project is awarded, the vendor and CABA will work together to create an official contract. This contract will be signed by both the vendor and CABA prior to the commencement of the research project.

Important Guide: This RFP is for $80,000 USD. We encourage prospective bidders to be creative in deriving their scope, objectives, and cost of the research to provide maximum value.

Signature of Authorized Company Official: Konkana Khaund

Konkana Khaund **(Print Name)**

July 3, 2020 **(Date)**

Appendix B – Team Member Bios

Mark Simoncelli, Partner and Global VP of Consulting
Frost & Sullivan, North America

Functional Expertise

Over 17 years of large scale business growth & transformation expertise, which include thought leadership and implementation internationally (US, Europe, Asia/Pacific, India, Middle East and Africa). Particular expertise in:

- Growth Strategy implementation, Growth Expansion, Commercial Due Diligence and Post Deal Integration
- Digital Transformation and Business Change implementation (end to end Transformational Change)
- Organization Development & Culture Change
- Channel and Process Optimization & Business results realization
- Change Management (Org Design, Training, Communication, Journey Navigation) & Program Management

Industry Expertise

Experience base covering broad range of sectors, leveraging long-standing working relationships with leading industry participants' Senior Executives

- Business & Financial Services (Banking, Insurance)
- Public Sector (Local Government)
- Chemicals, Materials & Food (Retail, Manufacturing)
- What I bring to the Team
- Strategy Development
- Business Transformation Implementation
- Change Management
- Project Management
- Business Growth

Career Highlights

- Extensive expertise in topics related to Business Transformation.
- Regular International speaker at the Institute of International Research
- Programme Management in several leading private and public sector firms:
- Local Government, Cape Town
- Woolworths, South Africa
- Nedbank, Standard Bank, Absa, Sanlam

Education

- BSc Honours from Rhodes University, Grahamstown, South Africa

Konkana Khaund, Director of Consulting, Energy & Environment

Frost & Sullivan, North America

Functional Expertise

Over 18 years of experience in research and consulting in home and building technologies, environmental technologies, and urban infrastructure sectors, covering:

- Management and supervision of global research on connected homes and intelligent buildings, urban infrastructure and smart cities
- Markets, Technologies and Industry Research , including market commercialization prospects and best practices
- Project feasibility studies, acquisition target research and due diligence
- Geographical expansion strategies and new market exploration

Industry Expertise

Seventeen plus years in the energy, environment and building technology sectors, with focus on both traditional and sustainable solutions including:

- Smart homes and building solutions, urban infrastructure development, energy management, connected homes, cloud technologies, Internet-of-Things (IoT) and cybersecurity, building automation and control, smart cities, sustainable solutions, energy efficient technologies and solutions, climate technologies, HVACR and data centers
- Water and waste water, waste management and remediation, environmental quality solutions
- Emerging segments such as carbon markets, capture technologies, environmental monitoring and diagnostics
- Associated service markets and vertical industry segments
- Thought leadership promotion through active participation in industry association-led activities and collaborative research programs

What I bring to the Team

- Long standing industry association, understanding of market trends and behaviour from stakeholder's viewpoint
- Extensive client interaction experience, including strategic project execution and management
- Broad perspective of people, regions and industry sectors with work experience in North American and Asia
- Frequent presenter at major industry events such as Smart Grid Modernization Summit – Connected Homes think tank, Intelligent & Green Buildings Summit, Realcomm, Niagara Summit, Growth Innovation & Leadership Conference (Frost & Sullivan), leading industry webinars and forums
- Often featured, quoted and interviewed in national publications and newswires such as Bloomberg, the Wall Street Journal, CNN.com, Business Week, Forbes.com San Francisco Chronicle, Green Biz, Associated Press, New York Times and Chicago Tribune
- Serves on the advisory board of Realcomm/IB-Con ; member of the Intelligent Integrated Buildings Council, the Connected Home Council and White Paper Committee of the Continental Automated Buildings Association

Career Highlights

- Industry Manager with Frost & Sullivan's Energy & Environment Practice since 2011; Sr. Industry Analyst and Program Manager with the same practice from 2008-10; Research Analyst, Building Technologies, 2006-08
- Senior Consultant with CBRE South Asia Pte Ltd as core member of the Strategic Consulting Group, 1998-2005
- Established relationships with major industry players and organizations, including Philips, GE, Schneider Electric, Emerson, Cisco, Intel, AT&T, Samsung, IBM, Ingersoll Rand/Trane, Johnson Controls, Siemens Building Technologies, United Technologies Corporation, Honeywell, US Green Building Council, Continental Automated Buildings Association, Realcomm.

Education

- Masters Degree in Economics (Specialization – Econometrics and Development Economics); BA – Economics (Hons), Delhi University, India

Lucrecia Gomez, Principal Consultant, Energy & Environment

Frost & Sullivan, North America

Functional Expertise

- More than 16 years of energy and urban infrastructure consulting expertise, which includes particular knowledge of:
  - Market entry and expansion strategies
  - New product development and launch strategies
  - Process mapping and analysis
  - Third-party business plan verification

Industry Expertise

- Extensive professional experience in the buildings and energy sector, with a focus on:
  - Energy transmission, distribution and generation technologies
  - Demand response and grid optimization technologies
  - Microgrids and energy services
  - Technology contracting processes and procurement evaluations
  - Controls, automation, lighting, HVACR and performance contracting
  - Generator sets and other distributed generation solutions
  - Oil and gas (upstream, midstream and downstream)
  - Renewables (Wind, solar, biomass)
  - Fuel cells (stationary, portable)

What I bring to the Team

- Multi-functional teams management
- Proficient in the implementation of strategic initiatives
- Combined marketing, strategy and organizational perspective
- Strong experience on strategic projects for business development and growth

Career Highlights

- Research Manager of Frost & Sullivan's Global Innovation Center and Green Energy Program Manager of Frost & Sullivan's Energy Business Unit, both since 2008
- Oil and Gas Program Manager as well as the Energy and Power Systems Industry Manager of Frost & Sullivan's Energy Business Unit, both since 2010
- Research Manager of Frost & Sullivan's Energy Business Unit, since 2013
- Research Director of Frost & Sullivan's Energy Business Unit, since 2015
- Previous related experience at Schneider Electric, as well as corporate marketing experience at an international bank

Education

- Master's in International Economic Politics from the University of Belgrano (Buenos Aires, Argentina)
- Corporate Law Degree from the University of Buenos Aires (Buenos Aires, Argentina)
- Six Sigma-Green Belt (Buenos Aires, Argentina)

Romualdo Rodriguez, Consulting Director,
End User Research Group
Frost & Sullivan, North America

Functional Expertise

Over 15 years of experience as a quantitative market research and marketing strategy consultant, including hand-on experience on **six CABA projects** delivered to IBC and CHC
Experience covers:

- Consumer and professional industry end user research
- Brand research – consumer and B2B
- Advertising and message optimization
- Product features configuration and pricing optimization
- Market segmentation and positioning research
- Predictive modeling
- Advanced multivariate analysis
- Choice modeling using various methods (ACBC, CBC, MaxDiff, etc)
- Marketing strategy formulation based on quantitative research insights

Industry Expertise

Experience in quantitative market research for the following sectors and categories

- Brands of Fortune 500 companies
- Global research for automotive, transport, energy, technology, healthcare sectors
- Above-brand research to uncover category drivers

What I bring to the Team

- Ability to leverage experience with automotive and transport market in particular
- Ability to bridge business objectives and quantitative research objectives
- Ability to provide relevant marketing strategy framework and analytics framework.
- Ability to apply creativity and innovation to both research design and research presentation.
- Ability to derive and integrate key insights at a strategic level.

Career Highlights

- Strategist, Quantitative Research, In-Sync
- Director, Advanced Analytics, Customer Research, Frost & Sullivan

Education:

- Ph.D. in Business Administration (focus: Business Strategy)
- Master in Business Administration
- BSC Marketing Management
  - AB Behavioral Science (minor: Sociology)

Pratik Paul, Principal Consultant, Energy & Environment

Frost & Sullivan, North America

Functional Expertise

- Over **10 years** of professional expertise, which include Market Research, Advisory, Business Development and Project Management; Particular expertise in:
  - Market Research and Sourcing Strategy recommendations
  - Connected Home; AI & ML; Visionary Innovation Research
  - Analytics and Business Process Implementation

Industry Expertise

- Experience base covering a broad range of sectors, leveraging long-standing working relationships with leading participants in the following industries
  - Artificial Intelligence (AI), Machine Learning (ML), Connected Homes, IoT and the Embedded Ecosystem
  - Temperature Controls, transportation and logistics, thermal power plants and associated buildings
  - Industrial Durables (Metal Products and Injection-Molded Plastics) across multiple industries
  - High-Technology and Discrete Manufacturing

What I bring to the Team

- Strong ideation skills backed by analytical ability
- Data-driven approach to provide focused information and solutions
- Wide experience in managing large scale connected home research projects
- Vast knowledge of the smart and connected technology solutions markets and its opportunities and challenges
- Close relationships with key stakeholders in connected home and digital transformation industry segments

Career Highlights

- Extensive expertise in Market Research, Advisory, Project Management and Bid-Management functions in the following firms.
  - Continental Automated Buildings Association
  - Consumer Technology Association
  - The CSA Group
  - Emerson
  - Philips Lighting
  - Larsen and Toubro Ltd.
  - Infosys BPO Ltd.
  - Beroe Inc.

Education

- Masters in Business Administration from Symbiosis International University, Pune, India
- Bachelors in Technology from Amrita University, Coimbatore, India

Anirudh Bhaskaran, Senior Consultant, Energy &Environment

Frost & Sullivan, North America

Functional Expertise

Over 10 years of industry expertise, which include research and consulting, with particular expertise in:

- Smart Buildings, Urbanization and Infrastructure Sectors
- Disruptive technologies and business models
- Energy Efficiency Technologies
- Water and wastewater process and reuse technologies
- Sustainable Developments

Industry Expertise

- Experience in the homes and buildings sector with primary focus on:
  - HVACR, building controls and automation, lighting and energy efficiency
  - Energy services and performance contracting
  - Building and Homes Energy Management
  - Smart and Connected Homes

What I bring to the Team

- Statistical and Analytical skills
- Modelling and Forecasting abilities
- Techno-economic representations

Career Highlights

- Developed a performance model on solar photovoltaic systems for Indian climatic conditions in Robert Bosch Engineering and Business Solutions India Ltd., Bangalore
- Performed energy audits on Vapour compression Air-Conditioning systems, Solar thermal collector systems, Diesel – Generator sets in PSG Hospital, Coimbatore

Education

- Master of Engineering in Energy from PSG College of Technology, Coimbatore, Tamil Nadu, India
- Bachelor of Engineering in Mechanical from Anna University, Chennai, Tamil Nadu, India

Appendix C – Sample of Past Research

As a sample of Frost & Sullivan's past research, excerpts from the executive summary and the first chapter of the project "Life Cycle Costing and Intelligent Buildings" that was undertaken on behalf of the IBC, CABA in 2013 is provided here.

For more details or to download a free copy of this report please click on the following link:

https://www.caba.org/lccib

Executive Overview

1.1 Project Background

The Continental Automated Buildings Association (CABA) is a not-for-profit industry association dedicated to the advancement of connected home and intelligent building technologies. The organization is supported by an international membership of more than 300 organizations involved in the design, manufacture, installation, and retailing of products relating to home automation and building automation. Public organizations, including utilities and government organizations, are also members.

The Intelligent and Integrated Buildings Council (IIBC), a core working committee of the Continental Automated Buildings Association (CABA), commissioned this research project titled "Life Cycle Costing of Intelligent Buildings," with the objective that it could assist in building the industry's knowledge base and perspectives on life cycle cost (LCC) methods, and the issues and challenges associated with its adoption. Frost & Sullivan was commissioned by the project steering committee, instituted for the specific purpose of funding and overseeing this collaborative research, to undertake the project on behalf of CABA.

1.2 Overview and Focus Areas

The heterogeneous and fragmented nature of the building technology industry and its associated service segments warrants that various stakeholders be involved in any given project delivery process. The ultimate decision on technology adoption is usually dependent on the influence of various service partners. Differences in operational methods of these partners leads to delay in implementation, and often results in the selection of low-cost options that do not offer benefits to the building owner.

Stringent budgets and quicker payback frequently become the sole criteria for selecting a particular set of technology solutions. Incorporating intelligence is usually either postponed indefinitely or not considered at all. The present procurement processes followed in the industry further add to the issue because contractors, system integrators, and consultants exert varying degrees of influence on the building owner's decision making process.

The intelligent buildings industry is characterized by vendors and service providers from established technology, product, and solution segments, as well as those offering smart and energy-efficient alternatives. These players operate in the market with a variety of service providers involved from prototype development to delivery. Given this position, there are challenges that the industry participants have to face in communicating their value proposition to the building owner as well as his consultants and external project partners.

Therefore, the key focus areas agreed upon by the project steering committee include the following:

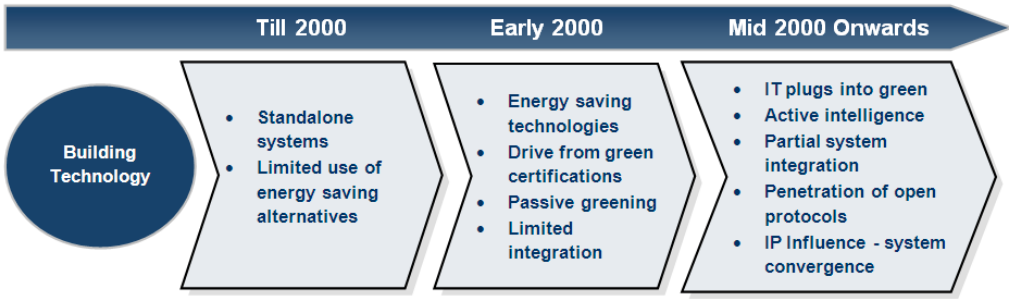
- Current status of adoption of intelligent technology and LCC methods
- Optimal delivery process for success of adopting LCC
- Level of awareness of various decision makers
- Process changes to be adopted
- Opportunities for industry participants

The content of this report encompasses the above focus areas.

Intelligent buildings serve as a dynamic environment that responds to occupants' changing needs and lifestyles. As technology advances and as information and communication expectations become more sophisticated, networking solutions both converge and automate the technologies to improve responsiveness, efficiency, and performance. To achieve this, an intelligent building combines data, voice, and video with security, heating, ventilation, air conditioning, and refrigeration (HVACR), lighting, building controls, and other electronic controls on a single IP network platform that facilitates user management, space utilization, energy conservation, comfort, and systems improvement.

Exhibit 1.2 shows the technology transitions in intelligent buildings, as tracked by Frost & Sullivan over the last decade.

Exhibit 1.2: Technology Transitions in Buildings



Definition of LCC[5]

Frost & Sullivan's research for this project indicates that there are two distinct approaches[6] adopted for building-related LCC evaluations, depending upon which stakeholder group is involved and what aspects of a building's life cycle play a role in the process. Typically, end-to-end life cycle or whole building life cycle (WLC) appraisal is carried out for a much broader set of assessments of cost-benefit and performance of the facility/asset over its lifetime. WLC is more suited to new and greenfield projects. WLC amounts to LCC plus external costs and a wide range of other analyses, including environmental cost-benefit and social cost-benefit analyses. LCC, on the other hand, is used under a somewhat narrower context where an evaluation of costs is required to be carried out for incorporating/replacement/retrofitting products and technologies into an already existent facility/asset. However, it occurs that the two terms are often used interchangeably.

For the purpose of this research, a consistent definition of LCC[7] is adopted as follows: "LCC represents the sum of all recurring and one-time (non-recurring) costs over the full life span or a specified period of a project, service/process, or technology. It includes purchase price, installation cost, operating costs, maintenance and upgrade costs, disposal cost, and remaining (residual or salvage) value at the end of ownership or its useful life."

1.6 Summary of Key Findings

The key findings[8] of this research are as follows:

- Frost & Sullivan's interactions with various industry participants, as part of the primary research process for this project, reveal that initiatives adopted by institutional bodies and technical organizations over the last two decades have brought the concept of LCC to the forefront of pre-project evaluations in intelligent buildings and construction.
- Despite gaining early focus, LCC has remained largely confined to project evaluations within the federal sector[9], with very limited frequency of use witnessed in other vertical segments. This is attributed to a variety of factors including inconsistent methodologies, lack of valid data, irreconcilable values, and above all, apathy of building owners, vendors, and service providers to voluntarily incorporate LCC into the early phases of a project.
- Nevertheless, because of the need to logically approve capital investments and to validate return on investment and equity, cost assessment tools have become a necessary part of the project flow even though a full-fledged LCC approach may not be pursued.
- LCC is often substituted by simple payback analysis and other capital cost justification methods to meet the same objective. They offer the minimum required incentive to bridge the gap between having to accommodate untendered costs, as opposed to allowing parametrically justified investment.
- Intelligent buildings essentially fall within two major categories—partially integrated and fully integrated[10]. The true value of effective operation and maintenance (O&M), progressive asset management, and cost savings via predictive energy management are only achievable with a fully integrated approach. This, in turn, is reliant on the building industry's motivation to adopt open standards and integrated systems, selected on the basis of their ability to offer lowest life cycle costs.
- The intelligent buildings industry participants are showing gradual signs of moving away from putting undue emphasis on initial costs and simple payback and towards a more holistic approach where recurring costs, incentives, and life cycle assessments are taken into consideration.
- A major drawback in the presently used LCC methods is that these are characterized by the absence of a consistent methodology for deriving LCC. But perhaps more hindering than this issue is the fact that the majority of these tools and calculation techniques cannot be easily comprehended by building owners and their operations staff.
- A fragmented delivery chain and transactional interactions among value chain partners further act as restraining factors in LCC adoption.
- It is encouraging to witness a growing breed of building owners and asset managers that lay emphasis on superimposing cost-benefit analysis over an extended project life span, whereby better visibility into recurring costs and incentives can be obtained.
- Among prevalent LCC tools, the National Institute of Standards and Technologies building life cycle costing tool is by far the most widely accepted[11] and forms the basis of various customized LCC techniques.
- There is a greater need for consultants, owners, vendors, and service providers to collaborate and create a market approach to promote inclusive decision making so that integrated design and delivery approaches are supported.
- The immediate need for industry participants is to organize initiatives to work together and create structural frameworks for joint collaboration in technology deployment as well as propagating LCC adoption.

Chapter 2: Intelligent Buildings and the Role of LCC

2.1 Overview of the LCC Adoption Process

As a concept of providing computational support for the analysis of capital investments in buildings, life cycle costing has existed for a relatively long time. Concerted initiatives[1] adopted by institutional bodies and technical organizations over the last two decades have brought this concept to the forefront of pre-project evaluations in many industries. LCC is intrinsically a subset of life cycle analysis (LCA), which comprises a much wider framework of tools and evaluation parameters to address environmental, ecological, energy, and other impacts comprehensively for any project or sector. LCC, on the other hand, is more specific to built environments and extends end-to-end through the life cycle of a building project. This includes all stages from pre-construction, construction, project management, and continued operation of the building or asset through its life cycle.

As evident from Frost & Sullivan's discussions with industry participants for this research, in North America LCC has received significant impetus due to early interest from organizations such as the National Institute of Standards and Technology (NIST), the Rocky Mountain Institute[2] (RMI), Harvard University[3], the Athena Institute[4], and various state and province-led LCC initiatives[5] in both the United States and Canada, starting from the early 1990s. Despite gaining early focus, LCC remained largely confined to project evaluations within the federal sector, with very limited frequency of use witnessed in other vertical segments. This is attributed to a variety of factors including inconsistent methodologies, lack of valid data, irreconcilable values, and above all, apathy of building owners, vendors, and service providers to voluntarily incorporate LCC into the early phases of a project.

Nevertheless, to logically approve capital investments and to validate return on investment (ROI) and equity, cost-assessment tools have become a necessary part of the project flow, even though a full-fledged LCC approach may not be pursued. Frost & Sullivan's primary discussions with participants of this study suggest that LCC is often substituted by simple payback analysis and other capital cost justification methods to meet the same objective. Such substitute approaches may not lead to a complete amalgamation of all necessary elements such as first costs, training costs, operation and maintenance (O&M) costs, service agreement costs, upgrade/retrofit costs, and disposal/deconstruction costs, and does not enable involved parties to understand the true ROI. However, they offer the minimum required incentive to bridge the gap between having to accommodate untendered costs as opposed to allowing parametrically justified investment.

2.2 LCC and Intelligent Buildings

Intelligent buildings are characterized[6] by the presence of devices, controls, and systems that interconnect and communicate with one another to enable an environment that is responsive and adaptive to occupants' needs and comforts. The degree of "intelligence" varies by the sophistication underlying the software-aided applications and communication network that helps these devices and systems function in an interoperable manner and share operational data. This ultimately forms the backbone of this evolving concept. The evolution and transition in buildings has led industry experts to dwell upon various terminologies such as green, automated, intelligent, smart, and high performance to define these buildings.

Examples of intelligent buildings in North America range widely, starting with structures where some degree of system automation and control strategies have been implemented to achieve significant reduction in energy and resource wastage, to a comprehensive enterprise-wide integrated platform that eliminates all silos. No matter how robust the vision of an intelligent building is today, there are some distinct functionalities and applications that have come to exist within its domain, and others that may be prominent as part of its future evolution.

Yet, as Frost & Sullivan's discussions with industry participants for this research indicate, the important outcome of this transition is that industry stakeholders, and the value chain catering to the intelligent buildings industry, agree on some of the fundamental principles that this concept revolves around. These include the following:

- Definition of intelligence – the attributes that encompass and contribute to intelligence
- Technology, product, and service profile – the various means that help achieve and continuously maintain intelligence
- Tangible and intangible benefits of an intelligent building – both quantifiable and non-quantifiable benefits that provide a distinguishing mark from other buildings
- A building's intrinsic relationships with energy – its ability to consume, generate, and store energy
- Environmental and social impacts of buildings – impacts that should be considered to determine the optimal life cycle cost

These fundamental principles are crucial in conducting LCC analysis for buildings that primarily exist within three distinct profiles[7] today: non-integrated, partially integrated, and fully integrated buildings. While the majority of buildings today conform to the first two profiles, it is the fully integrated profile that ultimately provides the building its intelligence quotient. Intelligence, in turn, is dependent upon the level of system integration, interoperability, inter-communication, and granular visibility into the operational dynamics that has been achieved in a building. Before diving deeper into the elements of LCC analysis for intelligent buildings, it is important to analyze the key characteristics of buildings based on these three profiles. Exhibit 2.1 depicts a building's characteristics associated with its corresponding level of system integration and intelligence, as progressively tracked by Frost & Sullivan over the last decade.

Exhibit 2.1: Characteristics of a Building and the Level of System Integration

Building Profile	Spec Approach	Reliance On	System Integration Specialist	Integration Determinants	Limiting Factors
Non-integrated	• Segregated approach divided across divisions of construction specification master formats	• Performance specs with minimal design documentation	• Overtly dependent on contractors	• Availability • Low cost • Relationships • No open standards • Difficult to accomplish system integration	• Long-term maintenance contracts of manufacturers • Engineering-by-design not adopted as a norm • Costly upgrade contracts
Partially integrated	• Combination of segregated and integrated approach	• Some design documentation, but generally standalone system/hardware intensive • Extensive use of Middleware/Web services to enable unified user interfaces and peer-to-peer communication between disparate systems	• Dependency on contractors and system integrators	• Advocacy of open standards to some degree • Cost still overrides decisions • Benefits of integration not fully exploited	• Hardware intensive with multiple communication interfaces/gateways making the switch to full integration cumbersome • Proprietary strongholds persist
Fully integrated	• Technology contracting or integrated consulting approach with a sole source contractor assigned	• Design documentation is a mandatory norm • Sub-system integration at the control network level reduces multiple devices and drivers	• Collaborative approach and accountability shared by multiple stakeholders with the building owner at the center of decision making	**• Specs dictated by compatibility and interoperability** **• Demonstrates lowest life cycle cost**	• Variances in cost estimation • Perception issues with regards to cost and time consumed • Lack of skilled professionals

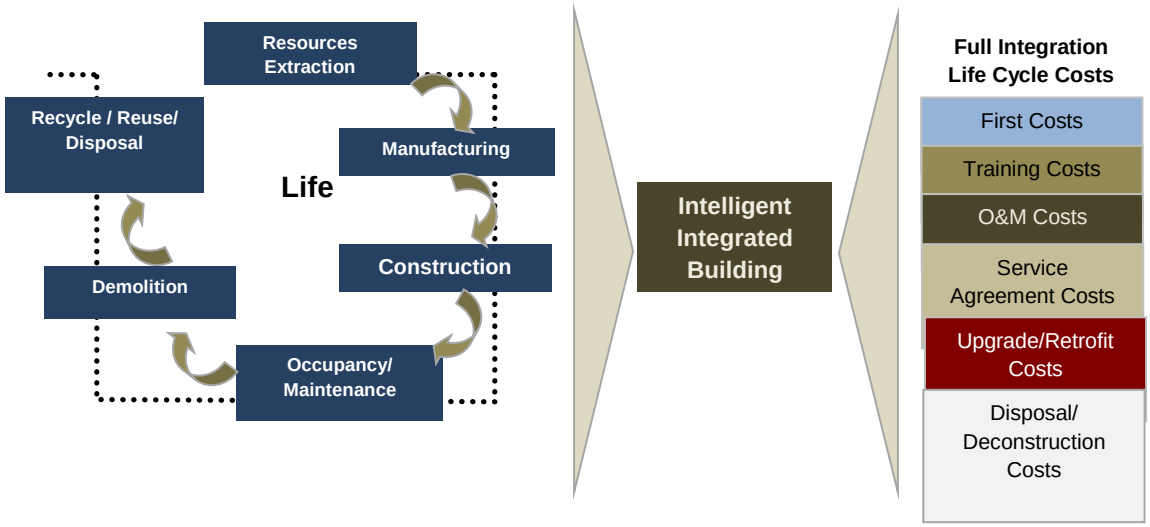
Source: Frost & Sullivan, 2013

The single-user graphical interface for all systems and advocacy of a non-proprietary system are distinct advantages of the partially integrated approach. However, the true value of effective O&M, progressive asset management, and cost savings via predictive energy management are only achievable with a fully integrated approach. This, in turn, is reliant on the building industry's motivation to adopt open standards and integrated systems, selected on the basis of their ability to offer lowest life cycle costs[8]. Depending upon the technology or service that is under consideration as part of the full integration process, the life cycle costs will incorporate other elements that are relevant to those considerations. This will also dictate the replacement period, replacement cost, duration of life cycle, and value of inflation over that life cycle.

2.3 LCC Methods for Buildings

To understand the determinants of life cycle costing for intelligent buildings, it is important to consider the elements that constitute the life cycle of building products[9] as shown in Exhibit 2.2.

Exhibit 2.2: Typical Life Cycle of Buildings and Associated Costs



These impacts are important in evaluating which project alternatives would be optimal when comparing various solutions to execute building systems integration. Such comparative analysis is carried out to determine economic value of a project by evaluating one, or all of the following:

- Determining net savings (NS)
- Savings-to-investment ratio (SIR)
- Internal rate of return (IRR)
- Net present value (NPV)
- Lowest life cycle cost

For instance, two project alternatives may deliver the same performance requirements, but differ with respect to initial costs and operating costs. In such cases, the alternative that is capable of significantly reducing O&M costs, and thereby, maximizing net savings would be preferred over the other. While most projects may be sanctioned with just the determination of net savings, or IRR, the lowest life cycle cost is by far the most comprehensive. The purpose of LCC is to select the design and/or technology that will ensure the facility will provide the lowest overall cost of ownership consistent with its quality and function. Needless to say, LCC analysis should be performed early in the design process while there is scope for refinement to the design or technology spec to achieve a low LCC.

Frost & Sullivan's discussions with primary research participants of this project, as well as review of secondary data[10], indicate that there are two distinct approaches adopted for building-related LCC evaluations, depending upon which stakeholder group is involved, and what aspects of a building's life cycle play a role in the process. Typically end-to-end life cycle or whole building life cycle (WLC) appraisal is carried out for a much broader set of assessments of cost benefits, and performance of the facility/asset over its lifetime. WLC is more suited to new and green field projects where WLC amounts to LCC plus external costs (including, but not limited to, environmental, social, and community costs that are included in LCA) associated with any project and a wide range of analysis. LCC, on the other hand, is used under a somewhat narrower context, where an evaluation of costs is required to be carried out for incorporating/replacement/retrofitting products and technologies into an already existent facility/asset. However, the fact that the two terms are interchangeably used cannot be ruled out. In fact, several accredited standards and LCC techniques[11] are notorious for propagating this ambiguity and confusion. Interviews conducted among building owners and asset managers as part of this research reveal that external consultants (estimators, architects, and consulting engineers) often club LCA components into building LCC calculations. This research defines LCC as including both original costs, and cost incurred throughout the whole functional lifetime, including demolition. The stakeholder involvement, and the variation in components that may exist in either approach, are qualified for clarity. Sources of information for either approach constitutes similar agencies[12] such as NIST, Building Owners and Managers Association (BOMA), National Institute of Building Sciences (NIBS), Federal Energy Management Programs of Department of Energy (DOE/FEMP), and RSMeans, to name a few. Exhibit 2.3 shows Frost & Sullivan's interpretation of the LCC approaches adopted for buildings, as indicated by primary and secondary research undertaken for this project.

Exhibit 2.3: LCC Approaches Adopted in Buildings

Approach	Data Categories (All or Part)	Stakeholder Involvement	Sources of Information	Limitations
New project whole building life cycle appraisal (WLC)	• **Costs** – acquisition, capital, taxes, inflation, replacement, resale, recurring and non-recurring O&M, repair, energy, insurance, demolition/disposal • **Impacts** – social, environmental, economic	• Environmental/site planners • External development cost estimators • Equipment vendors Building owner/developer Architect/design build firm • Performance contract providers • Post-completion and continued service providers • External cost estimators	• Data aggregators (e.g., RSMeans, NIST, DOE/FEMP, BOMA, NIBS) • External third-party data and cost estimators • Equipment vendors and service providers	• Financial analysis – some components do not take inflation into account • If life span of project alternatives vary, WLC does not yield comparable results
Existing project life cycle costing (LCC)	• **Analysis** – LCC, NPV, IRR, NS, SIR, payback, sensitivity and scenarios, risk and uncertainty, other computations • **Other data** – occupancy, physical performance, quality of equipment	• Building owner/developer • Contractor • Technology vendor • Project management provider • External cost estimators	• Data aggregators (e.g., RSMeans, NIST, BOMA, DOE/FEMP, NIBS) • Internal O&M and performance data logs • External estimators • Service providers	• Financial analysis – some components do not take inflation into account • Investment options can be compared only where that investment yields income • Some analysis only provides a rough estimate of profitability, not an exact number • Difficulty in comparing alternatives where project life span varies

Source: Frost & Sullivan, 2013

For both new and existing projects, the key factors during the early design stage would be occupancy and physical data. Frost & Sullivan's interactions with industry participants for this project reveal that inadequacies in these components can result in grossly misleading analysis that, in turn, could defeat the purpose of carrying out WLC or LCC analysis of project alternatives. Still, estimators can at least have control over these data sets and strive to reconcile information from relevant sources.

But when it comes to performance and quality-related data, it can get rather subjective and values seem to fluctuate. Such data is often dictated by codes, policy, and standards that often do not have a clear way of defining these components. For instance, energy performance metrics used by various LCC tools rely on ambiguous calculation criteria[13] (actual performance versus time-dependent value), and there is no fully justified way of including one measurement metric over another. Most commercial building owners talked about this issue when citing the key challenges they and their estimators face in deriving LCC analysis accurately. Consequently, this makes such performance data less reliable, as compared to cost data.

Moreover, the ultimate accuracy of both LCC and WLC approaches is dependent on how detailed and evolved the design spec process is, and how the value chain influencers were brought into the project scheme. The overriding importance of either approach is, of course, dependent upon cost results. However, cost data, if not properly complemented with supplementary analysis (sensitivity, scenarios, break-even) is meaningless in full or part LCC evaluation and interpretation. Project alternatives that are selected on the basis of such comprehensive cost analysis are far more reliable and have evidently provided a more succinct business case to sanction project investments.