



# SOLAR FOR TRUCKS AND TRAILERS

The fuel costs faced by the trucking industry are a significant part of the expense to operate a tractor-trailer in North America. Over the past decade fuel has been as high as \$0.65 per mile driven and then dropped to \$0.34 by 2016. At these two points, fuel costs accounted for 39% and 21% of the total cost of operating a commercial vehicle respectively. The price per gallon for diesel as of June 2018 has now risen to around \$3.28 per gallon (\$0.48 per mile) from the 2017 yearly average of \$2.65.

In addition, the United States Environmental Protection Agency (US EPA) and the National Highway Traffic Safety Administration (NHTSA) have enacted greenhouse gas emissions regulations on commercial vehicles extended to 2030 that require manufacturers to develop and sell

technologies to improve efficiency. These factors have driven fleets, manufacturers, and others to improve the efficiency of over-the-road tractor-trailers.

Fortunately, myriad technologies that can cost-effectively improve the fuel efficiency of Class 8 trucks are readily available on the market today. Unfortunately, multiple barriers have stymied industry adoption of such technologies, including a lack of data about the true performance gains these technologies offer, and a lack of confidence in the payback for investment into these technologies. To overcome those barriers and facilitate the industry's trust in and adoption of the most promising cleaner operating technologies, the North American Council for Freight Efficiency (NACFE) produces a series of

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Confidence Reports, of which this report on solar for trucks and trailers is the sixteenth.

Interest in solar panels is growing among fleet managers because truck batteries are often no longer able to meet the power needs of today's trucks due to increased driver comfort demands, idle reduction regulations, and increased tracking requirements. However, because solar photovoltaic (PV) panels are so new to the trucking industry, many are unsure how to calculate payback when considering investing. The goals of this Confidence Report are to: (a) explain solar applications for trucks and trailers, (b) describe considerations to take into account when evaluating whether to invest in solar panels, and (c) create awareness about the major trends driving and influencing the field of solar technologies as applied to trucks.

## TECHNOLOGIES CONSIDERED IN THIS CONFIDENCE REPORT

This report only considers solar panels and associated systems that are currently available on the market for over-the-road applications. The panels differ a great deal from the "traditional" panels many are used to seeing in residential, community garden, or even utility-scale applications. Whereas those panels tend to be rigid and thick, the solar panels designed for the trucking industry are flexible, thin, lightweight, and capable of being affixed to the curves of a tractor fairing. The panels designed for trucks are also specially designed to handle more than the standard hailstorm—with most products capable of surviving intense vibration and thermal cycling, branches, and even truck washes.

## SOLAR APPLICATIONS FOR TRUCKS

Solar panels have applications both on the tractor and the trailer. The roof fairing of the tractor has historically gone unused and has ideal access to sunlight. The main uses of solar on tractors are to supplement battery HVAC systems and hotel loads without adding additional batteries.

**Battery HVAC support:** Battery HVAC systems have gained popularity thanks to increased driver comfort demands, idle reduction regulations and noise ordinances across the country, and reduced maintenance and operational costs (compared to engine-based systems). Solar panels can extend the runtime of battery HVAC systems, not only to help the HVAC system make it through the night without draining the truck's batteries, but also to reduce the load on the alternator the next morning, resulting in fuel savings. The solar system can extend the life of the batteries and dramatically reduce, if not completely eliminate, costly roadside assistance calls for dead batteries.

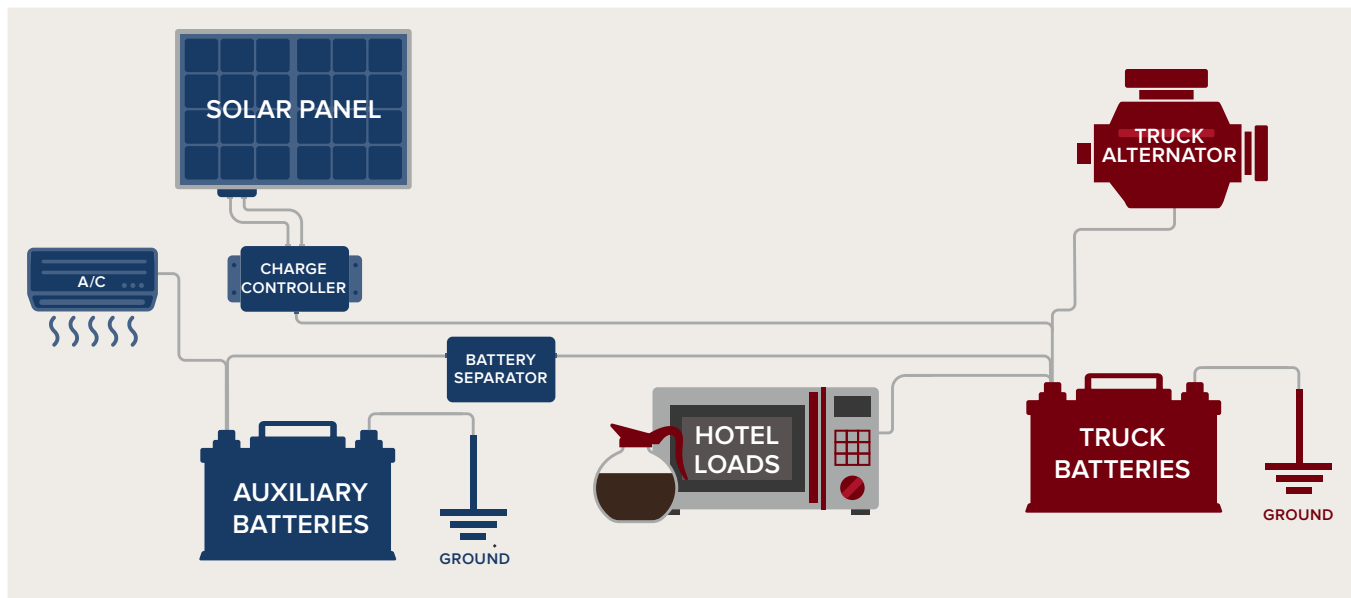
## METHODOLOGIES

This report's conclusions were generated through desk research and interviews with solar panel and cabin heating, ventilation, and air conditioning suppliers; tractor and trailer builders; and many large and small fleets with experience using solar. The study team also used the spring 2018 truck shows to meet with and learn from many of the key industry stakeholders.



FIGURE ES1

SOLAR PANELS CONNECTED TO TRUCK BATTERIES



**Hotel loads:** As electric devices and appliances such as refrigerators, TVs, coffee pots, and microwaves become more and more popular and more and more expected in cabs, these items can place an enormous load on the truck's electrical system. The combined load of all of these devices might only be sustained for about eight to 10 hours by a truck's batteries before reaching a critically low voltage. Solar panels can augment the energy coming from the truck batteries and maintain the batteries at a higher state of charge, extending the battery life and increasing driver comfort by allowing hotel loads to operate for longer periods of time.

Trailers have traditionally been powered by the seven-way connector between the tractor and the trailer, which powers brakes, running lights, and blinkers. However, as trailers have evolved, a number of other electrical loads have been added to trailers that make the electrical system significantly more complicated. Many of these electrical demands can be supported by solar panels. Solar applications for trailers include support for liftgates, telematics, and refrigeration units.

**Liftgate support:** The extra power available from the solar panel can augment that coming from the engine alternator, maintaining the liftgate batteries at a higher average state of charge, thus extending battery life. The solar panel may also make it possible to eliminate a DC-DC voltage converter to boost the voltage to the trailer batteries.

**Refrigeration and telematics support:** Some trailers are equipped with transport refrigeration units (TRUs) that have a battery dedicated to starting the small diesel engine that drives the refrigerant compressor when needed to maintain the cargo at the proper temperatures. The diesel engine in most units has an alternator to make sure the battery stays charged and can supply power to other trailer-mounted devices like telematics systems. A properly sized solar panel can provide additional current and battery charging capacity to help manage these devices, maintaining the batteries at a higher state of charge and extending battery life.

## BEST PRACTICES FOR EVALUATING SOLAR FOR YOUR FLEET

In evaluating the overall benefits of operating tractors and trailers with solar panels, one must consider factors such as total energy produced, fuel saved, wear/panel life, battery life extension, and a fleet's total energy profile when determining the total cost of ownership of the panels. The following should be taken into account when evaluating if solar panels are a good investment for your fleet:

- System installed cost
- Panel rating vs. physical size. In some cases, the area to mount the solar panel may be limited.
- The fleet's battery replacement rate
- The historic number of roadside assistance calls to jump-start or replace batteries

- Area of the country in which the vehicle predominantly operates

Specifically for tractors, considerations include cost savings due to reduced idling, less load on the alternator during normal tractor-trailer operation, increased battery life, and avoidance of emergency roadside assistance. There will also be savings due to driver satisfaction and retention, although that is harder to quantify. Tractor trade cycles should also be considered, as solar panel life is generally longer than the typical fleet trade cycle.

For trailers, considerations include analyzing electrical requirements for liftgates, refrigeration units, telematics, lighting, pallet jack charging, etc.; the duty cycle the trailer electrical system is likely to encounter; and cost savings due to increased battery life and avoidance of emergency roadside assistance. The average trade cycle in most fleets for trailers is typically longer than that for tractors, allowing the investment for solar panels to be spread over a larger number of years, potentially making the business case more viable.

## TRENDS INFLUENCING SOLAR FOR TRUCKS

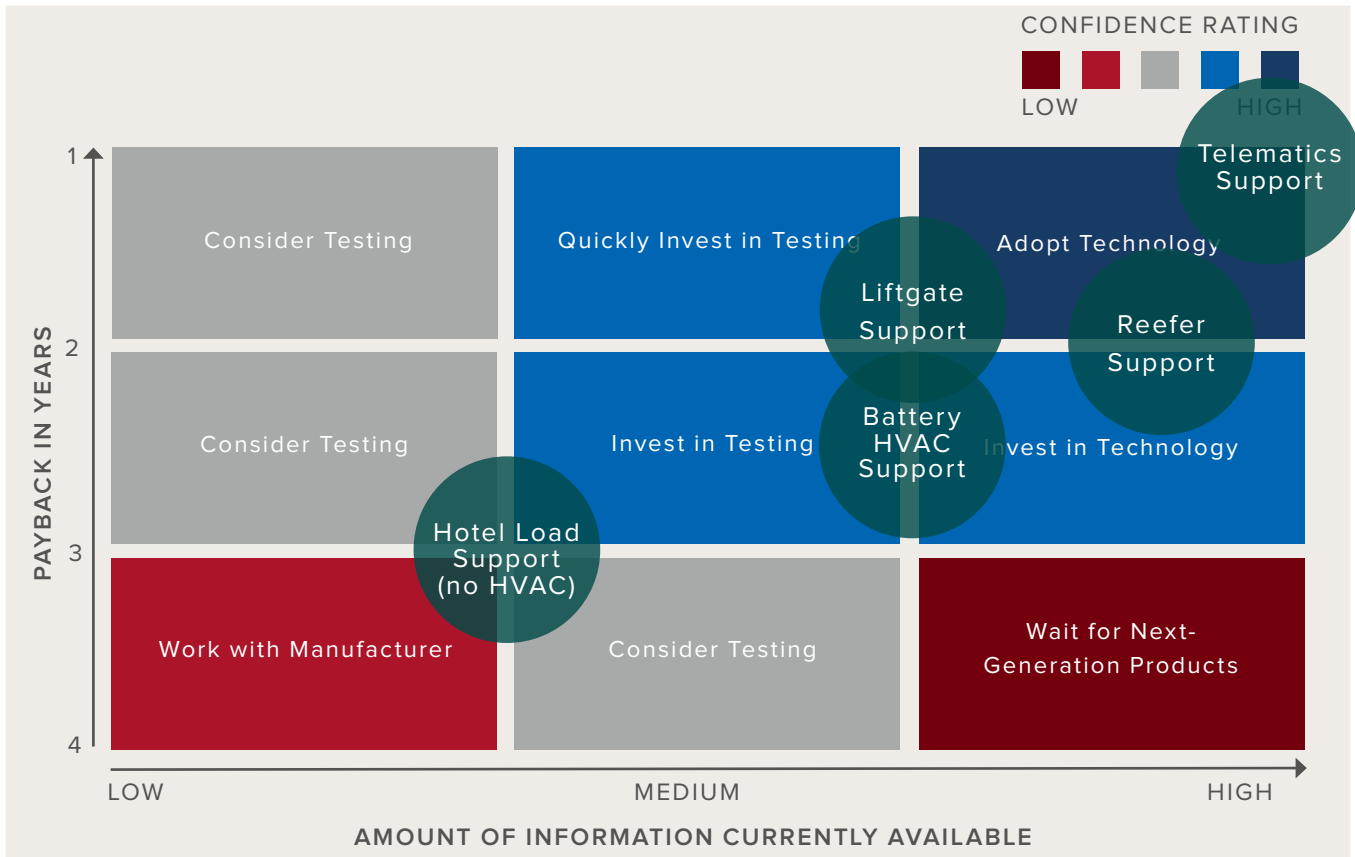
Some major trends are driving and influencing the field of solar technologies as applied to trucks including the shortage of truck drivers, hours of service regulations, the solar investment tax credit, solar tariffs, and even the emergence of commercial battery electric vehicles. Solar technology is also constantly evolving, and the future might lead to improved technologies, cost reductions, more electrification of trucking loads, and extended trade cycles.

## CONFIDENCE RATING

The matrix below indicates how confident the NACFE study team believes trucking fleets should be in the investment case for solar systems for various trucking applications.

Given these conclusions, NACFE believes that fleets should seriously consider investing in solar systems, following the best practices described in this Confidence Report. We think the application of solar panels on trailers with

**FIGURE ES2**  
CONFIDENCE MATRIX FOR SOLAR ON TRUCKS







extra electrical loads like telematics, refrigeration units, and liftgates make sense as a means of improving battery life and reducing the need for roadside assistance. This is especially true if the trailer spends long periods without being attached to a tractor. And the opportunity to extend the run time of battery HVAC systems makes installing solar for battery HVAC support a good solution.

## CONCLUSIONS AND RECOMMENDATIONS

After years of development globally and in North America, the status of solar systems for the trucking industry today and for the future can be summarized in four key messages:

1. Solar technology for trucks has progressed to the point where the panels on the market are flexible, thin, easily installed, and reliable. Some applications, like supporting the batteries for trailer telematics systems, are an excellent application of the technology and should be strongly considered for future purchases. For other applications of solar technology, the cost versus benefits should be evaluated to see if it makes sense in the specific application.
2. Fuel savings are generally a very small part of the overall benefit that comes from a solar panel installation.
3. Solar panel installations need to be sized appropriately for their intended application. For example, the size of a solar panel to support a battery HVAC system on a tractor might be limited by the area available on the tractor fairing, whereas a solar panel to support a refrigeration unit only needs to be large enough to provide a small trickle charge to the refrigeration unit starting battery.
4. We don't yet have hard evidence from fleets that the payback from the investment in solar panels matches that claimed by the manufacturers. We have verified that the benefits fall in several categories with the biggest benefits being from extending battery life and avoiding emergency roadside assistance for dead batteries. Many fleet users are happy with the investment they made and intend to continue to use solar panels in the future.



*“Frequently drivers would have issues with short run times on battery powered APUs. On many occasions drivers would find the battery bank wasn't fully charged at the beginning of their rest period, however with the addition of the solar panel the battery banks were ready when they were needed. The solar is also tied to the battery start bank which lessened the need for jump starts and service calls within the fleet.”*

-Allan Dahringer, MVT Director of Maintenance

For tractor solar panel applications involving sleeper cabs equipped with or without battery HVAC systems, we recommend using the payback calculator provided with this Confidence Report to help evaluate whether a system makes sense. This tool allows fleets, manufacturers, and anyone else to input various fleet-specific data into a calculator that economizes the benefits and consequences for specific operating practices.

Typical solar panel expected life is generally longer than the typical large fleet trade cycle for tractors and, to a lesser degree, trailers. Currently, the installation methods do not allow the transfer of a solar panel from one vehicle to another economically. If a solar panel installation could be easily transferred from one truck to another, it could be an advantage for the overall fleet investment. There could be improvements over time where solar panels could be incorporated into the fairings and trailer roofs to make the installation cleaner and less expensive.

**NACFE is always seeking to expand the data or case studies that we can provide to the industry. We invite you to share your own experiences with solar for trucks.**

*“Sitting here at the dock, in the hot sun, having solar power to keep my batteries charged and have the air conditioning inside the cab works out very nice since the addition of the [solar] system to my truck. It’s quite a contrast to the other trucks that are sitting here in the hot sun with their trucks idling away and not managing to save fuel while they’re sitting at the dock. It’s quite an advantage to use the sun itself to keep you cool.”*



—Henry Albert, Owner Operator,  
Albert Transport, Inc.



## NACFE

The North American Council for Freight Efficiency (NACFE) is a nonprofit organization dedicated to doubling the freight efficiency of North American goods movement. NACFE operates as a nonprofit in order to provide an independent, unbiased research organization for the transformation of the transportation industry. Data is critical and NACFE is proving to help the industry with real-world information that fleets can use to take action. In 2014, NACFE collaborated with Carbon War Room, founded by Sir Richard Branson and now a part of RMI, to deliver tools and reports to improve trucking efficiency. These reports include a series of Confidence Reports that detail the solutions that exist, highlight the benefits and consequences of each, and deliver decision-making tools for fleets, manufacturers, and others. As of early 2018, NACFE and RMI have completed 16 such reports covering nearly all the 85 technologies available.

[www.nacfe.org](http://www.nacfe.org)



## ROCKY MOUNTAIN INSTITUTE

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing.

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## GET INVOLVED

NACFE provides an exciting opportunity for fleets, manufacturers, and other trucking industry stakeholders.

Learn more at: [www.nacfe.org](http://www.nacfe.org)

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