Intro

California is committed to reducing greenhouse gas emissions through various approaches. However, the two largest contributors to greenhouse yes emissions in California or transportation and electricity generation. California currently has X percent of check vehicle sales implants on burning internal combustion engine vehicles by 2035. At the same time, California is increasing the number of charging stations in the state, having over X currently and Y amount in 20xx. Electric vehicle technology has improved, and new vehicles can charge in X minutes. This is due to Level 3 charging, which can be as high as 350 kilowatts opposed to Level 2 charging, which is capped at 7.2 kilowatts. While this innovation has led to a higher practicality for electric vehicles, it also leads to more difficulty for the owners of these chargers since they can create a tremendous amount of loads very quickly. Most level two chargers consumers use are similar in load to an air conditioner. While California tries to increase clean energy penetration, it also needs to reduce the amount of GHG emissions produced by transportation through electrification. This leads to two conundrums: how will California add enough capacity for electrified transport, and how clean is the grid to minimize the amount of emissions associated with battery electric vehicles? One proposal to mitigate the strain on the grid is to keep electricity production and EV charging local by using microgrids. As microgrids and EV chargers become ubiquitous, it is crucial to study the economic and environmental impacts EV charging in particular fast charging, will have on microgrids.

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Results

The charging setup is modified in open Modelica for different layouts and scenarios. The scenarios are described in Table I. Scenarios 1 through 4 need to utilize the best represent a more typical setup at most EV charging stations. Scenarios 5 through 8 utilize the peak shaving abilities of a large BESS to mitigate the impacts on demand and emissions of EV charging, especially Level 3 charging. Scenarios 1 and 5 show a base case where only solar or solar and ABS are installed at a building. This is to control the experience and compare it with the other scenarios to show the impact of EV charging. scenarios 2 and 6 would be considered the more typical EV charging setup. Most commercial centers mostly use level 2 charging, which is relatively cheap and simple to install and does not have too much of a major impact. Scenarios 3,4,7,8 add one 50 kW charger to the setup. This represents the rapid adoption of fast charging and its impacts on commercial buildings. Each scenario is run independently of one other, and the power outputs of the different components in the simulation are shown in Figure 5. Each scenario’s power pulled from the grid is juxtaposed in Figure 6, and the daily CO2 emissions average from each scenario is shown in Figure 7. The emissions and electric price amounts of each scenario are shown in Table II.

Conclusion

Electric vehicle charging will have a significant impact on the electric costs and emission levels of a microgrid. Level 2 charging had and relatively minimal effect on costs, with 60 to 90% increase in electricity costs, which is not much considering that four level 2 chargers were used. However, just one Level 3 EV charger can cause double to quadruple electric costs. Level 2 chargers have a very small impact on demand charges even when all four chargers are running since the 7.2 kilowatts of each EV charger is way less and each has a max peak relative to the system. However, the 50 kW peaks created by the Level 3 charger nearly eclipse the demand for the HVAC units, and when both are in unison, it can double the maximum peak and the demand costs. This happens mostly at noon when each HVACS and EVs run simultaneously. Energy charges for both with and without the BESS are similar, albeit slightly higher with BESS. This is expected since BESS does not reduce energy costs, only demand charges with the flat rate used by the university’s utility company. Level 2 charging and significantly easier to recover the charging costs compared to Level 3 charging. The difficulty is that just 1 charging event that aligns with the other loads can easily double the price of that month's electrical bill. Implementing a Level 3 charging control system must prohibit users from utilizing fast charging at peak hours when charging one vehicle can cause major costs to the provider. Aside from the major cost differences, locally produced solar combined with EV charging has a huge potential to reduce CO2 emissions from transportation. Even when utilizing both level two and three chargers and no BESS, there's only a 42% increase and carbon dioxide emissions compared to no EV charging at all, Increasing volume from 21 tons of CO2 to 30 tons of CO2. The X amount of vehicle trips mitigates this slight increase in CO2 if combustion engine vehicles were used instead.