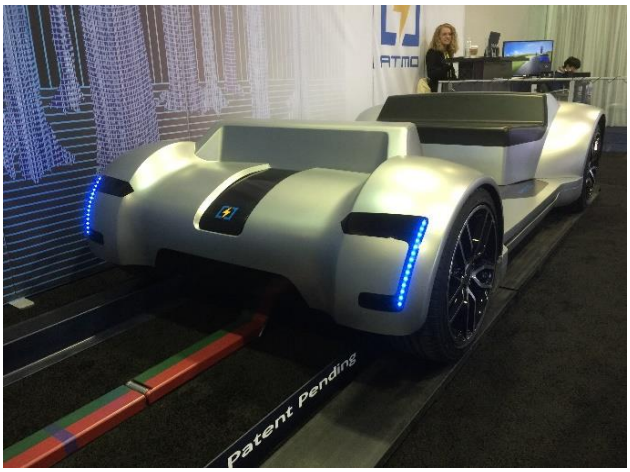
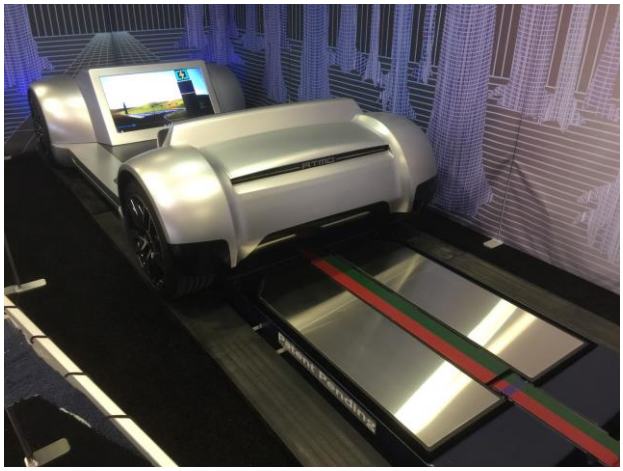
Electric Vehicles

Is your EV truly a modern wonder, or is it an old fat dog on a chain?

Ok, I admit it; I expected the market, the media and the industry to all come to a screeching halt and stare drop-jawed at our sleek EV battery swapping technology when we debuted it in January at CES in Las Vegas. I marched into that show thinking we would surely leave with new partners, funding, and loads of positive media coverage. Reality came crashing down on those beliefs as soon as we dropped the curtain on our display, and waited, and waited for anyone to take notice of us. We were swapping battery packs in 30 seconds with our demo car over and over again on the carpet, and nobody cared.



By the end of the show I was standing in the aisle blocking people as they passed in pitiful attempts to explain what we do to anyone who might give us a few seconds of their time. After a huge two-year build up that took all of my friend's and family's money and required major personal sacrifices from myself and my partner, the word "disappointed" didn't quite span the range of emotions I went through for the first month afterward. But as is the case for all those who choose to dust off and carry on, I learned much and began to see what needed to be done.



Last year, while focusing all of our energy on preparing the company for a debut, I assumed our roll-out path was paved for us; simply put, that the argument for battery exchange was not an argument at all, that it was clearly a superior method of repowering EVs to those who are "in the know" as they say. After all this was evidenced by boardroom decisions at VW, Renault/Nissan, and Tesla to pursue a battery exchange option while they were already tooled for plug-in only, they just failed to visualize an appropriate technology. So, the issue that has become apparent

to me now is, almost nobody is “in the know” about electric vehicles and the problems they face. The industry has been burdened with some very limiting realities with electric drive, and the message to the consumer has been necessarily trimmed to sell any EVs at all. This article will fill that void by shedding light on the real reasons behind high EV cost, the insurmountable barriers for plug-in-only EVs, and what it is to be *efficient* -not just electric. By the end of this quick read you will not only understand more about the industry, but see how battery swapping provides a complete solution to a cleaner electrified future.

I know you might think the electric vehicles produced today are a modern, sleek and a hip symbol of advanced transportation, but I am here to tell you they are old dogs on a chain. They run on extremely simple and aged technology which has the same enemies it had in the 1800’s, namely that batteries are heavy, they cost something, they take up space, and that many are needed to create satisfactory range. Laboratories have continued to produce smaller, longer lasting and faster charging battery cells, but millions of hours of research and billions of dollars of capital have yet to yield a light weight, high power-density cell. So, since there is no magical “cold-fusion” power source that weighs a gram and provides 300 kWh, electric drive systems are inherently heavy and that affects the cost to own an EV in a few market-pivotal ways. The first one to understand is that the high cost of manufacturing an EV, which is evident in the initial price of the vehicle, is more due to the dramatic increase in weight added by the batteries than the cost of the batteries themselves. So, the more range that is demanded by the buyer, the more weight is added, which must then be countered in a number of expensive ways.

If you can imagine the engineering required to build a sport sedan that sells based on style and road performance and then mash that (in your mind of course) with the engineering it takes to build a ¾ ton pickup truck capable of carrying you, your passengers, and 1500 lbs. of batteries, you can begin to see where the problem lies. A drivable electric sedan that can get close to 300 miles range per charge is essentially a super-duty, ultralight car that has to travel nearly fully loaded at all times. Now, for the sake of comparison, imagine whipping your Mercedes C-Class around a mountain bend with 12 people in it. Would it handle differently? I think so. But if that is your application of a C-Class, higher performance suspension and drivetrain, wheels, and added bracing should stiffen the car back up to near factory intentions, but hey, that’s gonna cost you mate! *Heavy Duty* + *Light Weight* = **High Cost Every**

Time. This cost is greatly reduced by incorporating a battery exchange option because satisfactory range is achieved by swapping the pack, not increasing the size of it. And before you complain that you don't want to trade weight for inconvenience, let me say… you won't.

I usually start every presentation by asking my audience for a show of hands from everyone in the room that will drive over 60 miles today. In my neck of the woods, which is the SF Bay Area in CA, I usually see two or three hands out of thirty. The fact is, the average motorist drives 29 miles per day over four trips in the US. So why does the market demand a 300-mile range EV? The answer: in case you need to drive 300 miles at any point during your ownership of the car and don't have time to charge batteries en route. This is why the term "range anxiety" has been widely adopted to describe this market barrier and not "range limitation." It is simply a concern that the purchase of an EV will constrain your freedom of movement at some point. The result is, the buyer is faced with either purchasing an expensive racecar built around a big heavy pack (that also takes a long time or a lot of energy to charge) or to purchase a limited range vehicle.

Enter battery swapping, and the option to purchase a lighter, less expensive and more efficient car appears. The buyer should only have to pay for additional range as needed, when needed, through seamless battery exchange.

We call this new feature,

"range-on-demand"

… because people *love* control. And let us not discount the plug… All electric vehicles are plug-in vehicles with the simple addition of a plug, and possibly an onboard charger, this includes vehicles that can also swap the battery out for a charged one instantly. So, owners will use their EV as a plug-in 80% of the time, benefiting from cheap power at home or work, and then make exchanges that are less inconvenient than being stopped by a traffic light when they need long range.

I bet you are wondering how “seamless” battery swapping can possibly be, given the bulky robotic failures that have tried and died in the past… plus, isn’t this at least as inconvenient as stopping for gas? And you don’t want to have to do that every 100 miles or even less… This is where the battle truly lies, not in whether or not battery swapping is a logically better choice (that much is clear), but whether or not we can make it convenient enough for the masses. Recognizing this from the beginning, we have developed an amazing harmony between autonomy, mechanism, and network, guided by strong values of modularity and simplicity to bring you a battery exchanging and charging system that is more scalable than the plug-in EV charger.

Fig.A

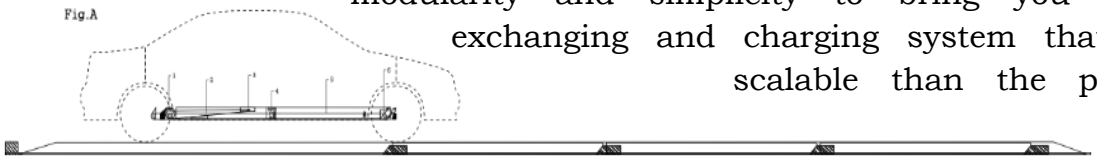
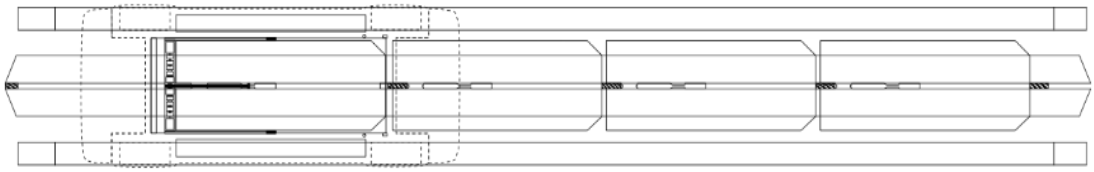
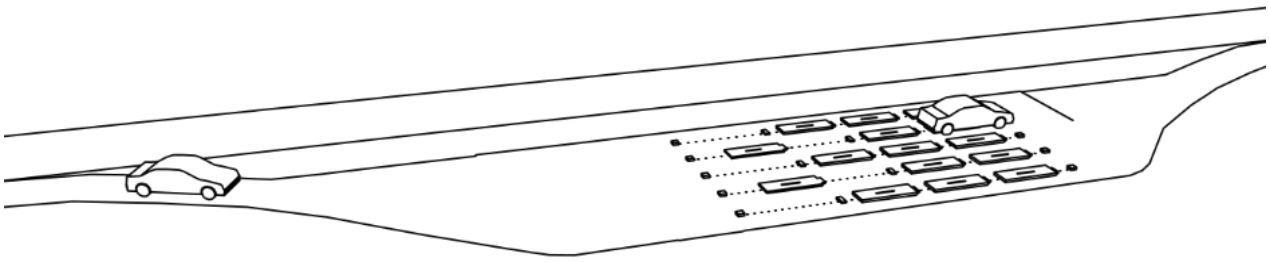


Fig.B



Our technology uses the vehicle itself under semi-autonomous control, via a small onboard auxiliary power source, to position depleted packs over an awaiting charge terminal equipped with a lift arm. It then calls to the terminal to retrieve the spent pack, rolls under auxiliary power to a charged pack, and finally, calls that terminal to insert it. The terminals are stationary and arranged inline so the vehicle can straddle the packs and terminals and travel over them one after another. There can be as little as two terminals lying in a parking space, or an infinite number in a plaza or along a highway. The terminals can easily be added-to or subtracted-from an extremely broad range of locations because **no groundbreaking** is necessary for the installation of our equipment. Further, this system is compatible with a wide range of battery packs due to a single, central engagement point, and vehicles are guided directly to a specific pack reserved for them by our routing network.

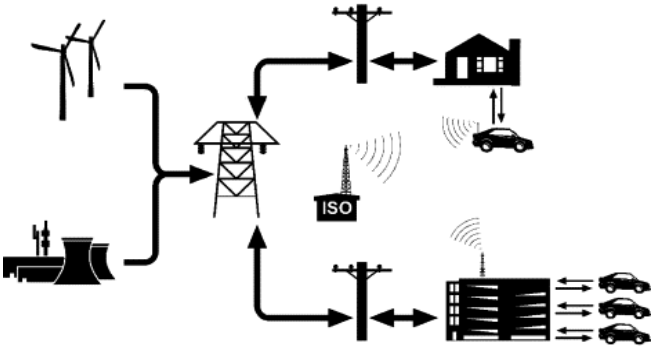


When a long-range route is selected for the vehicle, the necessary packs are reserved as long as the vehicle is en route. If the vehicle is being driven randomly around town and gets low on power, the vehicle will automatically create a route to the nearest unreserved compatible pack and notify the driver. Once at the site, the vehicle is driven up to the line of terminals, manual control is suspended and autonomous control then guides the vehicle through the process in 20 seconds, returning manual control at the exit of the line of terminals. This technology represents a new level of convenience as there is no driver involvement, there are endless location options (parking lot, side of road, home, alley, etc.) and packs are reserved ahead, so no searching and waiting. Beyond these advances in user experience, one can easily imagine how perfectly our system blends with autonomous electrified micro-transit vehicles, which will certainly be numerous in the near future.

Indeed, this system is so game-changing that the best way to introduce it to the world is to change the game with it. How? Solve a problem that no plug-in-only EV can really solve. Like powering bigger, constant duty fleet vehicles. These 5000+ pound trucks, vans, and SUVs represent half of all vehicles sold in the US, vans being the smallest but fastest growing segment of all, yet they have no electric option that can compete with any internal combustion (ICE) powered counterpart. These buyers are very lucrative for the industry because they usually buy more than one, and they need new vehicles every few years. The catch is, you can only sell them with numbers, they won't sacrifice the bottom line for a pretty face.

Back to the wonderful world of battery exchange. Firstly, we can get the job done and run electric vans and trucks all day for a competitive price, and secondly, we can optimize the network of exchange terminals for the customer because fleets usually run along established routes. Later, that network will sell private cars.

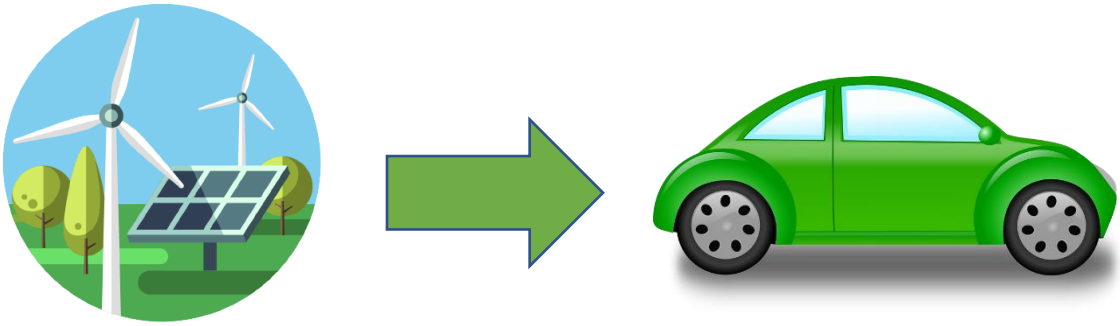
Plug-in-only options in this category have no ability to compete with ICE powered vehicles because the cost becomes impossible to overcome when a 300-mile range is necessary to make the sale. As an example, using the efficiency difference between a gas-powered sedan and a gas-powered van (1:1.75), and the Tesla Model S P100D as the benchmark 300-mile electric sedan option, a



pack capable of pushing a van 300 miles would need to be around 175 kWh. This would add 2500 lbs. to the vehicle (@14lbs/kWh) which would require a one ton van to now be a 2+ ton. Like I said, plug-in-only vehicles are old dogs on a chain, and they simply can't run with the pack.

All this weight has to be pushed around by energy at the end of the day, and energy is what we need to be spending *less* of if we want to move toward cleaner skies. The utilities are doing their part by innovating within the realm of the smart-grid, where new ways of generating, transmitting and spending energy are developing at a gallop. One of the key mechanisms necessary to give power companies more freedom in creating efficiency is storage, and not just a centralized block storage, but highly accessible and reliable micro-storage throughout the grid. Battery exchange stations not only provide this pack-to-grid micro storage function, but they will grow in number and coverage as the greatest sudden power demand jump in history unfolds; the mainstream adoption of electric cars.

Did you know that the average 300-mile plug-in-only electric sedan, during a complete capacity charge, will consume more power than a subdivision of 125 homes does over 24 hours? And if half of the US buys electric cars next year (half because the math is easier since there are two cars per household), the demand on the grid will increase by a factor of 15 (29 mi per vehicle @1.75mi/kWh:1.1kWh per household). That means each household that "goes electric" will increase their power consumption by an average of 30 times, and commuters will obviously draw much more. So, what can be done? In the same way that you purchase a high efficiency refrigerator, light-bulb or washing machine, you should drive a lighter car. Just because a car is electric does not mean it is efficient, and in the world of transportation, nothing affects efficiency more than weight. An average EV fitted with a 100-mile exchangeable pack will be more than 25% lighter than its 300-mile plug-in-only counterpart. So, do your part and don't drive an overweight vehicle.



Perhaps the best way to round out this article is a call to action. I hear people complain about the problems with electric vehicles on a regular basis, and it makes me wonder what is more important to the world, the cost and convenience of operating a car or the cost of pollution. Toxins are entering our food stream at ever increasing levels, the global temp is getting hotter, and people in parts of the world are living in a smoggy hell that was once a beautiful city. We can change this in an orderly fashion but electric transportation is an essential and fundamental first step. Unlike petrol, electricity is a currency much like the concept of cash. You can make it in many ways and spend it in many ways. So, while YES, it is true electric cars currently run on 67% fossil fuels in the US, in Norway they run on 98% renewable power. Making a transition now to electric cars will pump money into making much better and more efficient electric cars in the very near future (like the ones with our tech), which can then reasonably be powered by wind, solar, and hydraulic generation. Understanding this concept is essential to giving the auto industry the foothold it needs to painfully change its direction toward a cleaner future, free of smog, traffic, and potentially global conflict… a guy can dream.

Please take a look at the following links to learn more about Atmo Auto Power, thanks!

- **Website:** www.atmoclear.com **Email:** info@atmoclear.com

- **Videos:**
  - **Overview Ad:** https://youtu.be/lmKIbWVxPKs
  - **ALE in Action:** https://youtu.be/4ezn5MH8nfU
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