

Attn: Marta Klopotoska
CABA Programs Officer
Continental Automation Buildings Association (CABA)
1173 Cyrville Road, Suite 210
Ottawa, ON K1J7S6

Healthy Buildings and Indoor Environmental Quality

CLOSING DATE

March 28, 2022

4:00pm ET

FROM: Harbor Research

Evidence of Knowledge and Experience (12.2, 13.2)

Harbor Research brings to this project substantial industry experience, and a team with relevant expertise in connected product solutions for the Internet of Things, intelligent buildings and artificial intelligence. Beyond Harbor Research's internal knowledge and expertise, we access thought leadership from our wider community of industry experts in intelligent buildings, building security as well as advanced data-intensive, artificial intelligence and predictive maintenance applications. Senior staff will oversee and manage this research effort as well as participate in a focused and applied manner on the scope, design, and execution of this research program.

Glen Allmendinger - President and Founder

Glen is the founder and president of Harbor Research, a strategy consulting firm with offices in Boulder, Colorado and Berlin, Germany. Since the firm's inception in 1983, Allmendinger has worked closely with a broad spectrum of telecommunications, information systems, security, electronics, and automation and equipment manufacturing companies in North America, Europe, and the Far East. These companies range in scope from small, entrepreneurial start-ups to major multi-national corporations. His project direction and consulting has assisted these firms in the development of corporate and business unit strategies, new product, market and service opportunities, and new core capabilities. Glen has consulted to the National Research Council on technology and competitiveness as well as emerging technologies for social wellbeing. He is a member of IEEE, ASME, and ACM and has worked closely with several industry trade associations including CABA. He has worked on DARPA-funded research focused on advanced analytics and sensing systems technology and was a key participant in the planning and development of the National Center for Manufacturing Sciences. Allmendinger received his BA from New York University, and completed graduate studies at MIT's Center for Advanced Media Studies.

Harry Pascarella – Vice President

Harry specializes in Industrial IoT with a focus on manufacturing and natural resources markets. Harry works with clients across a variety of industries to validate and dimension their growth strategies and advise on industry segment and application target selections. Recently, Harry conducted several studies in smart buildings including a deep dive into energy management as well as a market study on the larger market that looked at usage behavior. Harry also worked with the largest LED lighting manufacturer in the United States to develop a business case for connected lighting platforms. Harry received his bachelor's degree in Economics from the University of Colorado – Boulder.

Daniel Intolubbe-Chmil – Consultant

As a Consultant, Daniel has led research initiatives shaping critical insight around the evolution of high-performance networks across industrial, commercial and enterprise verticals. Daniel also helps keep a pulse on the market, providing curated content and updates to Harbor's real-time market tracking across all sectors of the economy. Dan has helped lead two previous CABA Council engagements, and has deep expertise across networking technologies within buildings and homes. Prior to Harbor, Daniel has conducted economic research to complete his Honors thesis regarding Education Policy, entailing policy/market research and econometric analysis. He graduated from CU Boulder with a degree in Economics and a minor in Humanities.

Michael Levy – Consultant

Michael is a Consultant at Harbor Research with experience leading research projects for a variety of projects across verticals. In particular, he has led research engagements that focused on real-time networking, data analytics and machine learning solutions, and sustainability. Michael participated heavily in the CABA Smart Home as a Service engagement, where he explored in-depth the evolution of connected home business models, applications, and services. Prior to Harbor, Michael worked for a mid-tier consultancy in Washington D.C. that specializes in privacy and cybersecurity, operating security operations centers (SOC) across the United States. He graduated from Northwestern University with a double-major degree in English Literature and German.

Jamil Muna – Consultant

As a Consultant, Jamil has owned the delivery of strategic and deeply technical research. He has operated in variety of industries and implements a process-oriented approach to achieve a comprehensive understanding of his clients' needs. Jamil led CABA's landmark research report on AI & Predictive Maintenance in Buildings and supported on the Connected Home & AI report as well. Prior to Harbor, Jamil worked with Accenture as a management consultant. He graduated from Columbia University with a degree in Financial Economics, and completed his MBA from Cambridge University.

Evidence of Previous Experience in and Indoor Environmental Quality for Healthy Buildings (12.3, 13.2, 13.5)

Founded in 1984, Harbor Research Inc. has more than twenty-five years of experience in providing strategic consulting and research services that enable our clients to understand and capitalize on emergent and disruptive opportunities driven by information and communications technology.

Our firm has been involved in the development of the smart systems and machine-to-machine (M2M) market opportunity since 1998. The firm has established a unique competence in developing business models and strategy for the convergence of pervasive computing, global networking and smart systems. Our extensive involvement in developing this market opportunity, through research and consulting, has allowed the firm to engage with clients in the technology supplier community—both large and emergent players—as well as a diverse spectrum of device OEMs, services providers, and end-customers.

Highlights related to our experience include:

- The first comprehensive research study on the Intelligent device networking and M2M arena in 1999;
- Smart systems and IoT forecast modeling work since 2002;
- October 2005 Harvard Business Review article “Four Strategies For The Age of Smart Services” (we were the firm that “named” the concept of Smart Services);
- Over forty-five white papers to date on various opportunities related to smart devices and services;
- Launch of SmartSphere in 2016, first online platform to map relationships of top companies in the IoT space, analysis of 500 players including many in the smart buildings market and custom news tracking software against Harbor’s taxonomies;
- Work with leading intelligent buildings and smart home constituents and market innovators (Cimetrics / Analytika, Skyfoundry, Eaton Residential Business, Tridium, Optimum Energy, Johnson Controls, Pacific Controls, Jones Lang LaSalle, Samsung, Schneider Electric, Honeywell);
- Work with a broad spectrum of intelligent building network equipment and silicon suppliers (Cisco, Dell, HP, IBM, Samsung, AT&T, Verizon, Intel, Qualcomm, Microsoft, etc.);
- Work with what we believe is the largest community of device manufacturers focused on developing Smart Device and Smart Services solutions.

Harbor Research’s recent relevant experience in the arenas of both smart homes and intelligent buildings and includes more than 30 engagements over the last 4 years, including the following illustrative examples:

- Collaboration with **CABA** on [Monetization of Intelligent Buildings \(2018\)](#) that examined how to monetize intelligent buildings from the perspective of building owners, developer, solution providers (OEM manufacturers and service providers) and other stakeholders including stakeholder analysis, business opportunities, technical barriers and opportunities, future market direction, issues, use-cases and industry recommendation.;
- Collaboration with **CABA** on [Intelligent Building Energy Management Systems \(2021\)](#) that provided a framework, market requirements, ecosystem analysis and market sizing for the building automation systems, energy storage, and other energy management hardware and software solutions including services, security, data analytics, systems, and processes for building operators and technology suppliers based on top identified use cases within the target market;

- Collaboration with **CABA** on [AI and Predictive Maintenance in Intelligent Buildings \(2021\)](#) that defined and developed business opportunities within predictive maintenance and artificial intelligence technologies as they relate to intelligent buildings.
- Collaboration with **CABA** on [Connected Multi-Dwelling Units and The Internet of Things \(2017\)](#) that assessed the opportunity surrounding Connected MDUs, including a survey of 1,500 MDU owners, technology suppliers and service providers in the space, including 60 in-depth interviews to validate research findings. The engagement summarized the top IoT application and use case opportunities among primary buyers of technologies in the space, supported by a 5-year smart systems forecast model.
- **Assessment of New Data Integration and Analytics Opportunities within the Commercial Buildings / Client: Innovative Software Supplier in the Commercial Buildings Market**
Harbor worked with an innovative software supplier to articulate the opportunity associated with its new and differentiated buildings analytics and energy management platform. We developed a white paper focused on how value is created from machine data, the true value potential of leveraging data created by IoT-enabled buildings, the software tools required to manage and analyze IoT building data and the business models made possible by new software technologies.
- **Assessment Uptime Solution Planning and Market Development for a Cloud-Based After-Sales Service Software Solution Provider.** Harbor worked with a software supplier of aftermarket solutions for original equipment manufacturers and end customers to optimize equipment and service operations through the use of AI and ML.
- **Predictive Maintenance Software Architecture & Business Model Assessment for a Solution Provider for Boilers and Boiler Room Systems.** Harbor worked with a leading commercial and industrial boiler manufacturer to help define the company's business model and technology architecture related to predictive maintenance and related applications of smart systems and IoT
- **Opportunity Assessment & Go-To-Market Development for Control in Intelligent Buildings for a Large Industrial Controls Supplier*.** Harbor leveraged experience across industry verticals to determine the most attractive near-term and long-term opportunities for the client's current suite of industrial control solutions. Included in the research was an analysis of the intelligent buildings vertical focused specifically on critical systems such as HVAC and energy distribution. Harbor was able to map the intelligent buildings ecosystem and determine selling strategies in order to create granular recommendations on go-to-market channels, profitability, end-customer needs, and partnership considerations.
- **Analysis of IoT Applications for Intelligent Buildings for a Large Korean Technology Manufacturer*.** We focused on developing a comprehensive forecast model to determine the number of connected devices and potential revenue streams; identifying and profiling key competitors in the marketplace; and developing use cases for attractive applications in the intelligent buildings space. Project findings helped client determine attractive applications to pursue as well as helped identify required capabilities for success.

*Contacts for project references available

Other example clients and engagements our team has worked on include:

- **Honeywell** – Building and Residential Control Components – Security Systems Innovation
- **Eaton Electrical** – Development of Home Automation System and Market Analysis for Residential and Light Commercial Opportunities for Network Services
- **Acuity** – Smart Lighting Systems and Services Market Opportunity Assessment

- **Schneider Electric** – Building Management – Energy Management Opportunities
- **Bosch – Corporate Planning** – Residential and Commercial Security Systems Opportunity Analysis
- **Pacific Controls** – Connected Buildings, OEMs and Mobile Professional Opportunity Analysis
- **Siemens** – Smart Buildings and Facilities Market Forecast, 2016-2022
- **Diversey, ABM** – Platform Aggregation Strategy for Commercial Services in Buildings
- **ARM** – Future Mobile/Consumer Security Requirements Analysis
- **Revolv** – Review of Product Plans for Connected Home Automation Offering
- **Tendril Networks** – Analysis of Energy and Related Services for Home and Consumer Markets
- **Intel** – Connected Home Developer Market Analysis – Analysis of Developer Requirements for Hardware Development Kits
- **Cisco Systems** – Connected Consumer and Connected Real Estate Opportunity Analysis and Technology Roadmap for Security Services for Consumer and Commercial Applications
- **Lightsource Energy** – Residential and Commercial Rooftop Solar Energy and Monitoring Services Analysis
- **Ayla Networks** – Smart Home Whitepaper

For additional examples of previous experience related to intelligent buildings, please see Appendix D of this document.

Summary of Harbor Research Project Approach (12.4, 12.5, 13.1, 13.5)

Proposed Project Methodology

Harbor Research is proposing a collaborative project methodology to conduct a market analysis, survey research and industry expert/thought leader interviews for CABA's Intelligent Buildings Council (IBC), including a methodology and supporting work scope to analyze the trends and forces, customer needs, use case opportunities, risks, and ecosystem formation around artificial intelligence technologies as it relates to the intelligent building industry.

Harbor would leverage heavy involvement from senior staff members including Glen Allmendinger and Harry Pascarella. Harry would assist with both the primary and secondary research efforts from which user behavior and interactions with smart speaker and hub technologies would be surfaced. Glen would oversee the entire project, and provide specific insights on players, business models and other market dynamics by tapping into his IoT and consumer market experience and contact base. To define and develop business opportunities within indoor environment quality solutions as they relate to healthy buildings, Harbor would undertake the following activities:

- Review and analyze existing applicable CABA and non-CABA industry research including past CABA research such as Intelligent Buildings and Covid (2021), Intelligent Building Energy Management Systems (2021), on AI and Predictive Maintenance in Intelligent Buildings (2021), Monetization of Intelligent Buildings (2018), Intelligent Buildings Design Implementation (2018), Connected Multi-Dwelling Units and The Internet of Things (2017), Intelligent Buildings and the Impact of IoT (2017) and other relevant industry research.
- Review previous Harbor Research analyses of smart homes, "Internet of Clean", predictive maintenance, artificial intelligence, building controls, evolving power generation and distribution dynamics, BMS and control platforms, and intelligent building best practices, including leveraging all of our work with CABA.
- Conduct interviews with CABA membership thought leaders as well as thought leaders in Harbor Research's community and network.
- Create a foundational framework for understanding the evolution of consumer needs and technology priorities in the realm of Health and Indoor Environment Quality ("IEQ") solutions, from which the Steering Committee and Harbor Research can collaborate, including:
 - Trends and forces that describe the status and future state of Indoor Environment Quality ("IEQ") in healthy buildings;
 - An overview of the technological advances in indoor environment quality, including the role played by sensors and sensing technologies, as well as the growing importance of continuous monitoring;
 - Initial set of risks/vulnerabilities (e.g. cybersecurity and privacy), pain points (e.g. implementation time), and barriers to adoption that arise when considering IEQ in healthy buildings, all of which can be validated or disproved by survey participants (see below);
 - Market application map and framework that portrays the range of IEQ solutions within the market landscape for healthy buildings as well as the corresponding factors such as business models, partnerships, use cases, value propositions, propensity to pay, solution packaging, and models of pricing and selling;

- Portrayals that address relevant requirements for IEQ solutions based on top identified use cases within the healthy building domain, including ventilation, air quality, thermal health, moisture, dusts and pests, safety and security, water quality, noise, and lighting and views;
 - Ecosystems analysis of existing players (technology suppliers, OEMs, network providers, software vendors, building developers, facility operators, construction firms, etc.) and emerging IEQ players in the domain of healthy buildings to identify roles in the value chain;
 - Market sizing model and forecast for IEQ solutions in the healthy building domain from 2022 – 2027, identifying the most attractive sub-segments and use case opportunities.;
 - Identification of best practices for delivering IEQ solutions in the healthy building domain (partnerships, implementation strategies, etc.) as well as case studies of dominant and innovative companies within IEQ solutions in the healthy building domain;
 - Identification of new and emerging revenue streams, service innovations and value-added services (as well as the resulting Rol) enabled by IEQ solutions in the healthy building domain today;
 - A roadmap of IEQ solutions for the healthy building domain stakeholders, covering all CABA member types, to support solution and ecosystem development;
 - Initial set of recommendations for how companies participating in the market for IEQ including technology suppliers, OEMs, building developers and building operators should position themselves to take full advantage of the opportunity; to be validated or disproved by interview and survey participants (see below).
- Design a research process design to validate and analyze the proposed market concepts and hypotheses using surveys and in-depth interviews:

Survey

- Harbor will administer an online survey of market participants along with supplemental conversations, the survey will include **750-1000 respondents** divided between the following segments: building tenants and occupants, intelligent building operators, intelligent building owners, and intelligent building developers (additional breakouts of survey respondents among these groups to be determined by Harbor and the CABA Intelligent Buildings Council (IBC) Steering Committee). The survey will be designed in conjunction and cooperation with the CABA Intelligent Buildings Council (IBC) Steering Committee. Harbor will plan to explore the use of a preference-based survey approach to understand respondents' behaviors and preferences in relation to indoor environment quality in healthy buildings including:
 - Modes of interaction with IEQ in healthy buildings
 - Key value drivers and differentiators from the different stakeholders' point of view, including customer pain points
 - Customer value or use cases not yet addressed by the industry
 - Technical maturity and ability to interact with IEQ in health buildings
 - Perceived risks of IEQ solutions in healthy buildings
 - Top technology features and functions required to leverage data created by healthy buildings that improve indoor environment quality
 - Technology adoption rates and likely future technology roadmaps for IEQ solutions in healthy buildings

- Identification of buying behaviors, adoption hurdles/timing issues, and willingness to pay inherent in the purchasing process for IEQ solutions in healthy buildings
- Preferred modes of interaction and support between suppliers and adopters within the industry
- The effect of COVID-19 effect on the perception and adoption of IEQ solutions in healthy buildings
- Harbor will conduct this survey with the support of a reputable panel or multiple panels will allow us to quickly and effectively deploy this survey to the target audience.

Interviews

- Harbor will conduct parallel supplemental in-depth interviews (**approximately 10-15**) with marketplace stakeholders, building owners, appliance manufacturers, service providers, software players as well as related specialist providers of IEQ technology and IEQ solutions. Interviews will comprise of a mix of telephone and video interactions based on a discussion guide designed in cooperation with CABA. These interviews will work to understand how technical requirements and user needs are shifting, along with how these marketplace stakeholders expect customers wish to interact with applications to monitor and improve indoor environment quality in healthy buildings, including differences customer needs and technology and competitive movements.
- Harbor will then employ a “Delphi-like” methodology/approach, based on above survey, to conduct a review of research results with a balanced cross-section of thought leaders and industry specialists/experts (**approximately 5-10 people**) to further validate results and provide a balanced coverage and perspective.

Analysis

- Based on the above research and survey work, Harbor will create a series of strategic alternatives that align stakeholders with opportunities across payments and solution delivery opportunities for emerging and current applications and services. This analysis will include:
 - State and Evolution of the Market: Trends & Forces
 - See **Appendix D: Research Questions** for additional details
 - Customer Needs, Adoption, and Buying Behavior for Indoor Environmental Quality for Healthy Buildings
 - See **Appendix D: Research Questions** for additional details
 - Supplier Dynamics and Best Practices in Indoor Environmental Quality for Healthy Buildings
 - See **Appendix D: Research Questions** for additional details
 - Evolution of the Opportunity: Future Considerations for Stakeholders in Indoor Environmental Quality for Healthy Buildings
 - See **Appendix D: Research Questions** for additional details
- Harbor Research will utilize both industry expert interviews and consumer surveys to examine all major aspects of **Indoor Environmental Quality for Healthy Buildings**. The scope will also include recommendations for implementation and integration, specially covering the implications for indoor environment quality solutions, as well as strategic alternatives that align stakeholders with opportunities, challenges and key considerations arising from implementing these technologies in intelligent buildings.

Acceptance of Deliverables and Project Timeline (12.6, 13.6)

Harbor Research accepts the terms laid out in the RFP delineating the project deliverables as well as the total elapsed timeline for the study.

This proposal adheres to the following guidelines provided:

- 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.
- We hereby certify that the price quoted is not in excess of the price charged anyone else, including our most favored customer, for like services.

Activity	Anticipated Date
Research set-up and kick-off meeting	Late April 2021
Secondary research	May – June 2021
Primary research	June – July 2021
Analysis and reviews	July – September 2021
Draft report delivery	September 2021
Final report delivery	September 2021
Final Webinar (2 hours). A group webinar for all the funding organizations.	October 2021
Organizational Webinars (1 hour each). One webinar for each organization on the Steering Committee.	November 2021
Think Tank Webinar (1 - 2 hour). A group webinar for all the Steering Committee funders. Occurs after the organizational webinars.	November 2021
Industry Webinar (1 hour). To all CABA contacts to present the high-level executive summary findings only. This occurs after the four (4) month embargo period.	2023
Industry Workshop	2023

CABA Membership Status (12.7)

Harbor Research is a current and active member of CABA.

Harbor Research Profile (13.4)

An internationally recognized research, technology, and business development consulting firm, Harbor Research has predicted, tracked, and driven the development of the Internet of Things since our inception in 1984. While our history is long, our strategy is simple: capture and create value by combining accurate data discovery and analysis with creative systems-thinking. It is this mindset that has given us the privilege of working with some of the greatest companies in the world. Today, we continue to work with C-level executives and top management of some of the world's most consistently successful companies and innovative startups. In the same way that the market has flexed and grown over the years, our services and experience have grown to make us the premier service organization you see today. We work with clients in a variety of ways including consulting, advisory, research and content development, thought leadership and workshop facilitation.

Harbor Research has offices in both Denver, Colorado and Berlin, Germany with ample experienced personnel to complete the scope of this project on time and to the highest standards.

Appendix A: RFP Signature (12.8)

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.



Glen Allmendinger
President
Harbor Research, Inc.
Date: 28 March 2022

APPENDIX A: Mandatory Requirements and References

RFP Reference	Requirement (Bidder's proposal should repeat exactly as defined in the RFP)	Reference Page
12.2	Evidence of knowledge and experience of personnel of current theory and practice in the Intelligent Building discipline by providing short relevant biographies of all personnel who it is proposed will participate in the project. The vendor's project leader must have a minimum of 10 years relevant experience.	Pages 1-2
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 may be required from these three (3) clients, only if requested by CABA. References are normally not required.	Pages 3-5
12.4	A summary of how the vendor proposes to perform the project and the relevant experience of the proposed staff.	Pages 6-8
12.5	<u>Identify the sample size of both the interviews and surveys.</u>	Pages 7-8
12.6	Acceptance of deliverables as identified in the Terms of Reference / Prospectus and proposed schedule.	Page 9
12.7	<u>The vendor must be a member of CABA or agree to become a member of CABA (US\$850)</u> (before the RFP is reviewed).	Page 10
12.8	<u>RFP Signature</u> - Bidders must complete, sign (end of Section 17) and return this RFP form prior to the closing date.	Page 11
12.9	<u>Costs must be in USD.</u> A fixed price including a full cost breakdown as per Section 16, "Financial Proposal" must be provided.	Financial Proposal
12.10	The Financial Proposal must be submitted as a separate package (PDF document) to the Technical Proposal (<u>NO FINANCIAL INFORMATION MAY APPEAR IN THE TECHNICAL PROPOSAL.</u>)	Financial Proposal

APPENDIX B: Rated Requirements and References

RFP Reference	Requirement (bidder's proposal should repeat exactly as defined in RFP) Technical Rating	Points		Referenced Section/ Page in Bidder's Proposal
		Max.	Min.	
13.1	<p>The methodology section of the proposal will be an analysis of:</p> <ul style="list-style-type: none"> • How the proposal will achieve the stated objectives • The breadth and depth of the proposed work • Effectiveness of the methodology • The innovativeness of the approach • Ability to reach non-traditional stakeholders • The understanding of the issues pertinent to the project • <u>Include the sample size for both the surveys and in-depth interviews</u> • Include the proposed segmentation of the sample groups (surveys and in-depth interviews) • The ideal project will have a North American focus (both Canada and the United States) <p><i>Optional: Additional related research reports, research subscriptions or other material may be used to strengthen the proposal.</i></p>	40		Pages 3-5
13.2	The relevant knowledge and experience of the vendor's proposed staff in the Intelligent Building field and in performing studies of this nature. The vendor must indicate the proposed involvement of the senior staff assigned to the project.	20		Pages 1-2
13.3	The vendor's previous experience in the Intelligent Building sector and in conducting research projects requiring consultation with a broad cross-section of the industry. Previous research will be reviewed.	20		Pages 3-5
13.4	Corporate profile demonstrating a convincing record of fulfilling contracts on time and on budget, depth of personnel capability and other resources.	10		Page 10
13.5	The vendor's knowledge of the Intelligent Building industry both in North America and worldwide (if applicable).	5		Page 3-5, Appendix F
13.6	Timetable, including interim and final stages.	5		Page 9
	TOTAL TECHNICAL POINTS:	100	70	
13.7	Financial Rating – Total price and detailed cost breakdown. TOTAL FINANCIAL POINTS:	30		

APPENDIX C: Additional Experience in the realm of Indoor Environmental Quality for Healthy Buildings

The above requested list of three projects is not a complete list of relevant assessments the firm has completed. Other relevant work includes:

- For a multinational provider of cleaning and hygiene products in the hospitality, healthcare, food and beverage, food service, retail, and facility management sectors, we provided a comprehensive analysis of the 'Internet of Clean' sector including key market dynamics, current competitor and peer supplier strategies and maneuvers, as well as competitor solution features & packaging, use cases and services delivery models
- For the largest social media and networking company in the US, we conducted a demographic research study on a consumer-device prototype to understand the use cases, applications and target constituents in support of a Market Requirements Document.
- For the largest manufacturer of electrical products in North America, we conducted user survey research as well as competitor, peer and alliance candidate direct interviews to uncover unmet customer and user needs for new and evolving "connected" energy management and services opportunities.
- For the global leader in network infrastructure equipment, Harbor conducted an analysis of managed services opportunities in connected residential multi-dwelling and commercial properties, including market sizing, competitor analysis, alliance development analysis and go-to-market design.
- For the world's largest semiconductor and processor manufacturer, Harbor conducted an analysis of IoT opportunities within the residential sector. Primary emphasis was placed on opportunities where media and content were dominant values to determine core computing and network bandwidth requirements.
- For a venture-backed startup, conducted an analysis of consumer energy services offerings to help target candidate developer alliances as well as partnership opportunities with utilities and related services providers.
- Worked with CABA to develop an opportunity assessment within Connected MDUs, conducting a survey of 1,500 MDU owners, technology suppliers and service providers in the space, including 60 in-depth interviews to validate research findings. The engagement summarized the top IoT application and use case opportunities among primary buyers of technologies in the space, supported by a 5-year smart systems forecast model.
- For a large silicon player, Harbor defined and developed a software architecture for competitive analysis of IoT platforms. This research examined twenty-five supplier and OEM platform providers in the IT, Telco and OEM markets to validate and segment monetization and pricing models.
- For a leading connected lighting solution provider, Harbor defined new and expanded smart services and IoT solutions as well as building the business case required to support this critical growth initiative. Harbor clearly articulated alternative strategies and solutions available to the company and defined clear steps and a program of actions to fully prosecute the market opportunity.
- For the software branch of a leading industrial and energy OEM, Harbor analyzed of the costs and economics of asset performance management in support of asset health, productivity, optimization, and compliance and integrity. Harbor developed a market model that broke down the costs of data

management and analytics tools, and located gaps the company's software may not address currently and can be added to the product roadmap.

- For the largest manufacturer of electrical products in North America, Harbor conducted user survey research as well as competitor, peer and alliance candidate direct interviews to uncover unmet customer and user needs for new and evolving "connected" energy management and services opportunities.
- For the global leader in network infrastructure equipment, Harbor conducted an analysis of managed services opportunities in connected residential multi-dwelling and commercial properties, including market sizing, competitor analysis, alliance development analysis and go-to-market design.
- For a venture-backed startup, conducted an analysis of consumer energy services offerings to help target candidate developer alliances as well as partnership opportunities with utilities and related services providers

APPENDIX D: Research Questions to Be Answered

State and Evolution of the Market for Healthy Buildings and Indoor Environmental Quality (“IEQ”) Solutions: Trends & Forces

- What does the healthy building ecosystem look like across the spectrum from installation to operation to updates and ownership?
- What healthy buildings and other IEQ solutions are currently being introduced and adopted in intelligent buildings and why? What are the major barriers to full scale adoption of new solutions for healthy buildings?
- What is the device and/or market size and forecasted integration, hardware and software revenue for solutions providing IEQ in healthy buildings from 2022 – 2027? How does this revenue opportunity differ by market segment and application?
- What is the current technology trajectory of healthy buildings as assets enabling organizations to evaluate multiple health, wellness or productivity metrics against benchmarks?
- What is the role of network providers in the evolving state of IEQ for healthy buildings and how will this change with the introduction of private 5G and LTE networks?
- What key regulatory and socioeconomic forces are driving or slowing the adoption of IEQ for healthy buildings?
 - What are the implications of wider adoption of IEQ for data ownership, cybersecurity, and data privacy?
 - What are the ethical and legal implications as well as potential for greater government intervention of wider adoption of IEQ for healthy buildings?
- How has the concept of the healthy building been redefined as “post-pandemic resilience” grows in importance? How will this trend evolve?

Customer Needs, Adoption, and Buying Behavior for IEQ for Healthy Buildings

- What are the key differences in IEQ customer types? How should positioning, channel and sales tactics differ by customer personas in the healthy buildings domain?
- What IEQ applications and use cases for healthy buildings are driving the largest business opportunities in which market sub-segments today?
- What are the top pain points customers face when introducing IEQ technology in healthy buildings? How do the top applications and use cases address key customer needs and pain points? How do healthy building constituents determine costs and benefits of IEQ technologies?
- What are the disconnects arising between customers and suppliers when either integrating existing solutions or adopting new IEQ solutions?
- What value propositions and KPIs do buyers consider most when adopting IEQ solutions in healthy buildings? Are these customers well informed of the value provided by IEQ solutions in healthy buildings? How will this evolve in the future?

- How willing are customers to pay for IEQ solutions in healthy buildings and what pricing models are taking hold in the market? Are new business models, including HVAC and air-quality as-a-service type offerings gaining acceptance and adoption?
- What are the specific challenges and opportunities regarding remote or cloud-based operation / control of HVAC and IEQ solutions?
- What is the future of personalized, seamless healthy building experiences that balance occupants' or tenants' ability to customize healthy building attributes, while still respecting privacy?

Indoor Environmental Quality ("IEQ") for Healthy Buildings: Supplier Dynamics and Best Practices

- How do customers most often interact with suppliers? What client budgeting, investment and solution packaging and delivery considerations do suppliers need to consider when selling solutions?
- Who are the key established players across each of the following identified segments: hardware and software technology manufacturers and suppliers, OEMs, integrators and installers, service providers?
- Who are the key hardware and software innovators creating disruption within the realm of IEQ for healthy buildings? How are they differentiating themselves?
- What are the strengths and weaknesses of the identified players in the market for IEQ today? Which business and solution delivery models are the most successful today, and how will this change in the future?
- What new acquisitions, investments, partnerships, and ecosystems are developing in the market for IEQ solutions for healthy buildings?
- What is the role played by standards, frameworks and scorecards with which vendors of healthy buildings technologies and their clients value the effects of IEQ technologies?
- What is the role played by builders, especially, in quantifying and valuing the benefits of healthy buildings to support industry growth and success in competitive real-estate environments?
- What are the leading use cases that can promote "softer", and harder-to-demonstrate healthy buildings metrics — such as "feeling" more productive and comfortable, and/or sensing that an environment is more conducive to teamwork?
- How do channel-to-market best practices differ across player type, solution, industry sub-segment?
- How can the adoption of a healthy building concept contribute towards a building's energy efficiency?

Evolution of the Opportunity: Future Considerations for Stakeholders

- How will the market for IEQ solutions evolve in the near-term and the long-term? What implications does this have for key stakeholders in the healthy buildings domain?
- What segments, technologies and software are being adopted for IEQ for healthy buildings both today and in the future?
 - Analytics from occupant tracking solutions and other technologies to support healthy buildings
 - Control and monitoring capabilities available in the future healthy building

- Spatial intelligence and workplace analytics, and their implications for optimizing use of space
- What are the key socioeconomic and regulatory barriers and opportunities in the market? How can stakeholders capitalize on these opportunities?
- What are the best practices for mitigating customer concerns, communicating value propositions and delivering or integrating IEQ solutions for healthy buildings?
- What major barriers and difficulties do suppliers have when delivering IEQ solutions for healthy buildings? How can stakeholders effectively prepare to address problems such as proprietary platform software solutions and differences in IEQ hardware platforms?
- What are the best practices for pricing and monetizing IEQ solutions in for healthy buildings? What ecosystem participants will stakeholders need to engage to have an effective market channel? What customer behaviors and solution delivery considerations should they be taking into account when determining how best to structure their pricing and revenue models?
- What Post-Covid opportunities are presenting themselves as viable business opportunities within the realm of IEQ for healthy buildings?

APPENDIX E: Current State of Healthy Buildings

After enduring more than two years of a historic, global pandemic, providing assurances about air quality to building occupants and tenants has become fundamental to enabling a return to the “world before” as defined by allowing workers to return to their place of work as well as improving the safety of multi-dwelling residential units. However, it would be a too optimistic to believe that the deployment of healthy buildings concepts, and in particular, the adoption of environmental air quality solutions have become pervasive.

The coming years will now test the attraction and resilience of healthy buildings concept and its evolution to support new capabilities. It will be imperative to evaluate those solutions and service offerings that are most likely to provide value beyond this current pandemic.

Healthy buildings not only include environmentally responsible and resource-efficient building concepts, but also integrates human well-being and performance. Healthy buildings are therefore designed to support the physical, psychological, and social health and well-being of people in buildings and the built environment. Most people spend a majority of their time indoors.¹ Healthy buildings necessarily play an outsized role in the health and well-being of humans.

The benefits of healthy buildings are manifold: reduced absenteeism and presenteeism, lower health care costs, and improved individual and organizational performance. Harvard School of Public Health published [The 9 Foundations of a Healthy Building](#): ventilation, air quality, thermal health, moisture, dusts and pests, safety and security, water quality, noise, and lighting and views.

Emerging intelligent building systems provide a distributed control and information system that enables networks of intelligent devices to monitor and control the mechanical systems in a building and integrate data from existing BMS systems. These solutions are enabled by a new class of software tools and data frameworks that allow data to be aggregated from across the fractured vendor ecosystem. Advanced data management, analytics, AI and machine learning algorithms applied to integrated datasets are identifying and capturing new efficiency gains from building systems. These new technologies and use cases are not only changing the way that buildings stakeholders operate, but also how they co-operate.

This evolution has fundamentally changed how healthy buildings solution providers must address the market. Despite all the likely future demand for healthy buildings that has resulted from a pandemic-induced assessment, service providers will still have to overcome a range of challenges to realize the full promise of healthy building solutions. Some of the major challenges include realizing new growth opportunities that leverage data from IoT-enabled buildings, interoperability, cybersecurity, data ownership, enterprise privacy, customer needs, building a portfolio of IoT products and services for vertical markets, and monetization models for these products and services. Particularly difficult for suppliers is the ability to meet the needs of the range of constituents and stakeholders they serve.

Today's building managers, operators and owners are seeking cost-effective and easy-to-use tools that coordinate the operation of traditional building systems with newly connected IoT systems. As these end-customers mature, they are increasingly asking what value-added services they can enable with their IoT data. Gathering data and storing it in the cloud is not enough; new use cases such as predictive

¹ Americans spend an average of 87% of their time in enclosed buildings and about 6% of their time in enclosed vehicles according to the National Human Activity Pattern Survey

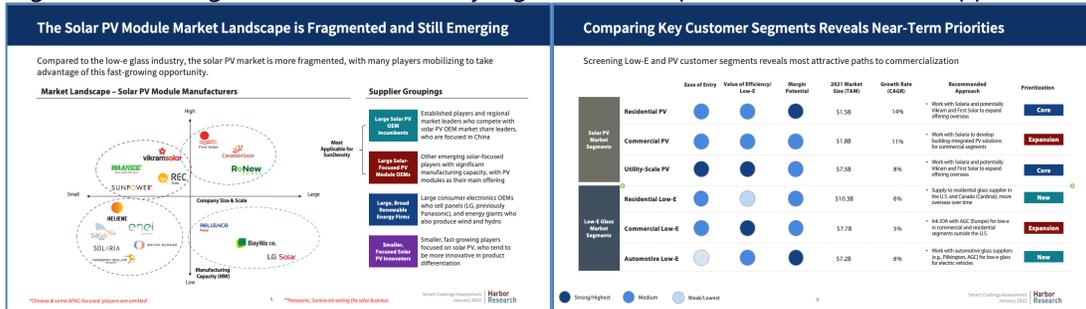
maintenance and operations visibility require tightly integrated systems that look nothing like disparate building spaces they manage and occupy today.

Innovative technologies in intelligent buildings reduce operating and maintenance costs thanks to their ability to collect and analyze data. Sensors placed on equipment can automatically program maintenance activities, which are therefore based on use rather than pre-scheduled intervals. Interestingly, the significance of a well-functioning HVAC system has increased recently due to COVID-19 concerns.

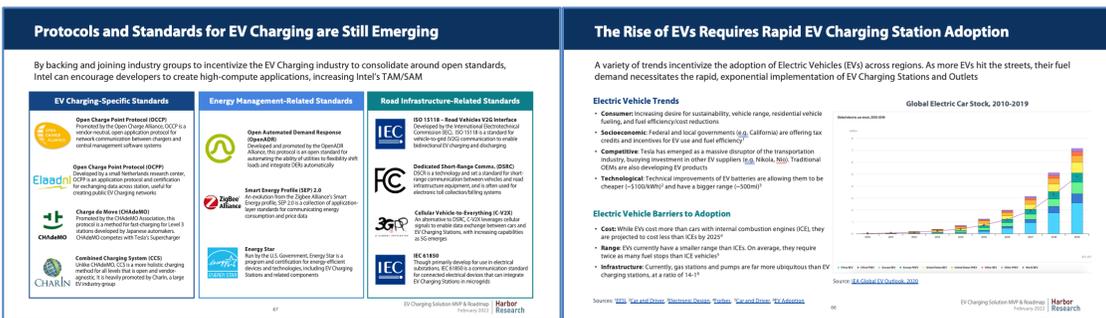
While customers are not ignorant to their benefits, deploying and integrating new solutions to enable healthy buildings is often a difficult prospect confounded by siloed solutions, customer building improvement budgets and disparate adoption patterns. This has resulted in market confusion; end-customers do not know what they are getting for their money, solution providers do not know what end-customers are willing to pay for, or how offerings should be priced, packaged and deployed. As customers weigh the risks and rewards of indoor environment quality for healthy buildings, suppliers will need to adopt creative business models and go-to-market strategies to effectively demonstrate a healthy Return on Investment.

APPENDIX F: Sample Research

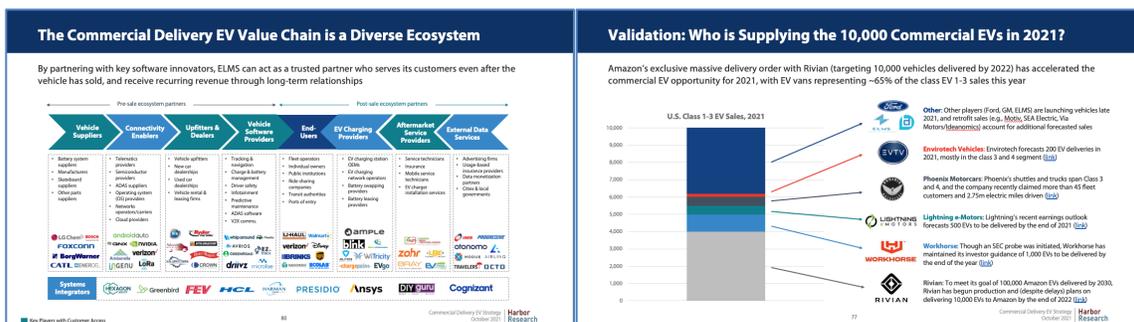
F1. 2021 — For a specialist provider of photonic solar conversion products and services, we developed a framework to select the most attractive growth opportunities overall and within vertical industry segments and target accounts backed by a go-to-market plan for PV and Low-E applications.



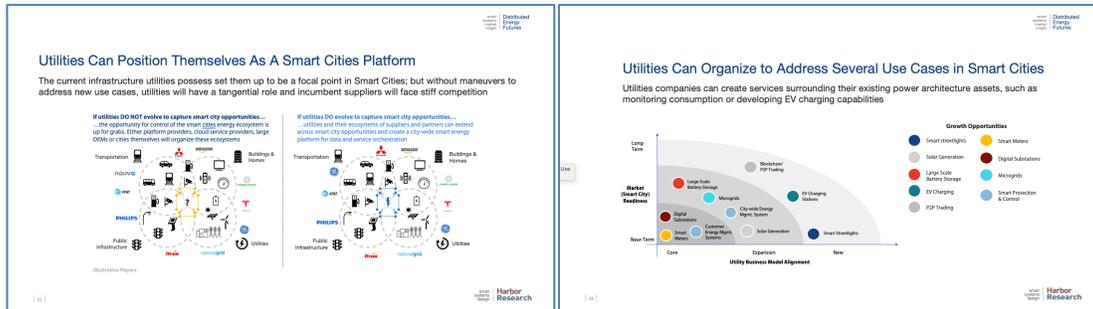
F2. 2021 — For one of the world’s leading silicon chip manufacturers, we designed MVP solution and a future development roadmap for an offering that serves EV charging suppliers and end customers, including detailed technical and functional architecture for current and future Level 2 and 3 EV charging solutions



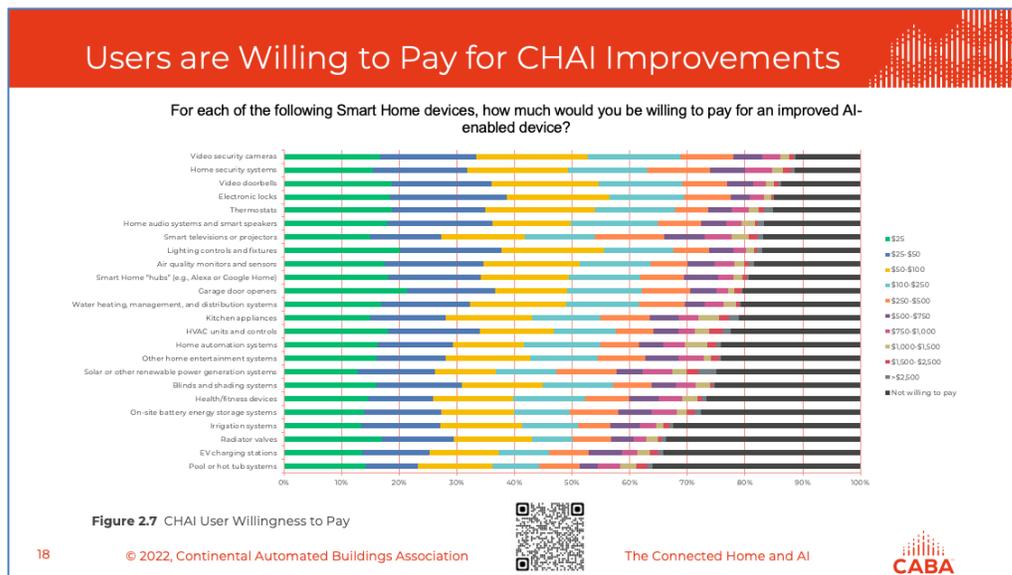
F3. 2021 — For a developer and manufacturer of Class 1 commercial electric vehicles, developed a road map to realize new digital and connected vehicle growth opportunities based on customers perceptions of what digital solutions and services provided the most value and differentiation



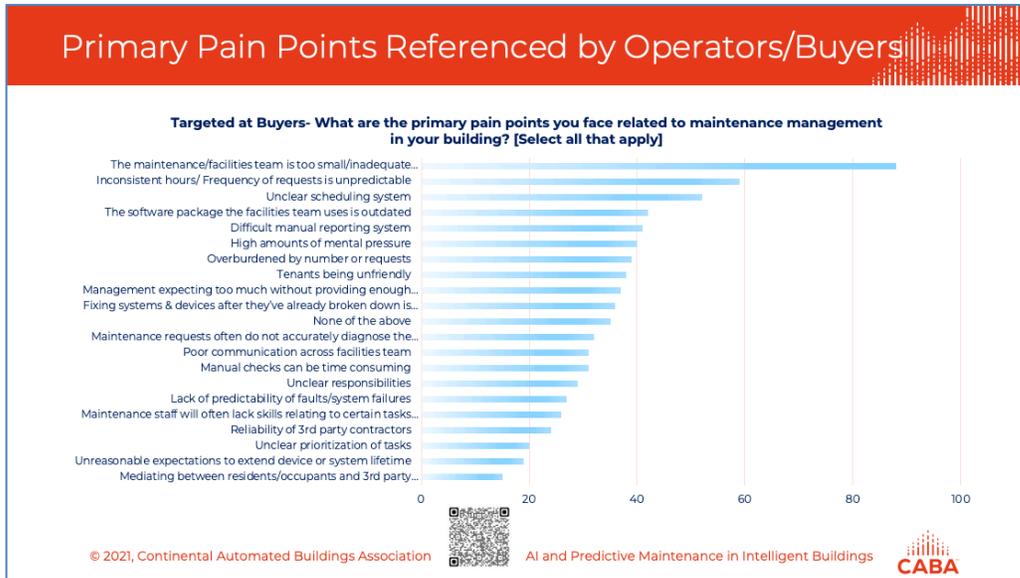
F4. **2021** — For the creator of one of the first solid-state digital circuit breakers for commercial and industrial applications, we designed and facilitated a process to accelerate development of the company’s remote services strategy.



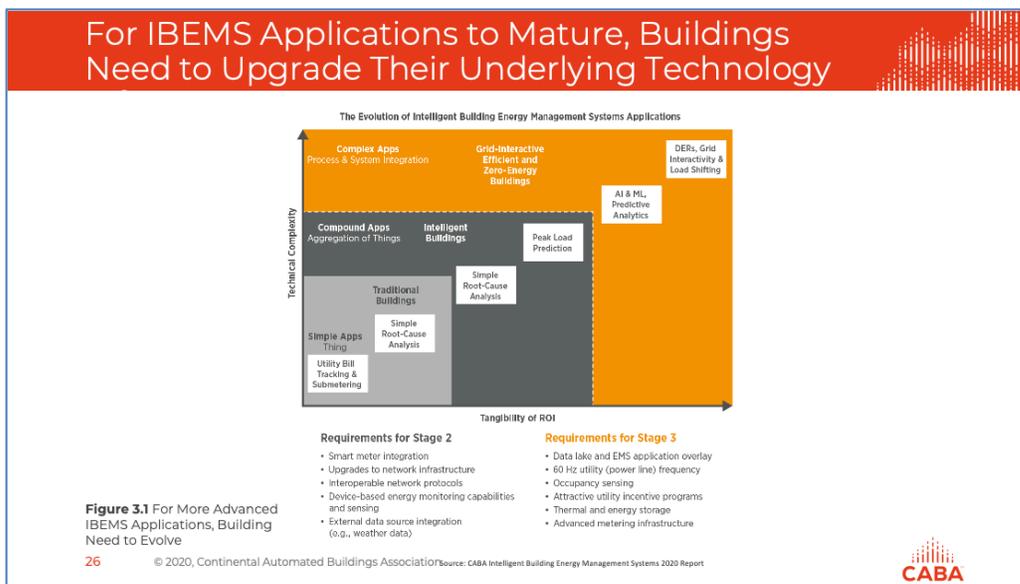
F5. **2021** — Collaborated with CABA on [The Connected Home and AI \(2021\)](#) that created a foundational framework for understanding the connected home’s evolution of consumer preferences around artificial intelligence applications in the home, with a particular focus on data and ownership and user privacy and their appetite to install and use artificial intelligence applications in connected homes, and developed recommendations for stakeholders on how they can best position themselves in this evolving connected home landscape



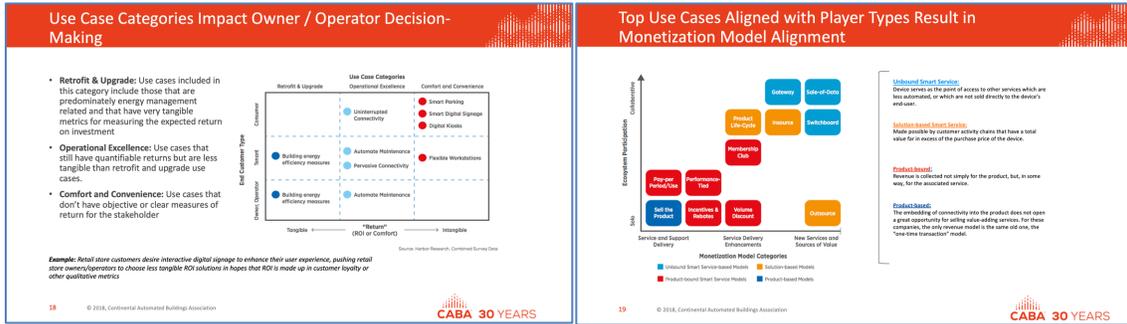
F6. 2021 — Collaborated with **CABA** on [AI and Predictive Maintenance in Intelligent Buildings \(2021\)](#) that defined and developed business opportunities within predictive maintenance and artificial intelligence technologies as they relate to intelligent buildings.



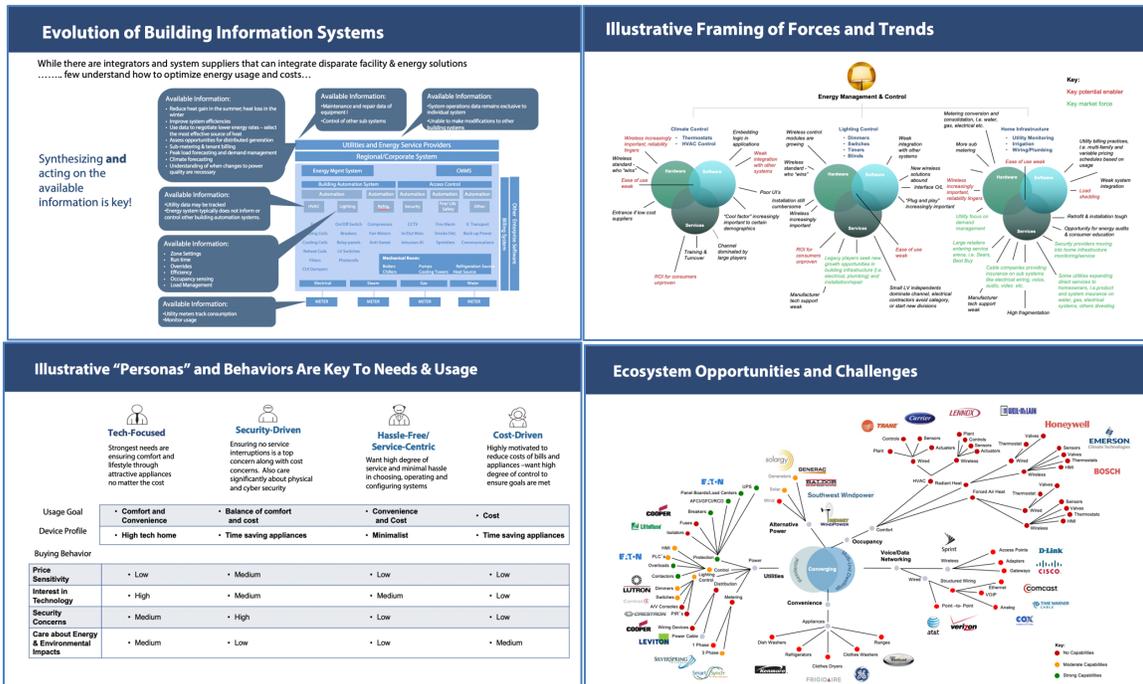
F7. 2021 — Collaborated with CABA on [Intelligent Building Energy Management Systems \(2021\)](#) that provided a framework, market requirements, ecosystem analysis and market sizing for the building automation systems, energy storage, and other energy management hardware and software solutions including services, security, data analytics, systems, and processes for building operators and technology suppliers based on top identified use cases within the target market



F8. 2018 — Collaborated with CABA on [Monetization of Intelligent Buildings \(2018\)](#) that examined how to monetize intelligent buildings from the perspective of building owners, developer, solution providers (OEM manufacturers and service providers) and other stakeholders including stakeholder analysis, business opportunities, technical barriers and opportunities, future market direction, issues, use-cases and industry recommendations.



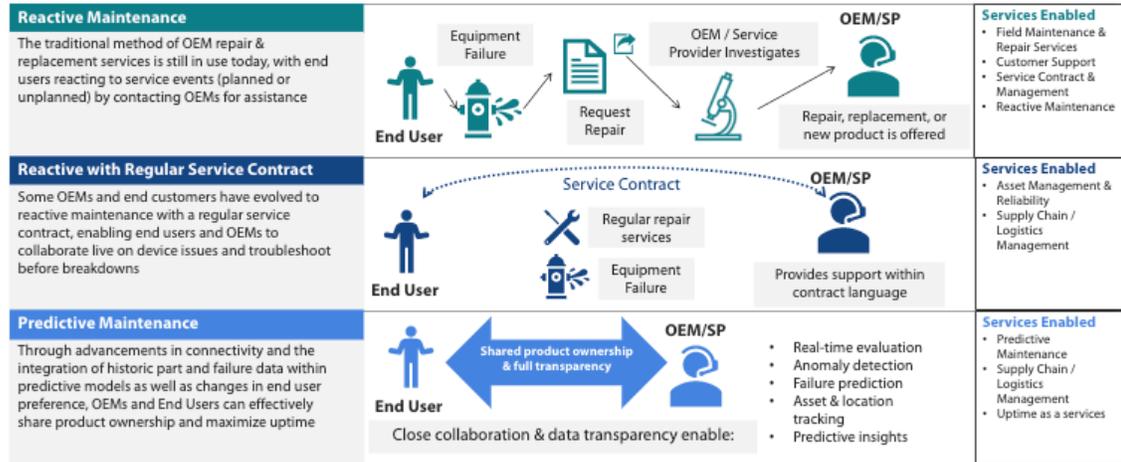
F9. Intelligent Buildings Opportunity Assessment (select outputs below)



F10. Recent Study "Assessment of Uptime and Predictive Maintenance" in February 2021

The Evolution of Maintenance Solutions Towards Predictive

The adoption of new monitoring, data management, and analytics technologies is enabling predictive maintenance strategies that coordinate OEMs, Service Providers, and end customer personnel in increasing asset uptime



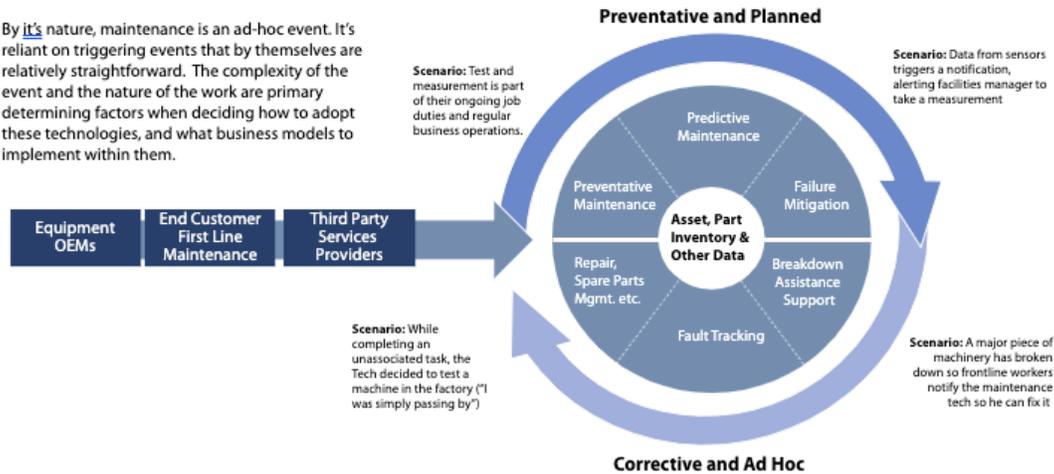
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Uptime Strategy February 2021 | Harbor Research

Customers Need Better & More Integrated Aftermarket Solutions

The value of digital transformation is gaining traction among end customers, but the complexity of this strategy is causing challenges across all industries.

By its nature, maintenance is an ad-hoc event. It's reliant on triggering events that by themselves are relatively straightforward. The complexity of the event and the nature of the work are primary determining factors when deciding how to adopt these technologies, and what business models to implement within them.



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Uptime Strategy February 2021 | Harbor Research