Opportunities to save energy and generate revenue in shared mobility

New models for small-to-medium electric fleet operators

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As climate change and pollution become increasingly critical global issues, more and more on-demand and shared mobility businesses are evaluating when and how to electrify their fleets. If it were simply a matter of social responsibility, it would be an easy decision to make. But for most companies in this segment – especially small-to-medium enterprises (SMEs) – it's also a matter of economic viability.

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Executive Summary

Small-to-medium enterprises (SMEs) in the on-demand and shared mobility market segment that operate 50 electric vehicles (EVs) or fewer, continue to explore ways to secure savings on their rising energy costs and manage the peaks and troughs of their energy use. To achieve this without negatively impacting revenue, they schedule EV charging at set intervals between operating shifts. However, finding additional energy savings can be difficult.

We have found that investment in physical assets such as energy storage or energy generation may deliver incremental cost savings, but that in itself does not deliver an attractive return on investment (ROI) for businesses of this size. Solutions that offer peak demand management (PDM), however, may offer considerable value against the cost to implement them. Digitally enabled solutions could offer next-level PDM and return even greater value to these fleet operating businesses.

As these businesses continue to operate with growing peaks in energy demand, the grid infrastructure will face challenges in capacity, stability, and resiliency. There is an immediate opportunity for independent distributed network operators (IDNOs) to mitigate this threat by working with these businesses to stabilize their grid through investment in the peak management assets (such as energy storage) that businesses find uneconomical to invest in themselves.

One of the biggest opportunities for such SMEs to capitalize on their charging infrastructure is to right-size it and then to maximize utilization. There are many ways that businesses can do this. One way that could generate significant secondary revenue is by selling spare capacity through parking and charging services to other businesses that operate EV fleets. This can be enabled by leveraging relatively inexpensive digital platforms for marketing and scheduling the spare capacity.

The opportunities that exist today in this evolving EV charging ecosystem will change in years to come with the increasing penetration of distributed energy resources (DERs) in the grid and emergence of Energy-as-a-Service (EaaS) models. Increasing regulations for energy trading and data ownership will also have an impact. Businesses that are able to capitalize on these opportunities today will not only reap the economic rewards but will also play a significant part in guiding the evolution of energy policy in the electrification revolution.

Context

Around the world, traditional small-to-medium enterprises that operate fleets are starting their electrification journey, bound by the parameters of their local policies and energy tariff structures. For businesses such as taxi operators and courier service providers, flexibility in when they operate is limited. As these businesses electrify their fleets further, their electrical energy footprint will grow dramatically. With energy remaining a growing, unavoidable operational cost, many businesses are turning to industry experts to understand whether there are savings to be made from leveraging traditional and non-traditional energy assets, such as those that form part of ABB's FleetGrid solution.

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FleetGrid is an ABB solution that offers multi-variable, near real-time optimization to maximize customer benefits in fleet electrification.

It includes a software solution for EV fleet operators to achieve business goals such as cost, CO_2 emissions and vehicle minimum state of charge among many others. To deliver this, FleetGrid integrates tariffs, operational constraints, and the impact of weather on energy consumption by facilities and EVs. This solution is also able to interface with relevant software like route planning and scheduling.

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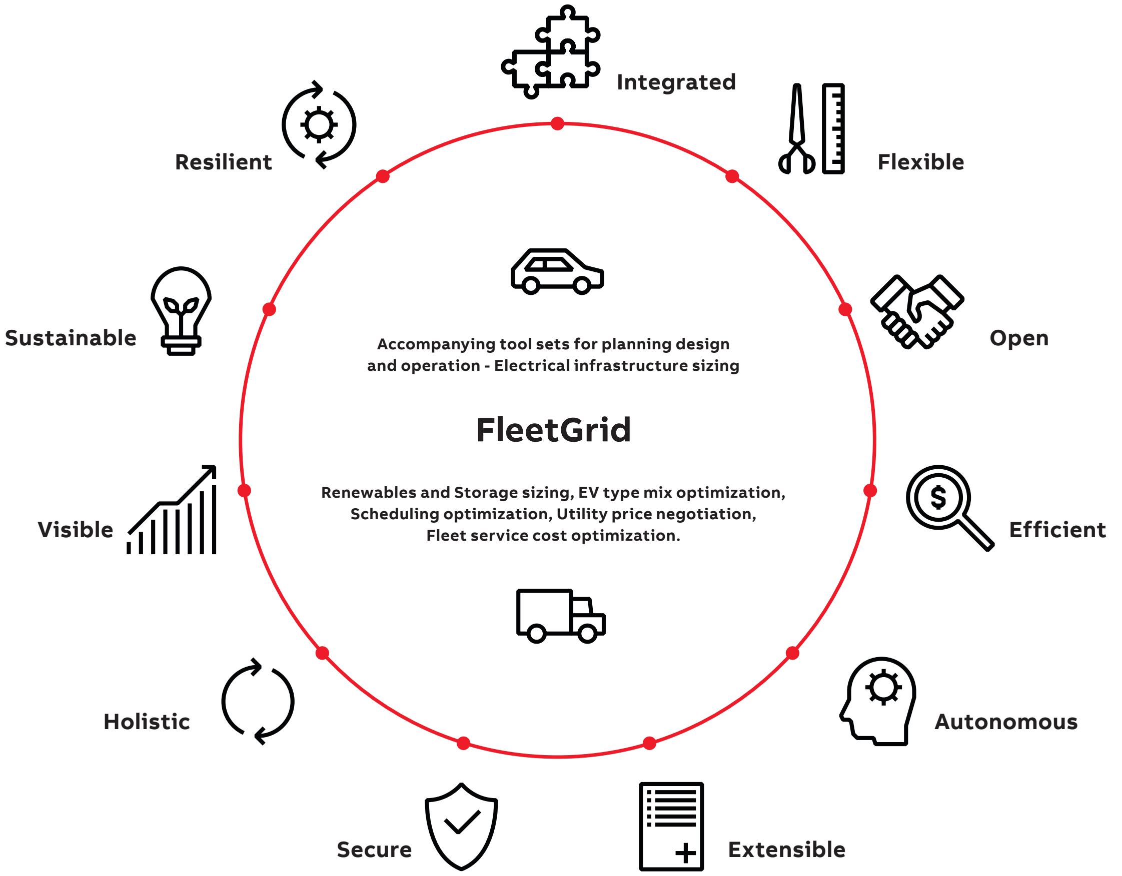
Figure 1: FleetGrid customer value proposition



ABB's FleetGrid solution delivers a suite of tools to optimize the planning, design, and operation of electrified fleets.

For businesses of this nature, who are unlikely to gain economies of scale on their operational energy savings as larger businesses may, we pose the question:

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Are there other valuable commercial opportunities to capture in this evolving market? Specifically, are there opportunities that not only focus on energy savings, but also deliver new revenue gains?

ABB has partnered with mtz - münchner taxi zentrum (mtz) in Germany to explore the opportunities around both energy savings and new commercial models that can be used within the market today. mtz is a taxi operator in the greater Munich municipal area, operating a growing number of full electric Jaguar iPace vehicles in a fleet of 100 vehicles. mtz's main hub, located in the urban outskirts of the centre of Munich, is today equipped with 5 chargers that power its fleet of 10 EVs.

As with many businesses, the decision to electrify mtz's fleet came down to both economics and corporate social responsibility. The company has pursued the electrification of the fleet in an effort to reduce its carbon footprint while leveraging the many incentives the local and national government bodies are providing, such as free inner-city parking and tax rebates. For mtz, the benefit of operating an electric fleet lies in reducing maintenance and repair costs without negatively impacting operating lifespan; with the latest projections, the forecasted lifespan of these EVs and their batteries far exceed prior expectations.

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"As a company with a large fleet that drives millions of kilometers every year, we see it as our responsibility to choose an ecological way to provide our service. Therefore, we decided in 2008 to switch our fleet to hybrid engine vehicles. In 2018, we were able to go the next step into an almost zero emission transport future with the introduction of the first e-taxi fleet in Germany. Beside the ecological focus, we also see a positive impact on the economical side, with reduced operating costs, especially when driving a lot of kilometers as we do in the taxi business. To operate optimally, we need to have access to a fast-charging infrastructure.

Together with ABB we were able to build up a charging solution in our facilities. The digital analysis gives us the opportunity to optimize the costs and revenues, to open the infrastructure to others, use power in a sustainable way and support the change into an e-mobility future – the starting point for the e-mobility hub."

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Gregor Beiner,
CEO, mtz - münchner taxi zentrum

Methodology

mtz and ABB partnered to study the opportunities to both save on the cost of energy and explore potential new revenue streams for mtz's EV operating site in Munich, Germany. The insights gained from this study can be applied not only to mtz but also a host of other SMEs that are seeking ways to maximize ROI as they electrify their fleets.

Replicating the core revenue model for the business highlighted the inflexibility of the charging schedule for mtz. Like most SMEs whose revenue is directly related to its mobility, time spent charging is inversely proportional to revenue.

Or to put it another way, time spent charging is time spent not earning money. As such, not only is the time at which charging takes place inflexible, but there is additional pressure to charge the vehicles as quickly as possible.

With charging schedules fixed, the energy profile of the business was analysed on an annualized basis for their existing fleet size of 10 EVs. We monetized the peak demand profile and corresponding energy consumption to show the annual cost of electricity for the business over the course of the year.

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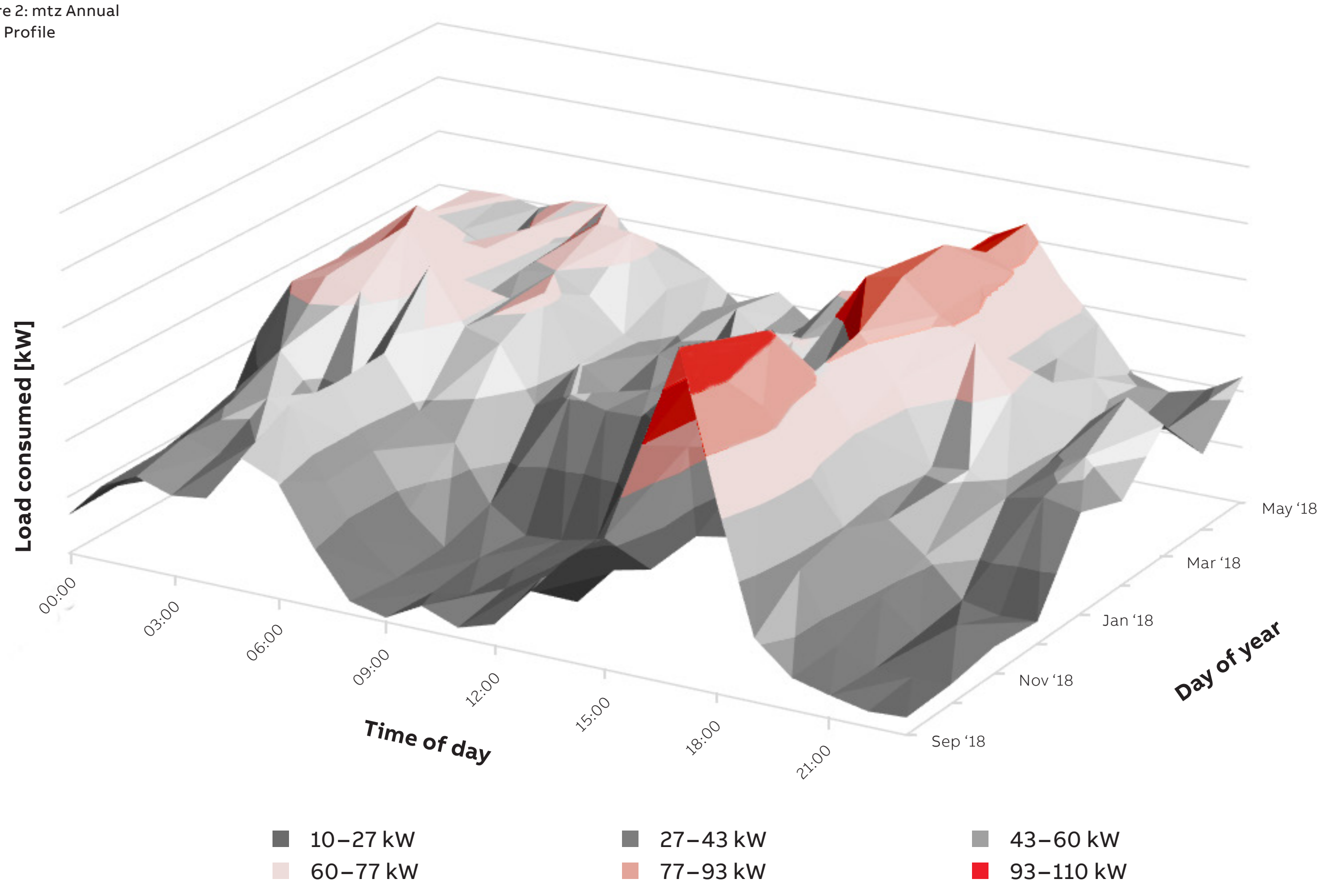
Figure 2: mtz Annual Load Profile



The energy load consumed by mtz varied by both time of day and time of year. There were two peaks during the course of the day throughout the year. In this case, the maximum peak power consumed exceeds 100 kW.

Following this, we simulated a number of ABB FleetGrid solution scenarios against the current operation to show the impact to energy and potential savings from including FleetGrid architectural components in the site energy infrastructure. The scenarios included:

1. EV Peak Demand Management (PDM) using duty cycling and/or rate-limiting during charging event
2. Existing Operations + PDM using Storage (20–100 kW)
3. PDM for EV site using storage (20–100 kW) as well as duty cycling and/or rate-limiting during charging event

Finally, we extrapolated the results for a growing fleet, with simulations carried out from 10 EVs and 5 chargers, to 50 EVs and 25 chargers in operation at the site for all scenarios in category 1 and 3. All scenarios simulated are listed in the Appendix.

The existing energy profile for the business operating 10 EVs was also analysed to determine spare charging infrastructure utilization, with and without PDM for EVs, on a daily basis. This showed the extent of utilization of the peak allowance and highlighted the “spare” power that the business was not consuming regularly throughout the course of a typical 24-hour period.

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“At ABB, we want to accelerate our e-mobility customers’ ability to capture new value by leveraging digital, integrated solutions. In an ecosystem becoming ever more congested with many different players taking on many different roles, speed may be the real differentiator that accelerates the pioneers past the stagnant incumbents to become segment winners. mtz has a focus on sustainability and a core business that depends prominently on mobility. For such customers, we need to make sure we can support their transformation in a way that enables them to achieve their strategic goals fast, and without disruption to their core business.

Working with mtz, we bring together our global network of expertise to test and develop solutions that can form a synergy with real businesses, today and tomorrow.”

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Roze Wesby,
Global Director Digital Transformation in Transport at ABB

Insights

The ABB-mtz analysis yielded five interesting insights:

Insight 1: Mobility-dependent SMEs will operate in shifts

Fleet operating businesses maximize their revenue by operating those vehicles when they need to meet demand. For taxi companies, customer demand for rides is cyclical; cars need to be available to take advantage of the two demand peaks per day, one in the morning and one in the evening. With the rare exception of a local event or disruption, this cycle does not change. For courier services, demand is highest during working hours. Businesses operating mobile services such as gardening, cleaning or beauty services follow distinct weekday and weekend shifts. Even in our “new” shared mobility car clubs, club members hire in predictable daytime, evening and weekend cycles. Businesses make profits by maximizing this revenue first and reducing their cost base second. Therefore, to capture this demand, vehicles need to be on the road for as long as possible during higher demand periods. For electric fleets, this results in a pressure to charge vehicles as quickly as possible when demand is lowest. Unsurprisingly, most businesses in this position plan and stick to fixed charging shifts.

Assuming this type of business knows how to maximize its revenue, minimizing costs is often the next step to maximizing profits. For electric vehicle fleet operators in the not-yet-autonomous world, the cost of energy is not their biggest expense. In fact, the cost of energy is significantly lower than the most expensive operational expense to the business – its people.

The cost of energy must also include the impact that our ever-increasing demand footprint has on our planet. Large and small businesses alike continue to expedite sustainability into the forefront of both strategy and operations.

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Minimizing the negative impact on our world by curtailing unsustainable energy sources and greenhouse gases (GHGs) or improving the efficiency with which we consume energy will continue to be paramount to our corporate social responsibility.

In many cases, this has been the catalyst for a business decision to transition an existing fleet from a conventional internal combustion engine (ICE) fleet to EVs.

Minimizing the cost of energy, while a nice-to-have, should never get in the way of first maximizing revenue, and second optimizing the spend on expensive resources. This is especially the case for smaller fleet operators of 50 vehicles or fewer who may not be able to gain significant economies of scale on energy savings alone. What energy savings can provide, however, is a maximization of profits after these two steps, and of course a better social impact even if there is a risk of small reductions in revenue.

Insight 2: Fixed shifts mean peaks are unavoidable but manageable

The cost of energy is made up of two components: the amount of energy consumed and the peak power demand that occurs during the billing cycle. In some geographies, the cost per unit of energy consumed depends on the time of day that the consumption takes place; energy is charged at a higher rate by utilities at peak times (typically day) than off-peak (typically night). This is consistent across Germany as well as many countries around the world. It should be noted that as energy demand increases for EVs as well as built assets that move away from traditional Heating, Ventilation and Air Conditioning (HVAC) systems and fuels, energy providers are continually revising cost and tariff structures for their customers. As such, utility tariff structures may become significantly more complex. Some utilities already present additional tariff components that vary with time-of-use, season and network load. Some also offer Demand-Response and Ancillary services to better manage network reliability and congestion, which can also impact costs for their customer. For the purposes of this study, mtz represents a typical business that operates a small fleet of electric vehicles against a relatively simplistic tariff structure. Operating with two shifts in 24 hours, the business has an energy profile as follows:

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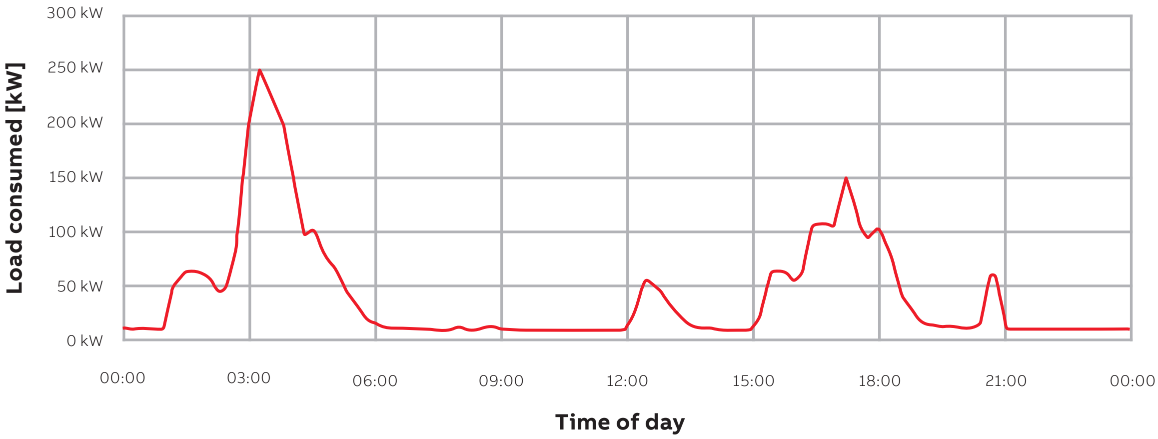
Figure 3: mtz Load Profile over 24-hour period



A simple view of the peaks of mtz's load against the grid in a 24-hour period.
The two major peaks take place before the morning shift begins, and again before the evening shift begins.

As discussed previously, businesses tend to set regular charging shifts to maximize revenue for the business.

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In an ideal world, the time to charge the fleet would be reduced as much as possible by using fast and ultra-fast charging technology to maximize the time on the road. Practically, however, the cost of the fast charging and ultra-fast charging infrastructure would rarely prove economically viable for a small fleet.

Not only is the technology expensive, but urban locations where SMEs operate continue to be challenged to find high-power lines to connect to, and often have to endure waiting times of three years or more for any new high-power cabling to be installed.

In highly fragmented markets such as Germany, more than 800 utilities offer energy services and countless network operators own and expand the transmission and grid networks. New high-power network decision-making in these areas is often even slower. It is hindered by both the economics of such an undertaking for a smaller business, and public lobbying against perceived disruptive work to deliver necessary upgrades.

To keep the EVs operational throughout their shifts, the charging facility needs to be able to deliver energy to the fleet against the load profile above. The total consumption of energy (kWh) that will need to transfer from the charging facility to the vehicles does not change, as the energy capacity of its fleet does not change. Also, as the time available to charge the fleet due to the fixed shift also does not change, this energy profile of peaks (kW) from the site to its fleet does not change.

Where an opportunity to reduce the cost of energy to the business does arise however, is between the first phase where power is taken from the grid to the facility, and the second phase where power is transferred from the facility to its charging fleet. While the cost due to energy cannot be impacted (as the energy consumed by the fleet is fixed), the cost due to peaks can be.

At peak times, rather than consuming energy directly from the grid, a site may be able to leverage technologies that store energy, generate localized energy on demand, or provide a combination of both. In the first instance, energy storage such as fixed battery assets, installed at the site in large containerized configurations, can be charged during off-peak times should the tariff support them. Then, during fleet charging periods, this additional energy capacity can be used to supplement the capacity that is taken directly from the grid to deliver against the demand profile of the fleet. This lowers the peak of energy being pulled from the grid and in turn reduces this cost component of energy for the business.

Alternatively, adding new energy sources on or near the site, such as photovoltaic cells (PVs), wind or river turbines, can also provide on-demand energy when combined with energy storage to reduce the demand on the grid. In most cases these on-premise new energy sources would be installed in conjunction with a battery to capture energy throughout the day and night, and to deliver it to the fleet during charging periods. Unlike using a battery alone, leveraging energy generating assets would reduce the total amount of energy taken from the grid. Using a combination of energy storage and energy generating assets would reduce the energy spend of the business by impacting both cost components – total energy consumption and peak power demand.

Leveraging any configuration of these technologies to successfully manage the peak critically requires a peak demand management (PDM) system. In fact, a powerful PDM solution can be used without any additional physical assets and still achieve significant dampening of the peak. This is because PDM solutions can control the energy demand of the chargers, or in other cases even control the flow of energy through the switchgear supplying the chargers.

Real-time, digital PDM solutions such as these have minimal cost with significant impact. They provide a powerful difference between a basic charging configuration and a smart system that delivers against real business ROI.

It is important to note that for SMEs with 50 vehicles or fewer, a combination of their urban location and facility size may make it impractical to install energy generating assets at or near their site – and such technology may be too expensive for such an SME to pursue. That makes digital PDM solutions all the more powerful for these businesses.

Through this study, we modelled the impact of leveraging different combinations of energy storage technologies with PDM for a site operating different EV fleet sizes, and the impact these technologies could have in reducing the peak demand profile of the business on the grid.

We can clearly see that with upgrades to storage size along with PDM, fleet operators can achieve incremental improvements to their peak demand profile from the grid's perspective, and therefore will achieve incremental energy savings.

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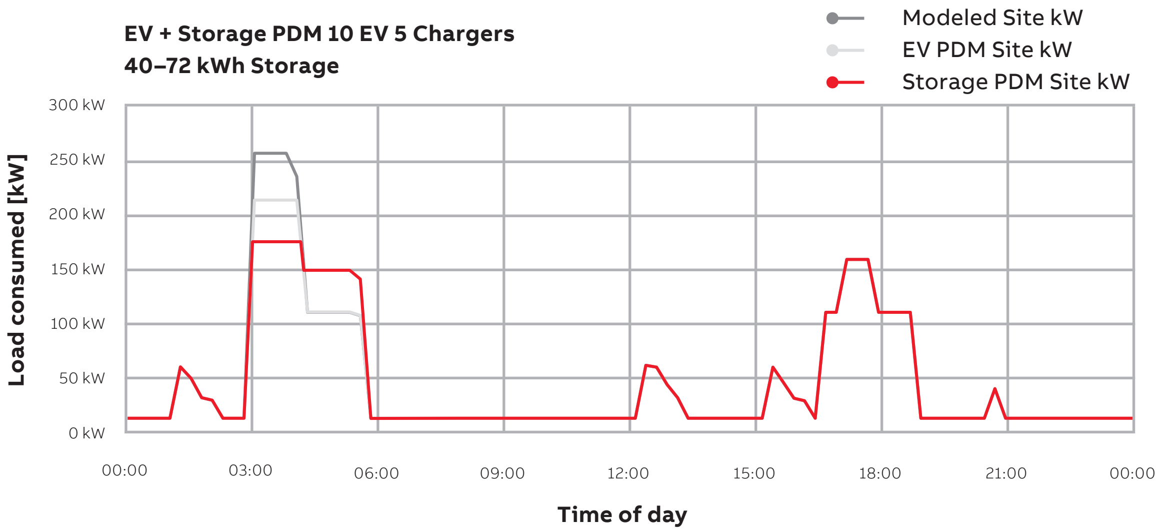
Figure 4: Load Profile – 24 hours without PDM, with EV PDM only, and with storage PDM only



The study modelled the impact to the peak load of implementing various PDM solutions. An EV PDM alone could reduce the maximum peak by 15%, while implementing storage PDM would reduce the peak by 32%.

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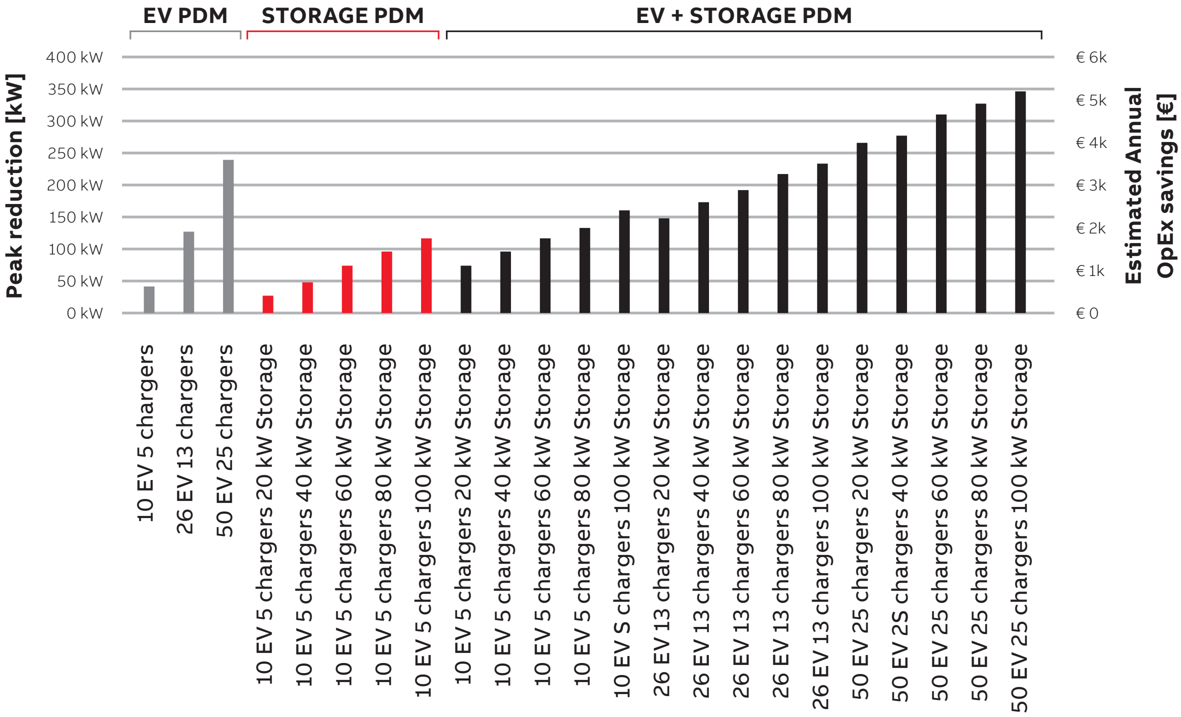
Figure 5: Operational expenditure savings for EV, storage and combination PDM for increasing fleet sizes



Incorporating PDM for EV alone, storage alone, or a combination of both can have significant impact on reducing peak loads. This peak reduction can lead to significant savings over the course of a year, especially for growing fleet sizes.

However, given the cost to procure and install physical assets such as the energy storage capacity modelled in this exercise, these incremental savings would not be sufficient to provide a reasonable return on investment time horizon for an SME of this size. In fact, in most cases the cost of procurement and installation of any physical hardware will far outweigh the savings reaped. This would suggest that the only economical investment by businesses of this size to optimize their energy consumption would be in PDM software solutions supported by smart charging and electrical infrastructure that can react to the software.

Insight 3: Shifting peaks away from the peak times of the local market could allow a business to save considerably on the cost of energy

Energy consumption for a typical municipal area peaks during the day. Some utilities capitalize on this by operating an energy tariff that varies throughout this period rather than offering one price per kWh of energy throughout the time period. When utilities meter and charge for energy during this period of high consumption, the cost can vary from one hour to the next, or even one minute to the next. In some places this kind of sophistication and granularity of the metering and charging model is only available on the wholesale market. In Germany, where this study took place, the retail energy market also uses this sort of dynamic pricing model; if the general loads are high, energy is relatively more expensive, and vice versa.

Operational businesses that consume energy under this model will interface with the utility through a marketplace, buying and selling energy in as near real-time as the utility and marketplace can guarantee. For these businesses, shifting the times at which they buy and use energy could not only reduce the price per unit, but in some instances could even lead to negative pricing; businesses could even be paid to take energy off the grid at the right time.

For a business, optimizing their EV charging shifts against this model can have a considerable impact to the cost of energy. These businesses may be able to shift their energy consumption to low or negative priced times and minimize the energy consumption of the business during high-price times. Should the business not be able to shift their operating schedule entirely, as many businesses cannot due to their market demand, leveraging the integration of battery assets may enable them to shift or reduce their peaks without impacting charging operations, and generate new peaks at low-priced times.

Insight 4: Utilities and IDNOs must secure the stability of their grid; investing in grid-edge static storage could be the answer

For typical utilities that are not paid on an efficiency metric, the fact that energy consuming customers are not investing in energy generating infrastructure is good. It keeps the customer from reducing their demand from the grid; more energy means more revenue, and so their business growth accelerates. It may also seem good to utilities that SMEs do not find it economical to invest in assets that will dampen their peaks, since higher maximum peaks mean higher rates for customers to pay. However, higher peaks may also weaken the stability of the grid, negatively impacting utilities and IDNOs. With relatively stable energy tariffs projected for the next few years across most major energy markets, businesses such as those discussed in this study are unlikely to change most business peak energy demand behaviour beyond a small optimization as PDMs become more prevalent. As the penetration of EVs (and other large energy-consuming

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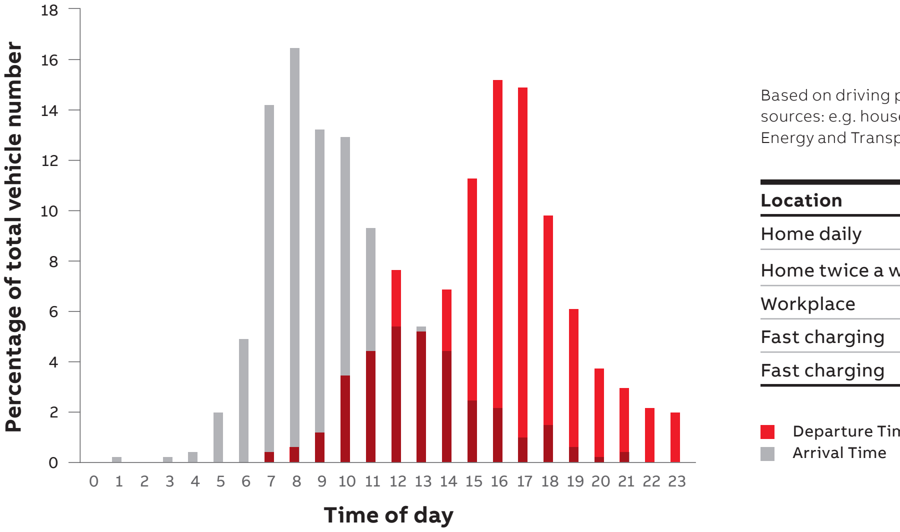
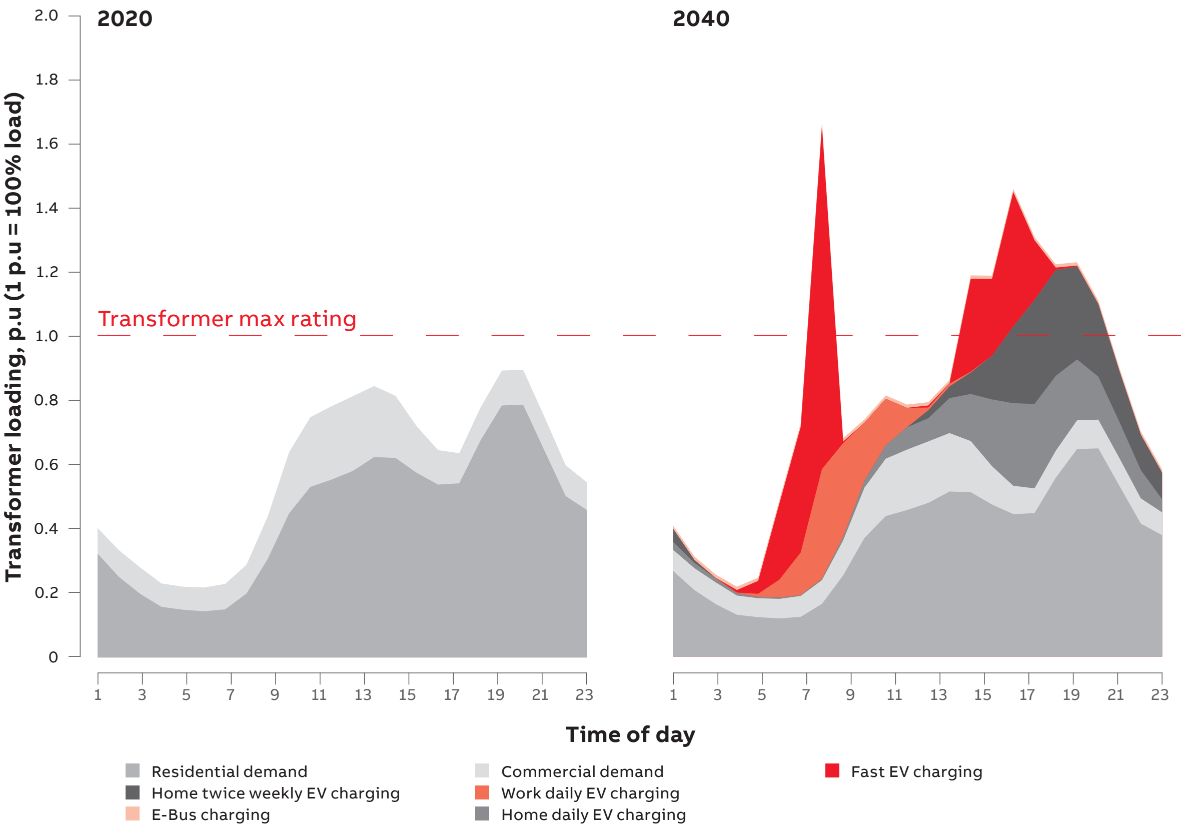
Figure 6: EV charging profile in Germany against transformer load, 2020 vs. 2040

Charging profile – Example of a driving profile for Germany:



Based on driving profiles obtained from public sources: e.g. household surveys by EC's. Institute for Energy and Transport.

Location	2020	2030	2040
Home daily	90%	60%	25%
Home twice a week	9%	25%	25%
Workplace	0.8%	10%	15%
Fast charging	0.2%	5%	35%
Fast charging	0.2%	5%	35%



By including the projected loading due to personal EVs, the transformer load is projected to exceed the transformer maximum rating by more than 60% in 2040 – causing wide-scale critical network failure.

assets) grows in the market, the peaks experienced by IDNOs are projected to increase considerably.

Every increase in the peak demand of the local grid places more strain on the existing energy transmission and distribution infrastructure, and also forces IDNOs to install sizeable and expensive upgrades to infrastructure capacity. Operating grid infrastructure with large daily energy swings is not only less efficient, it also causes a significant decrease in stability due to increased "wear and tear" from these extreme circumstances. This increases the need for maintenance and repair for the IDNOs and increases the chance of failures and subsequent outages. In markets like Germany where higher numbers of smaller IDNOs and utilities operate, this can prove particularly costly.

But in this great threat lies an opportunity: IDNOs and utilities, knowing that businesses may be unwilling to invest in uneconomical static storage assets to reduce their own peaks, could step in to introduce static storage at customers' business locations themselves. They may choose to do this to mitigate the future cost of reduced efficiency and increased maintenance, repair and upgrades should the grid become less stable from the impending growing energy demand. We know that this form of installation has value to the businesses that will be demanding those high peaks from the grid, and so may be willing and able to offer the physical space for the installation at their site for no fee at all. As a result, the utilities and IDNOs achieve a more stable peak demand (and reduce the adverse impacts of the ever-growing peaks), and the charging site operating business reduces their maximum peak demand (although nominal) without the cost of investing in infrastructure. This is a rare and powerful win-win opportunity for both players in this evolving ecosystem should these businesses be able to collaborate and negotiate such a deal.

Some utilities have attempted this approach, making battery assets a core component of their grid development strategy. While generally successful, events such as a recent fire at the Arizona Public Service Battery Facility, pose a number of questions related to the stability of the typical Lithium-Ion battery once these assets are connected and form part of the grid network. The ongoing challenge of public perception and municipal support will play a big part in the success of securing future installations.

Insight 5: Considerable additional value can be extracted by businesses that maximize energy utilization outside of business-critical charging periods

As discussed previously, managing energy demand peaks, while a worthwhile pursuit, is unlikely to offer SMEs more than incremental savings on their energy expenditure. If the shift patterns to charge the fleet are set, and the subsequent energy demand peaks are predictable (and perhaps somewhat optimally dampened by an economical PDM solution) it begs the question: how can a business extract the most value from its grid connection and EV charging infrastructure?

In Figure 7 we can see that during a single 24-hour period there are up to 20 hours in which the charging facilities are not occupied. Since the

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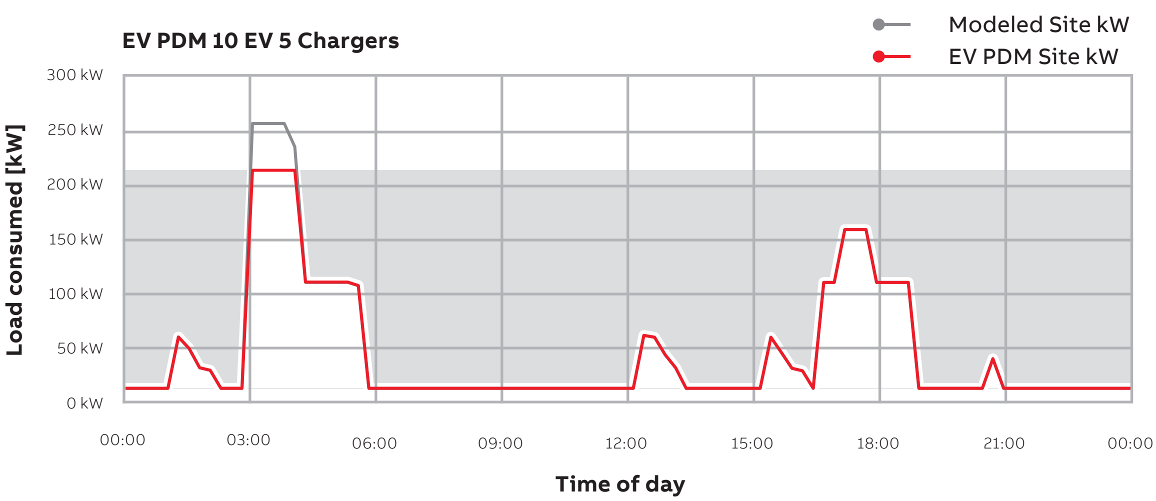
Figure 7: The mtz load profile – 24 hours with EV PDM for 10 EVs with 5 chargers, highlighting potential load available for secondary purpose



Significant unused load capacity could be available for an SME to capitalize on to build new revenue streams.

maximum peak is a major cost component of the energy expenditure, there would be no further penalty should the business operate under the natural business peak for the remaining 20 hours. In theory, this leaves a total potential additional load capacity in excess of 4000 kWhrs over a 24-hour period available for the business to capitalize on.

Businesses could capitalize on this spare capacity by selling it as a service to those who need it, whether consumers or businesses. As more people procure EVs for personal use, from typical 5-door urban cars and motorcycles to eScooters and eBicycles, urban consumers will increasingly seek out convenient opportunities to charge their vehicles. For other businesses that may likewise be undertaking their own transition to an electric fleet of perhaps light commercial vehicles (LCVs), simply finding higher-speed charging facilities in urban areas is a typical challenge. For them, leveraging the assets of businesses that have already undertaken the considerable investment in this supporting infrastructure to charge their fleet is a smart move.

From a legal standpoint, many parts of Europe (including Germany where the study was completed) continue to legislate around the rights of charge-point operators to offer energy or energy services to consumers and businesses. For businesses in many jurisdictions, energy resale is prohibited by law. However, some alternative business models do exist for businesses to sell certain types of energy services to other businesses, priced not by amount of energy consumed, but instead characterized by parking time with the provision of charge point infrastructure.

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If priced correctly for local demand, attracting customers to procure such services would allow the provider to capitalize on the value of their grid connection and leverage it as a new revenue stream that supplements their core business.

By increasing the utilization of their grid connection, this new revenue can provide considerable profit for the business once the cost of energy is subtracted from the fee paid by business customers. In doing so, the business becomes a charge point operator.

It is critical for businesses that wish to explore this opportunity to establish whether setting up the necessary processes and technologies to market and deliver this service on top of their core business activities makes economic sense. Fortunately, in most urban areas, the combination of the lack of charging infrastructure and increasing EV market penetration provides a ripe market opportunity. In addition, a significant capital investment is not required to leverage publicly accessible digital charge point databases or digital app-based booking systems. From a hardware standpoint, there may be some upgrades required to the systems, but most configurations need no more than a simple digitally-enabled meter to allow the business to measure and monitor their now rather variable energy profile. As long as the business can operate below their business-critical maximum peak for the remaining hours of the day and night, this new service can provide sustainable new revenue. mtz and similar SMEs wishing to pursue such a business model will also need to pay particular attention to the tariff structure that limits virtual load hours, or the total number of hours they operate at a defined level of power consumption.

For an SME operating five chargers, the business could offer services for up to 80%, or four vehicles per hour, for the remaining hours of operation. This would ensure they remain well below their maximum peak. Assuming a market demand of 50% of available capacity across the 20-hour period, the SME could gain revenue from demand equal to two cars per hour for 20 hours, or 40 car-hours over the period. The total daily profit therefore could be equal to 40 times the “parking” fee, minus cost of energy used and other expenses. Facilities with higher speed chargers could demand higher fees of their business customers – naturally these customers will also be consuming more energy. Should a parking fee be priced at €20 per hour, the additional daily revenue could total €800; not a trivial secondary income. Considering cost of energy and perhaps an additional resource to manage the operation, significant profits will still be secured by delivering this new service to the local business-to-business market.

Of course, if a fleet operator has room for additional flexibility in its shift schedule, the business could also stagger their own charging in line with demand cycles. This would allow them to improve their utilization of their charging assets and support them to power more EVs with the assets they have as they undertake the transformation of the remainder of their fleet. This allows the business to operate for longer without the need to invest in further charging infrastructure.

Finding opportunities to accelerate change and unlock value

In the electrification revolution, the impact of electrifying transportation varies dramatically for different types of businesses. Individual business challenges include the size of the fleet, availability of energy, type of utility tariff offerings and size and flexibility of the energy profile. Additionally, transformation for a fleet of ICE vehicles to EVs may depend on the geopolitical environment, climate and even traffic and road conditions. With a clear understanding that one size will not fit all, finding the best solutions to not only save on energy but generate new revenue depends on an expert understanding of the market and the possibilities around commercial opportunities it holds.

For ABB and mtz, our collaboration allows us not only to establish what is possible for our fast-evolving mobility operators, but also enables us to accelerate the pace of change in order to unlock the value these new digital technologies will bring businesses around the world.

Whatever your market conditions, solutions like ABB's FleetGrid are configured to accommodate your business needs and market conditions to deliver on your mobility strategy.

Let's write the future. Together.

Appendix

Simulation Scenarios
Simulation scenarios undertaken to project impact to energy and potential savings of inclusion of FleetGrid architectural components in the site energy infrastructure:

1. EV Peak Demand Management (PDM) using duty cycling and/or rate-limiting during charging event
2. Existing Operations + PDM using Storage
   a. Existing operations + 20kW Storage PDM
   b. Existing operations + 40kW Storage PDM
   c. Existing operations + 60kW Storage PDM
   d. Existing operations + 80kW Storage PDM
   e. Existing operations + 100kW Storage PDM
3. PDM for EV site using storage as well as duty cycling and/or rate-limiting during charging event
   a. PDM for both EV & 20kW Storage
   b. PDM for both EV & 40kW Storage
   c. PDM for both EV & 60kW Storage
   d. PDM for both EV & 80kW Storage
   e. PDM for both EV & 100kW Storage

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