Where Goes Thou Davis?

A Look at Fast Chargers and How They Fit into
the Davis EV Charging Infrastructure

Rev. 3
11 August 2020

Table of Contents

Version	History
1	Original
2	Added list of consultants and recommended corrections to city documents
3	Removed Microgrid section to separate document

Introduction

This booklet was prepared for the city of Davis. Its original purpose was to describe how EV charging has evolved over the past few years. For those who may not be familiar with the new generation of fast chargers, it provides pictures and descriptions of some recent installations. It also addresses the issue of how to best use the grant money that is available to the city and provides supporting data. Some relevant questions include: are fast chargers an asset or a liability in the downtown business district. Where in Davis should they be installed? Finally, this booklet provides some background information on microgrids as relates to charging infrastructure.

This document draws on a number of sources: personal experience of the author, basic engineering principles, the Davis EV Charging Plan, as well as suggestions from a colleague who is very knowledgeable about large scale EV charging projects.

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Main points and suggestions

These are the main conclusions of the author:

• Placing fast chargers downtown requires discussion. Not all fast chargers are alike. Some will meet the goals of the city and some will not.

• The primary objective of the SACOG grant should be to install at least two new corridor chargers. Locations should be the Nugget Shopping Center and the Sutter Davis Medical Offices OR SIMILAR SITES. These locations are more convenient than downtown for both Davis residents and corridor drivers.

• Corridor chargers should be new generation. Older style chargers would rapidly lose their usefulness to EV drivers as vehicle batteries improve.

• An additional way to use the SACOG grant is to leverage the funds to create a larger infrastructure.

• For downtown, the objective should be to have increased foot traffic without increased vehicular traffic. For this reason, lower power chargers are preferred. This encourages visitors to remain in the area and visit downtown businesses. Lower power chargers are also less expensive and occupy smaller space.

• By comparison, fast chargers downtown would encourage more traffic and provide insufficient time for shopping, dining, etc.

• There are other ways to encourage downtown foot traffic, such as street closures etc. (beyond the scope of this paper).

• If grant funding is limited, it is better to have two state of the art fast chargers than five old style chargers that are compromised.

• Microgrids have many advantages and can be a good addition to charging infrastructure. The city can use the data in this paper to predict some of the advantages.

• The city should have programs in place to reach out to retail property owners and identify locations for additional fast charge sites.

The big question for Davis: Do it fast or do it right?

Background on fast chargers

A new generation of DC fast chargers has evolved to allow rapid charging of electric vehicles with larger capacity batteries. The following table, from the report of 5-20-2020, has been modified to include new generation chargers.

Table 1: Types of Plug-in Electric Vehicle Chargers

Charging Level	Power Supply	Charger Power	Miles of Range/Hour of Charge	Charging Times	
				BEV	PHEV
Level 1	120 VAC Single Phase	1.4kW @ 12 amp (on-board charger)	~3-4	~17 Hours	~7 Hours
Level 2	240 VAC Single Phase up to 19.2kW (up to 80 amps)	3.3 kW (on-board)	~8-10	~7 Hours	~3 Hours
		6.6+ kW (on-board)	~17-20	~3.5 Hours	~1.4 Hours
Older DCFC	208 or 480 VAC three phase	45kW (off-board)	~50-60	~30-45 Minutes (to ~80%)	~10 Minutes (to ~80%)
New gen DCFC	208 or 480 VAC three phase	100-300 kW (off-board)	200-400	TBD	TBD

Additional characteristics include:

	Older chargers	New generation chargers
Power	25-50 kW	100-300 kW
Physical area required	Relatively small area, as charger and dispenser are often in the same cabinet.	Larger area - not unusual to have 4 to 6 large boxes per site, including: • Transformer • Charger units • Dispenser units
Power required	208 or 480 V three phase. Transformer sometimes required, depending on power available on site.	208 or 480 V three phase. Transformer almost always required (150 to 500 kVA, tied to utility “medium voltage”).

How does the number of EVs on the road relate to charging?

We are assuming that in the coming years, EVs will become a greater percentage of total vehicles (10, 20, 50%). As this occurs, It can be predicted that charging will evolve from occasional fast chargers located in parking garages and shopping malls to dedicated EV charging sites. Just as existing gas stations are designed for fast turnaround time and maximum throughput, we may expect that future EV charging sites will have a similar objective.

Site layout

The following picture shows a typical charging site with a new generation charger. Not only must these sites be large enough to accommodate the components, they must also have sufficient space around them to allow easy driver access.

List of EVs

The following EVs have fast charge rates to accommodate new, larger capacity batteries.

Consumer vehicles

Vehicle	Battery Pack	Max Charging Speed
Ford Mustang Mach-E	98 kWh	150 kW
Hyundai IONIQ	38 kWh	100 kW
Hyundai Kona Electric	67 kWh	80 kW
Kia Niro EV	64 kWh	100 kW
Kia Soul	33 kWh	100 kW
Nissan LEAF Plus	62 kWh	100 kW
Tesla Model 3	80 kWh	120 kW
Tesla Model Y	75 kWh	250 kW
Volkswagen ID.4	83 kWh	150 kW

Exotic vehicles

Vehicle	Battery Pack	Max Charging Speed
BMW i4	80 kWh	150 kW
Audi e-Tron	95 kWh	150 kW
Byton M-byte	95 kWh	150 kW
Jaguar I-PACE	90 kWh	100 kW
Lucid Air	130 kWh	150 kW
Mercedes EQC	80 kWh	110 kW
Polestar 2	78 kWh	150 kW
Porsche Taycan	93 kWh	270 kW
Rivian R1S/R1T	180 kWh	160 kW
Tesla Model S	100 kWh	120 kW
Tesla Model X	100 kWh	120 kW

Please see Appendix A for images of new EVs with larger batteries.

List of new generation chargers in the Sacramento area.

Location	Installed/managed by	Max Charging Rate
Sacramento Intl. Airport	Electrify America	150 kW
County Fair Mall (Woodland)	EVgo	100 kW
Market West, Arena Blvd.	Electrify America	150 kW
Target, N Freeway Blvd.	Electrify America	150 kW
16th & L St. Parking Lot	Electrify America	150 kW
Southside Park	EVgo	175 kW
Target, Riverside Blvd.	Electrify America	150 kW
The Cannery, Alhambra Blvd.	Electrify America	150 kW
SMUD HQ	SMUD	175 kW
Target, 4th Ave.	Electrify America	150 kW
Walmart Supercenter, Florin Rd.	Electrify America	150 kW
Laguna Village, Center Pkwy.	Electrify America	150 kW
Walmart, Elk Grove Blvd. (Elk Grove)	Electrify America	150 kW

Number of new generation chargers in Davis: zero!

The above information is the best available at this time. Please see Appendix B for images of some new generation chargers in the Sacramento area.

Building a charging infrastructure

• What factors affects charge time?

Charge time depends on the size of the battery and the power of the charger. Experienced drivers know that charge rate tapers off after the car is approximately 80% full. New EV drivers may not know this and might stay for a full 30 minutes (until the charger times out). Some chargers time out after one hour, but this is not good charger design in my opinion. However, one hour does allow time for Uber drivers to sleep in their cars (humor).

• Is there a rule about EV drivers leaving their cars while charging?

The cardinal rule among EV drivers is that you move your car promptly after charging. Drivers shouldn't tie up the space for the next driver who wants to charge.

• What is an ideal charge time for corridor charging?

As fast as the vehicle will allow. Rate of charge is determined by the vehicle, up to the maximum output of the charger.

• What is an ideal charge time for downtown?

It can be assumed that 1 to 3 hours would be acceptable for downtown, so as to allow time for shopping, dining, etc. The following shows approximate charge time for two different chargers (for 50% charge).

	25 kWh battery	**80 kWh battery**
Level 2 (6.6 kW)	1.9 hours	6.1 hours
DCFC (24 KW)	0.5 hours	1.7 hours

Note that a 24 kW DCFC (as shown below) provides a good approximation.

24 kW DC charger

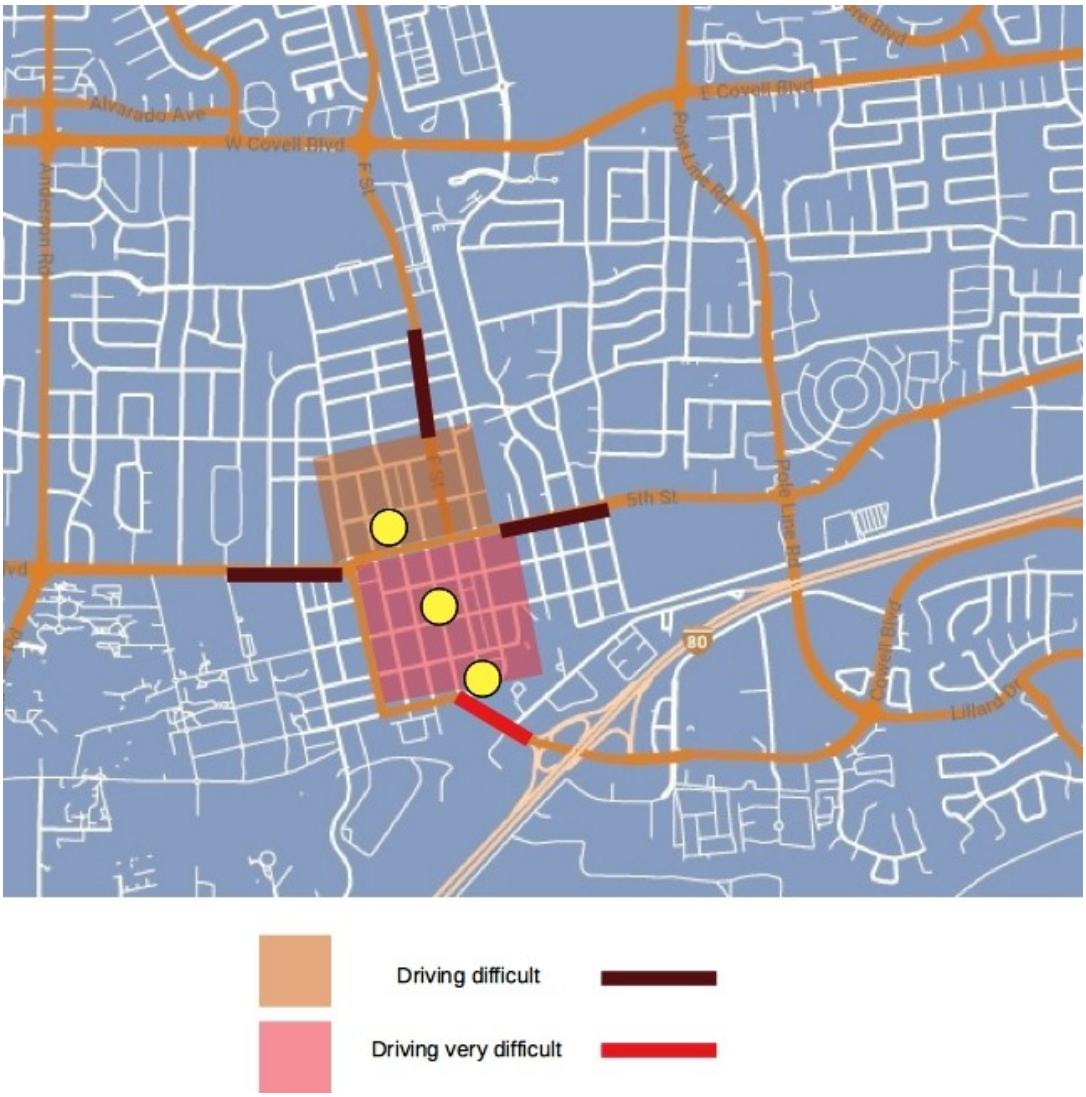
• Can older style DCFCs be installed and replaced with new generation chargers later? Probably not. There is a huge difference in size and power, so the space would have to be designed with that in mind. Note that increasing a site from 100 kW to 300 kW would be an increase of 200 kW, which would certainly require installing a large transformer. Installing old style chargers (and initially a smaller transformer) would seem to be waste of money.

• Where to place fast chargers?

For reference, a report to the City of Davis May 20, 2020 identifies these locations for DC fast chargers (note this is and/or):

- City Hall
- Downtown E Street parking lot
- Downtown Parking Garage at 1st and F Streets (I-80 corridor)
- Nugget Shopping Center
- and/or Sutter Davis Hospital/Medical Offices

However, there is a problem with this plan. The following map shows the downtown locations and some traffic considerations.



Please note that these traffic difficulties are not only impediments for corridor drivers, but for Davis residents as well.

• Traffic considerations for corridor chargers

For freeway drivers, chargers are near exits. For Davis residents, routes are on arterial streets.

• Commercial vehicles and buses

These vehicles would be better suited for corridor locations with new generation chargers than driving downtown.

• How can SACOG funds be leveraged?

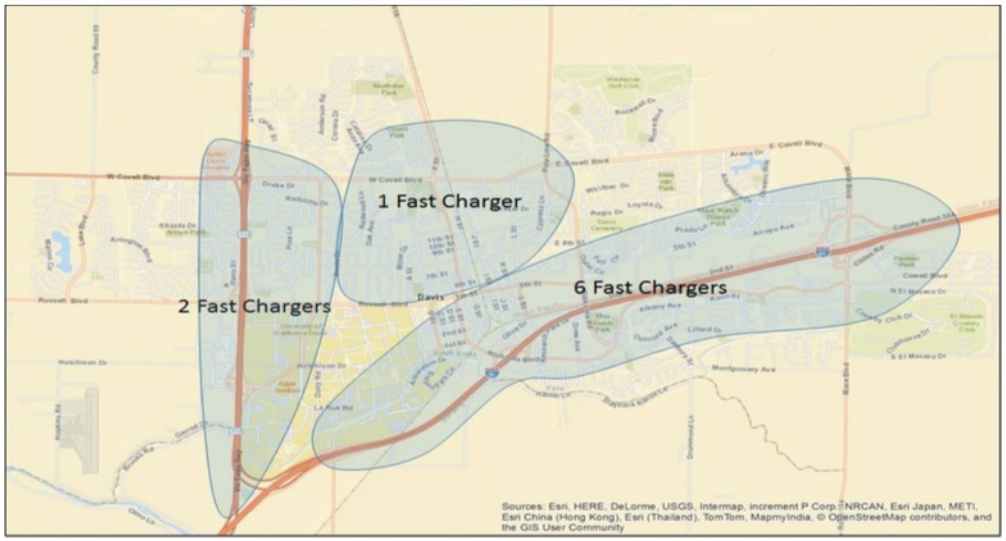
Davis can achieve a larger infrastructure by engaging a charging company to install and manage chargers throughout Davis, and using the SACOG funds to subsidize the project. The charging company would assume the risk for the project and greater coverage would be accomplished.

References to ITS Charging Plan

In general, this booklet agrees with the Charging Plan but goes into more detail regarding fast charging.

1. In the plan, nine fast chargers are suggested for corridors.

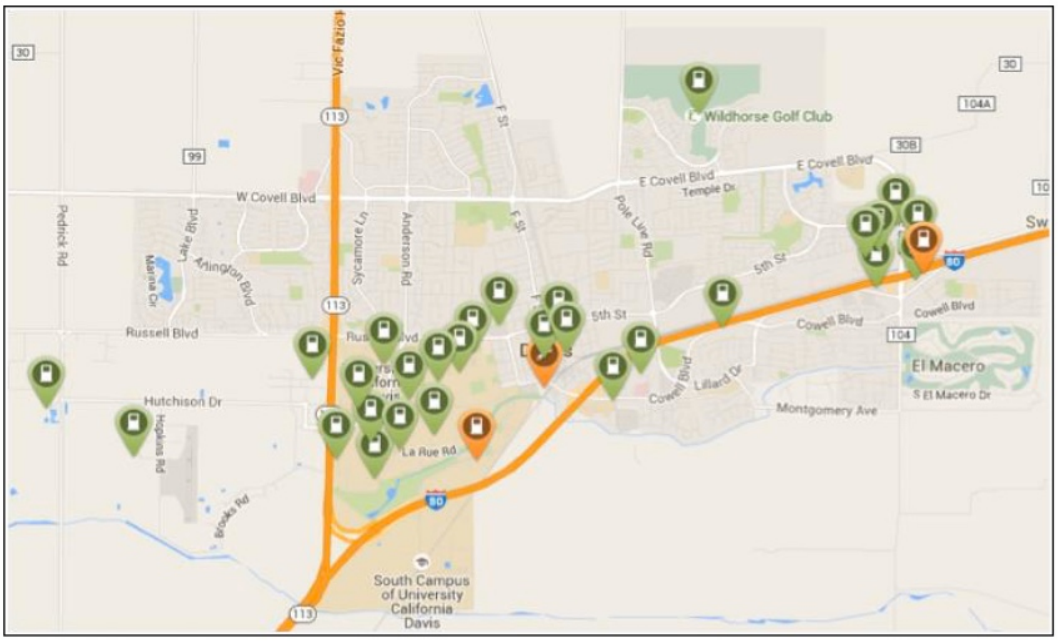
Figure 11 Fast charger approximate locations and numbers.



The zone boundaries are approximate and are meant to reflect the demand along Highway 113 and Interstate 80. In general, Fast chargers should be located near the freeway, but 1 or 2 could be sited along major arterials such as Pole Line Road that are slightly farther from the freeway. Priority site location is determined by a combination of electrical capacity and appropriate land use. For example, shopping centers near the freeway are an ideal Fast charger location since they support a variety of activities (restaurants, shopping, etc.), that travelers can utilize while they charge. This approach also can stimulate local economic activity.

2. The Charging Plan “recognizes the role and benefits of bringing business to downtown”, which is also one of the objectives of this booklet. However the Charging Plan does not propose putting fast chargers downtown (only Level 2). It is not clear where the suggestion originated that fast chargers be placed at City Hall, the Downtown E Street parking lot, and the Downtown Parking Garage at 1st and F Streets. The author believes that downtown chargers should be Level 2, or at most 25 kW fast chargers.

3. The Plugshare map in the Charging Plan is apparently outdated, as it shows three fast charger sites in Davis.


Wildhorse Golf Club
W Covell Blvd
E Covell Blvd
Temple Dr
Pedrick Rd
Lake Blvd
Arlington Blvd
Marina Dr
Sycamore Ln
Anderson Rd
F St
Pole Line Rd
5th St
Russell Blvd
Hutchison Dr
Hopkins Rd
Brooks Rd
La Rue Rd
Cowell Blvd
Lillard Dr
Montgomery Ave
El Macero
S El Macero Dr
South Campus of University California Davis
Vic Fazio Hwy
30
113
99
80
104A
30B
104

Recommended corrections to city documents

1. Suggested correction to the Report to Utilities Commission, June 17, 2020, authored by Kerry Loux et al.

As part of this project, the City of Davis is required to meet the following minimum requirements, based on the FEA with SACOG:

- Site, design, permit, construct and install Level 2 Chargers in the project area (3 minimum)

Page 2 of 5

Electric Vehicle Charging Implementation for "Electrify Yolo' Project
June 17, 2020

- Site, design, permit, construct and install DC Fast Chargers (Level 3) in downtown area within ½ to 5 miles of major freeway corridors (2 minimum)
- Purchase Mobile Chargers of the type similar to 'EV ARC' solar standalone charging stations (2 minimum)
- Purchase or lease electric vehicle(s) to transport 8 or more people (one minimum)

This needs to be reviewed. It does not agree with the recommendations of the ITS charging plan. As written it might be detrimental to the goal of increasing foot traffic downtown.

2. From the Request for Proposals (RFP), EV Charging Infrastructure

Potential Davis Locations:
Preliminary City of Davis candidate sites for feasibility and cost analysis, selected from the short-term action list in the 2017 City of Davis EV Charging Plan (EVCP) adopted by City Council and the FEA between City of Davis and SACOG (as per the Green Region grant narrative), include, but are not limited to:

Level 3 (DC Fast chargers)
A minimum of two locations will be selected by City staff team, following site feasibility and cost analysis, for development of the bid package:

Page 4 of 14

Item 6B- Attachment 1

Please see this booklet. Corridor chargers should not be located downtown. Certain types of fast chargers can be installed downtown if they promote foot traffic.

- City Hall (200 KW capacity available with current upgrade project implementation)
- City-owned Downtown E Street parking lot (adjacent to I -80 corridor; capacity or availability of electric connection unknown, existing non-networked chargers may be upgraded)
- City-owned Downtown Parking garage at 1st and F streets (adjacent to I -80 corridor; capacity or availability of electric connection unknown)
- City-owned Downtown Parking garage at 4th and G streets (adjacent to I -80 corridor; capacity or availability of electric connection unknown)
- Nugget shopping center and/or Sutter Davis Hospital/Medical Offices (I -80 and CA-113 corridors; capacity or availability of electric connection unknown)

Level 2 Chargers
These chargers are assumed to be networked dual chargers as per specifications in RFP. The total number at each site and potential future pre-wiring/panel upgrades to increase

These chargers (corridor chargers) are specified in the ITS plan and should be labeled here as high priority. Corridor chargers should be "new generation" and should be located where there is adequate space.