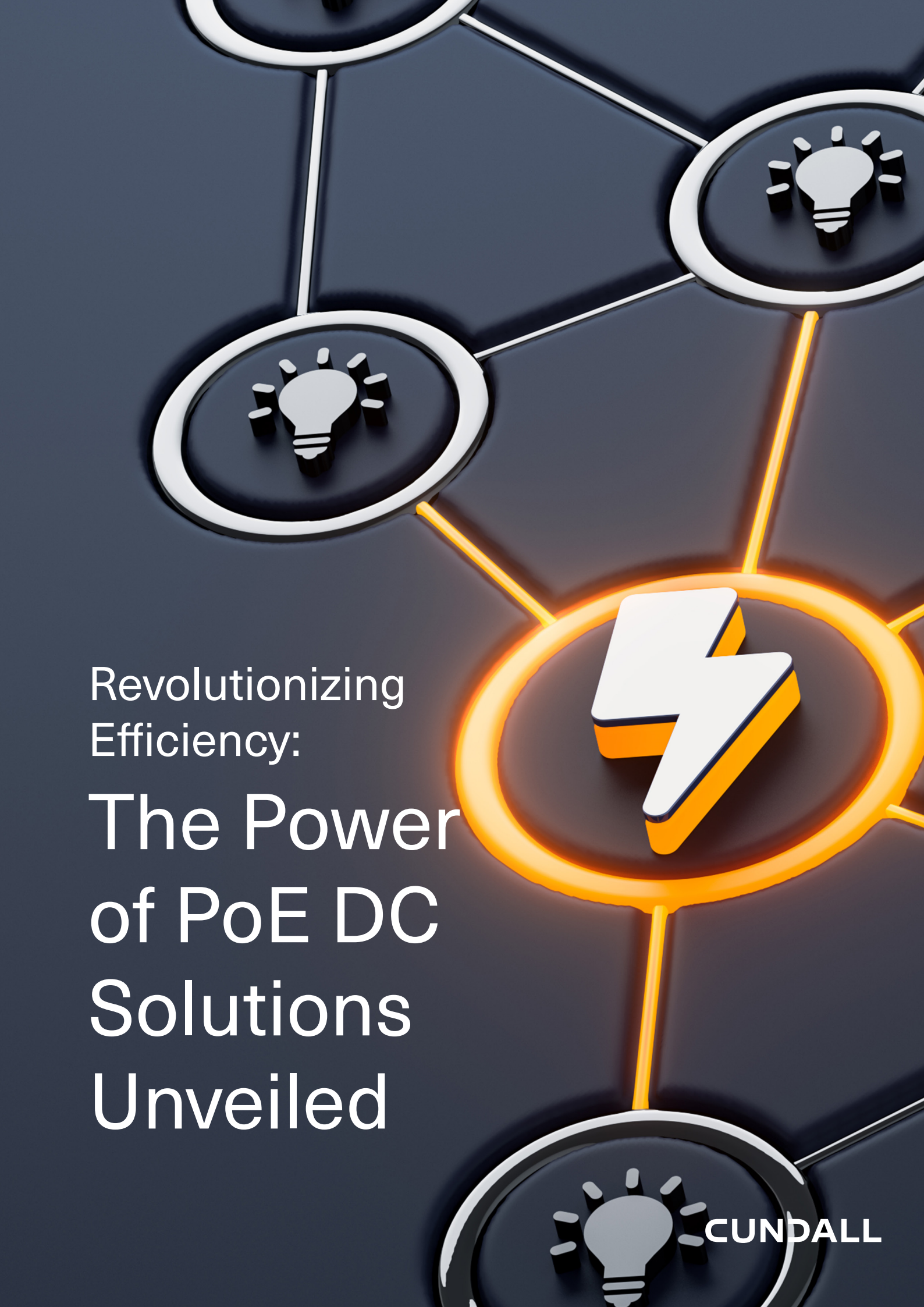




Revolutionizing
Efficiency:

The Power of PoE DC Solutions Unveiled

CUNDALL



New generation of Lighting

For decades, the commercial sector has relied on AC electrical distribution, witnessing remarkable advancements in appliance efficiency and distribution strategies. However, the urgent push toward achieving Net Zero Carbon emissions demands a departure from conventional methods. We must innovate to create more efficient and effective approaches.

Terms like "2 gang," "Dali," and "Wireless" have long been familiar in lighting control within the industry. Yet, these technologies might now seem outdated. The reality lies in embracing Internet of Things (IoT) connected lighting and IP-based control systems.

The construction industry stands at a crucial juncture where it must adopt these cutting-edge solutions. IoT-connected lighting presents a new paradigm, where every light fixture becomes part of a converged network, enabling precise control, real-time monitoring, and data-driven optimization. Simultaneously, IP-based controls offer scalability, interoperability, and enhanced security features, seamlessly integrating with other smart building systems.

The need for change goes beyond mere trend-following; it's about adapting to a future where sustainability and efficiency reign supreme. By embracing these innovations, the industry can create environments that not only respond but proactively adapt to evolving needs while significantly reducing their Operational Carbon footprint.

Is AC/DC conversion efficient?

AC/DC converters, also known as rectifiers, play a vital role in converting AC power into a DC power source. Previously, major manufacturers boasted impressive efficiency ratings at full load, hovering around 94%. However, these devices exhibited significant inefficiencies at low or no loads, resulting in millions of AC/DC power supplies in standby mode needlessly wasting power. Estimates suggest they consumed between 5% to 10% of the device's total electricity consumption. Given the prevalence of these devices in an average building, the collective losses were staggering.

In response, regulatory authorities intervened by setting standards to address both standby and full load losses. Manufacturers such as GE are working on "The creation of next generation true three-phase high power rectifiers providing greater than 96% efficiency. Current generation products are 91% and legacy products are 88% efficient" (Information and Communication Technology Portfolio Review, n.d.) [1]

Despite these advancements, a LED device rated at 22W might still incur a 0.66W power loss when switched off. In a large building equipped with 100 luminaires drawing a total power of 2.2kW, this translates to 66W being lost when the devices are turned off.

Non-linear loads like rectifiers introduce current harmonics into the power supply, impacting the broader building network. These harmonics can lead to increased maintenance costs, downtime, and, in extreme cases, equipment failure that often goes unnoticed until it occurs.

As the global push towards achieving net zero carbon intensifies, it becomes crucial to assess the proliferation of electronic devices. Surprisingly, the production of every 1 kg of electronics results in the emission of almost 25 kg of carbon into the atmosphere!" (Maxey Moverley, n.d.) [2]

So what technology can improve the lighting industry?

During the inception of electricity, Tesla and Edison engaged in a notable debate over the superior method for transmitting electricity, weighing the merits of AC versus DC. At the time, considerations like carbon emissions and efficiency held little sway, leading to the practical selection of AC power transmission—a choice that remains prevalent in today's market.

Fast forward to contemporary energy usage within buildings: Renewable sources like solar and wind predominantly generate DC power, which is commonly stored in batteries in its native DC form. However, all of our building operations and transmission systems are done in AC so we transform AC but..... for the seamless operation of various applications—ranging from computers, screens, phones, LED lighting, and an array of other technologies we have to transform this back to DC power.

This conversion of AC to DC is facilitated by AC/DC converters, ubiquitous wherever technology is employed within buildings. Moreover, Power over Ethernet (PoE) technology serves as a centralized system converting mains AC power into DC at a central location, typically within a data cabinet. This enables the transmission of power throughout the network in the DC format rather than AC, streamlining its distribution and removing the spread converters.

Newer technology within the switches can enable these to work from a 350Vdc input. This means batteries and PV can all be connected direct into the lighting systems.

So tell me is DC power in my building more energy efficient and lower carbon?

Transmission of AC power within buildings necessitates the use of expensive and carbon-intensive thick gauged copper wiring. Moreover, compliance with standards like BS7671 mandates that only certified professionals can install, maintain, and modify AC lighting systems, incurring substantial costs for building owners and maintenance contractors.

In contrast, Power over Ethernet (PoE) offers a low-voltage, Safety Extra-Low Voltage (SELV) installation. Once mains power is established at the data rack, skilled technicians can handle the remaining wiring and installation. This streamlined process not only expedites installation and maintenance but also translates to significant cost savings, aligning with the maxim that time equals money—a compelling proposition for developers.

The traditional 230V LED lighting systems, as discussed earlier, come with considerable carbon impacts. PoE lighting, however, presents substantial advantages. While there is a conversion process involved, the centralized nature of PoE inherently enhances system efficiency, resulting in minimal power wastage.

Comparing a traditional system's potential 66W power loss across 100 luminaires to a PoE system's 15W loss when devices are turned off showcases substantial savings. Notably, employing a single converter in PoE significantly reduces the carbon footprint compared to the hundreds required in a traditional setup. Moreover, the primary advantage lies in the copper wiring; AC systems demand heavier gauges (1.5 or 2.5mm) compared to lower gauge Cat 6a in PoE systems.

An assessment of the carbon impact demonstrates a marked reduction: "DC wiring gives rise to 60% less copper (lower gauge wire) than AC" (David, 2022) [3] which demonstrates a saving of carbon in the entire system. This demonstrates that moving to a PoE/DC solution could help with the crucial shift towards lowering the buildings embodied carbon targets and therefore assisting achieving "net zero carbon".

[3] David (2022). Emergence and Benefits of PoE (Power over Ethernet) Lighting. [online] Marshall DC Lighting. Available at: https://www.marshalldc.com/2022/08/03/emergence-and-benefits-of-poe-power-over-ethernet-lighting/?utm_source=rss&utm_medium=rss&utm_campaign=emergence-and-benefits-of-poe-power-over-ethernet-lighting [Accessed 26 Feb. 2024].



PoE and DC

Power over Ethernet (PoE) and Direct Current (DC) both facilitate DC power transmission. PoE, regulated by IEEE 802.3BT standards, enables up to 100W of power through a single Ethernet cable. However, The UK, Europe and the US are creating hybrid lighting and controls applications that utilise both PoE and PaE (Power and Ethernet) solutions. This innovative approach employs adapted servers capable of delivering 200W per channel (manufacturer dependent), offering designers and engineers enhanced flexibility.

The DC solution involves a single cable daisy-chained to light fittings, providing both power and data to luminaires. This configuration offers user-based control, sensor connectivity, and comprehensive smart metering, aligning with the new Part L of building regulations.

Utilizing DC cables from leading manufacturers yields similar carbon reduction benefits to PoE solutions. Additionally, this technology boasts several advantages:

Centralized Drivers: The system's centralized drivers allow for easier implementation of heat rejection or recycling systems.

Facilities Management: This allows for easier maintenance with no working at height, permit restrictions or isolation of electrical circuits required.

System Control: The setup facilitates extensive control, supporting an unlimited sensor network encompassing various functionalities, from door and window contacts to CO2 and noise monitoring. All these components are interconnected and managed via a centralized head end system.

Smart Connectivity: The system's smart and IP-connected nature positions it as a foundational element for future smart building endeavours.

The primary benefits of this approach lie in its remarkable energy savings and carbon reduction:

Energy Savings: The implementation of DC technology drastically reduces energy consumption compared to traditional systems. This reduction results from more efficient power transmission and centralized management, optimizing overall usage.

Carbon Reduction: By minimizing energy consumption, this system significantly reduces the carbon footprint associated with lighting operations. The streamlined approach and efficient utilization of resources contribute to environmental sustainability.

In essence, this shift to DC-based technology not only enhances control and efficiency but also makes substantial contributions toward energy conservation and environmental sustainability, positioning it as a forward-looking solution for modern buildings.

Green Energy Generation and Energy storage

By harnessing renewable energy sources like wind, photovoltaic (PV) solar panels, hydro, or Piezo kinetic systems to power your building, you're inherently generating electricity in DC. However, the traditional method involves converting this DC to AC for grid integration, only to later convert it back to DC for appliance use. This convoluted process not only leads to energy losses but also compromises power quality.

Implementing a building infrastructure centered around a DC topology offers a transformative solution. By directly utilizing locally generated DC power within the building's DC systems, we bypass the need for multiple conversions. This streamlined approach drastically reduces energy losses and eliminates the complexities associated with the AC-DC conversion cycle.

Moreover, this direct integration of DC power into the building's systems presents multifaceted advantages. It significantly curtails carbon emissions and enhances overall energy efficiency. Additionally, by seamlessly connecting this DC-powered infrastructure to the building's IP network, we open doors to a new level of connectivity and intelligence. This integration enables sophisticated control, monitoring, and optimization of energy usage, effectively transforming the building into a connected and "smart" ecosystem.

In essence, embracing a DC-centric approach not only simplifies energy utilization but also aligns with sustainability goals, offering a more efficient, environmentally friendly, and technologically advanced solution for building energy management.

Connecting Renewables into the National Grid is becoming an issue, one way to solve this:

Connecting Photovoltaic (PV) systems to the national grid can pose challenges, particularly in relation to voltage instability at the transformer taps. As more PV systems come online, they introduce variations in power generation, leading to fluctuations in voltage levels. These fluctuations, when significant, can strain the stability of the grid, affecting its overall performance.

In response to these voltage instability concerns, Distribution Network Operators (DNOs) might opt to restrict or reject new PV connections to the grid. However, a shift toward DC generation and DC building topologies presents a compelling solution to mitigate these issues.

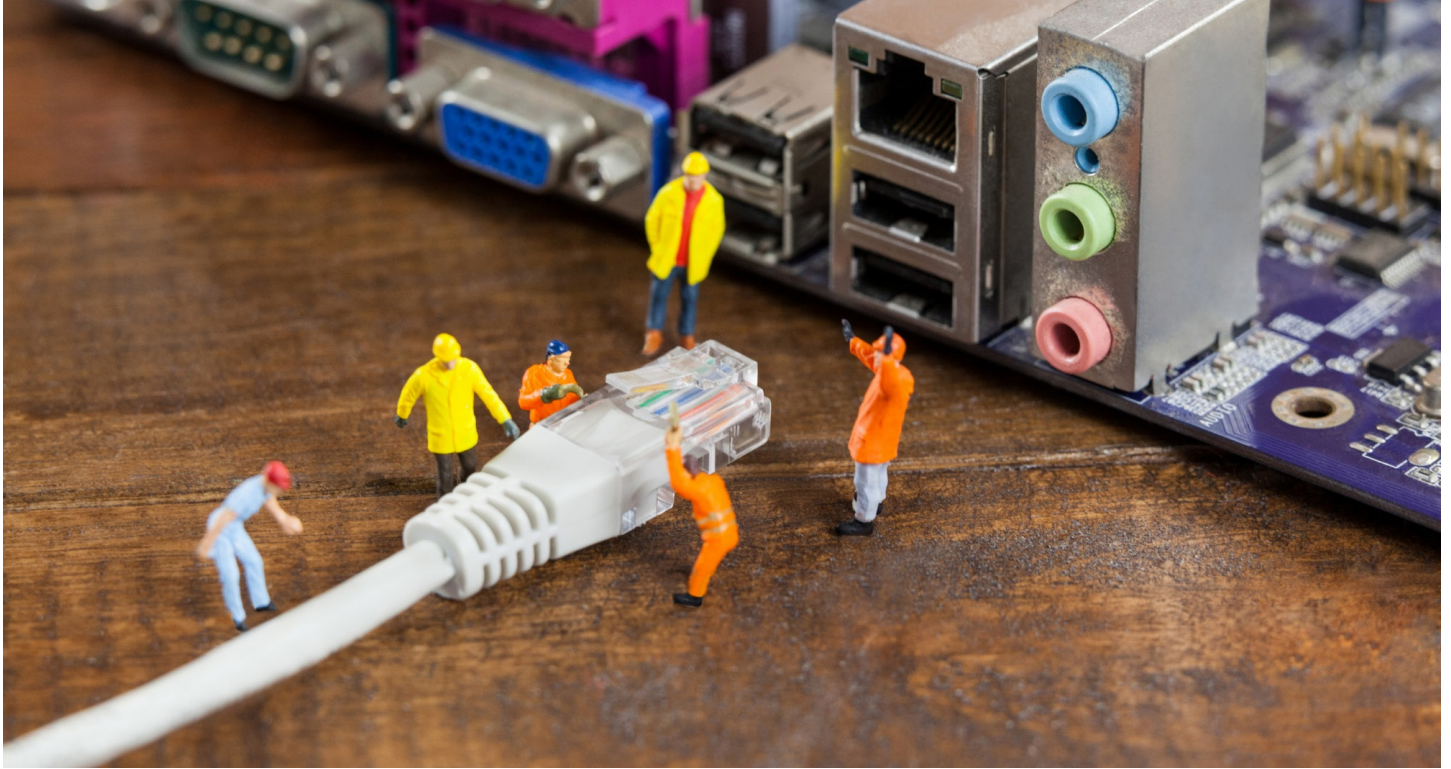
DC generation aligns seamlessly with the inherent nature of PV systems, as they naturally produce DC electricity. By directly integrating DC generation systems into buildings equipped with DC topologies, several advantages emerge:

Voltage Stability DC generation systems feeding directly into DC building systems eliminate the need for DC-AC conversions and grid interconnections. This direct connection minimizes the voltage fluctuations caused by intermittent power generation, ensuring greater stability within the building's electrical systems.

Reduced Grid Dependency By leveraging DC-based systems within the building, there's less reliance on grid interconnections. This reduced dependence alleviates the strain on the grid, circumventing the voltage instability issues caused by large-scale PV integration.

Optimised Efficiency: The streamlined DC-based approach ensures higher energy efficiency by avoiding multiple conversions between AC and DC. This not only reduces energy losses but also enhances the overall performance of the building's electrical infrastructure.

In essence, transitioning toward DC generation and DC building topologies offers a robust strategy to address voltage instability issues associated with PV integration into the national grid. By embracing a more direct, efficient, and localized approach to energy generation and utilization, buildings can effectively mitigate grid-related concerns while optimizing their own energy systems.



Cost of a DC system(Cap-Ex).....

By removing the 230Vac infrastructure you are removing a vast proportion of the of the electrical infrastructure costs, some of the items you can remove are as follows:

- AC Lighting distribution boards
- AC Cabling to luminaires
- Expensive Cable trays for AC wiring (cable baskets for data cabling / SELV cabling wtlil needed however this will be a reduced containment will size.
- AC cabling to all switching and controls
- Any lighting control costs would be removed as all control is done through the IP network.
- Cabling to Emergency Luminaires as this could be done through the DC network
- Costs associated with Testing and commissioning of the 230V lighting DBs and cable
- All costs associated with LED Drivers. I.E speaking with a top luminaire manufacturer you would simply buy the housing and LED chip only no drivers need to be brought.

The costs to allow for on a DC system are as follows:

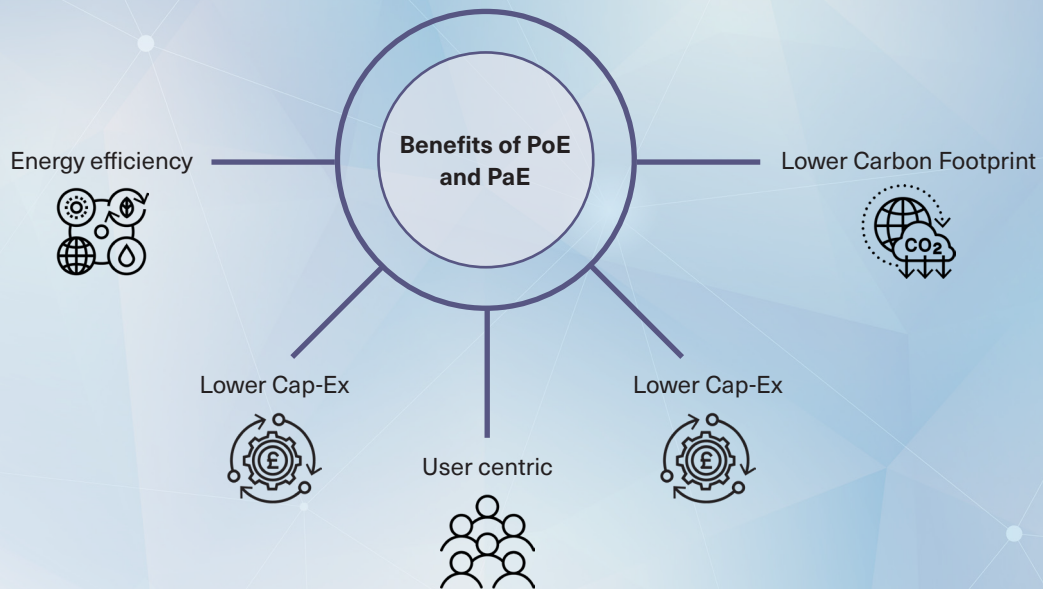
- DC luminaire cost
- Cost of a DC cable to run between fittings
- Cost of a cable basket to suit the DC cable
- Cost of installing a power supply to the data rack
- Data rack and DC switches
- No cooling is needed however, you may be able to use passive heat recycling
- Software and Commissioning costs

Cost of PoE Op-Ex.....

We've thoroughly explored and addressed the operational energy and carbon reduction aspects, specifically focusing on the maintenance of the PoE DC solution. The operational expenditure (Op-Ex) savings can be consolidated as follows:

1. Efficiency Gains from LED Lighting: Substantial energy savings achieved through the efficiency of LED lighting, resulting in lower overall usage.
2. Reduced Energy Losses through Cable Transmission: Minimized energy losses during transmission through more efficient cable systems, contributing to significant savings.
3. Maintenance Technician Visit Costs: Elimination of electrician requirements for routine maintenance visits, reducing associated expenses.
4. No Need for Access Equipment: Savings incurred due to the absence of specialized access equipment requirements during maintenance procedures.
5. Detailed Energy Metering: Detailed monitoring at various levels to enhance energy savings by providing comprehensive insights into usage patterns.
6. Enhanced Control Strategies: Implementation of more effective control strategies resulting in additional reductions in energy consumption.
7. Potential Re-commissioning Costs: Accounting for any potential costs related to re-commissioning processes, if applicable.

By focusing on these key areas, we're able to outline the significant ways in which the PoE DC solution not only reduces operational costs but also optimizes energy usage and promotes sustainability.



Final Roundup

We have conducted an extensive and meticulous analysis comparing traditional lighting with PoE/DC alternatives. However, we recognise that the ultimate determination of its benefits rests with the end-user or client. What we've discovered is that while this solution might not suit every building, it holds promise for consideration across a wide array of applications, sectors, and environments.

Understanding that each project possesses its own unique characteristics and requirements. This approach emphasizes conducting in-depth and tailored analysis which allows for a comprehensive understanding of the actual benefits, energy consumption patterns, and potential carbon reduction specific to the project at hand.

Our intention is to empower clients and end-users with precise and personalized insights and at least making them aware of the technology and were doing this by offering this information. We aim to facilitate informed decisions regarding the adoption of PoE/DC lighting solutions. It's about aligning these innovative solutions with the specific goals and needs of each project, ensuring that they contribute meaningfully to its success and sustainability.

