THE ELECTRICAL CONTRACTOR AS THE INTEGRATOR

ELECTRI INTERNATIONAL
THE FOUNDATION FOR ELECTRICAL CONSTRUCTION INC.

Conducted by MAXIM Consulting Group. Researchers: Michael McLin and Walead Atiyeh
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EXECUTIVE SUMMARY

In 2018, ELECTRI International funded a research project to develop a guide for ways an electrical contractor could enter and facilitate growth as an integrator in low voltage systems. Rapid changes in low voltage systems and the convergence of the information technology market are creating a need for a more highly-skilled contractor base and workforce across a broader range of low voltage systems. With the growth of low voltage systems, the traditional electrical contractor is facing scope reductions in its core traditional electrical work of conduit and wire. The industry is responding by cross-training its electrician base with technical and engineering skills related to low voltage systems, as well as hiring new low voltage technicians.

For the purposes of this manual, **"low voltage systems"** refers to those systems that would normally fall into the low voltage or extra low voltage category, all of which usually rely on a form of networking architecture.

Within this market, the low voltage systems include:

- *Access Control & Intrusion Detection*
- *CCTV Systems*
- *Fire Alarm Systems*
- *Building Controls (HVAC Controls/Lighting controls)*
- *Telephone and Network Infrastructure*
- *Public Audio / Visual Display Systems*
- *Low Voltage Energy Systems (including Power over Ethernet elements)*

The manual first evaluated major trends driving the low voltage systems market, and secondly, collected in-depth contractor specific information on how to capitalize upon these trends.

The constant evolution of technology in each of the above low voltage systems can make it seem difficult to stay informed on which systems and what technologies are available in the market. It can also make it difficult to quantify market data. However, by grouping the technologies by application (how they are used), market data are more widely available. The four application groupings used in this guide are:

- *Security Systems (inclusive of CCTV, access controls, intrusion detection)*
- *Life Safety Systems (Fire Alarm / Mass Notification)*
- *Facility Management (building controls, telephone and network infrastructure, lighting controls)*
- *Building Energy Management (Low voltage DC systems, Power over Ethernet)*

By placing low voltage technologies into these four application areas, data on the growth of the market are more easily captured and allow for a broader view of where the market is going, regardless of what low voltage technology is currently in use.

When studying contractors, the primary focus was on

- ✓ *What low voltage systems work is currently performed.*
- ✓ *How the contractors entered the market, the barriers to entry.*
- ✓ *The contractors' organizational structure.*
- ✓ *How contractors perform the work.*

Ultimately, researchers collected data from nearly 100 electrical contractors through an industry survey. Another 20 electrical contractors from all over the contiguous United States took part in an in-depth interview as part of this process. These electrical contractors currently perform work in education, healthcare, manufacturing, industrial, and commercial markets. Each contractor works in two or more of these vertical markets and they are usually pursuing this work in conjunction with their traditional electrical contracting work. None of the contractors interviewed to date has a significant presence in the residential market.

According to the ELECTRI Low Voltage Contractor Benchmarking Survey *(See Appendix A)*, contractors who perform both traditional electrical work and low voltage work typically find the low voltage market is more profitable than the traditional electrical market, in some cases twice as profitable or greater. Further, almost half of all electrical contractors expect the low voltage market to double in the next five years. Therefore, the low voltage market represents a significant area of growth in revenue and profitability that electrical contractors are well positioned to enter to their advantage.

It is necessary to note that the majority of union electrical contractors in the country report **less than $10 Million** in annual revenue (82% according to NECA). As is necessary in any industry or market- wide study, some generalizations had to be made. These generalizations may not apply to all companies all the time. Therefore, when a specific behavior or operation is mentioned, that means it applies to a majority of the companies interviewed and/or surveyed.

Electrical contractors continue to face the challenge of an evolving technological marketplace that requires new skills, different organizational structures to support skills and new project types, client demands for increased services and efficiency, and manufacturers introducing new systems that allow for competition by non-NECA licensed contractors as well as by manufacturers themselves.

The manual seeks to help guide contractors towards a low voltage systems strategy by answering three questions: ***Which markets? Which verticals? What competitive differentiators?***

To answer those questions the manual is organized in the following manner:

- ◇ *An overview of the low voltage market, trends, drivers, and projected growth*
- ◇ *Recommended strategies for entering the market*
- ◇ *Recommended organizational structures, licenses, certifications and skills*
- ◇ *A review of the scope of services contractors should consider offering*
- ◇ *Conclusions*

MARKET OVERVIEW

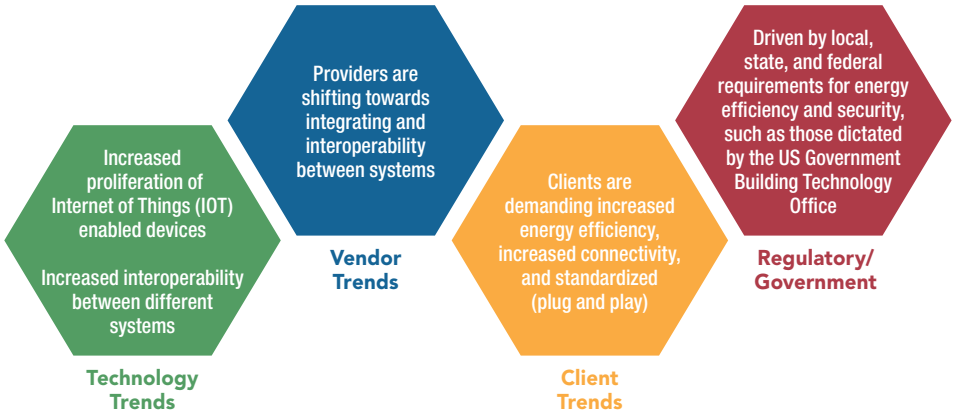
The market overview section covers trends driving the low voltage systems market growth and also provides an analysis of the market. This will help answer the questions "which markets" and "which customers" for whom a contractor should consider performing low voltage systems work.

MARKET DRIVERS AND TRENDS

There are several major trends currently driving low voltage systems market growths.

- **INTERNET OF THINGS:** Increased proliferation of low voltage devices enabled with "Internet of Things" (IoT) technology. This, in turn, increases the data and tools utilizing that data.
- **VENDOR SOLUTIONS:** Manufacturers are introducing business models in which digital services and products are being sold with the systems provided.
- **CLIENT DEMANDS:** Private clients are pushing for more cost effective and single source solutions, with higher levels of energy efficiency, safety, and security.
- **GOVERNMENTAL REGULATION:** Increased federal and state regulations for energy efficiency and security requirements.

Figure 1: Low Voltage Tech Market Drivers



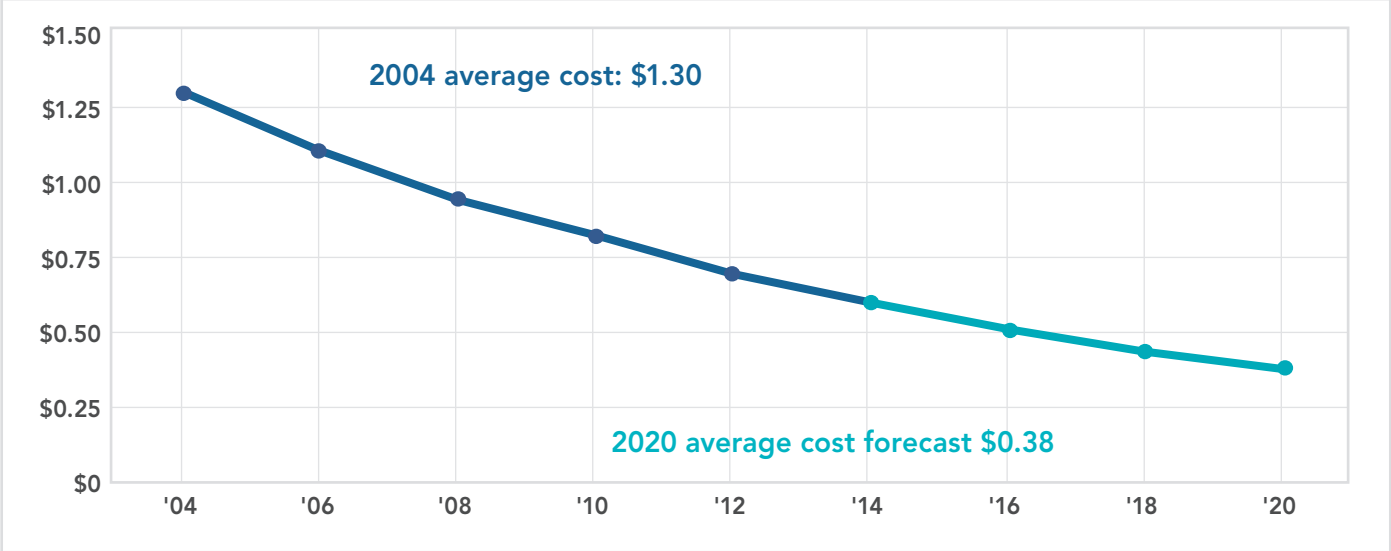
Each of the trends above is driving growth in the four application areas defined in the previous section (Security, Life Safety, Facility Management, and Energy Management).

TREND# 1: INTERNET OF THINGS

Currently, most electrical devices and gear, such as wall outlets, lights, and electrical panels, have no connection to the internet. There are estimates that as much as 50% of a building's electrical load is accounted for through wall outlets[1] yet these outlets are not connected to a network. By inserting a networked device between the outlet or panel and the device that is being powered, then that outlet itself becomes an IoT enabled device. These simple plug-and-play solutions are the cornerstones of much of the current market. Yet, as devices, products, and services become increasingly complex, contractors will require more sophisticated knowledge in order to implement solutions.

It is estimated there will be 20 billion IoT connected devices by 2020[2], far exceeding the number of people on the planet. This growth in connected devices is coming from increasingly cheap sensors, cheaper and more widely available bandwidth (cabled and wi-fi) for transmitting data, and an increase in processing power of devices (today's cell phone has more processing power than the computers that put a man on the moon in the 1960's).

Figure 2: Forecasted Average Cost of IoT Sensors[3]



TREND #2: VENDOR SOLUTIONS

While there are countless providers of IoT enabled devices on the market, brands play an important role in the selection of comprehensive solutions. There are new vendors continually entering the market, attracted by the growth and margins. Yet, a building developer is less likely to risk the project on a technology in its early stage offered by a new provider and would likely select a proven brand, even at the risk of a higher price point. The integration of multiple vendors and multiple systems is often identified as a major risk for clients and contractors alike. Further, once a client has embedded a vendor or brand into its project, there is a high cost of switching solutions, giving the client an incentive to continue working with a particular vendor or brand.

1. *(A. C. Menezes, 2014)*
2. *(Olavsrud, 2018)*
3. *(Goldman Sachs, 2018)*

To support the growth in the market, major suppliers, such as Schneider Electric and Siemens among others, offer technology solutions that help integrate different systems. While electrical contractors cannot be experts on all systems, contractors should be adept at understanding the needs and demands of clients, then evaluating whether a given vendor can provide a solution that can meet the client needs, and then selecting systems that can be procured and installed by the contractor. Some of the larger manufacturers with whom contractors should be familiar include:

- *Siemens Building Technologies Inc.*
- *Schneider Electric*
- *Honeywell International, Inc.*
- *Jonson Control, Inc.*
- *United Technologies Corporation*
- *Emerson*
- *ABB*
- *Rockwell*
- *WEG*
- *Yokogowa*

TREND #3: CLIENT DEMANDS

Clients are also pushing for a convergence of facility management systems, life safety systems, energy systems and security systems. The desire for this convergence is driven by using a shared infrastructure (wired and wireless) for data and power transmission, improved technology at a lower price, and greater data bandwidth availability. Consider:

- ***Security cameras are improving in quality with both 4k and HD adoption increasing, with data being increasingly driven over network cabling, or even wirelessly, instead of using coaxial cabling. With increased data storage and transmissions options at a lower cost, two of the traditionally largest bottlenecks – bandwidth and storage of surveillance data, are disappearing.***

- ***A move towards networked solutions that combines access control, video surveillance, and other alarms allows clients to provide more proactive security rather than reactive security.***

- ***There is a movement towards combining automated building functions (lighting, HVAC) with security due to the increased proliferation of devices equipped with the IoT. Such a combination will improve energy efficiency while providing other benefits of remote convenience, increased comfort, and better security.***

As fire alarm systems becomes increasingly connected to building systems, fire alarm systems are helping define the rules for maintainability of building systems tied to the fire detection and mass notification systems.

- ***Installations that combine both fire alarm and other non-life safety systems are required to have all of the integrated systems meet fire code requirements.***

- ***Lighting sensors, intrusion detection, and access control systems can provide data to first responders about the location of occupants in distress.***

TREND #4: GOVERNMENT REGULATION

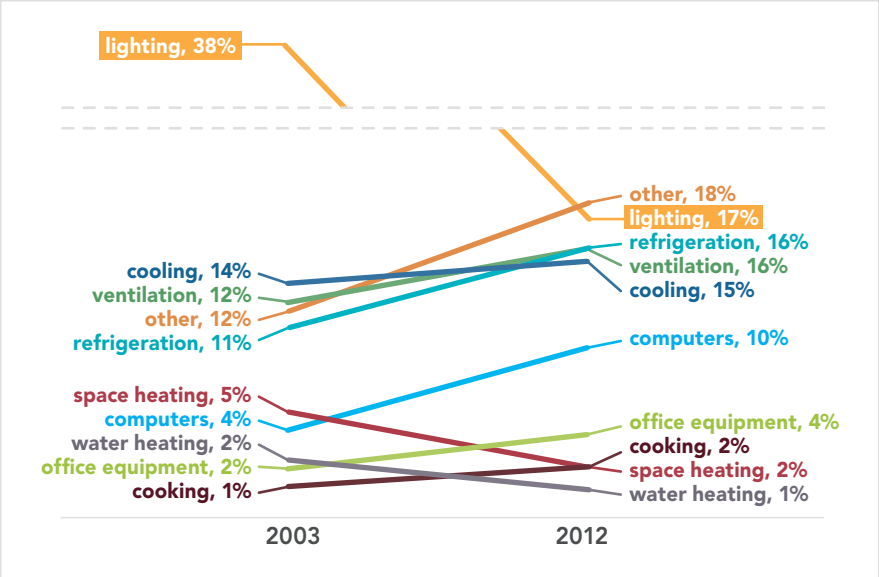
The commercial market has seen significant growth in the adoption of low voltage systems and is poised to continue that growth. State and local regulators are increasingly setting standards for reduced energy consumption by new construction. Currently, 40% of the total energy consumption in the United States is through buildings and, virtually every state has some type of program or regulation to reduce that consumption.

California, for example, has mandated net-zero energy consumption for new construction by 2030. That requirement plus other regulations by states will help manufacturers develop solutions that integrate security, life safety, facility management, and energy management. Integrating these systems will drive changes in energy consumption and reflect market demand for reduced energy consumption.

The proliferation of low voltage DC systems (LVDC) and Power over Ethernet (PoE) available devices, including lighting, is also increasing. This is leading to a reduction in traditional electrical wiring (but not necessarily conduit due to code requirements for certain systems), reduced installation costs, and improved design efficiency.

For decades, AC power has been the delivery means to supply power for motors, lighting, and other systems. However, DC power-enabled devices are starting to dominate the power loads due to the increase in data centers and new pc-based technologies.

Figure 3: Share of Electricity Consumption in Buildings[4]



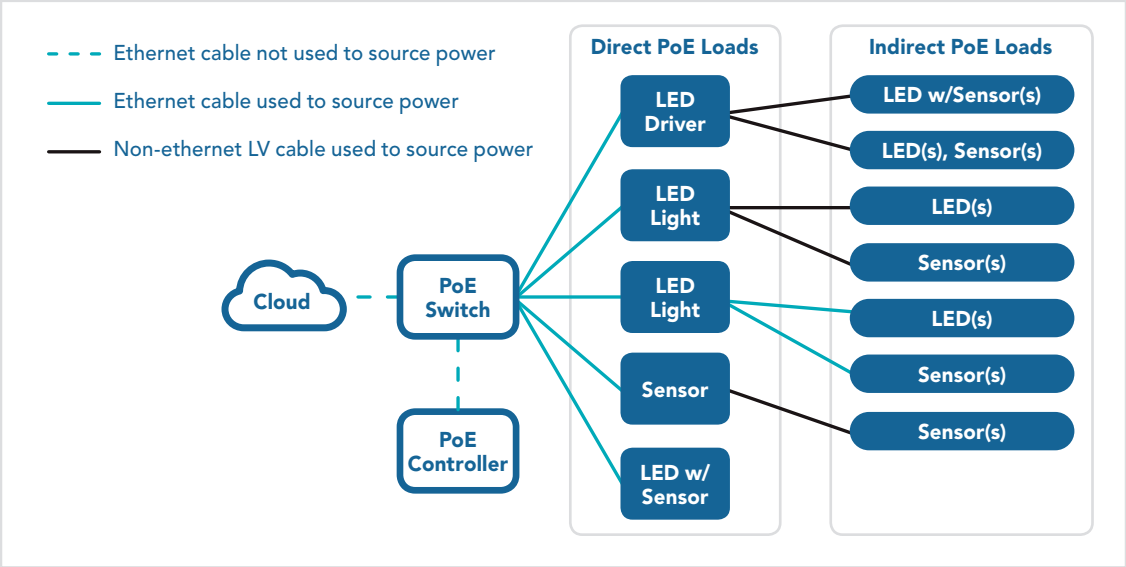
Projects utilizing an LVDC system or a PoE system can place equipment at optimal locations without being limited by additional power cabling, sources, or outlets. Location flexibility to these LVDC/PoE systems can be augmented by wireless control devices and sensors. Wireless systems allow for additional flexibility in connecting to existing building structures.

- ***The largest market share for PoE systems is currently connecting IP cameras and wireless access points. However, there are systems quickly becoming common place such as lighting, security access, displays, and network switches.***
- ***There is a new industry standard (IEEE 802.3bt) now being drafted. It will significantly increase the amount of power delivered to end devices up to 100 Watts, allowing PoE to broadly power lighting fixtures and a wide range of digital devices, sensors and controls.***
- ***PoE enabled devices all have their own IP address which allows for trouble shooting and reporting using standard network protocols (TCP/IP) thereby reducing repair/maintenance costs.***

4. (Administration, 2017)

These LVDC/PoE lighting systems are a low risk way of gaining market share in the growing low voltage market. PoE technology was initially developed to power low wattage devices such as IP enabled telephones and wireless access points. Over the past ten years there have been successive PoE standards put in place that have accommodated loads of increasingly higher power as well as an increase in the efficiency of lighting systems that can deliver increasing lighting outputs per wattage. This will eventually lead to an effect in which most LED lights will soon have power requirements that can be met by available PoE limitations. An example of a PoE lighting system architecture is illustrated below[5].

Figure 4: Example of a PoE Enabled Lighting Architecture



Electrical contractors who can offer the following functionality in their lighting packages will have an avenue for growth in other low voltage systems:

- *Lighting integrated with low voltage and PoE power and data systems*
- *Hybrid wired and wireless lighting control systems*
- *Combination of sensors with lighting control systems*

Lighting systems that combine with sensors that offer scheduling control, energy management, and security are growing in use, due to the low cost of sensors equipped with IoT enabled devices.

5. *(Energy, 2017)*

PROJECTED MARKET GROWTH

The previous section examined the trends that are driving the low voltage market. This section seeks to quantify the impact of those trends on the market itself, further helping to answer why a contractor should focus on the low voltage systems and for which markets.

The supply of the low voltage technology systems market is expected to double by 2022[6] in the building market alone. Consider these supporting examples of developments:

- ***Technology providers, such as Cisco, are partnering with electrical manufacturers to offer LVDC and PoE solutions.***
- ***Traditional utility operators, such as Verizon, are acquiring and partnering with lighting controls companies to provide integrated building solutions.***
- ***Clients are demanding and seeing reduced energy consumption in almost every sector from implementation of low voltage applications and technologies[7]:***
  - ***26% in educational institutions and hospitals***
  - ***41% in hotels and restaurants***
  - ***49% in wholesale and retail buildings***
  - ***52% in office buildings***

As stated earlier, when examining how to enter the low voltage systems market, it is simplest to categorize the market by application. The four applications selected for this manual are:

- ***Security Systems*** [8]
- ***Life Safety Systems*** [9]
- ***Facility Management Systems*** [10]
- ***Building Energy Management Systems*** [11]

The reason for this selection is that, regardless of the device or component in use today, end-users are looking for an application that meets their needs. For example, in a security application, a camera in use today may be obsolete in three years due to the availability of other more efficient cameras. Or, that camera maybe integrated with an access control/intrusion detector to provide facial recognition access. However, the end-user still requires a security system that provides the required functionality. Therefore, by emphasizing a market application, a contractor can more easily focus on a market sector or area rather than a specific tool or technology that is constantly evolving.

All four of the above applications are projected to grow by a combined 9% compounded annually by 2024.

6. *(Grandview Research, 2016)*
7. *(Building Automation Controls Association, 2018)*
8. *Security systems include access control, intrusion detection, and video surveillance*
9. *Life safety systems include smoke detectors, fire alarm, strobes, emergency notification, distributed antenna systems and mass notification systems*
10. *Facility management systems provide management for all of the systems within a building related to occupancy such as lighting, temperature, audio/visual communications, and networking*
11. *Energy management includes DC battery systems, low voltage energy systems, and PoE technologies*

Figure 5: Projected Growth by Application Area

Application	2016	2017	2018	2019	2020	2021	2022	2023	2024	CAGR (2016-24)
Security Systems	5.50*	6.27	7.09	7.95	8.85	9.82	10.83	11.91	13.06	**11.4%**
Life Safety Systems	2.69	3.04	3.41	3.78	4.18	4.59	5.02	5.48	5.96	**10.4%**
Facility Management Systems	6.88	7.54	8.18	8.80	9.41	10.02	10.60	11.18	11.77	**6.9%**
Building Energy Management System	2.00	2.21	2.42	2.62	2.83	3.04	3.24	3.45	3.67	**7.9%**
Total	**17.07**	**19.06**	**21.09**	**23.16**	**25.27**	**27.47**	**29.69**	**32.02**	**34.47**	**9.2%**

*This table demonstrates growth in each application area by 2024 (Security, Life Safety, Facility Management, and Energy Management) across the residential, commercial, and industrial markets[12]. *All Figures are in $ Billions*

SECURITY SYSTEMS

Security systems typically comprise the access control, intrusion detection, and video surveillance wiring as components of the security systems. The access controls would include card reader or other forms of controls (such as biometric). The intrusion detection would include motion detection and door entry sensors, and the video surveillance would include cameras and monitoring stations. The specific component or technology to be used by a contractor would be defined through the client demands, design specification, and procurement process. These systems are often integrated with other systems such as the life safety systems and facility management systems but can be standalone. Some states require a specific license to perform this work. The figure below breaks down the expected market sector growth.

Figure 6: Growth of Security Application by Sector

Market Sector	2016	2017	2018	2019	2020	2021	2022	2023	2024	CAGR (2016-24)
Residential	2.32*	2.70	3.10	3.53	3.99	4.49	5.02	5.59	6.21	**13.1%**
Commercial	10.79	11.99	13.21	14.43	15.66	16.93	18.19	19.49	20.84	**8.6%**
Industrial	5.42	6.16	6.94	7.76	8.62	9.54	10.49	11.50	12.59	**11.1%**
Total	**18.53**	**20.85**	**23.25**	**25.72**	**28.28**	**30.95**	**33.69**	**36.58**	**39.64**	**10.0%**

*This table demonstrates growth in Security systems which includes access control, intrusion detection, video surveillance, and other related components of security systems[13]. *All Figures are in $ Billions*

Over the next five years, the security system market is expected to grow by 10% compounded annually with the largest growth occurring in the residential and industrial markets. However, the commercial market has the largest actual dollar value and is still expected to be at least half of the market by 2024.

12. *(Grandview Research, 2016)*
13. *(Grandview Research, 2016)*

LIFE SAFETY SYSTEMS

Life safety systems include smoke detectors, fire alarm, strobes, emergency notification, distributed antenna systems and mass notification systems. The growing trend is for these systems to be integrated with the facility management systems, including the audio/visual notification systems. When the integration of a facility management system results in a shared infrastructure, it extends fire and life safety code-level requirements to systems that had different requirements in the past.

Figure 7: Life Safety Systems Growth

Market Sector	2016	2017	2018	2019	2020	2021	2022	2023	2024	CAGR (2016-24)
Residential	1.94*	2.20	2.47	2.75	3.05	3.36	3.68	4.02	4.39	**10.7%**
Commercial	3.32	3.78	4.26	4.76	5.28	5.84	6.42	7.04	7.71	**11.1%**
Industrial	3.60	3.91	4.21	4.50	4.78	5.04	5.29	5.53	5.77	**6.1%**
Total	**8.87**	**9.89**	**10.94**	**12.01**	**13.11**	**14.24**	**15.39**	**16.60**	**17.86**	**9.1%**

This tables demonstrates growth in Life Safety systems include smoke detection, fire alarm, strobes, mass notification, and other life critical components[14].
**All Figures are in $ Billions*

The market for life safety systems is expected to grow by just over 9%. However, in contrast to security systems, the greatest growth is occurring in the commercial markets. The industrial market is currently larger than the commercial market in terms of absolute dollar value but that is not expected to remain the case.

Figure 8: Case Study of an Integrated System

Denver Union Station is an example of a first of its kind integrated system within the Denver area. The system included a smoke management system that interfaced with a proprietary HVAC controls system, and a non-proprietary Public Address and Visual Messaging System. These proprietary and non-proprietary systems were integrated by an electrical contracting team that included St. Andrews Construction Company, Mass. Electric Construction Company, and third-party suppliers of the systems. This integrated system met both the needs of the client and the local code requirements for Fire Alarm and Mass Notification systems.

14. *(Grandview Research, 2016)*

FACILITY MANAGEMENT SYSTEMS

Facility management systems provide management for all of the systems within a building related to occupancy such as lighting, temperature, audio/visual communications, and networking. They also interface (and/or control) with other systems such as fire alarm. There is typically a dedicated control center, but the systems can usually also provide remote access through devices such as phones, laptops, and tablets. The largest market sector for these types of systems is the industrial market due to the high volume of lighting and HVAC controls in industrial facilities.

Figure 9: Facility Management Systems Growth

Market Sector	2016	2017	2018	2019	2020	2021	2022	2023	2024	CAGR (2016-24)
Residential	4.78*	5.30	5.81	6.32	6.83	7.35	7.85	8.37	8.89	**8.1%**
Commercial	7.64	8.30	8.94	9.55	10.13	10.70	11.24	11.78	12.32	**6.1%**
Industrial	9.32	9.94	10.51	11.02	11.48	11.91	12.27	12.62	12.94	**4.2%**
Total	**21.74**	**23.54**	**25.26**	**26.89**	**28.44**	**29.96**	**31.37**	**32.77**	**34.15**	**5.8%**

This table demonstrates growth in Facility management systems include lighting, audio/visual communications, networking, and HVAC[15].
**All Figures are in $ Billions*

The greatest growth in facility management systems is coming in the residential market, even though that market is not anticipated to reach the size of the commercial or industrial markets. The residential market is leading the commercial and industrial markets in the trend of connected homes and devices.

BUILDING ENERGY MANAGEMENT SYSTEMS

Building Energy Management Systems are related to and interface with facility management systems yet are characterized more on how to manage energy systems and improve efficiencies. They provide intelligent energy sources and systems that can drive down energy costs and comply with energy standards. The use of DC battery systems, low voltage energy systems, and PoE technologies are examples of these systems.

Figure 10: Building Energy Management Systems Growth[16]

Market Sector	2016	2017	2018	2019	2020	2021	2022	2023	2024	CAGR (2016-24)
Residential	0.69*	0.74	0.78	0.82	0.86	0.89	0.92	0.95	0.97	**4.4%**
Commercial	1.74	1.92	2.10	2.28	2.47	2.65	2.83	3.02	3.21	**8.0%**
Industrial	2.04	2.20	2.35	2.49	2.63	2.76	2.88	3.00	3.12	**5.5%**
Total	**4.47**	**4.86**	**5.23**	**5.60**	**5.95**	**6.30**	**6.63**	**6.97**	**7.30**	**6.3%**

*Use of low voltage energy systems, PoE, and DC battery systems are examples of Building Energy Management systems. *All Figures are in $ Billions*

15. *(Grandview Research, 2016)*
16. *(Grandview Research, 2016)*

The industrial market is currently the largest market sector for Building Energy systems, yet the commercial market is expected to overtake the industrial market by 2023. Commercial offices and small retail facilities lend themselves well to energy management systems because low voltage systems can meet many of the needs for lighting and other systems. However, for large industrial applications that require intense lighting and HVAC requirements, the efficiencies may not be as scalable. PoE Lighting, for example, is still limited in how much power it can deliver over long distances.

The table below combines all four application areas of Security, Life Safety, Facility Management, and Building Energy Management and demonstrates the growth by market sectors of residential, commercial, and industrial.

Figure 11: Residential, Commercial, and Industrial Market Sector Growth for Low Voltage Applications

Market Sector	2016	2017	2018	2019	2020	2021	2022	2023	2024	CAGR (2016-24)
Residential	4.91*	5.62	6.37	7.17	8.01	8.92	9.86	10.87	11.96	**11.8%**
Commercial	7.31	8.11	8.93	9.75	10.58	11.43	12.29	13.18	14.10	**8.6%**
Industrial	4.86	5.32	5.78	6.24	6.68	7.12	7.54	7.97	8.41	**7.1%**
Total	**17.07**	**19.06**	**21.09**	**23.16**	**25.27**	**27.47**	**29.69**	**32.02**	**34.47**	**9.2%**

*All four application areas (security, life safety, facility management, and energy management) are combined to show their growth by market sector of residential, commercial, and industrial[17]. *All Figures are in $ Billions*

In some cases of specific applications of low voltage systems, the residential market is leading the commercial or industrial markets with growth due to an infusion of low tech, self-install devices. That poses a threat to the traditional electrical contractor who might have difficulty competing in that space with non-traditional contractors. The value for engaging a traditional electrical contractor is in the more complex systems that require integration. Contractors must consider driving towards systems and solutions that have more complex integration markets which usually means the commercial and industrial markets.

KEY FINDINGS FROM INTERVIEWS

Most of the data within this section is considered secondary research, obtained from third party sources. However, interviews with contractors and vendors suggested the following:

- ***While proprietary systems have often hampered contractors in providing solutions to clients, the industry is slowly moving away from those systems. While some manufacturers still provide proprietary systems (especially in Building Automation and Fire Alarm), there has been an emergence of Platform as a Service (PAAS) which takes data from multiple sources and provides an integrated platform for clients and contractors.***

- ***Managing and integrating multiple system providers will require a greater level of effort than managing just a single proprietary vendor.***

17. *(Grandview Research, 2016)*

MARKET STRATEGIES AND GO-TO MARKET OPTIONS

Commercial and industrial clients, both in today's low voltage market and in the future, are generally savvier and will understand the different systems, technology and upcoming developments in the industry. Contractors who seek to be integrators for commercial and industrial clients will need to spend more time identifying the clients and developing the skills for a more technical proposal process regarding systems. Further, traditional Architectural, Engineering and Construction (AEC) designers do not have the skillsets to provide a finished and "buildable" design. Based on this, contractors will need to understand the systems proposed, identify the gaps in the design, and determine what will be necessary to provide a complete system to the client, even at the risk of adding scope to a proposal that a less sophisticated electrical contractor would miss

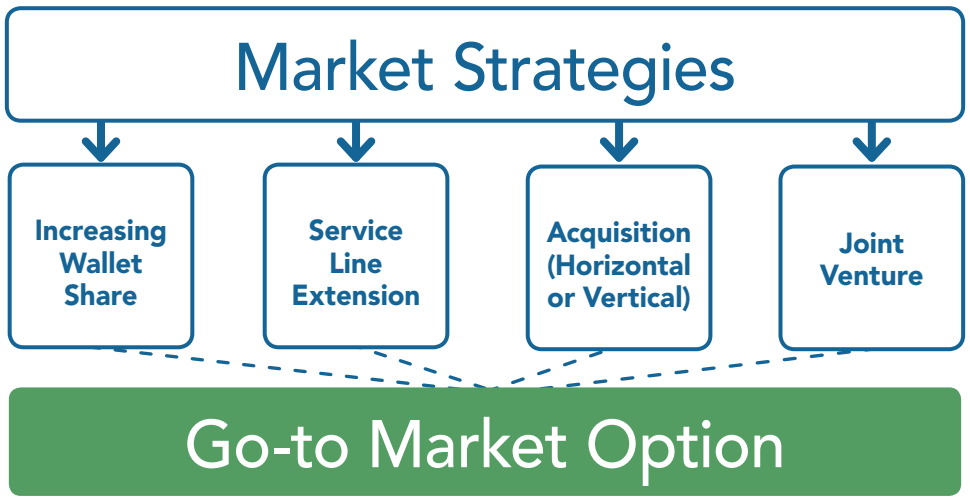
Selection of the correct market strategy should be supported by secondary market research data or by primary market research data which involves directly interfacing with clients, competitors, and vendors. And while there is no single "right" way for contractors to enter the market, several themes emerged from the study.

The market strategies that emerged through discussions with contractors who participate in the low voltage systems market include:

- *Increasing Wallet Share*
- *Service Line Extension*
- *Acquisition (Horizontal and Vertical)*
- *Joint Venture*

These strategies are then utilized to determine the appropriate go-to market option, with bidding as a systems prime contractor or as a subcontractor.

Figure 12: Market Strategies and Go-to Market Options



INCREASING WALLET SHARE

Wallet share is the portion that a client currently spends on a project or set of projects. For example, if an existing client has 10% of its construction budgets allocated for traditional electrical work, and another 5% allocated for low voltage systems such as a building management system, then increasing wallet share would be to capture the entire traditional electrical scope and the low voltage systems for a 15% total share of the client's wallet. A traditional electrical contractor might contemplate this since many of the activities (installing devices, pulling cable, terminations, testing) are similar in nature, and the disciplines are closely related.

This is a deliberate process, driven usually by client requirements. It requires adaptability and investment to develop a strong foundation that can be nurtured for more growth. The benefits of this approach are obvious:

- *Management completely understands how their business operates in the market.*
- *A culture in low voltage systems and advancements is already embedded within the organization both at the field staff level and in senior management.*
- *Growth in the market is sustainable and planned.*

However, for a contractor who has not yet entered the low voltage market, increasing wallet share may not necessarily be the best fit. There can be a different operating cost model for low voltage systems work along with high capital investment costs to acquire the necessary tooling, equipment and training staff and craft on how to perform low voltage work.

SERVICE LINE EXTENSION

In a service line extension, a contracting firm extends its name into a new form of work or market. This is related to wallet share but would be done by a related entity rather than the existing traditional electrical contractor. An example would be a traditional electrical contractor who dominates the traditional electrical market setting up a low voltage division under a similar name. This helps utilize the existing traditional electrical contractor brand to launch into new categories of work. If the clients of the new market are familiar with and satisfied with the core values and operating approach of the existing brand, then there is a likelihood of acceptance with the service line extension.

Yet, the acquisition of new clients for low voltage work in a service line extension may be difficult as experience and a company's resumé tend to matter when evaluating contractors on the riskiest portion of low voltage work: systems integration. Carefully examine the market through primary research prior to selecting this option. Then select clients, projects, and partners that support the business strategy.

ACQUISITION (HORIZONTAL AND VERTICAL)

An acquisition is a planned step to acquire a new business to meet a strategic need. In this case, it would be to obtain a form of entry into the low voltage systems market. **A horizontal acquisition is buying an organization that performs work in an adjacent area (such as a traditional electrical contractor acquiring a low voltage contractor).**

An electrical contractor who seeks to add a specialized skill (such as fire alarm) or penetrate a new market in pursuit of less competition and better profitability will acquire the talent or even buy a business that is already familiar with the nuances of the specialization and the market sector.

Vertical acquisition is when an electrical contractor buys a specialized supplier or other vertical component of the market (such as the only regional vendor of a particular product or system). The intent is to capture a bigger piece of the overall value stream and to increase revenue and profitability.

Traditional electrical contractors who acquire other organizations will gain:

- *Potential for immediate growth either with a new client base or through new shares of an existing market.*
- *Increased knowledge and experience that allow the acquiring company to pursue work it may not currently be able to pursue.*
- *Competitive edge in being able to price more work and purchasing volume.*

For contractors currently without a low voltage presence, entering the market via acquisition is a quicker option than an organic entry. However, challenges do exist with acquisitions:

- *An acquisition can have a steep up-front cost, and the acquiring organization might need to take on debt if it does not have significant cash available.*
- *Management might struggle with scaling the support needed to manage both companies. Integrating or restructuring two companies could lead to poor results.*
- *There could also be cultural issues between personnel groupings, technicians, and electricians if not properly managed.*

If a contractor is considering acquiring a low voltage contractor, integrator, or supplier then the following guidelines are suggested:

- *The business is already within the industry and/or market. For example, a regional electrical contractor purchasing a local fire alarm systems installer when there are code and licensing requirements the contractor does not meet.*
- *The management and/or key employees are included in the acquisition. Losing either management or key employees would increase the transfer risk.*
- *The business has a key strategic asset, such as being the only representative for a region or market of a technology platform in wide use.*

If a target company only has a few large clients, there is a risk that some portion of the client base will leave during the acquisition process thereby causing the acquisition to fail.

JOINT VENTURE

A joint venture is best described as a business venture where two or more contractors come together to share expertise and/or resources to win a specific contract or client. The joint venture is established as a separate entity with its own set of rules for management, apart from the originating companies themselves. The benefits of a joint venture are:

- *Sharing of risk and resources.*
- *Joint financial strength.*
- *Perhaps the only means of entry to a specific market or client.*

The use of joint ventures by low voltage contractors did not seem very prevalent. However, for an electrical contractor wishing to "test the waters" of the low voltage market, acquire knowledge or skills, and build a resumé, then a joint venture can be appropriate initial first step to entering the market. Depending on the nature of the work, the contractual agreement language, and the companies involved, there may be a loss of control and sharing of financial information between companies. Also, there could be increased record keeping requirements.

When entering into a joint venture agreement targeting low voltage work, the following guidelines should be considered first:

- *Does the size of the project with the low voltage work exceed the financial bonding capacity of the contractor?*
- *Does the market or geographical location of the project pose an impediment to bringing in additional resources or equipment for the work?*
- *Will the targeted joint venture company provide access to specialized knowledge or systems that do not currently exist?*

GO-TO MARKET OPTIONS

Regardless of the market entry strategy, contractors still need to bid either to general contractors or clients. Most electrical contractors who focus on low voltage systems said they act as a subcontractor to general contractors or other electrical contractors, a handful are direct to clients, and virtually no respondents said they bid to manufacturers of low voltage systems, or, if they do, it is rare. Most traditional electrical contractors, operating as subcontractors to other general contractors, are comfortable and familiar with that approach. The systems integration market, however, provides an opportunity for an electrical contracting firm to embed itself earlier with clients and steer them towards contractor-friendly solutions. However, choosing to do so is not a simple matter. There are several points that should be considered prior to start bidding directly to clients for systems integration work.

- ***Has the contractor successfully built and integrated low voltage systems as a subcontractor? Having a historical record of success with company advocates among clients and general contractors is an important consideration prior to bidding directly to clients.***

- ***How would existing relationships with vendors, manufacturers, and other existing electrical contractors be impacted? If a vendor has a relationship with a client that is impacted by an electrical contractor's firm inserting itself into the solutions development process as a prime, then the vendor may view this as a threat and be less likely to provide favorable pricing.***

- ***Does the contractor have a dedicated business development process that has already proven successful? If an electrical contractor does not have this, then it is likely that this has been handled by company executives. Business development directly with clients is a much more time and resource intensive process then as a subcontractor. This also includes the proposal process. Systems integration business development includes the process for developing a proposal that accurately describes the approach for the project, resources available, probable vendors or suppliers, and other pertinent information related to schedule and performance.***

- ***Does the contractor have the financial resources to support being a prime? Paying for a dedicated business development channel as well as the additional duties necessary to support being a prime will require additional capital that will have to come from the contractor's pocket.***

- ***Does the contractor have the organizational structure to support being a prime, including a business development department? Further, recruiting and staffing becomes a more intensive activity to support the growth as a prime.***

- ***Does the contractor have standards and processes in place to be a prime? Standards and processes yield more predictable outcomes. Bidding work as a systems integrator prime is a riskier approach and standards help minimize that risk.***

The rewards of performing work as a prime in the systems integration market can be substantial. Contractors can build a direct relationship with clients, leading to repeatable work and maintenance contracts, and can embed themselves earlier in the project development cycle. However, there is an added layer of cost and risk that must be carefully managed.

KEY FINDINGS FROM INTERVIEWS

The views of contractors and vendors who participated in this study suggested that when entering the market:

- ***Most contractors with a presence in the market entered it organically, requiring an investment over time both financially and in resources. Those contractors with a significant low voltage presence operate the low voltage division work as a separate entity from the traditional electrical work.***

- ***Contractors who did acquire other contractors were already present in the low voltage in a different system or capacity and performed the acquisition to strengthen their presence in the market by offering a different product or system.***

- ***When managing a maintenance contract, there is a significant cost in stock materials that must be kept on hand. This is especially true in a fire alarm system which requires a 24/7 response from maintainers and contractors.***

- ***If the regional market is not especially large, it can be difficult to enter the low voltage market in a significant way unless there is a competitive edge such as a licensing requirement.***

ORGANIZATIONAL STRUCTURE, LICENSES, CERTIFICATIONS, AND SKILLS

This section covers how contractors should consider setting up their low voltage systems organizations, and details the necessary tools to perform the work. In short, this helps answer the question of "what competitive differentiators".

ORGANIZATIONAL STRUCTURE

When identifying the correct organizational structure for entering the low voltage market, it is important to understand the strategy behind entry. If the strategy to performing low voltage work is simply to complement the existing electrical work, then a traditional contractor organizational structure approach is sufficient with merely a functional breakout for the low voltage scopes of work. If the strategy is to grow the low voltage integration work into its own business or profit center, then the organizational structure should reflect that approach. Further, the performance orientation and service nature of low voltage integration work tends to have a different management structure and craft base to support that work. For contractors who perform both typical electrical work and a significant amount of low voltage work, very few perform the work within the framework of their typical electrical scopes and have a separate division or entity to handle the low voltage work.

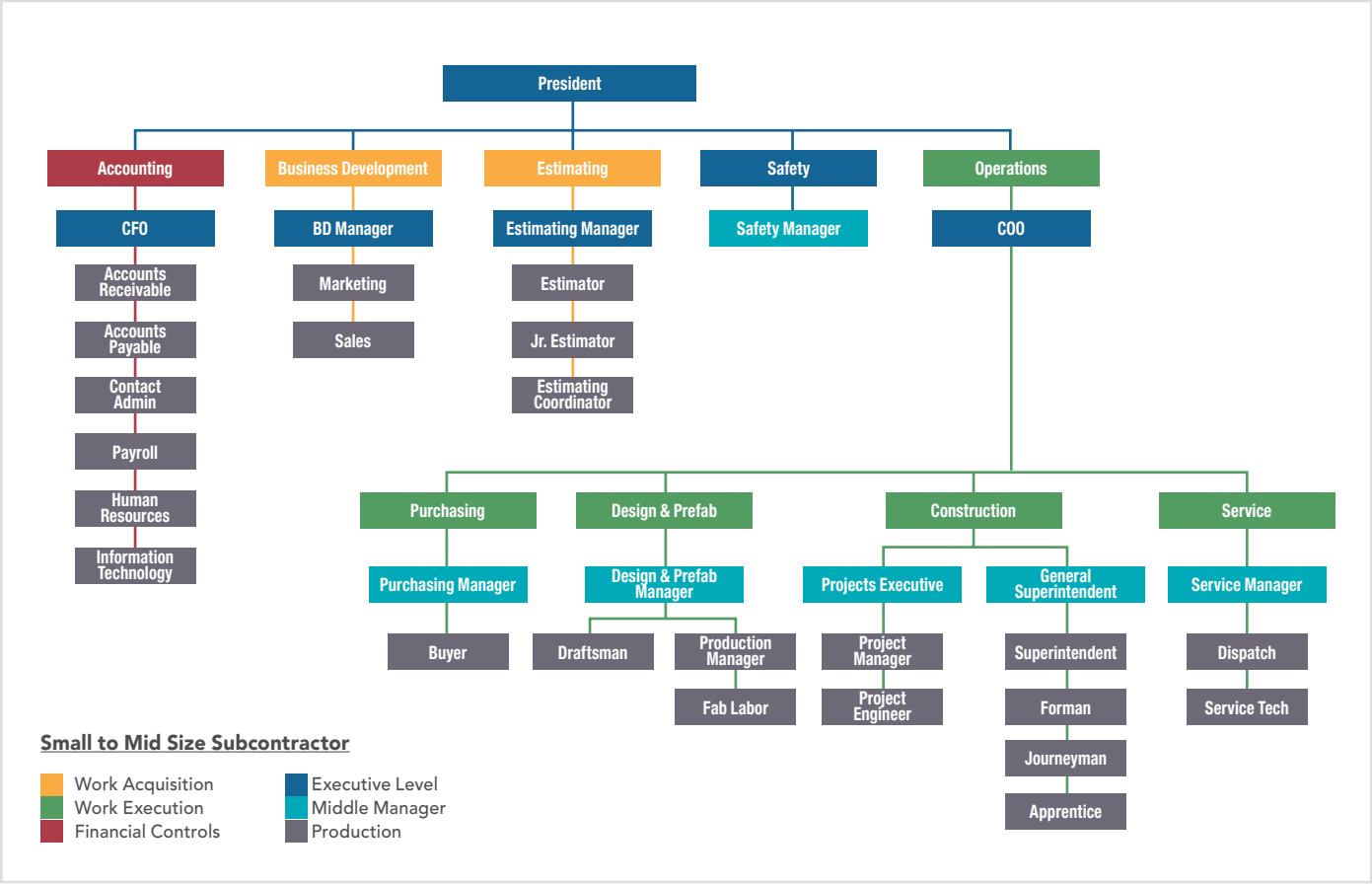
In most cases, performing work as an integrator in the low voltage market in a significant way requires setting up a low voltage or systems division separate from that of the traditional electrical contracting work. The nature of the work (more performance- and service-oriented), the skillsets required (different licenses, much more customer facing, and technology driven), and the scope of work (separate specifications, clients, and projects) will typically require a strategy different from that of traditional electrical work. There are two common organizational approaches for a contractor working in low voltage systems markets: Functional and Divisional.

FUNCTIONAL STRUCTURE

This structure is especially common in smaller companies in which the contractor does not operate in many different markets and tends to be more stable. According to the ELECTRI Benchmarking industry survey performed for this study over 2/3rds of all electrical contractors operate in this manner. These contractors share overhead and resources between the low voltage work and the traditional electrical work.

This allows staff with similar skills to be grouped together and allows for standardization of policies, procedures, and controlled growth. But this structure is not as well suited to contractors who are rapidly growing and diversifying in different markets. There would be a blurring of work between low voltage and traditional electrical work leading to inefficiencies and misallocation of resources.

Figure 13: Functional Structure



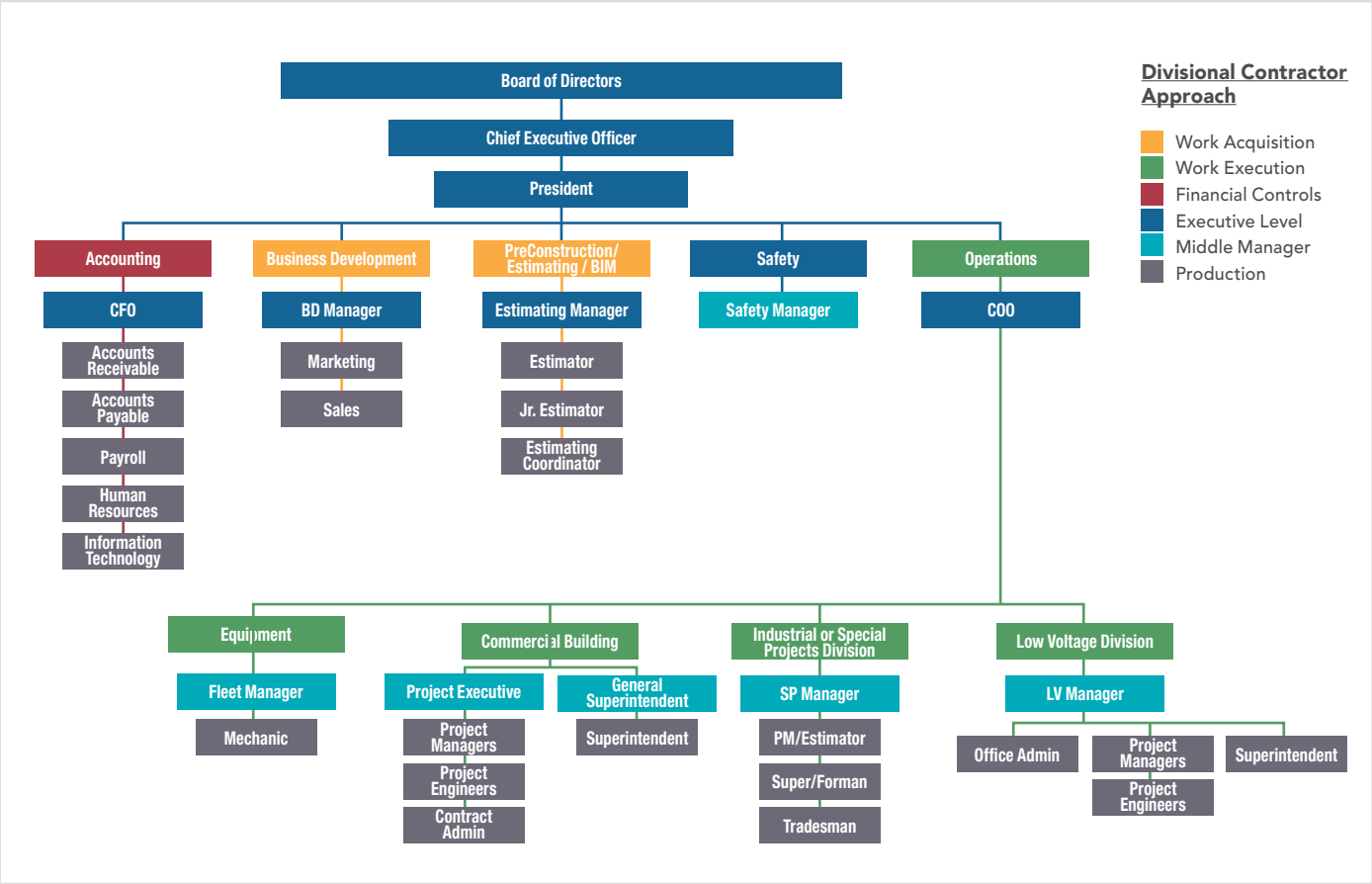
DIVISIONAL STRUCTURE

In this approach, there are divisions that stand next to each other and are connected at the top of the structure. Information is generally driven up to the top of the division, and then back down to other divisions as necessary. This arises from a perceived need to exert more centralized control of the service offerings as the company expands.

As an example, an electrical contractor with a heavy presence in the commercial and industrial electrical contracting markets has identified that the low voltage market is growing sufficiently enough that it warrants its own operating division and, accordingly, set up the following structure:

- ***Commercial Building Division:*** *Focuses on the commercial building market and has its own project management and other supporting functions.*
- ***Industrial or Special Projects Division:*** *Has its own structure and focuses on industrial customers or special projects such as power plants and factories.*
- ***Low Voltage Division:*** *Has its own project management and labor structure and focuses on providing low voltage services to all customers, including internally to the company's commercial building and industrial divisions. The Low Voltage Division shares estimating and other support functions with the commercial and industrial divisions.*

Figure 14 : Divisional Structure

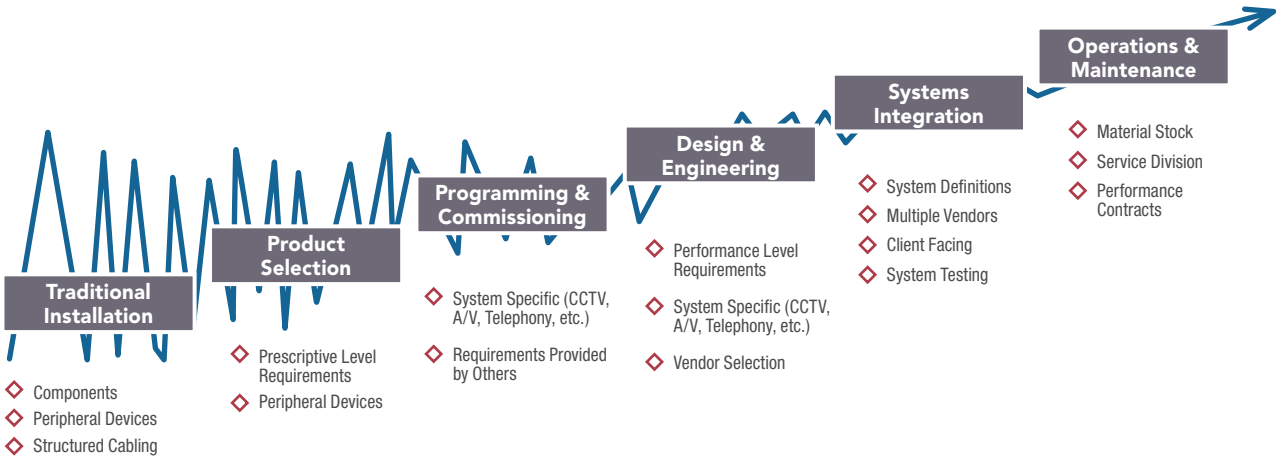


This approach makes it simpler to provide accountability for results division by division and allows each management team to look out for its own best interests. This also allows division managers to react quickly to market conditions, helps differentiate the overall company's service offerings, and can scale the operations to meet a specific market or area of work. For example, a low voltage division can be run by a single manager with 20 to 25 supporting technicians (depending on the size and scale of the work) whereas a traditional electrical contractor structure might have multiple managers with multiple electrician crews depending on the project backlog. Another advantage is that, if the division is set up as its own business entity, it may obtain licenses or other agreements necessary to perform scopes of work (such as fire alarm licenses) that the parent organization does not have or may want to segregate for liability reasons.

LICENSES & CERTIFICATIONS

The skills needed for the contractor in the low voltage market are different from those required for a traditional electrical contractor. Knowledge of basic structured data cabling installation and component installation, information technology, and engineering coalesce into the skills of a low voltage installer/technician. Therefore, to become a successful systems integrator, it is no longer sufficient to remain an installer of low voltage systems and leave it to the vendor or client to integrate the system. Contractors need to develop progressive skills in the following manner.

Figure 15 : Systems Integrator Progressive Skills



As contractors increasingly grow in sophistication, they move beyond a simple installer to product selection, programming, engineering, and integration. Each skillset tier above the traditional installation tier requires contractors to educate themselves beyond traditional electrical installer skills. It requires knowledge of low voltage systems design and information technology.

For the purposes of this manual the following terms are defined:

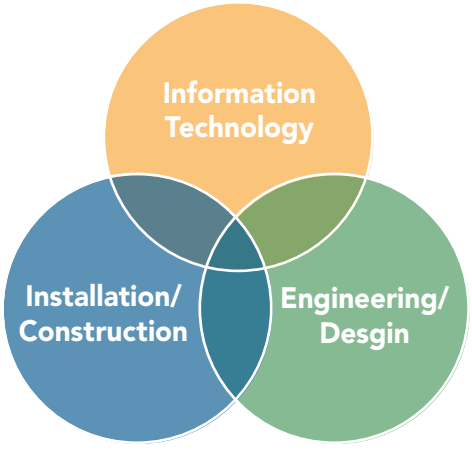
ELECTRICIAN

An electrically-licensed employee who installs, repairs, and maintains electrical systems for residential, commercial, and industrial clients and who adhere to all code and regulatory requirements. The National Electrical Contractors Association (NECA) is considered the governing body for the standards and guidelines of electricians and contractors performing electrical work.

TECHNICIAN

Technicians work with cabling and installation of security, voice and data, and controls systems. Electricians can perform many of the same tasks as technicians and technicians would need an electrical license to perform the same work electricians do. Technicians receive on-going training on new technologies that allows them to blend both the wiring and installation of low voltage devices with networks and systems, a broader skillset than that required of electricians. NECA provides a comprehensive state-by-state directory of low voltage electrician licensing requirements by occupation (alarm technician, telecommunication technician) at www.necanet.org.

Figure 16: Integration of Disciplines for Technicians



The duties of a technician (differentiated from duties of an electrician) would include:

- *Working with low voltage cabling and wiring. Conduit installation may be dependent on state and code licensing requirements.*
- *Terminating network cable, camera cabling, and other data (fiber) cabling*
- *Working with low voltage DC batteries*
- *Trimming out low voltage devices such as cameras, thermostats, and sensors*
- *Programming equipment*
- *Reviewing and providing comment on low voltage systems designs*
- *Ordering material and equipment to support low voltage systems*
- *Performing service calls to replace cameras or other low voltage components*

There are three typical methods for licensing low voltage technicians:

- *Jurisdictions that would license electricians would also license technicians. In this instance, there would be a similar apprenticeship/journeyman/master electrician track.*
- *Some jurisdictions would license technicians separately. The training and licensing requirements are different from electricians (and likely less involved).*
- *Some jurisdictions would license technicians separately based on system or role. For example, fire alarm technicians or voice/data technicians would all have separate licenses. This is especially common for fire alarm and security systems.*

Each locality tends to have its own requirements. Prior to performing work in a jurisdiction, the contractor must ensure having the necessary requirements to perform the scope of work. The following is a summary from NECA on which low voltage systems would need a license from a state agency. This does not include local or municipal requirements and should be verified with the latest information from each regulatory agency.

Figure 17: Low Voltage Licensing Requirements by State

State	Requirement
Alabama	General Low Voltage system Lock Smiths
Alaska	Communication system Fire and Security system
Alaska	Fire and Security Alarms
Arizona	Communication system
Arizona	Fire Alarms
Arkansas	Security Alarm system
California	Security Alarm system Lock Smiths
Colorado	Does not specifically license low voltage technicians at the state level
Connecticut	General low voltage system, especially those related to security system
Delaware	Does not specifically license low voltage technicians at the state level
Florida	General Low Voltage system Security Alarm system Fire and Security Alarm system
Georgia	General low voltage system
Hawaii	Does not specifically license low voltage technicians at the state level
Idaho	Does not specifically license low voltage technicians at the state level
Illinois	Fire and security alarm system
Indiana	Does not specifically license low voltage technicians at the state level
Iowa	Does not specifically license low voltage technicians at the state level
Kansas	Does not specifically license low voltage technicians at the state level
Kentucky	Fire and security alarm system
Louisiana	Security alarm system Fire alarm system CCTV security system
Maine	Fire alarm system General low energy electronics Low voltage landscape lighting
Maryland	Does not specifically license low voltage technicians at the state level
Massachusetts	Fire alarm system Security alarm system
Michigan	Fire and security alarm system
Minnesota	Low voltage technology system
Mississippi	Does not specifically license low voltage technicians at the state level
Missouri	Fire and security alarm system

State	Requirement
Montana	All types of alarm system (fire and security)
Nebraska	Fire alarm system
Nevada	Fire alarm system Photovoltaic system General low voltage system
New Hampshire	Does not specifically license low voltage technicians at the state level
New Jersey	Security alarm system Fire alarm system
New Mexico	Telephone system Fire and security system
New York	Security alarm system Fire alarm system
North Carolina	General low voltage system
North Dakota	Does not specifically license low voltage technicians at the state level
Ohio	Does not specifically license low voltage technicians at the state level
Oklahoma	Security alarm system Fire alarm system Alarm company system
Oregon	General low voltage system
Pennsylvania	Does not specifically license low voltage technicians at the state level
Rhode Island	General alarm system General telecommunication system
South Carolina	Security and fire alarm system Security alarm system
South Dakota	Does not specifically license low voltage technicians at the state level
Tennessee	General low voltage system, which includes: • Sound system • Intercom system • Fire Alarm system • Security system • Telephone line system and communications cables
Texas	Fire alarm system Security alarm system
Utah	Security Alarm system
Vermont	Residential fire alarm system Commercial fire alarm system
Virginia	Does not specifically license low voltage technicians at the state level
Washington	Telecommunications system
West Virginia	Fire and security alarm system
Wisconsin	Does not specifically license low voltage technicians at the state level
Wyoming	General low voltage system

As a practical matter, there are many sub-specialties within the low voltage market and many certifications (differentiated from licenses) that can be obtained for specific areas of work or systems.

Clients will also often specify that design, installation or programming of the systems must be performed by a person certified by a governing body such as the Electronics Technicians Association (ETA), National Institute for Certification in Engineering Technologies (NICET), Elite Continuing Education University (CEU), or Building Industry Consulting Service International (BICSI). The certifications offered by these groups include:

- *Data Cabling Installer (ETA)*
- *Fiber Optics Installer (ETA)*
- *Fiber Optics Technician (ETA)*
- *Certified Alarm Technician (ETA)*
- *Electronic Security Networking Technician (ETA)*
- *Electronic Systems Integrator (ETA)*
- *Fire Alarm Systems (NICET)*
- *Audio Systems (NICET)*
- *Video Security Systems (NICET)*
- *Advanced Electronic Intrusion Technician (CEU)*
- *Alarm Level 1 (CEU)*
- *Burglar/Fire Alarm Systems Agent (CEU)*
- *Video Surveillance and Closed-Circuit Television (CEU)*
- *Registered Communications Distribution Designer (BICSI)*
- *Registered Telecommunications Project Manager (BICSI)*
- *Data Centered Design Consultant (BICSI)*
- *Outside Plant Designer (BICSI)*

In addition to the skills provided by an entity such as the IBEW, the NECA state licensing requirements, and the certifications provided by third parties, many manufacturers also provide their own specific training programs. Some manufacturers also require that only certified technicians install, program or maintain their systems for warranty and liability purposes. This is especially true in fire alarm / mass notification systems. Manufacturer training and certifications are not competitive with the third-party certifications, but more as a complement to the publicly available trainings.

One issue with the many disparate vendor trainings, certifications, and licenses is that it typically follows the employee rather than the contractor. This means contractors must spend time and money (which could be a significant cost to a small contractor) to train employees and then put in place plans and a structure to retain those key employees who have the requirements to perform the work.

ENGINEERING & INFORMATION TECHNOLOGY SKILLS

To develop a successful systems integration business as an electrical contractor, it is necessary to supplement the skills and certifications of the contractor's craft workforce with additional engineering and information technology skills to develop and review solutions and perform other quasi-engineering functions. As the components of the low voltage systems become internally more complex, the low voltage systems themselves are becoming more plug-and-play in nature.

With the plug-and-play nature of equipment, there has also been a shift towards a throw-away mentality. Diagnosing electrical faults within the systems requires high-level engineering skills and technical knowledge that typically only reside at the manufacturer level. These system components have specified inputs and outputs so that, if a problem arises, rather than attempt to diagnose and repair the problem within the component, the component is simply replaced. Because of the increasingly plug and play nature of low voltage systems, the level of knowledge necessary to engineer a system can be simplified to the following tasks:

LINE DIAGRAMS

Contractors should be able to define (or at least be capable of reviewing) all the wiring connections between different systems and components. For example, in building automation systems where various elements are controlled by other systems (HVAC, lighting), connections to those systems should be identified for a clear definition.

ELECTRICAL REQUIREMENTS

Since systems contractors are intimately involved with the selection of the components, it is often necessary for the contractor to define the power requirements needed for all the systems to be installed. The calculated requirement will vary depending on component, manufacturer, and reliability and should be shared with the project electrical engineer to become a part of the specifications.

COOLING REQUIREMENTS

Low voltage components will generate heat which could affect the reliability of the systems unless it is accounted for in the design. Calculating the heat loads and determining the best method to cool them should be part of the engineering effort that systems contractors undertake and coordinate with other trades such as HVAC.

PREWIRE AND DEVICE PLACEMENT DRAWINGS

For ease of service, reliability and installation, systems drawings should always be produced or reviewed prior to the scope of work being performed. Many AEC designers do not fully depict where all components go as those steps are usually determined by the systems provider/designer, usually based on performance requirements as opposed to prescriptive requirements. It is important to include the systems elements on the floor plans or other drawings as early as possible to identify wiring paths, necessary conduits, and coordination with other trades. Doing so will also provide aesthetic benefits and will help generate necessary bills of materials for procurement.

KEY FINDINGS FROM INTERVIEWS

The views of contractors and vendors interviewed for this study suggested that:

- ***Due to the rapid changes in technology, there is a growing demand that key workers have knowledge in both electrical systems and low voltage systems. To meet this end, contractors prefer to take qualified electricians who are amenable to performing this work and train them in systems. This may, however, result in a disparity in wage rates when competing for work with other contractors who exclusively use technicians. Contractors should make the decision to pursue this path in conjunction with understanding the business strategy and organizational structure for competing in the market.***

- ***There is a high demand for people capable of planning, installing, configuring, and troubleshooting low voltage systems, inclusive of IT skills on the projects.***
- ***State licenses and many certifications are not sufficient to meet this demand and contractors are working with manufacturers to provide up-to-date and specialty training necessary to implement low voltage systems, beyond simple installation tasks.***
- ***Many manufacturers provide their own training, which is generally non-accredited, and is focused on the manufacturer's products.***
- ***Without a skilled workforce, contractors will find themselves unable to grow into systems integrators and will find themselves remaining as a traditional electrical contractor.***
- ***The barriers to training are the cost of trainings and time necessary. These factors are generally tied to the employees rather than the companies. That makes retention of employees a strategic necessity.***

In general, to meet market skillset and certification demands, most contractors in the market are either training their existing electricians and employing those with both low voltage and general electrician skills or sub-contracting the low voltage scopes of work. For most contractors who are self-performing the low voltage scope in a functional structure, the most common method is to train their existing electricians. Larger contractors or contractors with a separate low voltage division will tend to employ low voltage technicians, but that is not as feasible in smaller companies.

CONTRACTOR SCOPE OF SERVICES

The traditional approach for services offered by an electrical contractor is to get in and get out. That is - to bid the work, if necessary participate in a design process, procure and install material, and then leave. There may be some residual support for starting up an electrical system, and then contractors move on to the next project. This focus does not necessarily translate as well into a low voltage systems integrator approach where relationship building with clients and participating in the entire life cycle of a project from needs definition through programming, commissioning, and after-market maintenance and service are just as important as installation of a component device. This section helps to guide a contractor through the different service offerings that are a part of the low voltage systems work.

When contractors were questioned about their scopes of low voltage systems, virtually all performed installation work with some exceptions pertaining specifically to fire alarm. Some contractors did not perform any fire alarm installation work and subcontracted it out as there are typically additional regulatory and licensing requirements (that vary by state). Others performed fire alarm installation work under the direction of a licensed party (as allowable by state). Other common scope items performed by contractors include integration of systems (components within a system such as power) and designer (specifying and designing the system or completing the specification provided by a client). A common refrain is that most client engineers lack detailed knowledge of low voltage systems and it falls on the contractor to either complete the design in order to bid the work correctly or risk an incomplete bid. Other duties that are performed but less commonly include programming, testing, and maintenance. Several firms performed scope across all areas.

INSTALLATION

It is relatively easy to offer the installation scope of low voltage systems. The skills required for this work translate easily from that of a typical electrical contractor and include installation and termination of cabling, installation of peripheral devices, racks, and other related equipment. These activities can be done by a typical electrician and/or technician.

ENGINEERING & DESIGN

Contractors who offer low voltage engineering and design capabilities typically have grown into it organically in answer to clients' needs and to protect themselves from incomplete and performance- driven specifications. Today, the typical project delivery method, whether design-bid-build, design-build, or some other variant, will have the usual design milestones (30%, 60%, 90%, Issue for Construction) with most trades involved throughout the process, excepting the low voltage systems. Frequently, the low voltage contractor is not brought into the design phase until it is too late to affect the design in a cost-effective and significant way. **Electrical contractors who enter the client's design phase early and with a focus towards emphasizing the low voltage systems and their integration will have a positive outcome on the cost and success of the project.**

There is now an expectation that information and control capabilities are available from almost any system; even simple mechanical systems are expected to provide the ability to be integrated. However, most traditional AEC engineers do not understand the integration requirements and do not account for device placement, network infrastructure, and bandwidth. In short, traditional AEC engineers are ill-equipped to lead the engineering and system integration process. This provides an opportunity for an electrical contracting firm to embed itself early with clients to develop and implement integration solutions, thereby leading to award of a successful project.

The following are some of the tasks that contractors involved with engineering and integration efforts would perform on a project.

Requirements Analysis: During this phase, the contractor is determining client needs (including reviewing any legacy systems that might be upgraded or integrated into). During this phase the contractor would:

REQUIREMENTS ANALYSIS

During this phase, the contractor is determining client needs (including reviewing any legacy systems that might be upgraded or integrated into). During this phase the contractor would:

- *Review any existing systems and their interface points.*
- *Determine client needs and what constitutes success.*
- *Determine all other interface points (HVAC, security) and methods of interface (network wiring, hard wiring).*
- *Identify areas of risk and potential mitigations.*
- *Develop a scope of work – identify systems, hardware, necessary software components, interfaces and approach, sequence of operations, and potential solutions.*

EARLY DESIGN STAGES

This could be considered the preliminary - 30% - design stage. Once the requirements are finalized, the contractor prepares early design and engineering deliverables (drawings, specifications, submittals) that outline the entire project approach. This should be reviewed with the client to ensure the deliverables meet expectations. This would include:

- *Providing a system architecture that defines the infrastructure, components, and controllers.*
- *Proposing a platform or solution that details how it meets the needs identified in the requirements analysis. This might include more than one solution that allows the client to choose the best fit (depending on contractual obligations from the contractor).*
- *There may or may not be a functional demonstration of some of the components and systems proposed at this stage, such as a remote controller station setup to manage a camera or a light.*

FINAL DESIGN STAGES

This could be considered to be the 100% or Issue for Construction deliverables. The design effort is completed and the documents are buildable documents that an electrician or technician could use in the field.

When reviewing the processes for engineering and design of an integrated low voltage system, the following considerations arose through the interview process:

- *Start with the end goal in mind. Many clients have unclear expectations in contract documents for what the system will do and not do. Achieving consensus early in the design process on how the final integrated system will perform is vital.*
- *Determine the appropriate level of integration and engineering. For many applications, it is sufficient to integrate systems to a lesser level. An example would be control of a light with an access card terminal instead of a more advanced lighting control system with a remote control and other functions. In the integration world, simpler is better.*
- *Choose components, products, and systems that have broad marketplace acceptance. This makes it easier to service, maintain, and find skilled help for implementation.*
- *Define a single integration engineer or lead to manage the process of defining and implementing the integrated system.*

PROGRAMMING AND COMMISSIONING

The intent of the programming and commissioning process is to verify the performance of the intended design. The process confirms that the equipment and low voltage systems operate correctly, other trade's equipment (HVAC) integrate properly, and that power and cooling are distributed appropriately. Too often, electrical contractors leave the commissioning process until shortly before installation is completed, or leave it in the hands of manufacturers or vendors who do not necessarily have the same objectives or contractual obligations that the contractor does.

Ideally, it is best to begin planning for commissioning during the design and engineering phases by involving the people who will perform the commissioning. That enables the design process to identify and mitigate commissioning issues before any component is installed in the field. A commissioning specification should be developed as part of the design process and a draft commissioning plan should be drafted and reviewed with the client at that time. Preparing for commissioning during the design stage lowers the total cost of the project by ensuring the requirements are clear and the systems are simple to operate.

Commissioning focuses on the systems that primarily affect building maintenance and energy consumption. In the Construction Specifications Institute, most of these are covered in divisions 22-26 and include:

- *Indoor building environment*
- *Water heating and usage*
- *Lighting controls*
- *Energy controls*
- *Building management*

These systems are important and yet they are not entirely the whole of what should be considered as part of the commissioning process. In the CSI, these are covered under divisions 27 and 28 (Communications and Electronic Safety and Security respectively). These systems utilize the same or adjacent cabling and/or network infrastructures and should all be included in the commissioning process.

There are five process stages that should be addressed in a commissioning plan:

- ***Stage 1:*** *Submittal review and factory witness testing plans*
- ***Stage 2:*** *Equipment installation and pre-startup checklists*
- ***Stage 3:*** *Equipment startup and installation verification*
- ***Stage 4:*** *Individual systems testing and functional testing*
- ***Stage 5:*** *Integrated testing between systems*

Traditional electrical contractors typically engage in the equipment startup and installation verification, and then move into a support role for the remainder of the commissioning. However, in the role of a systems integrator, contractors need to take a more proactive approach in planning the process, identifying issues, analyzing, and problem solving. During the interview process, the following themes emerged:

- ***Defining roles and responsibilities for commissioning is critical. As an integrator of low voltage systems, contractors need to articulate who owns defining the requirements for commissioning, startup testing, systems and functional testing, and integrated testing between systems.***
- ***Having a written commissioning plan during the design stage is important as it focuses the clients, designers, contractors, and commissioners on what the end performance of the system should look like.***
- ***Building commissioning into the project schedule allows all parties to better understand when vital systems should be turned over and when other project elements need to be shifted to meet an on-time project delivery.***
- ***Expectations for pre-functional, functional, and integrated testing should be agreed upon by all parties before the design is completed.***

SERVICE AND MAINTENANCE

As the systems being designed, furnished, installed, and integrated are becoming increasingly sophisticated, maintenance of the systems is also becoming more critical. Clients need maintenance contracts to avoid risks and liabilities that could arise from a fault in the installed systems. This is a potentially lucrative market for contractors. The dilemma for most contractors is that having technicians on-hand 24/7 can be a costly investment in time, money, material on-hand, and training. Maintenance and service contract duties can include:

- *Verify that the system under operation is operating correctly*
- *Verify that all the latest updates (software) have been correctly loaded*
- *Verify that any peripheral components are operating correctly and perform any routine maintenance (cameras, door sensors, smoke detectors)*
- *Test components as necessary per any warranty or maintenance requirements from vendors and from the operations/maintenance plan for the system*
- *Maintain any software functions such as firewall*
- *Maintain any UPS or backup systems*
- *Verify that all interface points are operational and in good repair*

Each client and/or system will have its own needs that should be defined in any kind of service agreement with the contractor. These contracts, when properly managed, can also help build and preserve a long-term relationship with various clients.

The following themes emerged from the contractor interviews:

- ***Sometimes, maintenance contracts can be so lucrative that companies, such as fire alarm systems integrators, sell the original solution at a loss, with a maintenance contract that more than makes up for that loss.***
- ***Low voltage systems contain many situations in which, if the system does not perform as expected, the client may seek damages from the contractor. This is where having a well thought out commissioning process can help.***
- ***Moving away from proprietary systems towards those sold by distributors and vendors allows contractors greater opportunities to obtain service contracts.***

SCADA AND AUTOMATION SYSTEMS

Supervisory Control and Data Acquisition (SCADA) and Automation systems are directly related to low voltage systems integration. However, there are just enough unique characteristics that this manual has chosen to feature it as a separate service. SCADA and Automation (collectively referred to as SCADA from hereon) is a niche market and is often subcontracted out to SCADA contractors by other electrical or general contractors. The process industry (plants, manufacturing facilities) are the end users of most SCADA systems.

To provide a control system, SCADA systems use computers, peripheral devices such as programmable logic controllers, data communication components, and graphical user interfaces. However, most logic activities or calculations are performed in real-time by remote devices rather than a central computer system. SCADA systems have increasingly adopted IoT technology to improve interoperability between different components. However, there is an abundance of data being provided that must be displayed on a graphical user interface (GUI) and the development of that GUI is unique to every project. The skills to implement a SCADA system are related to those of other low voltage systems - installation, engineering, procurement, programming and commissioning. However there is the additional component of taking the data being provided from the system and developing a GUI model to display that data.

Creating a SCADA system usually requires a software system of which there are many options, both proprietary and non-proprietary. Several non-proprietary systems in wide use are also open-source (freely available). The software system creates a "script" which identifies all the operations/tasks that the system accomplishes and can then depict that graphically.

CONCLUSIONS AND RECOMMENDATIONS

Having the right strategy, organization, and culture to support low voltage systems work is equally as important as having a skillset in a technology. Low voltage systems are constantly evolving and the skills necessary to procure, install, test, and maintain those systems are fungible (mutually interchangeable). What is important is that the organization has a vision and a strategy to compete in the low voltage systems market and embeds that approach within its culture. The culture of a low voltage systems integrator will exhibit the following:

- *Systems Integration culture as a part of the company leadership.*
- *Technically competent engineers and professionals.*
- *Early start on integration activities for projects (requirements gathering, coordination with stakeholders, vendor-partner strategies).*
- *Careful management of systems supplier's scopes.*
- *Early involvement with clients and stakeholders on integration activities.*
- *Effective communication with all parties.*
- *A performance and service-oriented mentality.*

Electrical contractors should pursue systems integration work in conjunction with their traditional self-perform installation work, especially where code-level knowledge and requirements exist. By pursuing this work, the electrical contractor already has a jump start in the systems integration aspect. Most electrical contractors already have a base line for installing some ready-to-integrate systems such as fire alarm systems or security systems. These systems can thus become integrated into other systems such as HVAC or facility management. NFPA 72, the National Fire Alarm and Signaling Code, allows for security systems to be integrated with fire alarm systems, providing additional reasons to clients for why the systems integration should be performed by the installing electrical contractor.

Existing clients can often provide the best opportunities for additional work in systems integration. Many opportunities exist in the market for systems integration. They take a significant effort to identify, to build a relationship with a potential client, and then to obtain the work. Systems integration with a client for whom a traditional electrical contractor already provides services reduces the cost of pursuing that work and increases profitability.

APPENDICES

ELECTRI – LOW VOLTAGE CONTRACTOR BENCHMARK SURVEY RESULTS

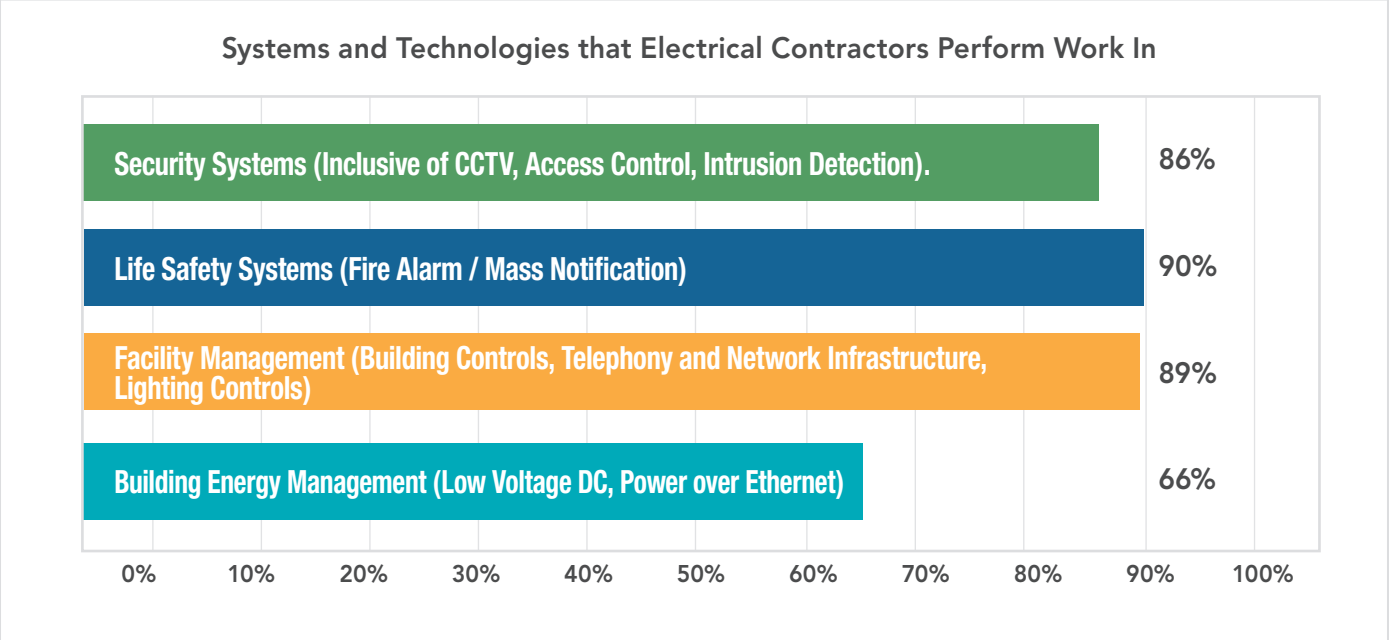
The ELECTRI Low Voltage Contractor Industry Benchmark survey provided information in five different areas of ways contractors are currently performing work in the market and their view of the market.

- *Systems or technologies in which contractors perform work*
- *Markets for which contractors perform work*
- *The organizational structure of contractors who perform low voltage work*
- *The profitability of low voltage work compared to traditional electrical work*
- *The skillsets of those performing the work*

SYSTEMS OR TECHNOLOGIES IN WHICH CONTRACTORS PERFORM WORK

In the first area, almost all contractors surveyed perform work in the low voltage areas of security systems, life safety systems, and facility management. While many also perform work in low voltage energy systems, that number of contractors was not as prevalent as in the other three areas.

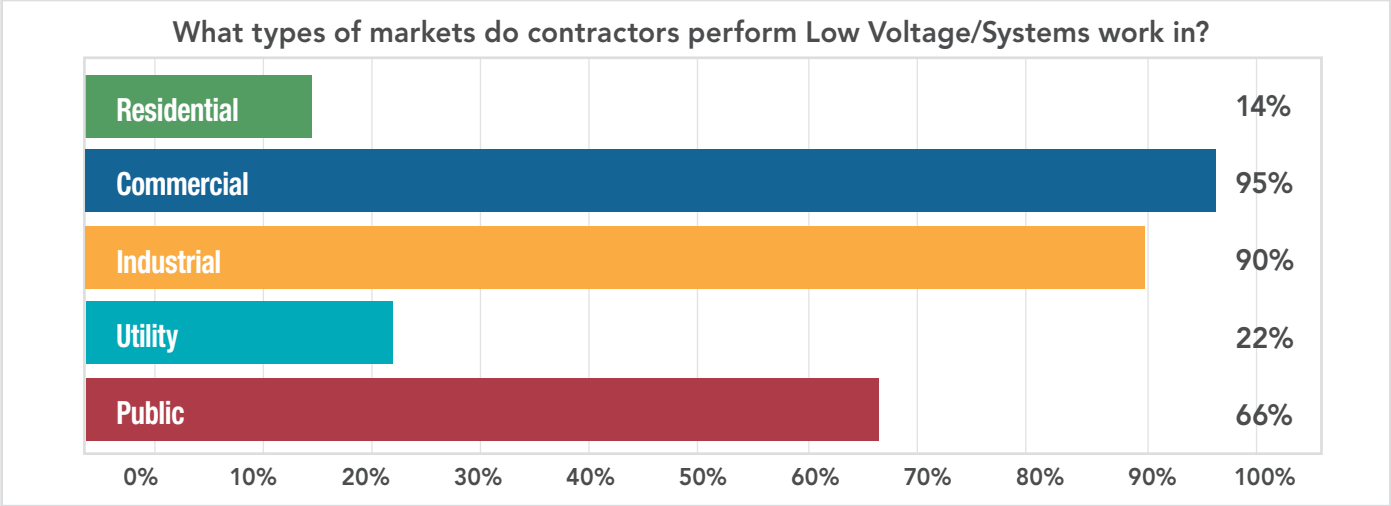
Figure 18: Systems and Technologies in which contractors perform work



MARKETS FOR WHICH CONTRACTORS PERFORM LOW VOLTAGE WORK

Contractors uniformly perform work in the commercial and industrial spaces, while very few perform work in the residential or utility markets.

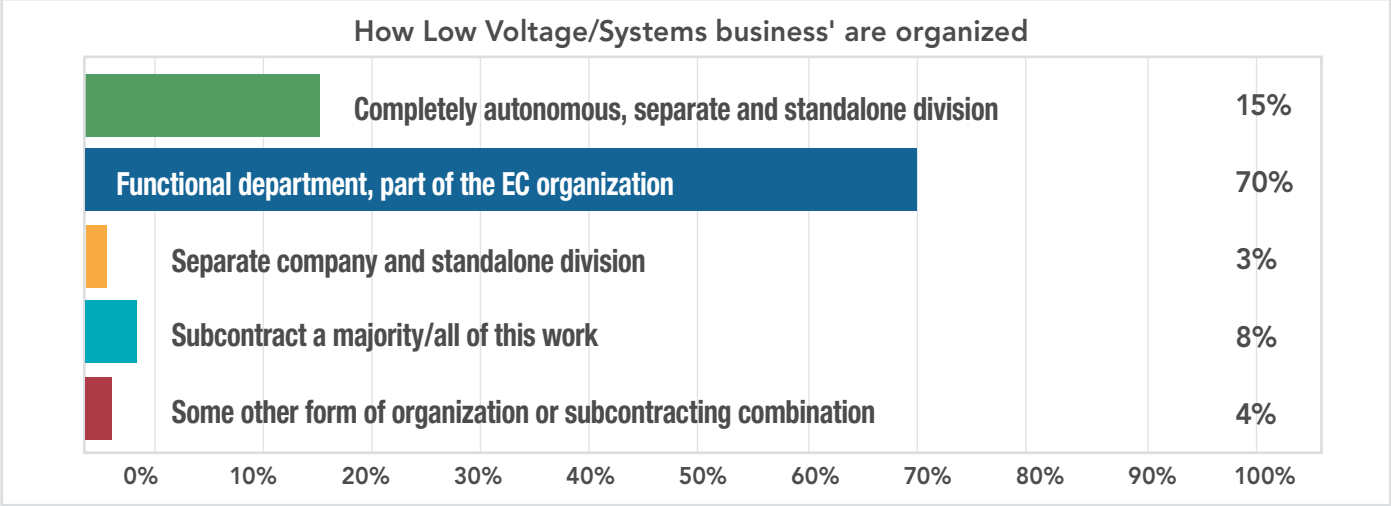
Figure 19: Low Voltage Markets



THE ORGANIZATIONAL STRUCTURE OF CONTRACTORS PERFORMING LOW VOLTAGE WORK

More than 70% of contractors perform low voltage work as a functional department within the larger traditional electrical contractor organization, sharing overhead and resources. Only 15% of the contractors have low voltage work as a stand-alone division. Yet, the interview data suggest those who do have it as a standalone division see it as a significant source of revenue and profit.

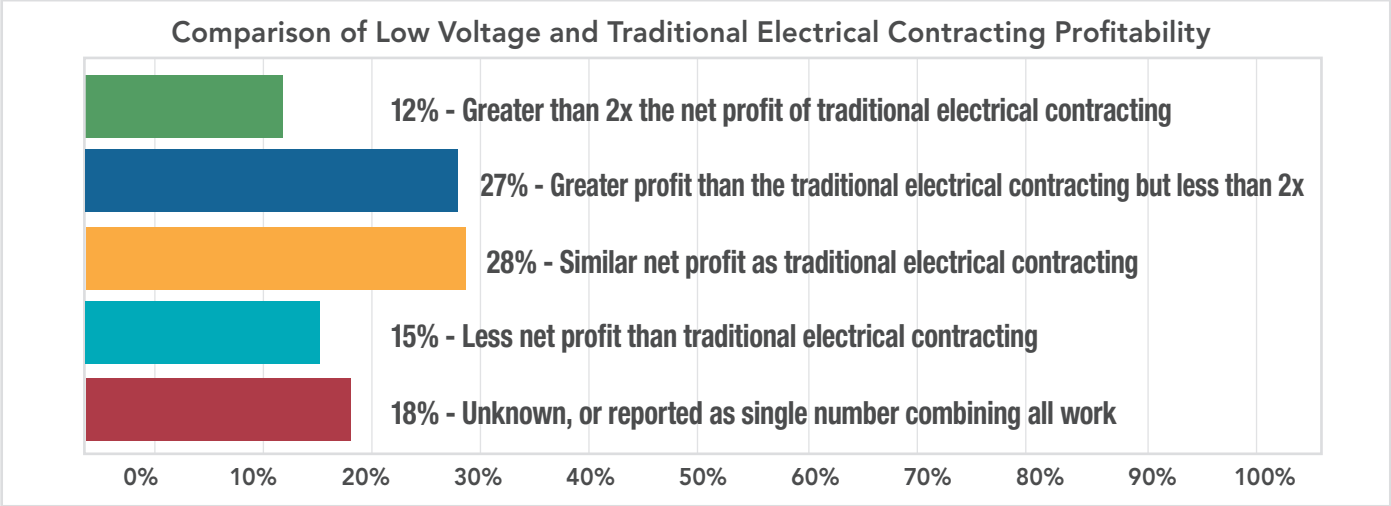
Figure 20: Organizational Structure of Contractors



PROFITABILITY OF LOW VOLTAGE WORK COMPARED TO TRADITIONAL ELECTRICAL WORK

More than one-half of the electrical contractors surveyed see the low voltage contracting business to be of similar or greater profitability compared to traditional electrical contracting. In fact, 40% see the low voltage business as having greater profitability than traditional contracting.

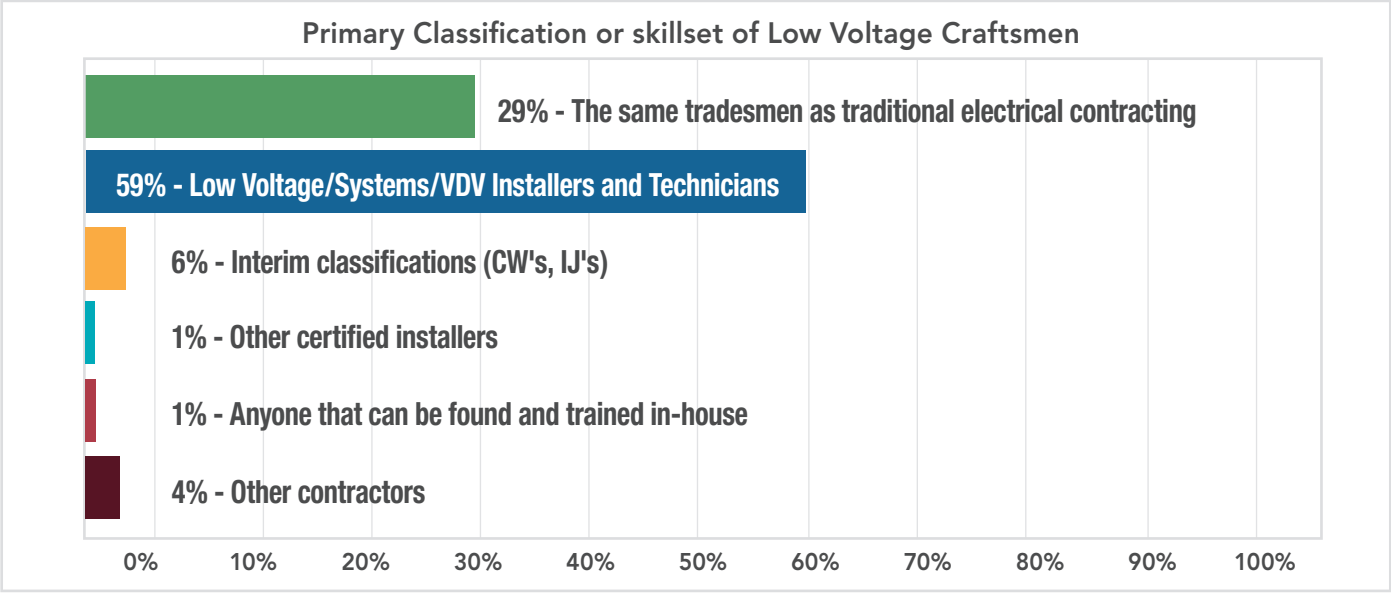
Figure 21: Profitability of Low Voltage Work



CLASSIFICATION OF LOW VOLTAGE INSTALLERS

The survey also revealed that most of the work performed was by low voltage technicians. There was a significant group that also used traditional electricians.

Figure 22: Low Voltage Installer Classification



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LIST OF RESOURCES, ASSOCIATIONS, AND CONFERENCES

The following trade and contractor associations can provide additional resources and information on upcoming conferences and educational opportunities on Systems Integration and Low Voltage Systems.

Control Systems Integrators Association
https://www.controlsys.org/home

National Electrical Installation Standards
http://www.neca-neis.org/state/state-low-voltage-licensing

National Systems Contractor Association
https://www.nsca.org/about-nsca/

National Low Voltage Contractors Association
http://www.nlvca.org/

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