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WHITE PAPER

Optimized Inverters vs. Traditonal String Inverters: Comparing the Data

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Executive Summary

Consumers trust smart energy experts to provide renewable technology that offers reliable value. The solar industry has recently seen bold claims about overcoming traditional string inverter limitations, sparking important discussions about technology evolution and performance standards.

DC-optimized MLPE (module-level power electronic) technology is known to outperform string inverters across several key metrics. With over 3.7 million SolarEdge installs globally, the advantages of DC-optimized MLPE technology, including superior safety, remain as relevant today as they were in 2015.

SolarEdge is committed to optimizing clean, renewable solar energy everywhere. We deliver on that promise with a technology ecosystem that generates up to 10% more power*, providing long-lasting benefits without compromising safety to cut costs.

In this whitepaper, we will demonstrate why the claim that traditional string inverters have substantially evolved is misguided and explore the data underlying three predominant advantages of SolarEdge DC-optimized inverters:

1. Value to Homeowners and Installers
2. Avoiding Operational Hidden Costs
3. Fewer Safety Risks and Liabilities

The Added Advantage of the SolarEdge Installer-First Business Model

We directly serve and sell to the world's leading installers.

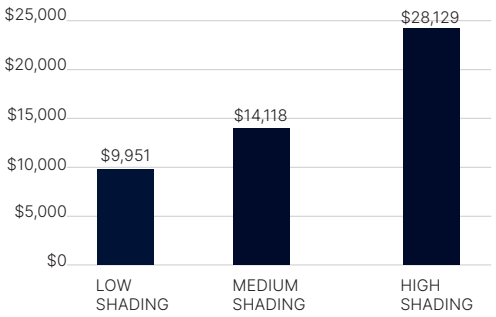
We're dedicated to an installer-first-and-only operating model. We're not in competition with our installers — we're honored to be partners. By supporting installers, we promote their business growth, allowing them to provide optimal homeowner benefits.

*Based on 5.16kW home in Alameda, CA and efficiency statistics derived from publicly available product specifications as of the date hereof.

Value to Homeowners and Installers

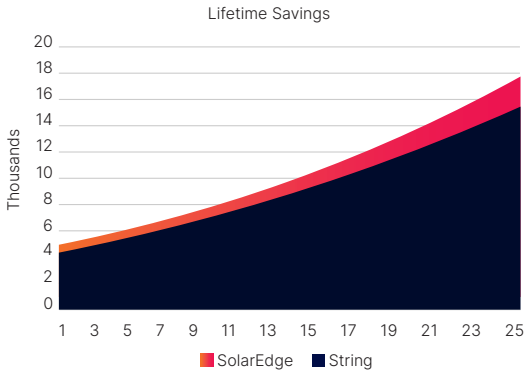
Optimized systems with MLPEs save $9,951 to $28,129 depending on shade conditions.

$9.95k to **$28k** in Energy savings**.

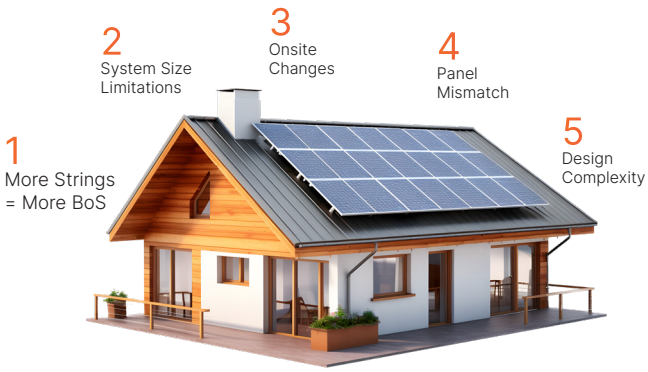


SolarEdge products deliver up to 10% more energy annually*, but in many cases, optimized system savings can be up to

12.8% more savings over a system's lifetime**.



Operational Hidden Cost



Traditional string inverters carry hidden design costs: higher balance-of-system (BoS) costs, string length limitations, and design limitations.

9.3% Traditional string systems are 9.3% smaller due to inverter design and installation limitations***.

Safety Risk and Liability

Increased Ongoing Installer Liability

Traditional string systems require periodic site inspections and put the onus on the installer to maintain UL 3741 compliance.

Dangerous String Inverter Voltages

Traditional string inverters carry potentially high voltages with no panel-level shutdown, potentially jeopardizing homeowners, installers, first responders, and property.

No Panel-Level Safety

SolarEdge SafeDC™ technology is designed to minimize voltage exposure risks by dropping optimizer voltage levels to a touch-safe 1Vdc. With Sense Connect, a proactive arc prevention feature, SolarEdge offers peace of mind where strings leave uncertainty.

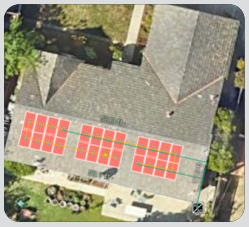
*Based on 5.16kW home in Alameda, CA and efficiency statistics derived from publicly available product specifications as of the date hereof.
**Based on over 20,000 sites pulled from NEM data
***Modeled in Aurora, 9.6kW PV system in Cupertino, CA, PG&E rates with 6% utility escalator and annual system degradation rate of 0.5%

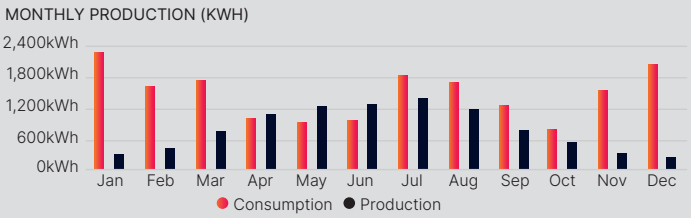
Value to Homeowners and Installers

SolarEdge sources monitor data from over 3.7 million residential installations worldwide. Combined with leading modeling tools, this data reveals that MLPE optimizer energy savings exceed traditional string system savings by up to $28,129*. This is particularly relevant given that nearly 70% of all US rooftops experience shading.**

Light Shading (Use Case 1)

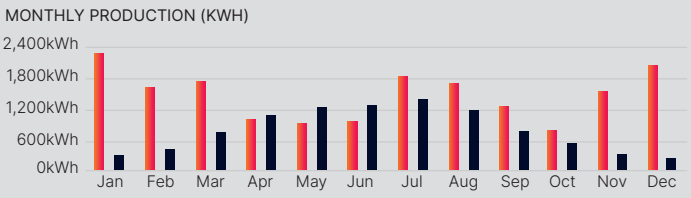
Up to
$9,951
or 2.7% Savings





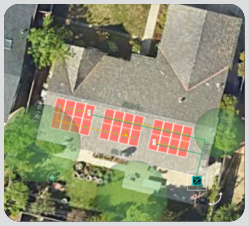
Medium Shading (Use Case 2)

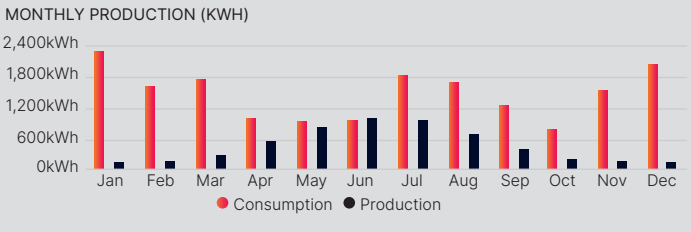
Up to
$14,188
or 4.5% Savings

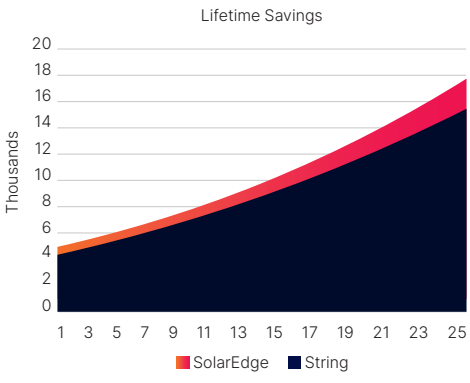


Heavy Shading (Use Case 3)

Up to
$28,129
or 12.8% Savings







7.6 - Average Shading Modeled in Aurora

Aurora modeling shows that MLPE systems achieve up to 12.8% more savings than string inverters, even in lightly shaded conditions. These returns motivate the world's largest third-party owners (TPOs) to power their systems with optimized inverters. TPOs recognize that MLPEs can consistently outperform string inverters and microinverters for maximum harvest over a system's lifetime.

*Modeled in Aurora, 9.6kW PV system in Cupertino, CA, PG&E rates with 6% utility escalator and annual system degradation rate of 0.5%
**NREL Photovoltaic Shading Testbed for Module-Level Power Electronics, Fig. 5.

Panel Mismatch

Panel mismatch is a persistent challenge in solar energy systems, often misattributed solely to shading. While shading is indeed a significant factor, it's not the only cause of string inverter inefficiency. In reality, any condition that creates discrepancies between panel outputs can lead to energy loss.

These discrepancies begin at the time of installation and tend to worsen over time. Several factors can contribute to module mismatch, including:

- Soiling
- Aging
- Damage
- Shading
- Manufacturing tolerances
- Azimuth variations and more

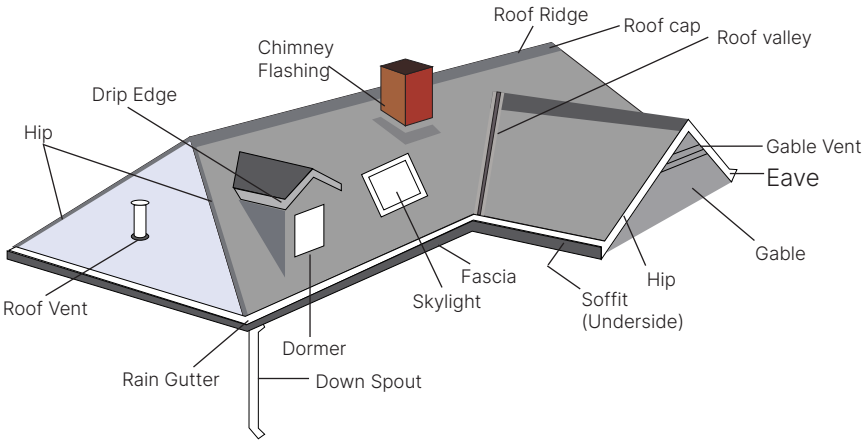
DC-optimized systems help to minimize these factors so that their respective impacts don't affect full strings: inefficiencies stay at the module level. In some cases, DC optimization have the ability to completely offset mismatch factors.

System Efficiency Comparison

Component	SolarEdge	Typical String Inverter
Inverter	**99%**	**97.5%**
Round-Trip Efficiency	**93.3%**	**89%**

SolarEdge's optimized systems outperform typical string inverters in efficiency. SolarEdge Optimizers achieve **99%** inverter efficiency, surpassing the **97.5%** efficiency of typical string inverters. Additionally, DC-coupled optimized systems have a higher round-trip efficiency of **93.3%**. Although some string systems are also DC-coupled, they only achieve **89%** efficiency.*

DC-coupled power optimizer technology, like SolarEdge's system, generates more power and savings for homeowners compared to traditional string systems, regardless of battery presence. When combined with other SolarEdge ecosystem advantages, these improvements can deliver up to 10% more energy annually.**



Adding One More Panel

Some manufacturers suggest offsetting energy losses by adding extra panels. However, this often fails due to space limitations or shading that affects the entire string's performance. For instance, adding a module next to a dormer might cause shading, impacting the whole string and negating the extra production.

In an optimized system, additional power from added modules boosts the system's output. Shading only affects the shaded module.

*Based on market data available as of November 2024.
**Based on 5.16kW home in Alameda, CA and efficiency statistics derived from publicly available product specifications as of the date hereof.

Larger Systems with Optimization

Optimized systems are, on average, 9.3% larger than string systems. That's better for homeowners and better for business.

SolarEdge's more than 3.7 million monitored installations worldwide demonstrate the benefits of MLPE during the system's lifetime. Analysis of data from these systems reveals that SolarEdge Optimized Inverters consistently support larger system sizes, producing up to 10% more energy for homeowners than traditional string inverters and helping to increase installer profit margins.*

NEM data displayed below provides evidence that SolarEdge systems outsize less flexible solutions by an average of 9.3% when normalized for inverter size (based on a 7.6kW inverter).

Inverter Vendor	Total KW	Number of Systems	Average System Size
SolarEdge Technologies	**133,666**	**13,938**	**9.59kW**
Traditional String Inverter	**68,752**	**7,822**	**8.77kW**

Operational Hidden Costs

SolarEdge sources monitoring data from over 3.7 million residential installations worldwide. Combined with leading modeling tools, this data reveals that MLPE optimizer energy savings exceed traditional string system savings by up to $28,129**. — particularly relevant given that nearly 70% of all US rooftops experience shading.***

1 More Strings = More BoS

2 System Size Limitations

3 Onsite Changes

4 Panel Mismatch

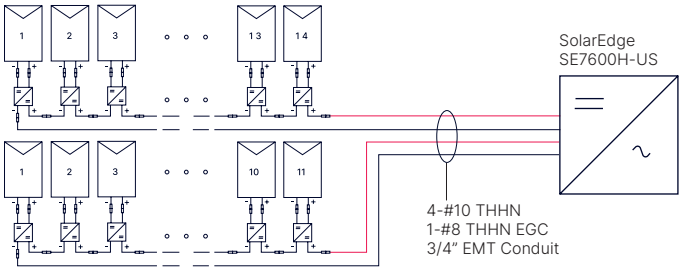
5 Design Complexity

Traditional string solar systems can present economic challenges due to unpredictable design and installation, leading to hidden costs for installers. This legacy technology's adverse effects on expenses and profit margins have led many smart energy experts to question its viability, prompting a shift towards more cost-effective solutions in the solar industry.

*Based on 5.16kW home in Alameda, CA and efficiency statistics derived from publicly available product specifications as of the date hereof.
**Modeled in Aurora, 9.6kW PV system in Cupertino, CA, PG&E rates with 6% utility escalator and annual system degradation rate of 0.5%
***NREL Photovoltaic Shading Testbed for Module-Level Power Electronics, Fig. 5

The Hidden Costs of String System Design and Installation

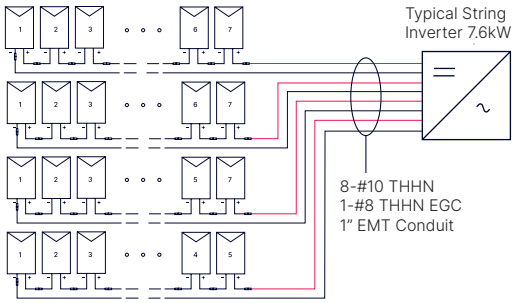
SolarEdge



Cost of a 60' home run from the PV array: $169.20
Only two strings required for a 25-panel system

VS

Typical String Inverter



Cost of a 60' home run from the PV array: $303.60
Four strings required for a 25-panel system.

More Strings. Higher BoS.

Traditional string systems often have low panel-per-string limits. This constraint necessitates more individual strings, raising BoS-related material costs.

The figure above shows how, for a 25-panel installation, a string inverter system would require four strings. By comparison, a SolarEdge DC-optimized system would only need two strings — at just over half the BoS cost.

Compared to optimized systems, traditional string systems face power and voltage constraints that limit production and complicate designs:

Power and Voltage Limitations*

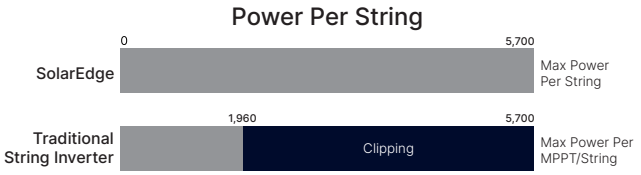
Traditional string inverters may clip power at the string level — sometimes as low as 1.96kW per system. In contrast, optimized systems are designed to produce up to 5.7kW per string without clipping.

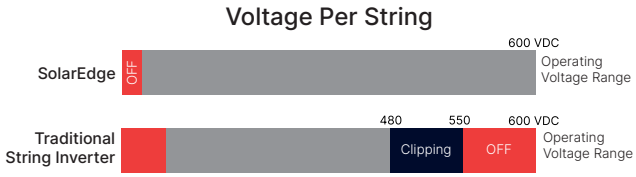
Design Criteria	**SolarEdge Home Hub Inverter**	Typical String Inverter
DC Voltage Per String / MPPT	**Optimizers ensure 8V - 1,05V per module, fixing the voltage per string to 370VDC - 420VDC**	60V - 480V for MPPT window
Power Per String / MPPT	**5,700W per string**	1960W per string

At lower voltages, traditional string systems need more voltage to begin producing energy, resulting in energy loss. Optimized systems are designed to start producing with less voltage.

At higher voltages, traditional string systems may clip power or shut down, whereas optimized systems are designed to continue producing power.

To avoid these issues, more strings must be added to traditional string systems, increasing design complexity and incurring higher installation costs than optimized systems.





*Based on market data available as of November 2024.

The Hidden Costs of Onsite Changes

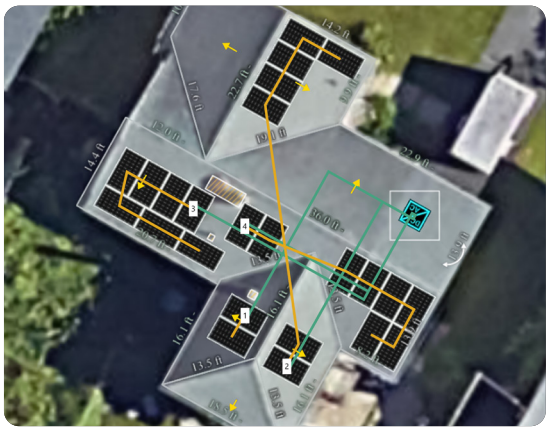
With MLPEs, moving a module onsite usually doesn't impact system production. With string systems, however, onsite changes often produce unexpected costs.

Traditional string system installers must exercise added caution during installs: moving a module can lead to shading, different azimuths, and other mismatches that cause production losses at the string level or systemwide. Commonplace onsite changes can result in lost output, higher homeowner costs, and potential rework expenses to address lost production.

Mixed Roofing Orientations

Roof arrays often span multiple orientations, especially in larger systems (see figure to the right). Traditional string inverters require all modules on the same Maximum Power Point Tracking (MPTT), to be on a common plane, limiting power extraction. Even with multiple MPPTs, string inverters face design constraints that can limit a system's size and power output.

By contrast, SolarEdge's DC-optimized system assigns an MPPT to each module. This full flexibility accommodates multiple roof orientations — even with as few as one module per orientation.



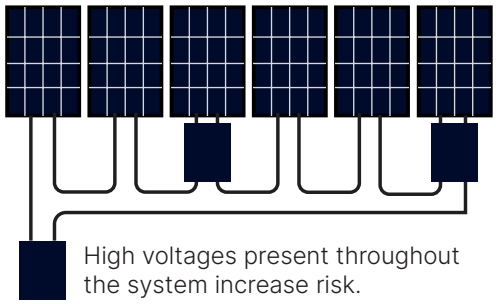
Safety Risk and Liability

The limited safety capabilities and design of traditional string inverters are often associated with life- and property-threatening thermal events. These setbacks have far-ranging impacts, compromising public faith in the solar industry.

Optimized inverting and MLPE technologies can mitigate these risks. Built-in features like rapid shutdown devices on every panel and proactive issue detection have enhanced system safety to restore smart energy market confidence.

Up to 600 Volts per MCI

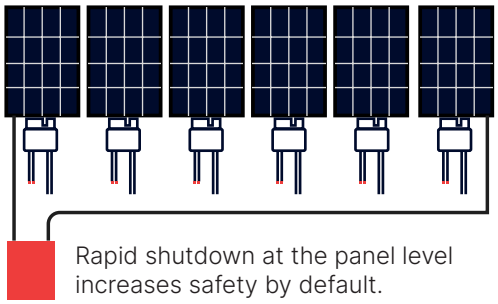
Typical String Inverter



High voltages present throughout the system increase risk.

1 Volt (Per Optimizer)

MLPEs

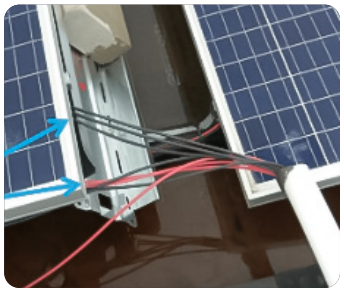


Rapid shutdown at the panel level increases safety by default.

SolarEdge Power Optimizers gained widespread adoption due to their inherent safety features, among other benefits. Power Optimizers limit human exposure to 1Vdc per optimizer during shutdowns, whereas traditional string inverters can expose people to potentially fatal 600Vdc during rooftop events like arc faults or wire damage. This safety advantage has prompted firefighters, standards bodies, and industry advocates to lobby against cost-cutting string-oriented loopholes that compromise NEC safeguards.

A Proactive, Situationally Aware Approach

System conditions like electrical arcs and thermal events can predict hazards and imminent failures. Sense Connect™ technology (embedded in SolarEdge S-Series Power Optimizers) is designed to detect and mitigate these events at the source. Sense Connect is engineered to sense temperature anomalies at the connector level and take appropriate action, such as alerting installers or shutting down the system before issues occur.



Meeting NEC and UL 3741 Codes Demands Added Effort with String Inverters

NEC and UL 3741 safety requirements cover both entire systems and individual components. Energy professionals using string technology must manage comprehensive compliance obligations, including PV hazard control system installation and monitoring.*

Compliance Founded on Zip Ties

While zip ties are common in PV systems, traditional string systems often rely on them for UL 3741 compliance. This method fails to isolate wires from metal components or provide continuous support, increasing damage and shock risks. Without MLPE devices, traditional string inverters could expose individuals to 600Vdc if plastic wire management fails. UV degradation of these plastic solutions necessitates regular inspections to maintain compliance.

String Technology Doesn’t Answer the Liability Question

MLPEs ensure UL 3741 compliance and module-level rapid shutdown, reducing voltages to touch-safe levels during issues like arcs, minimizing installer liability for rooftop safety. Traditional string inverters lack these features, shifting compliance responsibility to installers throughout the system's lifetime. Installers should consider this liability when choosing systems without module-level rapid shutdown devices.

*Solutions: **SolarEdge Technologies, Inc. "Cost Comparison: DC-Optimized vs. Non-DC-Optimized Solutions." SolarEdge Knowledge Center, 2023.**

The SolarEdge Installer-First Business Model

Installers and distributors should never feel forced to compete with their solar technology providers. SolarEdge provides an installer-first business model, treating PV professionals as partners, not competitors. Installers and distributors deserve tools and support to build efficient systems, meet compliance, and educate consumers. Some string inverter manufacturers' direct-to-consumer sales tend to create confusing bidding wars, benefiting only the inverter company and preventing installers from offering homeowners their best options.

- **Homeowners typically get bids from installers and manufacturers:**
  Installers who compete with their suppliers face unhealthy downward market pressure. Some offer self-funded discounts in a struggle to stay competitive.
- **Building strong sales teams carries a heftier price tag:**
  In a race to the bottom, sales teams offer lower prices to attract customers, reducing commissions and disincentivizing staff loyalty. Installers who want to increase retention often end up cutting their margins further to retain their key earners.

Key Takeaways

Economies of scale should work for smart energy professionals, not against them.

SolarEdge DC-optimized MLPE solutions offer up to $28K in lifetime savings, boosting energy production by as much as 12.8% annually.*

Some manufacturers leverage their brand recognition to dictate market prices, making competition risky for installers. In contrast, SolarEdge prioritizes installers, collaborating to better serve the industry and promote smart energy.

While traditional string inverter systems may have a lower initial cost, they are expected to come with significant drawbacks:

- Reduced generation potential
- Higher maintenance costs
- Increased upgrade fees

Successful professionals highlight MLPE's long-term financial benefits, helping customers see beyond the initial price tag to the bigger picture.

*Modeled in Aurora, 9.6kW PV system in Cupertino, CA, PG&E rates with 6% utility escalator and annual system degradation rate of 0.5%

Conclusion

Keep the industry moving forward

The solar industry's journey toward mainstream adoption continues to evolve. While traditional string inverters helped launch the residential solar revolution, DC-optimized systems represent the next generation of technology, enhancing safety through module-level monitoring and maximizing energy production through individual panel optimization.

SolarEdge's smart energy ecosystem does more than help reduce utility bills – it enables installers to build flexible, safe-by-design systems that deliver up to 10% more power each year.* Build your business around an ecosystem that helps increase savings, enhance safety, and promote sustainable growth through detailed performance data that empowers both homeowners and installers.

Learn more about SolarEdge Home.

*Based on 5.16kW home in Alameda, CA and efficiency statistics derived from publicly available product specifications as of the date hereof.

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