Mopping up *the* solar spill

Using optimized managed EV charging to absorb excess solar generation

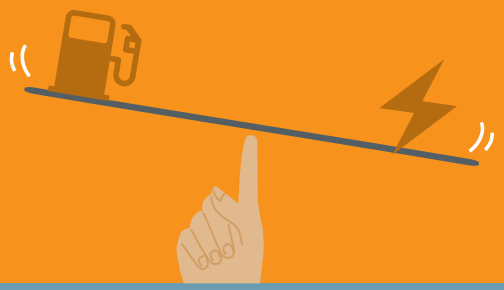
E Source

Emma Rieves

EVs can strain the grid … or strengthen it

Electric vehicles (EVs) are changing the electric grid, and they'll continue to do so as their numbers increase. And while EVs are heralded as an important step toward decarbonization, they can exacerbate peak demand periods—often powered by dirtier, nonrenewable resources—if their charging goes unmanaged. However, because EVs are a flexible resource, optimized **managed charging** can ensure that charging is coincident with solar output instead of peak demand. Pairing EV charging with unused midday solar is an opportunity to address pressing utility challenges, including increasing levels of **solar curtailment**, **negative pricing**, and potential demand increases associated with rising EV penetration. By siting those solar-optimized chargers at workplaces, you can unlock even more benefits for customers.

Don't wait for the sun to set on this opportunity: now is the time to start planning for and implementing workplace managed-charging programs for the benefit of the grid, your utility, and your customers.



Managed charging is the ability to schedule EV charging based on a variety of grid- and customer-level factors in real time.

Solar curtailment is the process of reducing solar production below its capacity due to low demand.

Negative pricing occurs when electricity generation exceeds demand. When it's cheaper to give energy away or pay others to take it rather than to curtail the resource, wholesale energy prices can "go negative."

Managed EV charging can reduce solar oversupply when programs are designed for solar-optimized charging

EVs are a flexible load, made even more flexible by managed charging, which initiates charging whenever the charge controller receives a signal of favorable grid conditions. Currently, most managed-charging algorithms rely on price signals to schedule charging. Conversations with two managed-charging vendors revealed that they have yet to optimize charging on renewable energy penetration because customers aren't asking for it (or because their offering is new to market).

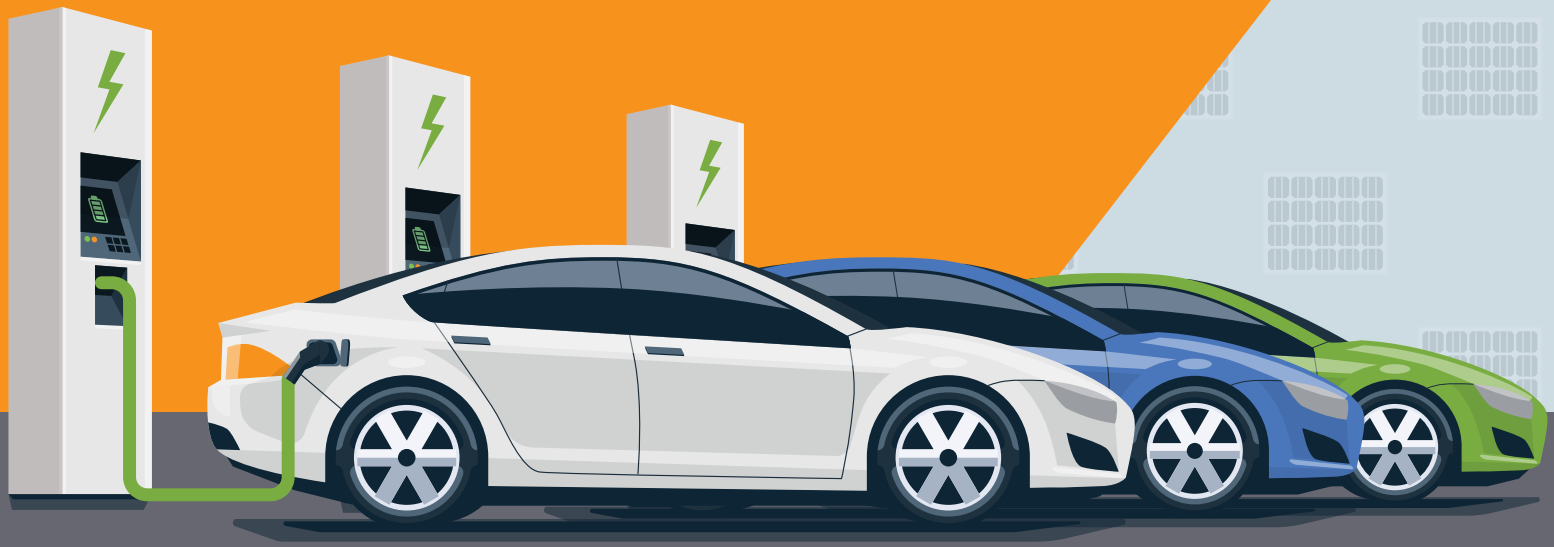
We're not aware of any managed-charging offerings using solar penetration or on-site solar production to optimize charging in commercial contexts, although Enel X's **JuiceBox Green 40** EV charger is capable of emissions-optimized charging on a residential level. But this presents an opportunity for daytime EV charging coincident with solar production to take advantage of excess power that might otherwise be curtailed.

The case for solar-optimized managed charging at workplaces

Solar-optimized charging is inherently time-dependent. Broadly, it's applicable in daytime periods that correspond with when the sun shines; on a more granular scale, the level of solar penetration varies daily and even on a subhourly basis. Therefore, implementing solar-optimized managed charging in practice requires several things:

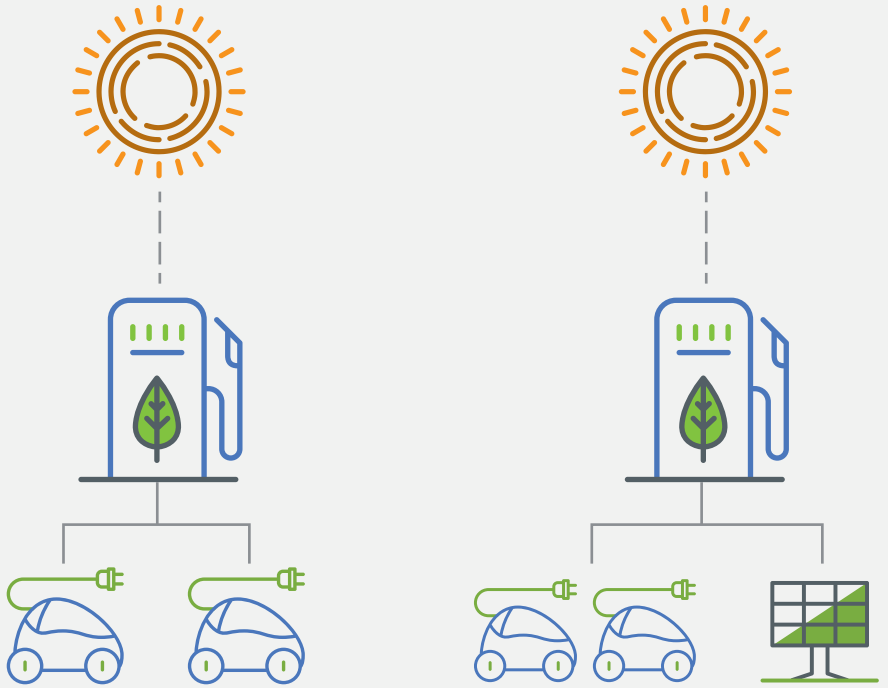
- A daytime charging period aligned with solar output
- A signal indicating grid-level emissions in real time
- Charging equipment conveniently located where people park their cars during the day

Workplace managed charging fits that bill.



Mopping up the solar spill with mobile storage

Through solar-optimized managed charging, EVs can mop up the solar spill—midday solar overgeneration—but unlike a typical mop-and-spill situation, absorbing excess solar generation provides more value than just removing a spill. Using EVs like mops doesn't just decrease curtailments, but it also adds value by creating demand and positive prices for midday solar and by better deploying existing renewable resources. These things add up to a cleaner grid.



New policies, a growing EV market, and the glut of midday solar make southwestern states an ideal proving ground for managed charging

EV penetration continues to increase, and so does EV load. The Lawrence Berkeley National Laboratory (LBNL) analysis Grid Impacts of Electric Vehicles and Managed Charging in California (PDF) estimates load growth from EVs could be 3,000 to 16,000 gigawatt-hours by 2025 in California alone, which represents a market penetration for light-duty EVs of 4% to 20%. This substantial load increase necessitates effective load management to prevent EVs from exacerbating peak demand and overwhelming the grid.

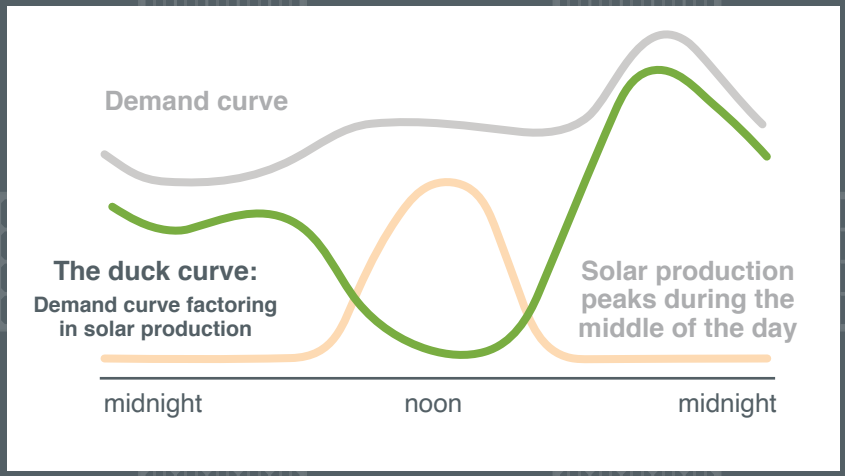
A growing number of states, municipalities, and utilities are committing to 100% renewable or carbon-free energy. As states, municipalities, and utilities make progress toward their renewable- and carbon-free energy goals, the grid will become cleaner. This makes EV managed charging an attractive opportunity because it reduces transportation emissions compared to an internal combustion engine vehicle (ICEV)—by displacing the emissions associated with gasoline—or even unmanaged EV charging.

California and other states—predominately in the southwest—increasingly need solutions that help mitigate the duck curve. The flexibility of EV charging makes it well suited to the intermittent nature of solar, especially when it comes to absorbing excess generation. In May 2019, the California Independent System Operator (CAISO) set a curtailment record, restricting 223,197 megawatt-hours of wind and solar; a month later, it set a record for solar generation at 11,363 megawatts. If there's no flexible resource capable of sopping up the midday solar glut, a great deal of existent and potential solar power will go unused. And aside from wasting carbon-free electricity, there's another huge downside to the overproduction of solar: negative pricing. In May 2019, CAISO prices were negative 14.4% of the time.

What's a duck curve

and what does it have to do with EVs?

The duck curve is a net load curve—the difference between forecasted energy demand and variable-resource energy generation—that gets its name from its resemblance to a duck. The belly of the duck curve reflects how solar production, which peaks midday, materializes as a drop in overall demand; the lower the belly drops, the higher the chance of oversupplying renewable energy that then needs to be curtailed or causes negative prices. The duck's neck is the steep ramp-up in demand from the afternoon drop to the evening peak, when grid operators need to quickly increase energy production—often using dirtier fuel sources—to meet increasing demand. **By using EV managed charging to absorb excess solar, EVs can "fill in" the duck's belly, which can help prevent solar curtailment or negative pricing.**



Managed charging reduces system costs and the need for renewable curtailment

In addition to reducing system costs compared to unmanaged charging, managed charging can reduce renewable-energy curtailments compared to a non-EV base case, unmanaged charging, and even EV charging on a time-of-use (TOU) rate. The benefits of managed charging are nonlinear and drastically increase as the market penetration of EVs increases.

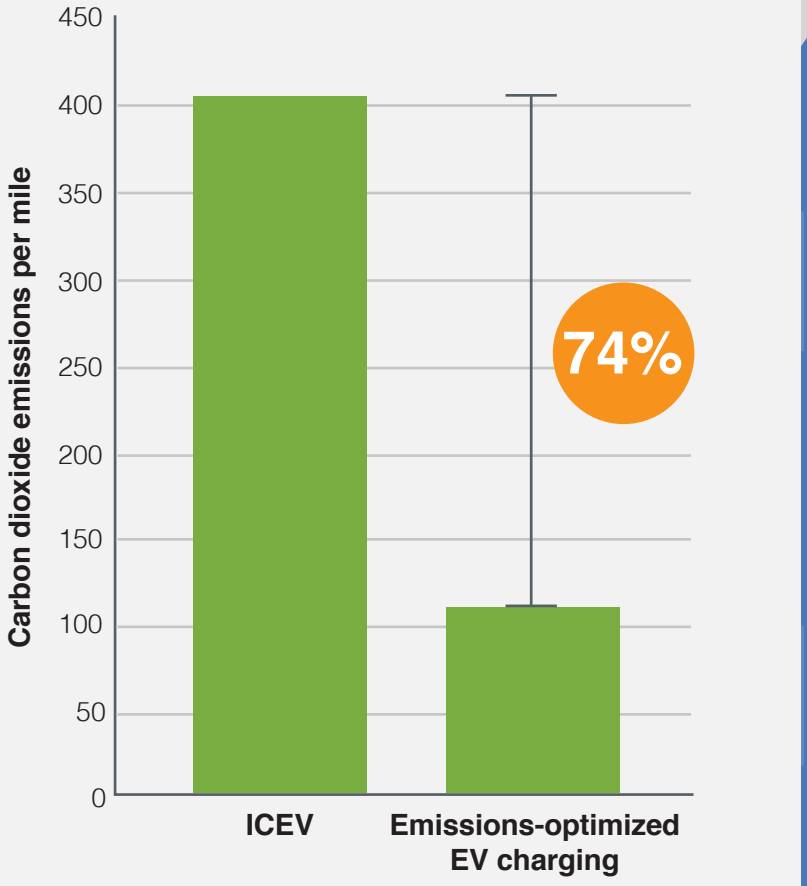
Managed charging reduces system costs compared to unmanaged charging by reducing EV charging coincident to peak demand, which might otherwise require building expensive new power sources, and by matching charging periods with renewable-energy resources that would otherwise be curtailed. In fact, researchers in the aforementioned LBNL study found that managed charging could significantly reduce renewable-energy curtailment compared to unmanaged charging in California. The reduction was even more significant compared to a non-EV scenario. The researchers also found that nighttime TOU rates could actually increase curtailment by not incentivizing or even penalizing charging during periods of high renewable energy.

	Low EV penetration (950,000 EVs adopted in California by 2025)	Reach EV penetration (5 million EVs adopted in California by 2025)
Avoided incremental cost of deploying EV managed charging compared to unmanaged charging	$83 million	$707 million
Reduction in renewable-energy curtailment compared to unmanaged charging	12%	48%
Avoided total system cost increase for each EV	$88	$141

Managed charging drives down emissions in a high-solar grid

While any jurisdiction can achieve greenhouse gas reductions through solar-optimized managed charging, solar- and renewable-rich grids—like California's—provide an especially promising stage for delivering deep emissions reductions. In September 2019, WattTime, a technology nonprofit that focuses on automated emissions reduction, published **How Emissions-Optimized EV Charging Enables Cleaner Electric Vehicles**, which investigates the emissions impacts of optimized managed charging in four generation mixes, including CAISO. The report concludes that the emissions impacts of emissions-optimized charging are significant on an annual and daily basis in CAISO—especially for daytime charging, which can take advantage of the abundant midday solar.

In fact, emissions-optimized charging reduces annual incremental emissions by **74%** compared to an ICEV, which is **9%** to **12%** more than with unmanaged charging.



Workplace managed charging is a win-win-win

	Minimizing expenses	Optimizing existing assets	Reducing emissions
Grid	Significantly reduces the need for costly investments in new energy infrastructure compared to other EV load-management scenarios	Creates demand for and increases the value of energy that would otherwise be curtailed or sold at negative prices	Makes better use of existing clean energy Reduces reliance on dirty peaker plants for on-peak EV charging Reduces emissions compared to ICEVs by displacing gasoline
Utility			
Business customers	Helps customers keep costs down by better managing their demand charges and, for businesses with on-site solar, better monetize the value of their solar	Serves as an effective corporate social responsibility measure or branding strategy, is a competitive differentiator, and increases employee satisfaction	Helps offset charging emissions and maximize the benefits of on-site renewable generation

Designing your managed-charging program for workplaces

Offer rebates and incentives for workplace charging equipment. The equipment should be capable of emissions optimization to maximize value for utilities and businesses. Level 2 chargers are the best bet for maximizing the value of workplace managed charging because charge time is long enough to wait out dirty power but short enough to ensure that people can leave with a full charge.

Encourage managed-charging providers to offer solar-optimization capabilities for commercial applications. While these capabilities already technically exist, they haven't been put into practice. Given the significant potential for emissions reductions that solar-optimized managed-charging provides and the increase in utility decarbonization goals, it's reasonable to make this a large part of what you're asking for out of a managed-charging solution.

Design rates that reflect grid-level conditions. If your commercial rate doesn't incentivize solar-coincident charging, your customers won't be motivated to participate in solar-optimized charging. Make your rate reflect solar conditions, which can take the form of a TOU rate with off-peak blocks that match periods with high solar penetration, or an hourly rate informed by real-time grid conditions.

Consider owning the charging equipment. You can reimburse your business customers for licensing, electricity, and other associated costs. This model can ultimately pave a pathway for vehicle-to-grid (V2G) charging when it becomes more technically and economically feasible to deploy at scale. This model can also allow utilities to monetize low-price solar by using this cheap energy supply and applying a higher retail rate for charging.

Make the charging stations highly visible. Doing so can encourage ICEV owners to consider purchasing an EV. Also make sure that EV charging stations are clearly marked to prevent other vehicles from occupying these spots.

Key takeaways

- Compared to unmanaged charging, managed charging can significantly reduce system costs.
- Managed charging reduces renewable-energy curtailment and facilitates better incorporation of existing renewable-energy resources, making the grid cleaner.
- Managed charging prevents charging coincident with system demand peaks, reducing costs and reliance on dirty peaker plants—emissions-intensive power sources used to meet peak demands.
- Workplace managed charging is an effective method for maximizing financial and environmental benefits for utilities, employers, and the grid.

Utilities and the grid face a slew of challenges that will only loom larger in the coming years, including:

- The duck curve and renewable-energy curtailment
- Expected increases in EV penetration
- Utility, state, and municipal commitments related to renewable energy and carbon reductions

Thankfully, solar-optimized managed charging in workplaces presents an opportunity to address each of these challenges simultaneously, while delivering cascading benefits to stakeholder groups. Now's the time to reconsider your approach and make workplace managed charging part of your portfolio.

For over 30 years, E Source has been providing market research, data, and consulting services to more than 300 utilities and their partners. This guidance helps our clients advance their customer energy solutions and enhance their relationships, while becoming more innovative and responsive in the rapidly evolving market.

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