EXTREME FAST CHARGING BUSINESS CASE ANALYSIS

A financial assessment of electric vehicle charging station ownership

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Extreme fast charging complexes can achieve profitability in less than five years, according to an analysis by Atlas Public Policy. The analysis used the EV Charging Financial Analysis to assess the business case for 1-plug, 4-plug, and 20-plug extreme fast charging complexes. The complexes either relied on in the electrical grid, referred to as the BAU or business-as-usual case, or had onsite solar photovoltaic (PV) generation and/or energy storage. In general, we found systems that were BAU had better financial performance than systems with onsite solar photovoltaic (PV) generation and/or energy storage, due to the higher capital costs that could not be fully recovered.

In general, fast charging sites with one or four plugs can achieve profitability, albeit at lower magnitude compared to sites with 20 charging plugs. Due to higher expected demand 20-plug sites can achieve a much higher profit.

BACKGROUND

Electrification of the light-duty transportation sector has advanced considerably in the United States since the first mass market electric vehicles (EVs) were introduced in late 2010. EV sales in the United States reached almost one million at the end of September 2018 [1]. With the growing prevalence of EVs in the market and longer range EVs on the horizon [2, 3], adequate charging infrastructure will continue to play a key role in EV market development. Charging outside of the home will become critical as longer range EVs enable longer trips and as EVs are purchased by households without access to dedicated at-home charging. In both cases, access to public fast charging will be important to meeting charging needs for these EV drivers.

Currently in the United States, DC fast charging stations typically supply up to 50 kilowatts (kW) of power. This level of power is supported by the EV fleet on the road and provides a faster charge than at-home charging, which is what is typically needed in a public setting. However, newer EVs will be able to support more powerful charging in the near term, reaching up to 350 kW or about 200 miles in less than 10 minutes [4]. Charging service providers are responding to this development and are building out networks in advance of these vehicles; Electrify America, for example will be equipping all its charging stations with the ability to provide up to 350 kW of power [5]. These extreme fast charging stations are the expected future of charging capabilities.

To prepare for the coming development of longer range EVs and extreme fast charging, potential owner-operators of this equipment must understand the business case for providing this service. Atlas Public Policy has developed a business case analysis tool for extreme fast charging complexes[1] to assess the business case for extreme fast charging under an optimal design configuration, which minimized the cost of the system to meet the charging needs. The inputs for the analysis tool reflect the optimally designed stations with PV and solar storage evaluated with the National Renewable Energy Laboratory's REopt model [6]. The assumption is that the optimal design presents the best-case scenario and understanding if

[1] Throughout this paper, an extreme fast charging complex is an individual charging site with four or greater charging ports capable of recharging a vehicle at 150 kW or greater.

other incentives are necessary or not to achieve suitable profitability for owners of these charging stations is an important consideration for public policymakers.

The business case analysis tool relied on the EV Charging Financial Analysis Tool, co-developed by Atlas Public Policy and available online at www.atlasevhub.com/category/tools. The analysis tool allows for modeling of many variables that could affect the financial performance of an extreme fast charging complex, including user fees, demand growth, electric power needs, battery storage requirements, grid integration requirements, and electric utility rates.

This analysis included the execution of a financial model for nearly 30,000 scenarios to test various system configurations, business models, private partnerships, and market conditions (see Figure 1).

FIGURE 1: SCENARIOS FOR BUSINESS CASE ANALYSIS

Site Configuration	Plugs Per Site	Incentives	Business Model Configurations
• Onsite Solar PV Only • Onsite Storage Only • Onsite Solar PV and Storage • Onsite Solar PV and Storage with Building Load • Business-as-usual	• 1 Plug • 4 Plugs • 20 Plugs	• No Incentive • No Demand Charge • Reduced Electricity Rate • EVSE Rebate • Construction/Installation Rebate • Make Ready • PV Rebate • Storage Rebate • Host Site Identification Rebate	• Annual Utilization Growth • Per Session User Fee • Energy User Fee

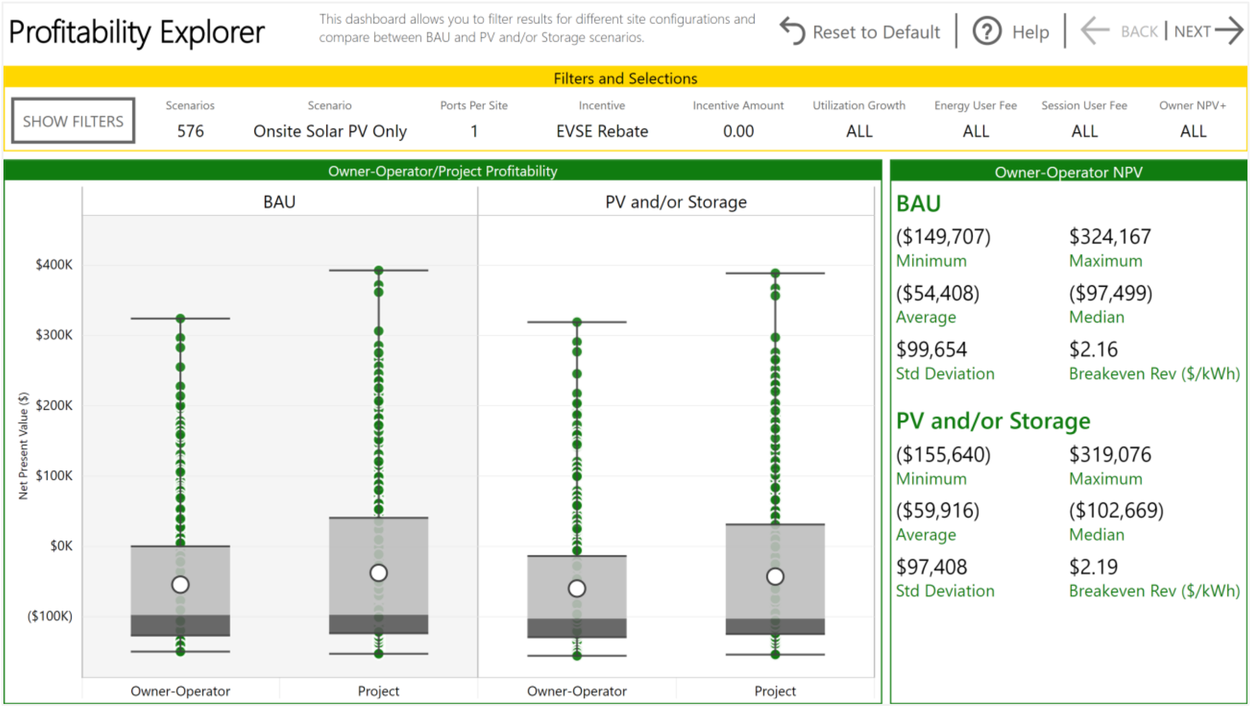
The business case analysis was run for business-as-usual runs (no PV and no storage) and over four site configurations with PV and/or storage. In both cases, the plugs per site, incentives, and business model configurations were varied.

The output from the tool is the net present value (NPV) to the owner-operator of the charging station along with the breakeven revenue in dollars per kilowatt-hour. A positive NPV indicates that the station could make a profit and negative NPVs indicate that the station is unlikely to do so. The breakeven revenue is the approximate user fee needed for the charging site to achieve profitability.

Although the model outputs precise NPVs, it is important to not get attached to these estimates. The direction, positive or negative, of the NPV is a more important metric to indicate the potential for profitability of a station for this analysis. The findings section references profitability and orders of magnitude of estimates for NPV to make comparisons between scenarios.

Atlas created interactive web-based dashboards to illuminate the results from this analysis as shown in Figure 2; the dashboard is available at www.atlaspolicy.com/extreme-fast-charging-dashboard. Users of the dashboard can select filters to see the results for the different scenarios outlined in Figure 1. For a given scenario, users can also compare the costs of BAU configurations to those with PV and/or storage. Findings discussed in the next section can be confirmed using the dashboard filters.

FIGURE 2: DASHBOARD OF ANALYSIS RESULTS



The interactive dashboards allowed us to explore the analysis results easily and complete our findings. The dashboard is available online at www.atlaspolicy.com/extreme-fast-charging-dashboard.

FINDINGS FOR POLICYMAKERS

- **Charging complexes without onsite energy generation and storage (BAU) had better financial performance than most complexes with either category (with exceptions)**. The exceptions include:
  - For all plug configurations, onsite storage only had better or nearly equal financial performance than the BAU case.
  - For the 1-plug sites with only onsite solar PV or energy storage or sites with both technologies had better or nearly equal financial performance than the BAU case. Meaning, only the onsite solar PV and storage with building load had better financial performance in the BAU case.
  - 4- or 20-plug sites with only solar PV or those with solar PV and onsite storage may not earn a profit. However, only including onsite storage may be a better financial decision. For 1-plug sites, onsite solar PV and/or storage could have better financial performance than no onsite PV or storage, except when the site is connected to the existing building load.

- **Complexes with only solar PV or energy storage have higher profitability than sites with both PV and storage.** The high capital costs of having both onsite solar PV and storage result in larger negative NPV estimates and slightly longer payback periods.
- **User fees can greatly improve profitability and reduce the investment payback period, especially when no incentives are present and utilization growth is flat.** For sites that experience no incentives and no growth in utilization, profitability for an owner-operator, on average, is possible when an energy user fee is employed, which appears to be more effective than a per session fee. Specifically, profitability is possible under the additional conditions below on average (and generally hold when looking at median values):
    - For 4-plug and 20-plug sites, when the highest energy user fee is charged ($0.60/kilowatt-hour) for the BAU and PV/Storage cases, which is equivalent to paying more than $3.50/gallon for a 35-mile-per-gallon gasoline vehicle. The same cannot be said for the 1-plug sites, which were expected to have a lower utilization and not reach profitability even with a user fee when looking at median values.
    - For 1-plug, 4-plug, and 20 plug sites, when the highest session user fee and highest energy user fee are employed.
- **Eliminating demand charge helps complexes with onsite storage only configuration more so than other charging complex configurations.** For all plug sites, eliminating the demand charge improves profitability. In the case of 4-plug and 20-plug sites, with onsite storage only, just eliminating the demand charge can switch the average NPV from negative to positive. However, median profitability values remain slightly negative in these cases.
- **Reduced electricity rates greatly improve the financial performance of charging complexes, particularly for sites with only onsite storage**. For 20-plug sites with energy storage, reducing the electricity rates increases the median NPV from negative approximately $3 million to positive $100,000. Although to a lesser degree, the median NPV also significantly improves for 4-plug sites with energy storage and reduced electricity rates.
- **More plugs mean higher costs, greater risk, but bigger potential returns.** The 20-plug sites have the highest capital costs. Compared to 1-plug sites, they have ten to one hundred times the average costs and for 4-plug sites five to fifteen times the average costs. They also have the greatest potential profitability given the right combination of incentives and user fees, ten to hundred times the profitability of 1- and 4-plug sites. This assumes that there is a higher utilization associated with these sites, but there is also a risk for investing in more plugs if the utilization is not as high as expected. In other words, more plugs do not guarantee more utilization.
- **Make ready incentives could increase the average profitability**. A make ready incentive could improve the average profitability of a project my tens of thousands of dollars for 1-plug and 4-plug sites, and by millions of dollars for 20-plug sites. However, the incentive alone cannot switch the scenarios from negative to positive profitability. Adequate user fees are more effective, but the incentives help to improve profitability.
- **Ensuring continued and growing utilization is important.** The previous results are all amplified if the utilization is assumed to grow by 5 or 10 percent over the course of 10 years. Utilization

alone, can improve the profitability of a project by tens of thousands to millions (for the 20-plug sites). It may also be important to test alternative utilization starting points to get a better idea of how it impacts profitability.

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APPENDIX A: ASSUMPTIONS

The business case scenarios were developed with the number of stations (plugs) as the initial differentiator—1 (low or high) at 50 kW, 4 plugs at 150 kW, and 20 plugs at 350 kW. The number of plugs determined the capital costs, electricity costs, and usage of the stations, which were either provided by Idaho National Laboratory and NREL, or were assumptions gathered from previous work by Atlas.

From there, the scenarios were divided into the cases of business-as-usual (charging stations but no PV or storage) and those with PV and/or storage. Next, the data were categorized into four designations: PV, storage, PV and storage, and PV and storage with the existing building electric load.

A range of charging fees were tested: by session and/or with an energy use fee. The utilization rate was tested as flat over time or annual growth rates of 5 or 10 percent; retail costs and PV/storage sizes were not adjusted.

Finally, incentives to simulate various roles an electric utility could play in an extreme fast charging complex were explored, including a charging equipment rebate, PV rebate, storage rebate, construction and installation rebate, "make ready", and host identification rebate. For each incentive, levels of 100 percent, 50 percent, and 25 percent of total costs were evaluated. A demand charge of zero, and minimum average electricity costs were also tested.

MARKET INPUTS

EV Charging Financial Analysis Input Field	1-plug 4-plugs 20-plugs	Source
EV fuel economy [miles per kilowatt-hour]	3.5	Atlas estimate used to calculate public benefits.
Conventional vehicle replacement fuel economy [mpg]	30	Atlas estimate used to calculate public benefits.
Energy security benefit [$per gasoline gallon displaced]	$0.01	Oak Ridge National Laboratory research found total benefit per EV of $2,040 by replacing a 40 mile per gallon vehicle with 207,000 lifetime miles.
Electrical grid benefit [$per megawatt-hour]	$14.58	From Ratepayer Impact Measure Test of Case Study 3 (public charging) from EPRI Report: % Benefit x Assumed rate of $0.075/kWh.
Electrical grid emissions rate [carbon dioxide equivalent pounds per megawatt-hour]	1,141.95	Total carbon dioxide equivalent per megawatt-hour for United States from U.S. Environmental Protection Agency's eGrid
Climate benefit [$per ton of greenhouse gas emissions abated]	$36	Social Cost of Carbon using 3% discount rate.
State and Local Sales tax [%]	0%	Atlas estimate – field currently not supported
Use traffic-derived values [1] or direct inputs [2]	N	Disable this method for estimating utilization rate.
Expected annual utilization growth rate [%]	0-5-10%	Atlas estimate used for charging use annual growth rate.

EV Charging Financial Analysis Input Field	1-plug 4-plugs 20-plugs	Source
[Station Type 1] Initial average utilization [# of charging sessions per station per year]	low: 609, high: 5,548 5,828 9,138	Idaho National Lab estimate.

OWNER-OPERATOR INPUTS

EV Charging Financial Analysis Input Field	1-plug 4-plugs 20-plugs	Source
Charging Station Capital Cost		
Charging station equipment cost per type 1 station [$]	$0 - $25,000 $0 - $80,000 $0 - $175,000	Idaho National Laboratory estimate from previous work. 4 plug (150 kW) scenario was extrapolated between the 1 plug (50 kW) and 20 plug (350kW) scenarios. $0 assumes cost are covered by a subsidy or grant.
Construction and equipment installation cost per type 1 station [$]	$0 - $25,000 $0 - $25,000 $0 - $25,000	Industry estimate. Costs include site preparation (excavation, boring, concrete cutting), lighting, shelter, and signage equipment and installation, curbing, asphalt paving and striping, and landscaping. Costs also include conduit and cabling installation, electrical equipment installation, grid connection hardware and labor. Rural labor includes travel costs. From previous model. $0 assumes cost are covered by a subsidy or grant.
Energy storage cost per type 1 site [$]	$0 - $140k $0 - $438k $0 - $2.3M	Installed $500/kWh + $1,000/kW (Note: Replacement: $200/kWh + $200/kW in year 10 not used as model ends at year 10). From Idaho National Laboratory and NREL (REopt Model). $0 assumes cost are covered by a subsidy or grant.

Photovoltaic energy system cost per type 1 site [$]	$0 - $547K $0 - $1.25M $0 - $8.3M	Installed: $2.465/W O&M: $18/kW/year From Idaho National Laboratory and NREL (REopt Model). $0 assumes cost are covered by a subsidy or grant.
Electric utility upgrades and grid interconnection cost per type 1 site [$]	$0 - $20,000 $0 - $30,000 $0 - $50,000	Idaho National Laboratory estimate and validated by industry. Utility interconnection costs include line extension at distribution voltage. Transformers are utility property, so are priced separately. Separate meter section with current transformers. $0 assumes cost are covered by a subsidy or grant.
Lease and property transaction costs per type 1 site (one-time fee) [$]	$3,000 $3,000 $3,000	Idaho National Laboratory estimate.
Host site identification and screening and design per type 1 site [$]	$0 - $12,500 $0 - $31,500 $0 - $108,500	Idaho National Laboratory estimate and validated by industry-estimated costs associated with site selection and contracting with site host, screening, and design. $0 assumes cost are covered by a subsidy or grant.
Total number of type 1 stations [#]	1 4 20	Based on the number of plugs provided from Idaho National Laboratory and NREL (REopt Model).
Total number of type 1 sites [#]	1 1 1	Atlas assumption.
Charging Station Utilization		
Maximum number of charging sessions per type 1 station [sessions/year/station]	Low: 1,400, High: 12,754 13,398 21,009	Based on the Idaho National Laboratory estimate for initial utilization and accounting for the maximum annual growth of 10%.
Energy Usage		
Average charging energy per type 1 session [kWh/session]	Low: 8.2, High: 9.2, Max: 15 31 40	Idaho National Laboratory estimate. 1 plugs are 50 kW charging stations, 4 plugs are 150 kW charging stations, 20 plugs are 350 kW charging stations.
Energy used/sold [kWh/year]		

Maximum power draw (type 1 station) [kW/session]	50 125 140	Idaho National Laboratory estimate. 1 plugs are 50 kW charging stations, 4 plugs are 150 kW charging stations, 20 plugs are 350 kW charging stations. Divide peak monthly demand (50 kW, 499 kw, 2801 kW) by number of plugs.
Average time of charging session (type 1 station) [minutes]	Low: 10, High: 11 12 7	Atlas assumption based on average charging energy provided per session.
Charging Station Revenue [Operating Revenue - Direct]		
Per-energy user fee (type 1 station) [$/kWh]	$0.00, $0.20, $0.60 $0.00, $0.20, $0.60 $0.00, $0.20, $0.60	Atlas assumption (Revenue Model Applied).
Per-charge event user fee (type 1 station) [$/session]	$0, $4, $8 $0, $4, $8 $0, $4, $8	Atlas assumption.
Number of subscribers in first year [subscribers/year]	0	Atlas assumptions. Did not include subscriptions.
Annual growth rate in number of subscribers [%]	0%	Atlas assumptions. Did not include subscriptions.
Subscription fee [$/subscriber/year]	-	Atlas assumptions. Did not include subscriptions.
Electricity		
Electricity retail price in first year (type 1 station) [$/kWh]	$0 - $0.30 $0 - $0.24 $0 – $0.21	From Idaho National Laboratory and NREL (REopt Model).
Monthly electricity fixed charges (type 1 site) [$]	$78 - $276 $83 - $264 $85 - $265	From Idaho National Laboratory and NREL (REopt Model).
Annual compounded growth rate in electricity price (type 1 station) [%]	0.25% 0.25% 0.25%	Atlas assumption.
Share of onsite energy generation (type 1 station) [%]	0 0 0	Share of onsite energy generation was built into the electricity cost assumptions. Based on the number of plugs provided from Idaho National Laboratory and NREL (REopt Model).

Demand charge (type 1 station) [$/kW/month]	$0 - $22 $0 - $16.60 $0 - $18	From Idaho National Laboratory and NREL (REopt Model).
Demand charge threshold (type 1 station) [kWh/month]	0 0 0	Atlas assumption.
Maximum load at site excluding charging stations (type 1 station) [kW]	0 0 0	Atlas assumption.
Maintenance cost		
Annual maintenance cost as percentage of equipment value (type 1 station) [%]	BAU: 12%, PV: 12-27% BAU: 4%, PV: 4-14% BAU: 2%, PV: 2-34%	Industry estimate. $250 per charging unit per month. For PV/Storage cases, includes PV O&M.
Communications cost		
Annual communications cost (average per type 1 site/year) [$]	$1,200	Industry estimate. $100 per site per month.
Warranty Cost		
Annual warranty cost (type 1 station) [%]	12%	Industry estimate. Assumed 1% per month.
Host site lease or access cost		
Host site lease or access cost (average per type 1 site/year) [$]	$3,000	Industry estimate. Assume $500 per station per year
Additional Operating Costs	$0	
Sales, General, and Administrative [% of Revenue]	5%	Atlas assumption.
Percent Equity Funded [%]	40%	Atlas assumption.
Assumed EBITDA exit multiple	0	Atlas assumption.
Owner-Operator Cost of Equity		
Risk Free Rate	1.25%	Atlas assumption.
Market Risk Premium	10%	Atlas assumption.

Maximum Debt Term [years]	10	Atlas assumption.
Owner-Operator Cost of Debt (Long Term) [%]	8%	Atlas assumption.
Interest Expense Rate [%] (Revolving Line of Credit)	4.3%	Atlas assumption.
Income Tax Rate [%]	20%	Atlas assumption.
Projected Shares Outstanding (Millions)	1	Atlas assumption.
Current assets		
Accounts Receivable [% of Revenue]	5.0%	Atlas assumption.
Other Receivable [% of Revenue]	0.0%	Atlas assumption.
Prepaid Expenses [% of Revenue]	0.0%	Atlas assumption.
Non-Current Assets		
Intangibles (Goodwill)	0.0%	Atlas assumption.
Other Non-Current Assets	0.0%	Atlas assumption.
Current Liabilities		
Accounts Payable [% of Revenue]	12.0%	Atlas assumption.
Revolving Line of Credit [% of Revenue]	3.0%	Atlas assumption.

PRIVATE SECTOR PARTNERSHIPS

EV Charging Financial Analysis Input Field	1 plug 4 plugs 20 plugs	Source
Point of Sale Revenue		
Average expected revenue per customer per minute [$]	$1	Atlas assumption.
Maximum retail revenue per customer per session (type 1 station) [$]	$25	Atlas assumption.

Costs		
Annual customer revenue sharing agreement (from sales) [% of revenue]	10%	Atlas assumption.
Per station subsidy (type 1 station) [$]	$0 - $550k $0 - $1.3M $0 - $8.3M	Atlas assumption. Ranges based on capital costs of equipment, construction, installation, utility upgrade, etc. At 100, 50, and 25 percent subsidies.
Annual flat fee (paid to owner-operator) [$]	$0	

PUBLIC SECTOR PARTNERSHIPS

EV Charging Financial Analysis Input Field	1 plug 4 plugs 20 plugs	Source
Cost		
Public Sector Cost of Capital [%]	5.4%	Atlas assumption.
Public sector funded portion of debt [% of debt needed]	0%	
Public sector funded portion of equity investment [% of equity needed]	0%	
Non-shareholder contribution to capital (grants, etc.) [% of equity needed]	0%	
Other annual non-revolving support (grants, etc.) [$]	$0 - $550k $0 - $1.3M $0 - $8.3M	Atlas assumption. Ranges based on capital costs of equipment, construction, installation, utility upgrade, etc. At 100, 50, and 25 percent grants.

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