Ecovillage at Ithaca

Cost Effective EV Charging for Multifamily Residential

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There have been numerous efforts at state and federal levels to jump-start the installation of chargers in various locations, including multifamily residential communities. However, there is a big gap between installing an initial charger or two vs. having ubiquitous EV charging available to every resident.

This paper describes an approach taken at Ecovillage at Ithaca to meet this challenge. Our hope is that this information can be of use to regulators, incentive program designers and operators of multifamily properties to facilitate and encourage EV charging at scale.

It’s about outlets, not chargers!

Most programs designed to increase the availability of charging focus, naturally, on *chargers*. That is a great place to start, but it doesn’t scale well. Focusing on installing individual chargers has a variety of shortcomings:

- It ties up huge amounts of available electric service capacity for only a few potential users.
- Wiring, trenching and electric service installation costs are prohibitively expensive on a per-charger basis.
- It does a poor job of adapting to a changing population of drivers transitioning from ICE (internal combustion Engine) vehicles to EVs over time.
- It may not address the administrative needs of operating chargers at scale, such as billing, support, equipment standardization, etc.

What’s the alternative?

If the residents, coop or condominium boards and/or managers of multifamily properties plan to eventually reach the goal of providing ubiquitous charging for residents, then there are implementation strategies which can reduce per-charger costs substantially while creating the administrative and support resources to operate well at scale.

These are:

1. Focus on installing 240v charging-ready *outlets*, not chargers
2. Use daisy-chained wiring for charging circuits.
3. Choose chargers with circuit-sharing capabilities.
4. Standardize on one vendor of networked chargers.
5. Plan ahead for scale.

These strategies are interlinked--each depends on the others to make them workable.

Working assumptions

Before we dive in to the details, let's first lay out the assumptions we are using as the basis for this strategy:

- This strategy is optimized for multifamily facilities with parking lots and/or parking structures physically separated from the housing units. Facilities with resident parking or garages directly adjacent to each unit may be better served by owner-installed charging infrastructure.
- EV market penetration will continue to happen along the s-curve typical for disruptive technologies (see this presentation by Tony Seba (https://youtu.be/Kj96nxtHdTU). This means that by 2030 at the latest, a majority of new vehicles purchased by Americans will be EVs, and there will also be a significant supply of used EVs on the market.
- If we don't plan ahead for this change, we will be unable to effectively meet this growing need. Therefore our property would become less desirable for potential residents than other sites who *had* planned ahead.
- By operating strategically, we can take advantage of economies of scale and minimize wasted investments that later require tear-out and replacement. This will substantially reduce our eventual costs for full build-out.
- Starting now with a cohesive plan will allow us to efficiently handle the administrative burdens, such as billing and charger management, and will avoid a trainwreck as the demand for charging increases dramatically over the next few years.
- Incentives for installing chargers will decrease over time, so there is a benefit to starting sooner rather than later.
- It is desirable to have chargers dedicated to specific residents whenever possible, rather than focusing on shared chargers. Thus, multifamily residents can operate much like homeowners who have their own garages. That is, they pull in, plug in the car and leave it there until the next time they need to drive. This also simplifies billing and allows for plug & play charging without authentication and app deployment.
- Patterns of driving and charging do not typically require that every EV needs to charge at full rate all night. We assume that most drivers will be driving average commute

distances of 20-50 miles per day, and therefore only require a few hours to top off their charge.

Detailed Strategies

Let's look at these one by one:

Installing 240v charging-ready outlets

The goal should be to have at least one parking space for each household be pre-wired and ready to receive a charger. That means we focus on how to provide the most NEMA 4-50 240v 40A outlets using the financial resources and service amperage budgets currently available to us.

Why is this helpful? Because it allows for much cheaper wiring strategies and avoids tying up capital buying chargers today which may not get used for years if particular residents are not yet ready to purchase an EV.

Having pre-installed these outlets, it also means we can be responsive to resident needs for charging as soon as they purchase an EV. They just order a charger and we plug it in, rather than waiting for us to schedule contractors to come in and do expensive and time consuming one-off wiring for each new EV.

Daisy-chained wiring

The problem with typical charger wiring is that large, dedicated circuits are used for each charger, which needlessly ties up valuable electric service resources. For example, if a given garage building is served by a 100 A circuit, then only 2 chargers could be installed in that entire building unless measures are taken to address that.

One of those measures is daisy-chained wiring. This means that, instead of each 240v outlet having its own circuit connected back to its own breaker in the electric panel, we connect 5-10 outlets in parallel on the same breaker/circuit. Thus, to wire a set of adjacent parking spaces, we need only one home-run circuit to the electric panel and then short hops of wire from one parking space to the next. This reduces the cost per outlet down to $200 or less, and allows a small electric service to support many parking spaces.

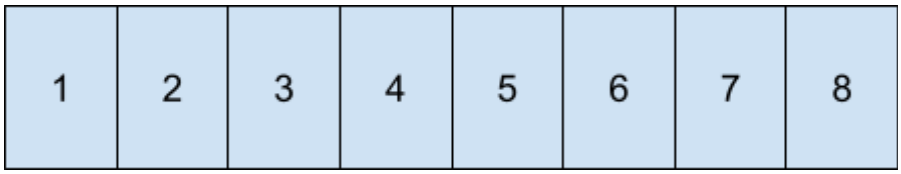
Choose chargers with circuit-sharing capabilities

To make daisy-chained wiring work without overloading circuits and blowing breakers, we need to use chargers that can communicate with each other to dynamically limit charging rates. Such chargers allow for the creation of charger groups for which a total amperage limit can be configured, and generally require a network connection to support the inter-charger communication to keep aggregate demand within that limit.

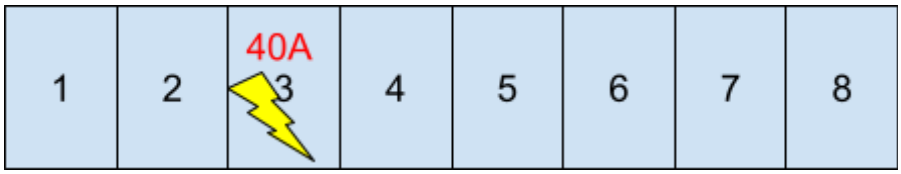
Ideally such capabilities will be dynamic and responsive to allow ideal utilization of each circuit.

Dynamic load sharing example

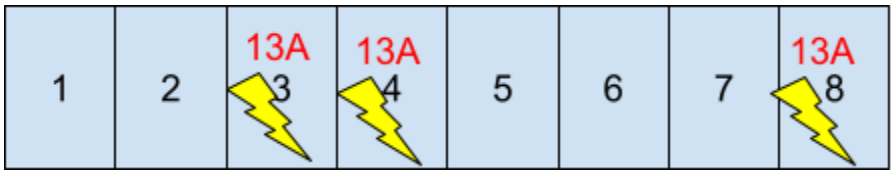
Say we have 8 parking spots which share one 40 Amp circuit:



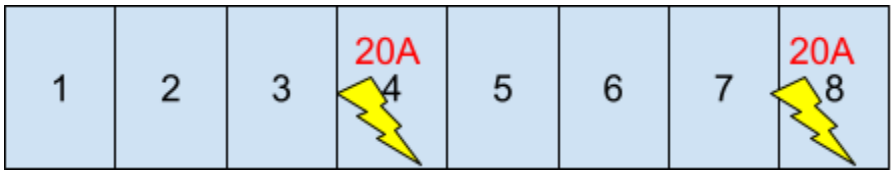
First, one car arrives home, parks in spot #3 and plugs in. That car gets the full 40 amps:



Next, 2 more drivers arrive and plug in. The chargers negotiate a new charging rate,and now each only use around 13A:



After a few hours, the original car in spot #3 is fully charged and that car signals that it is done charging. Now the remaining two adjust their charging speed up to compensate:



And so on.

Since most cars using this circuit have only driven the typical daily commute distance of around 30 miles, they only need a few hours on charge to top off. So even if their charge rate is sometimes adjusted downward, they will still be fully charged by the next morning. And if one

vehicle has returned from a long trip and needs a lot more charge time, they still will have plenty of time to top off as other cars come and go from using the circuit.

Using this approach, Ecovillage at Ithaca has found that a 100A service can effectively serve at least 20 EVs without issues.

Eventually, EV penetration may increase until there is too much contention for charge time on such long chains of shared outlets. If that happens, these chains of outlets can be easily adjusted by splitting them and adding additional home runs to the service panel (presuming there has also been a corresponding increase in service capacity). This allows for a cost effective ramping of charging capacity with minimal re-work.

Standardize on one brand of networked chargers

Selecting a particular model and/or brand of chargers which have the ability to communicate over a wifi network allows for a number of important benefits:

- Today, only chargers from the same vendor can perform dynamic circuit sharing via cloud services.
- Using the same vendor means that charging statistics from all chargers can be collected and downloaded in one place. This greatly facilitates billing.
- O&M is much easier. Maintenance people become familiar with installation and operation, it is easier to keep spare parts on hand, and administrators know how to configure new chargers as they arrive.
- All chargers have the full set of capabilities, so policies and administration strategies are much simpler than if you needed to accommodate any random chargers the residents wanted to install.

The term “Networked” here has a specific meaning: simply that the chargers can use a wifi signal to connect to a vendor’s backend servers to capture charging session information, allow for configuration, and support features like dynamic circuit sharing.

In some incentive programs, they use the term “networked” differently. In those cases, they mean that a charger is part of a public charging network, such as ChargePoint, Blink, Electrify

America, etc., and that therefore the charger is available to the general public who are members of that network.

For the strategy described here, either version of “networked” is an option. At a multi-family site, the chargers can either be private to only the residents or part of a larger network, and billing can be handled locally or through a network provider.

Plan ahead for scale

This simply means, operate from the assumption that eventually all or most of your residents will need access to charging, as they will all be likely to drive EVs at some point. That mindset means that you avoid taking shortcuts that work OK at first when there are only a few EVs but which become a major headache later on as EVs proliferate.

Some examples of scale related thinking:

- Seek to automate data collection. If you are doing billing for user charging activity, choose equipment that can automatically accumulate such data in one location that allows for bulk downloading. Avoid strategies of user self-reporting, reading meters with clipboards, having multiple back-end systems, etc.
- If you are administering resident billing yourself, rather than using a network, craft clear policies that work at scale. Questions to answer include:
    - Do you sell power at cost or add a markup?
    - How do you calculate energy costs? Do you include fixed utility fees, demand charges, credits from local or community PV installations? If you have multiple electric meters serving charging across your site, do you average costs across all users or calculate by meter? Do you use Time of Use metering, and if so, how are user costs affected?
    - Do you charge any session fees or time-related fees in addition to per-KWH charges?
    - Do you charge any system maintenance fees to fund ongoing maintenance and upgrades to your charging infrastructure?
    - Who buys the chargers--you or the residents themselves? If you, do you charge rental or lease fees for chargers to offset purchase and replacement costs?

    - Will you offer shared charging spaces, assigned charging spaces or both? What are the criteria for assigning a particular resident to one or the other?
    - If offering shared charging, what are policies for things like moving cars, session fees, idle fees, dispute resolution, etc?
    - Are you committing to provide charging on demand for any resident, or offering charging only in certain locations or only when you choose to provide it at some future date? How do you decide who gets access now and who has to wait?
- Plan for growing electric service needs. This can mean thinking about how you do wiring today in ways that won't require (much) rework later as you need more capacity. Sometimes it means installing larger wires than you now require, putting in spare home runs, installing buried conduits to places you don't yet need them while you have contractors on site, etc. It also means working with your electrician and/or utility to plan for service upgrades over time and/or taking advantage of programs such as the NY EV Make Ready program that helps fund such upgrades.
- Provide educational materials for residents or potential residents so they know what to expect and how to participate in your EV charging service so they can be confident in transitioning from an ICE to an electric vehicle.

Recommendations for regulators, utilities and incentive program managers

NY state has done a fantastic job of supporting and encouraging renewable energy and EV adoption, and we are very grateful to have been able to make use of these programs.

At the same time, it has been somewhat awkward to make our specific approach fit into the structure of these programs.

In particular, most incentive programs focus on installing a specific charger in a specific location and keeping it there for at least 5 years of operation. That makes sense, but often doesn't fit in with our "outlet-centric" approach and usage patterns for a couple of reasons:

1. Our focus is on a comprehensive buildout of charger-ready wiring. We want to make it easy and cost effective to support each new EV owner. But this means that our

investments in wiring and outlets are often waiting for the day that a resident decides to purchase an EV. Incentive programs to date do little to support this strategic "get ready for chargers" approach and focus instead on the chargers themselves.

2. In multifamily communities, residents come and go, cars get bought and sold and change is constant. Having a specific charger permanently pinned to a particular location means that chargers can sit idle for long periods as resident needs change. An approach that recognizes that outlets are permanent but chargers are sometimes mobile would serve multifamily communities better.

Regarding utilities and the PUC, we would be very grateful if you could devise some alternative approaches and tariffs specifically for car charging. Demand charges are a particular challenge in our environment.

This is because we have made investments in service capacity with future needs in mind, but which lead to prohibitive costs while EV adoption is still at low levels.

For example, in several of our clusters of carports, we installed upgraded 400A services. We had been unaware at the time (and were not informed) that this would move us from a residential tariff to a commercial tariff with demand charges. The result of this is that, in some buildings where EV penetration is still low, the high demand charges and the low KHW usage mean that we pay up to $1.00 per KWH when including those demand charges.

Obviously that is an undesirable outcome for encouraging EV infrastructure development.

In addition, current TOU (time of use) tariffs seem quite inflexible and poorly suited to our situation. Ironically, if we chose to program our chargers to all operate only during advantageous TOU time periods, that would concentrate our usage such that it would likely increase our demand charges, thus negating any benefit. Again, a misaligned incentive for PV adoption.

We don't presume to know exactly how to best balance the needs of EV customers and utilities, but would appreciate the attention of those that do.

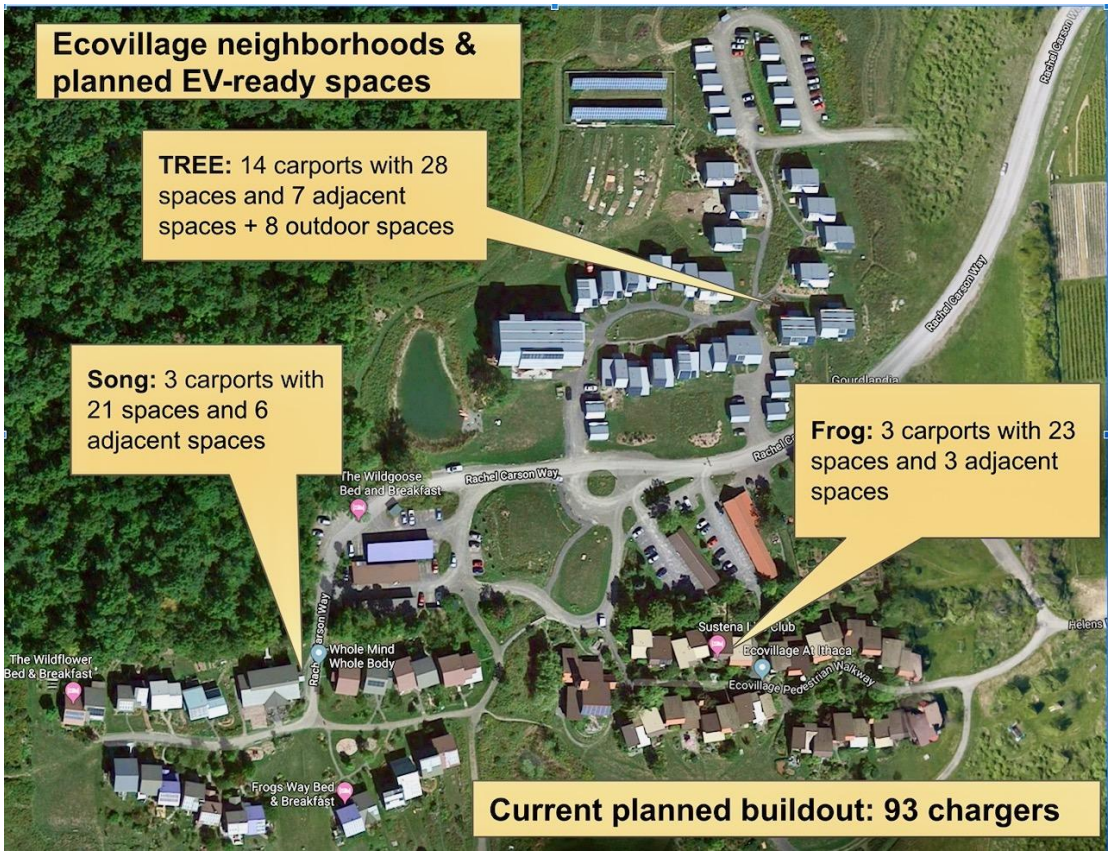
One area of particular interest to us is the development of effective utility<->charger demand signaling and a matching tariff structure to allow win-win alignment of utility needs and

customer cost-effectiveness. This ideally might eventually include vehicle to grid capability with compensation to EV owners for their contribution to grid stabilization to amplify its beneficial effects.

Finally, we want to encourage the development and adoption of open-source and open access technologies for managing chargers and collecting their usage data. A proliferation of proprietary systems does not serve the interests of end users and limits consumer choice.

As such alternatives mature and make their way through standards bodies, it might be helpful if regulators and incentive managers mandated support for these standards in commercial charging equipment in addition to any vendor-specific capabilities.

Specific choices made at Ecovillage Ithaca



Hopefully, the more general information above will be helpful for those seeking to promote or implement charging at scale. Here is some specific information on the choices made at Ecovillage Ithaca in case that is also of interest.

- We chose to create a committee of residents, known as the "Charge Team" and empowered it with the authority to set policy related to car charging. This committee was granted startup funds by the Coop Board(s) to install initial infrastructure, and has sought and received additional funding through some excellent NY State incentive programs such as **Charge Ready NY** and **EV Make Ready**.
- Our goal is to provide at least one charging-enabled parking space for each of our 100 households. That goal is about 80% complete.
- There are currently around 25 EVs owned by residents, representing about 25% of households. We found that EV adoption increased dramatically once we made charging infrastructure available.
- We standardized on the Juicebox chargers made by EnelX. We chose them because they provide networked capabilities, data collection and circuit sharing capabilities without (so far) excessive monthly fees. The hardware has been fairly robust and what few issues we have encountered have been quickly and cheerfully addressed by their support team.
- An interesting question is where to mount outlets and chargers within a carport. We generally have found it most practical to mount the chargers up high above the vehicles, because that simplifies wiring and protects equipment from damage. It also allows us to safely route the charge cable to have it descend wherever the charge port happens to be located on that specific vehicle.

- We have chosen to provide power at cost to our residents, while charging a $3 monthly fee to support ongoing operations.

- Calculating power costs is a challenge! Since our parking areas are dispersed around the site, they are supplied by 6 different utility service connections. Some of these use residential billing rates and some are 400A services that incur variable demand charges. Further complicating things, each of these services is enrolled with a community solar provider which provides us with a variable amount of supply credit that partially offsets utility supply charges. Monthly, we combine the billing info from these 6 services plus the solar provider and incorporate the variable demand charges as well. Our method is to average all these different costs across the whole site and divide them by the total KWH billed to derive an average KWH price for each time period. This is the price we charge our residents. It's a lot of work, and often made more difficult when the utility company is late with its billing.
- Generally, chargers are purchased directly by residents and then the Charge Team mounts and configures them. To take advantage of some of the incentive programs, it has been necessary for some of the chargers to be purchased and owned by the Charge Team. In those cases, we charge residents a monthly rental fee designed to fund the eventual replacement of the unit at its end of life.
- For charging outside of structures, we came up with this approach as an alternative to expensive vendor-supplied pedestals. Once you trench power to the structure, it is easy to wire outlets by running along the cross beams, and expansion is also quite simple. It is important that they be located in a way that minimizes the chance of accidental damage from cars or snow plows.

Ecovillage at Ithaca (https://ecovillageithaca.org) is a community of 100 residences in 3 compact neighborhoods on 175 acres of wild and agricultural lands in Ithaca, NY. It is dedicated to fostering cohesive community relations, connections to nature, food systems and the larger region, and working together to live well within a modest footprint.

Localforce.io is a consulting practice of Jeff Gilmore, resident of Ecovillage Ithaca, focused on technology and energy related projects.