CHICAGO COMMERCIAL ELECTRIC VEHICLE READINESS GUIDELINES

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PREPARED FOR THE CITY OF CHICAGO BY CALSTART

CALSTART

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WHY GO ELECTRIC

This guide is intended for commercial developers planning to incorporate electric vehicle infrastructure readiness into a project. The future of transportation is ever evolving and today we are at a historical moment. New technologies such as battery electric vehicles are reshaping the transportation landscape. Around the world, governments have created mandates and incentives to promote zero-emission vehicles. Switching to electric vehicles (EVs) has demonstrable social and health benefits, including less harmful air pollutants and noise pollution associated with traditional internal combustion engine (ICE) vehicles. EVs can also help save money; despite their higher up-front costs, they have much lower maintenance and operating costs than ICE vehicles.

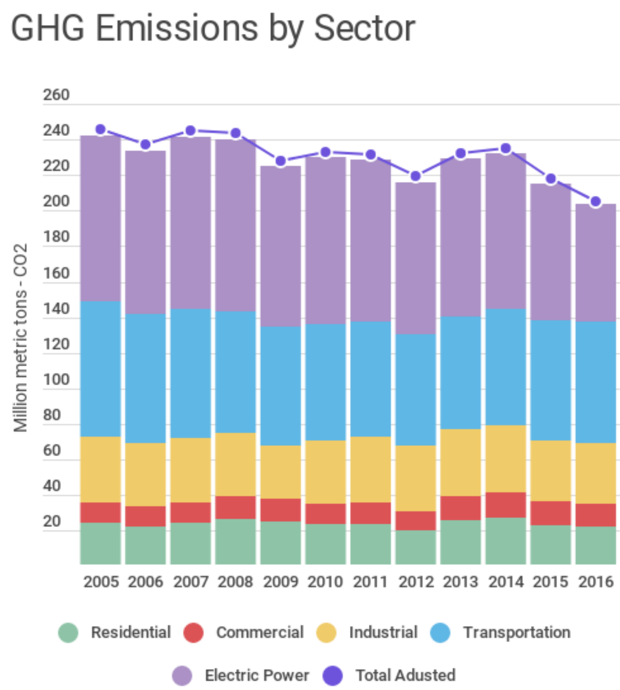


Figure 1. Emissions by Sector[1]

There is significant opportunity for electrification in the commercial medium- and heavy-duty (MD/HD) transportation sector, especially among local delivery vehicles. Overall, transportation accounts for about 29% of greenhouse gas emissions in the US. Illinois state data on greenhouse gas emissions follows a similar trend (Figure 1).[1] Total emissions from the transportation sector has increased by more than 66% in the Chicago metropolitan area since 1990.[2] Transportation has varied as the most significant and second-most significant contributor to greenhouse gas emissions since 1980 and has been on an upward trajectory since 2014. Public health risks associated with vehicle emissions include direct health impacts such as increased risk of respiratory and cardiovascular disease, as well as indirect health impacts from climate change.[3]

As Chicago continues to push for a clean transportation sector and improved emissions, developing properties with EV readiness in mind will be increasingly important. This document explains considerations for fleet electrification to developers and fleet operators and includes an easy to use reference checklist for developers and planners to use as they plan for an electrified future.[4]

1. Emissions data from the [Energy Information Administration.]
2. https://www.nytimes.com/interactive/2019/10/10/climate/driving-emissions-map.html.
3. EPA—Carbon Pollution from Transportation.
4. Environmental Law and Policy Center—Breathing Free in Illinois.

A BRIEF HISTORY OF INDUSTRIAL CHICAGO

Since its incorporation in 1837, Chicago has been a well-recognized industry and trade leader. Strategically situated between America's industrialized northeast and the frontier communities of the west, Chicago grew at an unprecedented rate as it became first an agricultural hub, and later a transportation and logistics hub. Disparate economic activities coalesced around the new city, creating a burgeoning economy based on resource extraction and transportation.[5] Rapid recovery after the Great Chicago Fire of 1871 made America's "Gateway to the West" the second largest city in the world by 1900.[6] Known for electric machinery, iron and steel production, and machine-shop and foundry production, Chicago suffered economically during the Great Depression but was well-situated to compete on the global scale as the world emerged from World War II.[7]

Chicago first adopted plans and policies to concentrate industrial activity into industrial corridors in the 1940s. A time of rapid expansion followed, and new investments in education and health care spurred a burgeoning white-collar economy in the city and surrounding region. Chicago boomed during the 1950s until technological innovation led to massive working-class job losses in the 1960s and the flight of the middle-class to Chicago's suburbs.[6]

Chicago struggled during the Great Recession, and despite being the second largest contributor to US manufacturing in 2018, the city's industrial growth has remained relatively flat in comparison with other metro areas during the recovery.[8, 9] The Chicago Metropolitan Agency for Planning's (CMAP) On to 2050 Plan provides a vision for the future of Chicago's metro region based on the principles of inclusive growth, resilience, and prioritized investment. It identifies strategic investment in the city's freight network to reduce delays caused by commuter-freight conflicts and allows people and goods to move seamlessly through the region.[10]

Encouraging more widespread adoption of electric MD/HD commercial vehicles can achieve multiple city priorities. Clean transportation helps promote heathy communities by reducing harmful air pollutants and reducing noise pollution. Electrification can also help strengthen the electric grid if off-peak charging can support greater grid utilization and as vehicle-to-grid communication protocols advance and leverage renewable energy sources.

5. Chicago Historical Society. Encyclopedia of Chicago—Business of Chicago.
6. Cronon, William, Nature's Metropolis: Chicago and the Great West. Norton Press, New York, 1991.
7. Chicago Historical Society. Encyclopedia of Chicago. —Demography.
8. Forbes. Where US Manufacturing is Thriving in 2018.
9. CMAP. On to 2050. Principles.
10. CMAP. On to 2050. Mobility—freight.

CHICAGO'S INDUSTRIES TODAY

Chicago's diverse economy serves as an innovation and manufacturing hub for a wide range of products. In 2016, World Business Chicago identified nine key industries that will help drive Chicago's economic future, industries that accounted for just over 50% of Chicago's gross regional product (GRP) in 2016 (Figure 2). These include manufacturing and freight services that have been important historical cornerstones of Chicago's economy, in addition to newer sectors such as biotech and medical technology where Chicago would like to position itself as an industry leader. The table below gives an overview of these industries in 2016.[11]

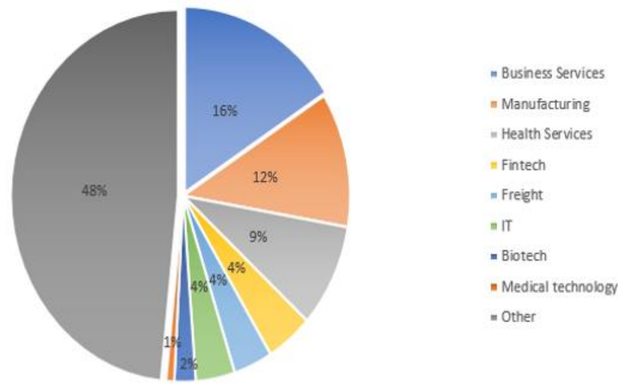


Figure 2. Contribution to Chicago's GRP by Sector, 2016

Industry	Gross Regional Product (Billions of USD, 2016 nominal)	% of 2016 GRP	# of employees in 2016	# of companies in 2016
Business Services	$97.2	16%	855,011	62,023
Manufacturing	$71.5	11.7%	414,100	13,500
Health Services	$55.9	9.2%	614,608	26,542
Fintech	$27.5	4.5%	122,129	7,629
Freight	$22.9	3.8%	190,049	12,213
IT	$23.1	3.8%	130,436	13,854
Biotech	$12.5	2.1%	36,172	580
Medical Technology	$4.8	0.8%	26,634	890
Energy	Energy is considered an intermediate good and thus not calculated in GRP.		53,470	3,653

Table 1. 2016 Overview of Chicago's 9 Key Industries[11]

11. World Business Chicago. Key Industries.

MANUFACTURING SECTOR

Manufacturing has always played a vital role in Chicago's economy. In 2016, the largest subsectors for manufacturing based on employment were fabricated metals, foods, chemicals, machinery, and plastics and rubber manufacturing.

Food manufacturing is especially vital to Chicago; over 200 food manufacturing companies, including well-known brand names who have global, national, or regional headquarters in Chicago. Additionally, food manufacturing is one of the few sectors where Chicago's growth outpaces the US national average, indicating a strong competitive advantage in that sector.[12]

Chicago has been concentrating industrial and manufacturing activity in industrial corridors since the 475-acre Stockyards opened in 1865. Today, approximately two thirds of all land zoned for manufacturing is contained within 26 designated Industrial Corridors. Chicago is in the middle of a process to update the land use plans for these corridors.[13]

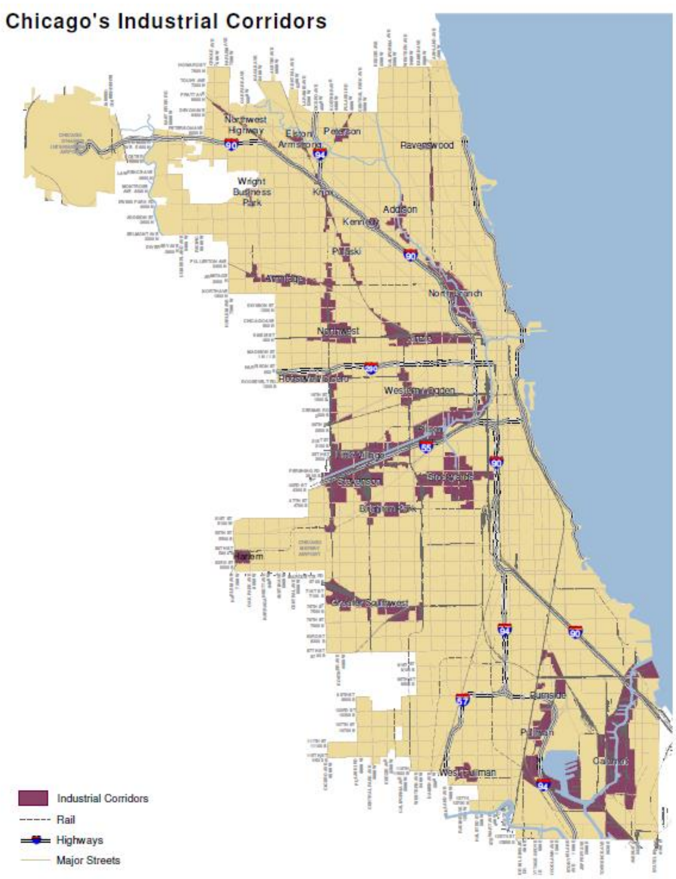


Figure 3. Chicago's Industrial Corridors

12. World Business Chicago. [Key Industries.]
13. [City of Chicago.]

TRUCK FREIGHT

Chicago is one of the most important centers of the US freight industry, with over $564 billion in goods passing through the region by truck, rail, air, and water freight. Of these transportation modes, truck transportation dominates the sector. Freight shipped by truck accounted for 76% of total freight tonnage and 71% of total freight value in Chicago in 2016. Additionally, 28.4% of workers employed in the freight sector worked for trucking companies. One in seven vehicles on Chicago's urban interstate highway system are trucks.[14]

Regional and local delivery vehicles have a high potential for electrification thanks to their daily duty cycle, and half the trips making stops within the Chicago Metropolitan Area are local or regional deliveries. A 2016 analysis of truck trips within the region showed that 33% were intra-county, 17% traveled between two regional counties, and 37% traveled outside of the 7-county CMAP region. An additional 13% of truck trips only passed through Chicago and did not originate or finish in the region. The 50% truck trips that are local or regional are likely good candidates for vehicle electrification.[15]

Chicago's congestion is only likely to get worse under a business as usual scenario. A study by the Bureau of Transportation Statistics determined that long-haul freight traffic could nearly double by 2045, with Chicago experiencing significant increases in traffic.[16] Although long-haul battery electric vehicles are still in the early stages of commercialization, several manufacturers have announced plans to manufacture these vehicles, and all-electric freight will become more prevalent in the near future.

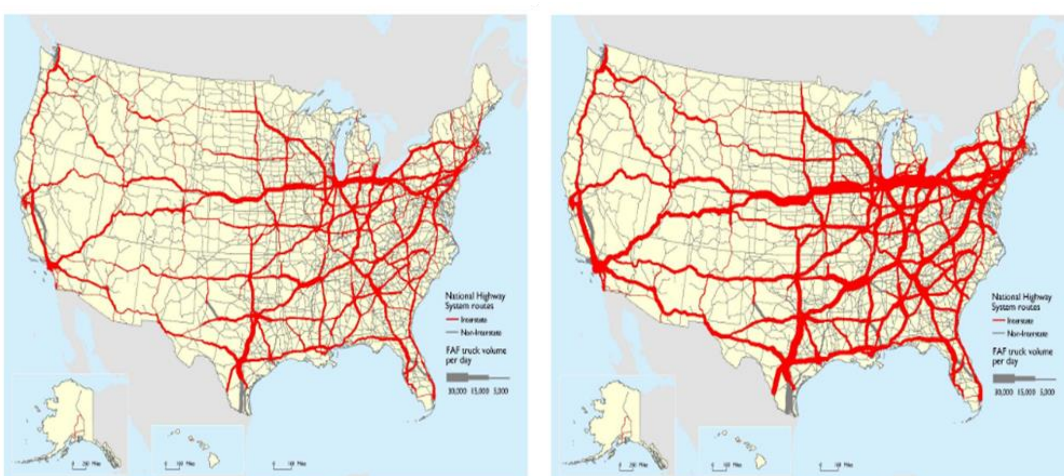


Figure 4. Volume of long-haul freight truck traffic on the National Highway System in 2012 (left) and projected in 2045 (right), expressed as the daily number of trucks on a route. Source: Bureau of Transportation Statistics.

14. World Business Chicago– Freight Overview
15. Chicago Metropolitan Agency for Planning. Freight Snapshot.
16. Bureau of Transportation Statistics. Freight Facts and Figures 2017.

INTERMODAL FREIGHT

While this document focuses primarily on on-road commercial vehicles, intermodal freight activity is becoming increasingly important for the movement of goods. Between 2000 and 2013, intermodal activity increased 35% in the US, with over half of all shipments within the US either originating from or terminating in Chicago.[17]

Air Cargo

Chicago boasts the only "dual hub" airport system in North America, with both O'Hare International and Midway International located within city limits, though the vast majority (99%) of air cargo passes through O'Hare.[18] Though the volume of cargo that travels by air into or out of Chicago is small by comparison to the volume of cargo trucked through the city, the value of goods transported by air tends to be much higher than goods transported by other means, with Illinois handling about $185 billion worth of air cargo annually.[19]

Rail Cargo

Six of the seven Class I railroads operating in the US have major terminals in the Chicago area. Nearly half of the nation's intermodal rail traffic passes through Chicago.[18] By 2040, Chicago's railroads are estimated to carry a total of 256,740 tons of cargo, effectively doubling the weight and tripling the value of rail freight that passed through the city in 2011.[20] Rail accounts for more than a quarter of all of Illinois' freight tonnage, with coal, basic chemicals, and cereal grains comprising the majority of that weight.[19]

Waterborne Freight

Chicago's economy was originally built on the city's proximity to strategic waterways. These waterways were strategically developed throughout the city's history to facilitate trade and transportation. The Chicago Area Waterway System (CAWS) is the only link between the Mississippi River and the Great Lakes systems. Although waterborne freight represents only 5% of total freight tonnage in the Chicago region, it is a cheap and attractive method of transportation for goods and commodities that are heavy weight and least time sensitive. Most common waterborne commodities in 2012 included coal, gravel, nonmetallic minerals, basic chemicals, and cereal grains.[21]

17. Chicago Metropolitan Agency for Planning. Intermodals.
18.World Business Chicago. Freight Profile.
19. Illinois Department of Transportation. Illinois State Freight Plan.
20. City of Chicago. Chicago Sustainable Industries: A Business Plan for Manufacturing.
21. Chicago Metropolitan Agency for Planning. Waterborne Freight.

WAREHOUSING AND STORAGE

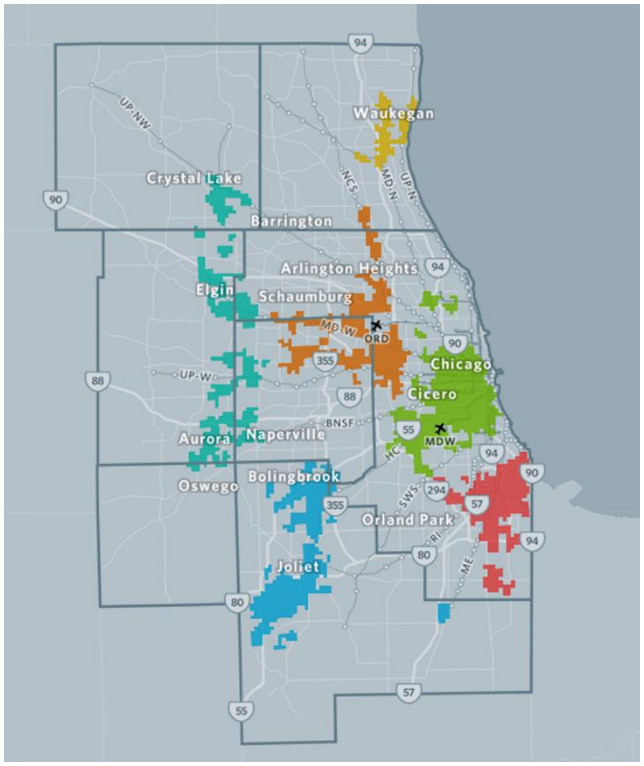


Figure 5. Chicago regional freight clusters, demonstrating areas of interconnected freight activity often centered around intermodal hubs.[26]

Warehousing and Storage in Chicago

As one of the centers of freight activity in the US, Chicago boasts one of the largest concentrations of storage and distribution space in the US. As of 2016, Chicago had over 600 million square feet of warehouse and distribution space, a quarter of which was located within three miles of an intermodal facility.[22] Much of Chicago's existing warehousing is located near the center of the region in established neighborhoods. However, these warehouses may be too small to meet the needs of modern warehouse operators; the size of newly constructed warehouses increased 30% between 2000 and 2015 as e-commerce reshapes supply chains.[23]

Accessibility to transportation networks is becoming an increasingly important factor to warehouse competitiveness. In recent years, industry has seen a trend of warehousing decoupling from the manufacturing industry; whereas once most companies vertically integrated their warehousing into their operations, today warehousing and distribution is becoming an industry of its own. In the future, warehouse operators will need to consider how to attract customers to their property, and as more manufacturers focus on their environmental impacts, electrification is one way to stand out from other warehouses and attract tenants and customers.[24]

Off-Road Electrification

Off-road equipment such as ground support equipment (GSE) for airports and cargo-handling equipment for ports, terminals and railyards are also moving towards electrification. Due to the very nature of the use cases for these types of vehicles they are well suited for electrification improving air quality in some of the highest polluted areas. Today, there is a growing number of electrified off-road offerings available to the market that can help airports, freight carriers and warehouse operators realize operational savings through reduced fuel and service costs on off-road equipment while again improving work site air quality. Electrification of off-road equipment can also help drive electrification in other transportation sectors. As the map of existing freight clusters

22. World Business Chicago. Freight Profile.
23. Chicago Metropolitan Agency for Planning. Freight Snapshot.
24. John Bowen. Moving Places, the Geography of Warehousing in the US.

demonstrates, freight already centers around zones of intermodal activity such as rail hubs and airports.[25]

Some of the equipment utilized in these off-road sectors are already commercially mature including smaller forklifts and ground service equipment. However new developments in energy storage and controls is allowing for larger pieces of equipment to be electrified. Also, lithium-ion battery chemistries are now utilized in the material handling equipment sector (especially forklifts). Previously this sector used larger lead-acid batteries that only allowed for one shift of operations per day. New lithium-ion batteries charge must faster and do not require 8 hours of cooling before re-use.

In the ground support equipment sector, there is a move to retrofitting older equipment with electric drivetrains. For example, large aircraft cargo loaders can be cost-effectively retrofitted and significantly lengthen the equipment lifespan. This also applies to larger aircraft pushback tugs.

Finally, the rail sector is also utilizing new electric technologies, especially for yard operations. All-electric tenders and movers are becoming increasingly available and costs are falling rapidly.

25. Chicago Metropolitan Agency for Planning. Freight.

EV READINESS GUIDELINES

Transportation electrification is an important way to reduce harmful emissions that affect human and environmental health. Around the world, local, regional, and even national governments are taking actions to promote electric vehicles (EVs) as an environmentally and economically attractive alternative to internal combustion engines.

The capital costs for EVs are falling thanks to advances in battery technology, and combined with government incentives, where available, the business case for electric vehicles is stronger today than ever before. Companies are starting to take notice; electric commercial medium-duty truck orders in the US skyrocketed in 2018 and 2019 when several national logistics companies ordered electric delivery trucks and vans.[26, 27] As technologies improve and manufacturers release new models, it is likely that deployment of electric vehicles will increase, particularly in short-range, fixed-route applications such as local and regional distribution, work trucks, and transportation services.

All these electric vehicles will need a place to charge. It is significantly cheaper to install the infrastructure for electrification in a new construction than it is to retrofit existing structures.[28] The following pages outline how to make new construction "EV Ready," that is, provide the necessary infrastructure to make possible the future installation of EV charging stations to avoid costly retrofits in the future.

The cost for retrofitting can be in the upwards of 4 times the cost. For a parking lot with 10 parking spaces and Level 2 charging stations, the estimated EV infrastructure costs amount to $920 per charging station during new construction, versus $3,710 per charging station for a retrofit, largely because of trenching, demolition, and additional permitting costs.[29] Whether a fleet plans to electrify today or 10 years in the future, EV ready construction will allow them to do so more cheaply and quickly than they otherwise could. This guide is intended for commercial developers planning to incorporate electric vehicle infrastructure readiness into a project.

EV Readiness Guideline: At least one, or 20% of loading docks and depot spaces (whichever is greater) should be prepared for the installation of charging stations. Wiring does not need to be installed at the site, but inaccessible raceways must be installed to all proposed changing stations locations.

26. FedEx.
27. LA Times.
28. http://www.swenergy.org/cracking-the-code-on-ev-ready-building-codes
29. Plug-in Electric Vehicle Infrastructure Cost Effectiveness Report for San Francisco.

STEP 1: UNDERSTAND THE FLEET

Each property and fleet are different. If you already have a customer for your property, work with them to determine their current and planned electrification needs. If you do not already have a customer lined up, you can incorporate EV readiness into initial design planning by considering the following:

Understand the site's fleet:

- ☐ **Number and class of vehicles**
- ☐ **Daily miles traveled by each vehicle**
- ☐ **Duty cycle for each vehicle**

Which MD/HD vehicles are a good fit for electrification? Not all vehicles are well-suited for electrification with the technology available today. MD/HD vehicles best adapted to electrification travel less than 150 miles per day in urban areas and make frequent stops. These vehicles also return to their home facility or a depot at the end of their shift to charge.

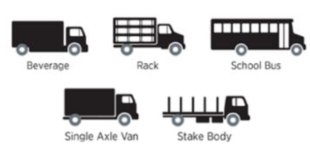
Category	Class	Gross Vehicle Weight Rated (GVWR)	Examples	Battery size (kWh)[30]	Estimated Range (miles)[31]
Medium-duty (MD)	4	14,001-16,000		82.8-127	80-110
	5	16,001-19,500		100-145	150-155
	6	19,501—26,000		90-325	50-230
Heavy-duty (HD)	7	26,001—33,000		140-325	100-230
	8	33,001+		132-550	56-250

Table 2. Battery Size and Range of Medium- and Heavy-duty Vehicles by Class

30. Based on OEM specifications for models available in August 2019. Most models are available with multiple battery sizes.

31. Based on OEM specifications for models available in August 2019. Actual mileage can vary depending on operating conditions and driver behavior.

STEP 2: DETERMINE YOUR CHARGING REGIMEN

Space requirements, refueling time, and the duty cycle of vehicles all impact what type of charging stations are best suited for a fleet. Charging stations are classified according to the amount of power they can provide at any given time. Higher level charging stations refuel vehicles at a faster rate getting refueling rates closer to diesel and gasoline timeframes but are more costly to install and operate.

Understanding peak demand: Also known as peak load, peak demand refers to a time when energy draw is highest from the grid. Typically, this occurs during the daytime hours and is higher in the summer. Because utilities must plan their infrastructure and power generation for peak demand, adding additional capacity during these times is more expensive. ComEd, like many utilities, charges higher rates for power distribution during times of peak demand. As you determine what type of charging is most appropriate for your site, you will need to balance duty cycles with the potential higher costs of faster charging and peak time charging.

The chart on the following page discusses different charging options and the best use cases for each.[32] It is important to note that the rate at which a battery charges reduces significantly once a battery reaches an 80% charge, therefore an 80% fill is used as the benchmark for refueling time. EVs have the ability to charge to 100% however the charging rates are significantly reduced after a battery reaches an 80% charge level and its best to not leave a battery at full charge for an extended period of time, as this can possibly affect its life cycle.

Charging time can also be affected by the vehicle itself. Most have a limit for how much power they can draw at once. For example, a first-generation Nissan Leaf can only charge at a rate of 3.3 kW, even if it is plugged into a level 2 charging station capable of delivering 19 kW. Even though the fastest Direct Current (DC) fast charging stations can charge at power levels up to 450 kW, the number of vehicles capable of charging at these power levels is still limited but expected to increase quickly as battery technology advances.[33] Already, Tesla has announced their semi-truck fast charging stations could be capable of delivering over 1 MW.[32] This will be an industry first.

32. International Energy Agency. Global EV Outlook 2019.

33. International Council on Clean Transportation. Lessons Learned on Early Electric Vehicle Fast Charging Deployments.

CHARGING STATION OVERVIEW

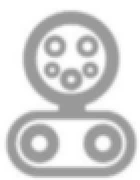
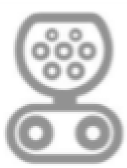
Charging Station Level (Electric Current Type)	U.S. Connector Type	Power	Fill Time for a 100kWh Battery (80% Fill)	Voltage	Best Commercial Use Case Example
Level 2 (Alternative Current (AC) 1-phase)	 **SAE J1772**	> 3.7 kW ≤ 22kW	7 kW = 12.5 hours 22kW = 4 hours	208/240V	Medium- and heavy-duty vehicles that sit parked for 5+ hours at a time
Level 3 (Direct Current (DC) Fast Charging)	 **CHAdeMO**	> 22 kW ≤ 43.5 kW	2+ hours	277/480V	Medium- and heavy-duty vehicles with shorter routes/smaller battery packs that have a natural pause in their duty cycle of around 2 hour or more; medium- and heavy-duty vehicles with a longer route / larger battery packs that can charge over several hours
Level 3 Combo (AC, DC Fast Charging) Note: Combined Charging System (CCS1) Combo 1 Connector is currently used in North America, but the CCS2 combo 2 may be used in North American MD/HD applications.	 **J1772 CCS1**  **J3068 CCS2**	Today, <450 kW, projected up to 1 MW	15+ minutes (future) 40+ minutes (today)	Industrial voltage levels (speak with your utility)	Medium- and heavy-duty vehicles that have a natural pause in their duty cycles (e.g. while waiting at a loading dock) that is less than 2 hours
Inductive Charging (DC)		Inductive charging equipment uses an electromagnetic field to transfer electricity to a plug-in electric vehicle without a cord. In HD applications, inductive charging is often used for in-route charging on bus routes with 150-300 kW charging capability.			

Table 3. Charging Station Overview

STEP 3: INCORPORATE EV PLANNING INTO INITIAL DESIGN

As you develop a site plan for initial approval, incorporate the following considerations into your plan:

Property layout:

- ☐ **Number of electric truck parking places**
- ☐ **Number of electrified docks**
- ☐ **Proposed location of electric service or utility meter(s)**
- ☐ **Plans for on-site electricity generation or battery storage (if any)**

Building characteristics:

- ☐ **Building power needs**

Additional power needs:

- ☐ **Workplace and public charging stations for light-duty vehicles**
- ☐ **Outside lighting**

Preliminary electrical plan:

- ☐ **Proposed locations for meter(s), raceways, switches**

PLEASE NOTE: You may need to return to this step after engaging with your local utility (step 4).

It is important to think about future needs. EVs will become more common in the MD and HD market over the next decade as battery costs are projected to fall from $350/kWh in 2020 to $200/kWh by 2030.[34] The International Energy Agency (IEA) estimates that between one and three percent (1-3%) of global MD/HD truck sales will be electric by 2030, with greater proliferation in the medium duty sector.[35] Technologies will likely accelerate adoption after that point. The National Renewable Energy Laboratory (NREL) estimates that by 2050, up to 61% of MD trucks and 41% of HD trucks could be electric.[36]

34. California Energy Commission. Forecast of Medium– and Heavy-Duty Vehicle Attributes to 2030.
35. International Energy Agency. Global EV Outlook 2019.
36. National Renewable Energy Laboratory. Electrification Futures Study.

STEP 4: ENGAGE WITH YOUR ELECTRIC UTILITY

Involve your electric utility as soon as possible. The utility needs to know the number of electric vehicle (EV) charging stations that will be installed to plan for any increased electricity demand. Other items to address with your utility include the power available at your site, the nearest electrical substation location, and if upgrades will be needed to nearby transformer or substation. These factors can all affect the cost of electrification.

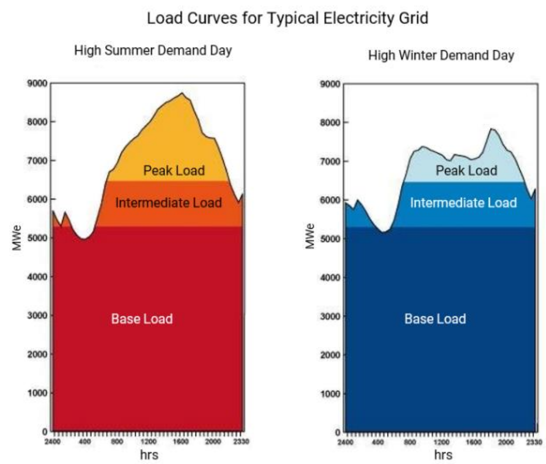
When you contact your utility:

- ☐ **Inform them of your plans (see step 3)**
- ☐ **Determine the amount of power available to the site**
- ☐ **Determine the distance from the charging location to the service or substation**
- ☐ **Indicate the planned charging cycle/charging times (if known)**
- ☐ **Discuss potential load management options (see step 5)**
- ☐ **Evaluate load sharing options**
- ☐ **Inquire about any available special EV or commercial utility rates**

Illinois divides the energy sector into two divisions: electricity distribution and electricity supply. ComEd provides electricity distribution (infrastructure) in the Chicago region, so you will need to work with them to ensure the infrastructure to your site is adequate to support the anticipated power needs. The fleet operator can purchase electricity through ComEd or through the region's other electricity suppliers or a different supply mix (e.g. renewable energy). Even if you choose to purchase electricity from another company, you will need to contact ComEd to discuss infrastructure plans. ComEd's online new business portal provides a central resource for new construction.[37]

37. ComEd

STEP 5: PLAN FOR IMPROVED EFFICIENCIES



The marginal cost of adding more capacity is expensive for utilities as it requires them to make capital investments that may not be fully utilized. To more assuredly recover the costs of serving high-demand customers (e.g. commercial and industrial accounts), utilities often assess accounts using demand charges, which are fees based on the highest amount sustained energy use for a set period of time. Energy efficiency and load management can reduce the operating cost to fleets by allowing property owners to use electricity more efficiently and at off-peak times, thereby reducing the peaks that set their demand charge assessments. These are optional additions to your site plan but can impact the peak loads experienced at each property.[39]

On-site storage:

As the cost of batteries decreases, on-site storage is an increasingly affordable option for reducing the costs of electricity. On-site storage allows a property to draw electricity from the grid during off-peak times and store it on-site for later use. On-site storage is a potential use for older EV batteries that no longer maintain enough of a charge to use in vehicles but are still usable for other purposes. You may consider identifying onsite storage options in your plans, especially suitable sites on the property to install on-site storage.

On-site generation:

On-site electricity generation can also help offset electricity costs during peak demand times. Solar grids are an excellent candidate for on-site electrical generation due to their relatively cheap costs and the fact that much of their energy production coincides with daytime peak demand, potentially offsetting electricity use during the most expensive time of day. If you plan to incorporate on-site generation into your design, you will need to submit an Interconnection Application with ComEd.[38]

38. ComEd.

39. Image source: Performance Analysis and Economic Effects of Maintenance and Hot Gas Path Inspection of a Combined Cycle Power Plant

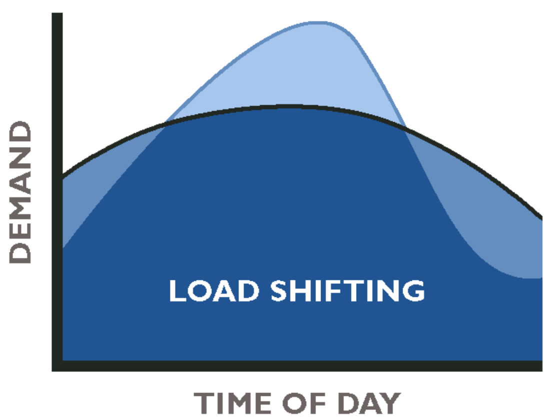
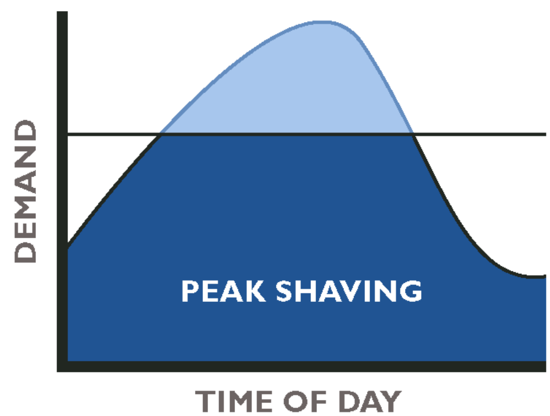
SMART CHARGING

Smart charging is an umbrella term that refers to software that enables communication between charging hardware and the electric grid to manage the flow of power to charging vehicles in the most efficient and flexible manner possible to optimize grid conditions, vehicle state of charge, and customer bill impacts.

Smart charging is most effective when charging at a depot where vehicles are sheltered and maintained when out of service. or in other situations where there is flexibility in time-of-use. Because of their reliance on internet-enabled software, charging stations with smart charging software require broadband or Wi-Fi connectivity to function.

In some cases, smart charging acts as a timer, allowing the user to set it to charge at a lower-cost time of day. Others are more advanced, actively directing the flow of power according to the needs of the vehicle(s) it's connected to and the parameters for charging set by the operator.

Choosing charging stations with smart charging can save money in two ways:

Load Shifting[40]	**Load (or Peak) Shaving**[40]
	
Shifts the time of charging to low-use / off-peak hours that usually have cheaper electric rates and/or will incur lower demand charges.	Reduces peak demand by reducing the power flow to recharge batteries and prioritizing charging more depleted batteries.

40. Image source: USAID.

STEP 6: ESTIMATE YOUR EXPECTED LOAD REQUIREMENTS

The energy loads required at your property may require upgraded transformers or substations, or possibly even a new substation, depending on local demand. Consultation with ComEd can help clarify if distribution infrastructure upgrades will be necessary. Each location differs, but generally significant upgrades are not needed until the peak load for a site exceeds 5 MW.[41]

Once you have an idea of what size, type, and number of vehicles will be operated on the property, and how they will be charged, determine the amount of energy required to power your site.

Your final calculation should include:

- ☐ **Maximum electricity used by 'X' number of charging stations**
- ☐ **Other site power draws**
- ☐ **Onsite storage or generation options**
- ☐ **Expected efficiencies from smart charging**

STEP 7: PERMITTING

The permit process can become more complex with increased power demands. Special permits may be needed for the utility to bring power to the site. All new construction requires an electrical permit application. There are no additional permitting requirements for the installation of EV charging stations themselves. Chicago has two special permitting programs for which your project might be eligible

Developer Services Permit Program

This program was developed to assist complex projects through the permitting process. To qualify for this program commercial projects must include:

-Buildings greater than 80 feet tall; or

-Business and Mercantile projects greater than 150,000 square feet; or

-Projects that require two levels of basement or deeper, and in addition utilize Earth Retention Systems (ERS).

https://www.chicago.gov/city/en/depts/bldgs/provdrs/permits/svcs/dev-services.html

Green and Solar Permit Incentives

This program provides expedited and priority review for permit applications utilizing green technologies.

To qualify for this programs, commercial projects must earn certification within the LEED or Green Globes rating systems or implement green technologies as described on the program website.

https://www.chicago.gov/city/en/depts/bldgs/provdrs/permits/svcs/green-permits.html

41. Black & Veatch. Electric Fleets.

ADDITIONAL CONSIDERATIONS

Signage

Signage should follow and include all signs and warnings required by the Chicago Electric Code. In addition, not all drivers are currently aware of EV charging and the necessity of keeping charging spots available for those vehicles that need them. It is therefore recommended that informational signage and signage designating the charging spots as "EV Only" are posted in order to ensure that the charging infrastructure is available to be used to full capacity. As has been seen with light-duty charging infrastructure, medium and heavy-duty charging spots are also susceptible to "ICE-ing," where a non-electric internal combustion engine (ICE) vehicle parks in a way that prevents the charging equipment from being used by EVs. Therefore, the "EV Only" signage is recommended, as well as having a policy in place for when ICE vehicles are in violation of the signs.

Lighting and Shelter

For commercial and fleet charging stations, adequate lighting is recommended for convenience. Shelter is not required for outdoor-rated charging stations but can provide added convenience for EV users. Locations within parking garages or private garages that are well protected from the environment may utilize charging stations that are not specifically outdoor rated. Adequate lighting should be provided so that users can easily read associated signs, instructions, or controls on the EVSE, and provide enough visibility to allow drivers to see to plug in their vehicles.

Safety Issues Related to Indoor Charging

Indoor charging may trigger ventilation requirements outlined in the 2018 Chicago Electric Code. Some batteries, particularly lead acid or zinc air batteries, emit hydrogen gas when charged. These cases are going to be very rare and found mainly in use with off-road equipment as few EVs today use these types of batteries, as battery technology is continuously evolving.

It is also important to ensure indoor depots have enough space for vehicles to safely maneuver into and out of charging spots and that EVSE equipment is out of the way, but easily accessible.

ADDITIONAL RESOURCES

For more information, please reference the following resources:

Alternative Fuels Data Center
https://afdc.energy.gov/fuels/electricity.html

The Alternative Fuels Data Center contains many resources for electric vehicles, including a guide titled the Plug-In Electric Vehicle Handbook for Fleet Managers and a listing of current funding opportunities.

American Legal Publishing Corporation
https://www.amlegal.com/codes/client/chicago_il/

The American Legal Publishing Corporation has a copy of the Chicago Electric Code available for reference online under Title 14E.

Chicago Area Clean Cities
www.chicagocleancities.org
The Chicago Clean Cities website contains information about EVs and includes a resource page for current funding opportunities.

City of Chicago's Environment and Sustainability Actions
www.chicago.gov/environment

The City of Chicago is a leader of innovative environmental initiatives, and sustainability is a key focus of Chicago's policies. Learn more about what the City is doing to reach its environmental goals.

ComEd
www.comed.com

In addition to having resources about Electric Vehicle basics and charging rates, there is contact information that may be needed if ComEd is the utility provider for a new EV-ready site.

Drive Electric Chicago
https://www.chicago.gov/city/en/progs/env/drive_electric_chicago.html

Drive Electric Chicago has basic information about plug-in electric vehicles and includes additional resources about them. Such resources include links to other Chicago sites for clean transportation, as well as a guide for home charger installation.

EV READINESS PLANNING OVERVIEW

7 Smart Steps to Plan for MD/HD Commercial Electrification

ASSESS NEEDS

STEP 1: UNDERSTAND THE FLEET

- Vehicle numbers and classification
- Daily miles traveled
- Duty cycles

STEP 2: DETERMINE YOUR CHARGING REGIME

- Charging location (depot, loading docks, etc.)
- Level of charging capabilities

PLAN EV INFRASTRUCTURE

STEP 3: INCORPORATE EV READINESS

Property layout:

- Number of electric truck parking places
- Number of electrified docks
- Plans for on-site electricity generation
- Plans for on-site battery storage

Building characteristics:

- Building power needs

Additional power needs:

- Workplace and public charging stations for light-duty vehicles
- Outside lighting
- Proposed locations for meters, raceways, and switches

STEP 4: ENGAGE WITH COMED

- Inform them of your plans
- Determine the amount of power available to the site without upgrades
- Determine the distance from the charging location to the service line or substation
- Indicate the planned charging cycle/charging times (if known)
- Discuss potential load management options
- Inquire about any special EV or commercial utility rates that are available
- Evaluate load sharing options

STEP 5: PLAN FOR IMPROVED EFFICIENCIES

- On-site battery storage
- On-site electricity generation
- Smart charging

FINALIZE AND PERMIT

STEP 6: ESTIMATE YOUR PEAK LOAD REQUIREMENT

- Electrified loading docks and parking spots
- Normal building load
- Any onsite generation offsets
- Any onsite storage offsets

STEP 7: PERMITTING

- Ensure the project meets the Chicago Electrical Code
- Apply for an electrical permit
- Determine eligibility for special or expedited permit programs

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