Game changer technology faces increasing market acceptance:

GOOD PROSPECTS FOR POE

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Power-over-Ethernet (PoE) infrastructures are well on their way to becoming a dominant technology. They combine data communication and power supply via a single Ethernet cable. The range of applications for PoE is wide. In the next five to ten years, PoE will continue to establish itself strongly thanks to new trends, PoE lighting and DC-grid technology are the most relevant to consider.

Our living and working space is currently changing at a rapid pace, including the living and working environment. The desire for greater well-being, security, energy efficiency and comfort are increasingly coming into focus when it comes to installing building technology. One way to ensure smooth operation is to use smart solutions. With PoE and IoT (Internet of Things) to network building systems, businesses and residential buildings are more energy-efficient, sustainable, cost-effective, secure and easier to control. In this regard, office, hospitality, healthcare and education are emerging as the four most promising market segments for immediate PoE innovation. Each of these industries faces rapidly changing market realities, especially as the pandemic continues.

INTELLIGENT BUILDING MANAGEMENT APPLICATIONS SUPPORTED BY POE

PoE has enormous potential. The technology is capable of supporting all kinds of processes and being the backbone of complete building services. The range of applications is broad, for example predictive heating-ventilation-air conditioning, personalised lighting control, indoor wayfinding, asset tracking to identify hardware and support areas, centrally managed security, dynamic personalised signage, real-time conference room availability and flexible workspace allocation. High reliability, ease of use and maintenance fulfil PoE by centralising the infrastructure.

POE: MAIN DRIVERS AND POSSIBILITIES

Various factors are currently favouring the spread of PoE solutions. With regard to ecology and climate protection, there is a growing awareness of saving energy and reducing CO2 emissions. Another factor is the operating costs. Due to increasing cost pressure, companies are faced with the challenge of reducing the power consumption of communication and data networks. Technological progress enables higher performance rates over 4-wire pairs. This is associated with increasing investments in Ethernet infrastructures. According to BSRIA's Grandview Research, PoE port shipments will increase sharply in the coming years. In 2023, the number of ports sold will be between 180 and 230 million. In 2022, the market is expected to need around 10 million PoE switches.
As shown in **Figure 1,** VoIP technology took the top position among PoE applications in 2019 with 36 million (= 32 % market share) installed ports. This is followed by the segments wireless access points (23 %), CCTV cameras (18 %), sensors (7 %) and motors and drives (4 %). The "Other" segment comprised 16 %. This includes BACS, A/V, Access Control and Lighting. The market for PoE lighting systems is still in its infancy, but it is booming. Here, an annual doubling is to be expected.

Figure 1

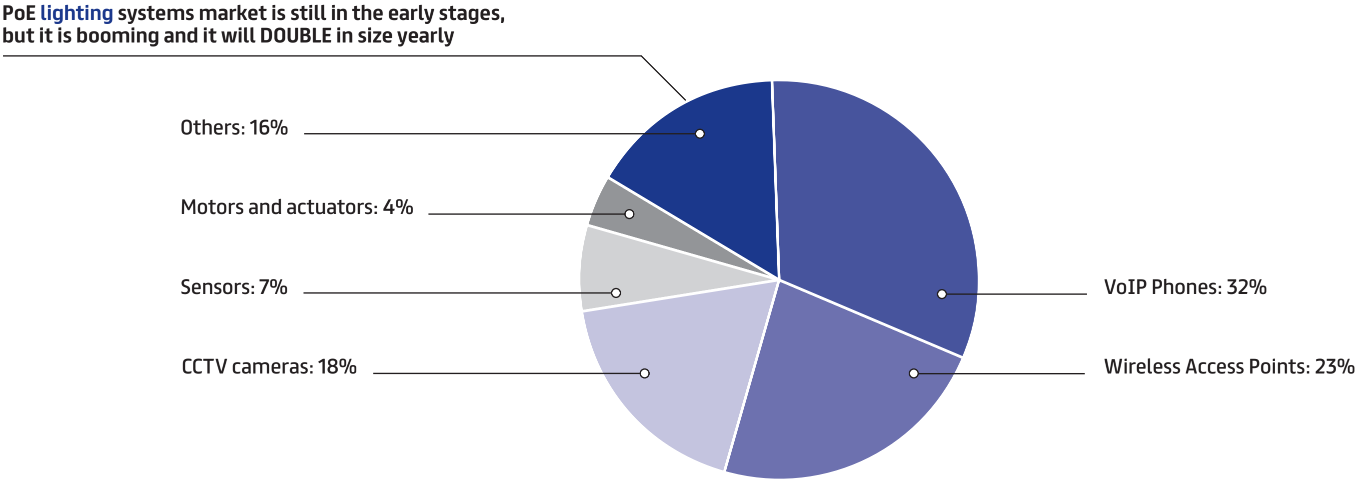
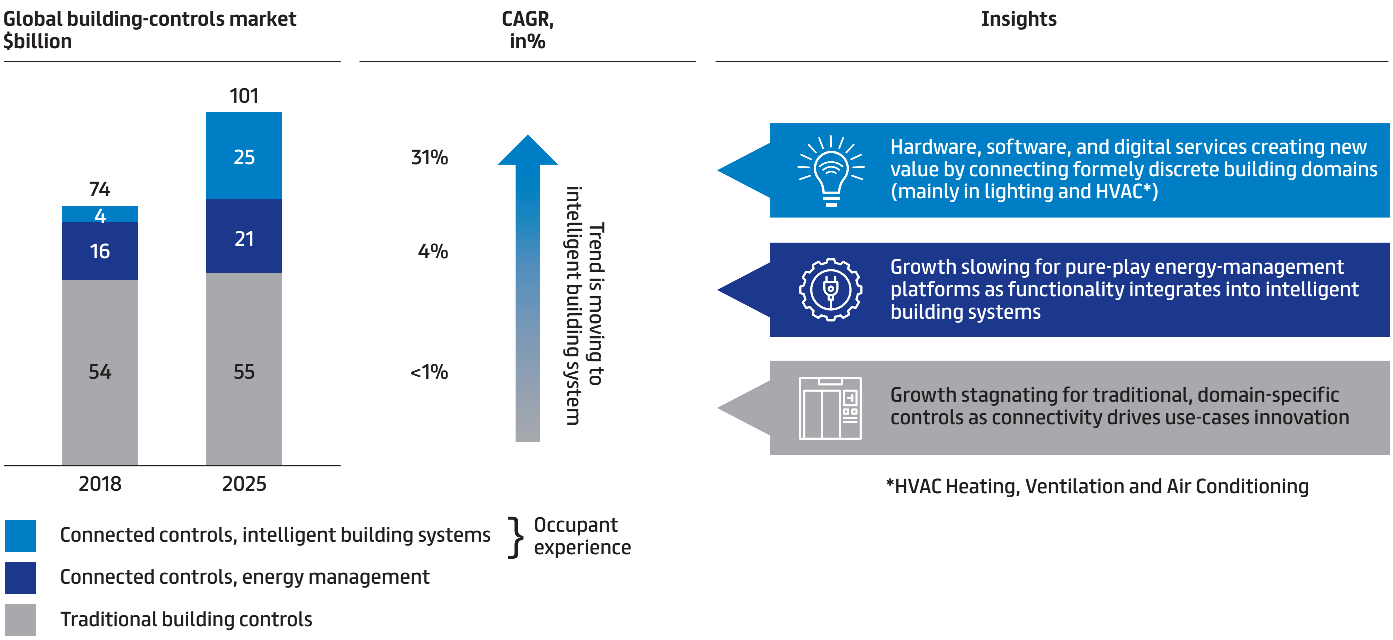


Figure 2



Source: McKinsey – Laying the foundation for success in the connected building era (2018)

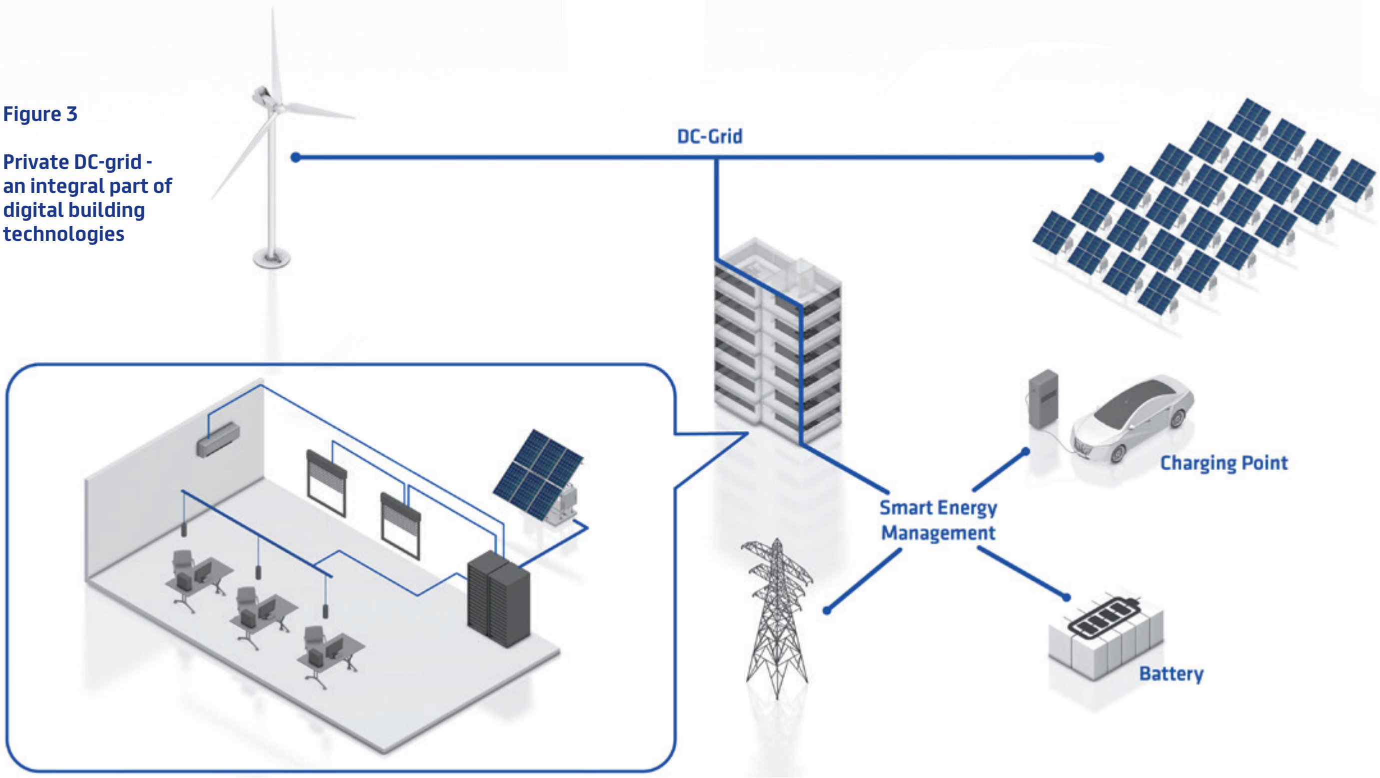
This development is also confirmed by McKinsey. As can be seen in **Figure 2,** the consulting firm forecasts the greatest growth potential for the “intelligent networking of hardware, software and digital services of previously separate building areas”. In this segment, lighting is the biggest driver. The influence of lighting is greater than with other technologies. As a feel-good factor, it plays a significant role in the living and working environment. In addition, the installation takes on a considerable dimension due to the widespread use of lighting and therefore has a weighty role. Another positive aspect: PoE-supported lighting can already be implemented at a good price today.

DC GRIDS VIA POE

Another trend that will favour the spread of PoE in the coming years is the increasing use of DC grids and the fact that more and more systems can be operated with DC. DC grids as illustrated in **Figure 3** are central DC network

Figure 3

Private DC-grid - an integral part of digital building technologies



infrastructures in industrial or production facilities. Here, all components are supplied within a self-contained, self-sustaining system via a DC voltage source, and not via the common AC grid as was previously the case. There are various reasons for adopting DC grids, first and foremost energy efficiency, cost reduction and energy flexibility in production.

By implementing to a DC grid, energy generated on site, both from renewable sources and recuperative processes, can be stored more efficiently. In times of massive energy policy rethinking and technological progress in energy storage and power electronics development, sticking to conventional AC/DC power supply is no longer the preferred choice. This is because, in addition to a significant reduction in costs and a saving in energy demand, a power supply via DC Grid is more robust with regard to fluctuating grid quality. It is also able to react flexibly to changing energy supplies, especially when buffering peak loads and bridging grid failures.

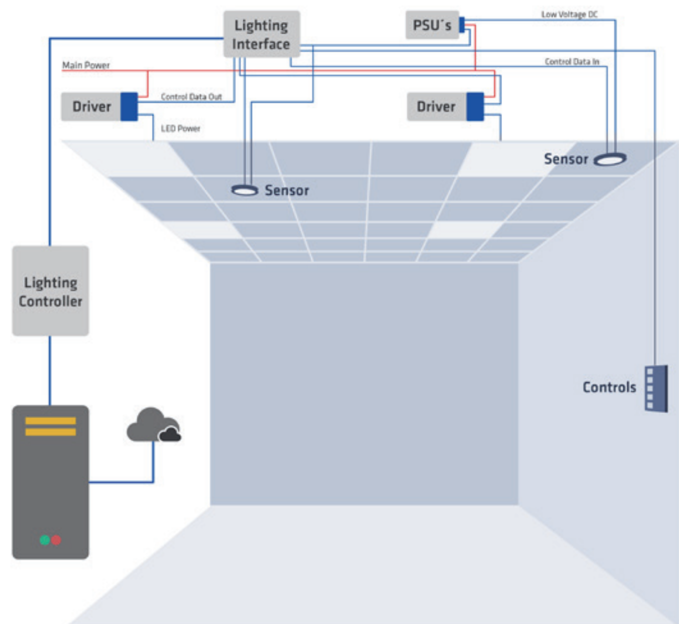
PoE proves to be a suitable technology for DC grids to supply power to all participating powered devices. The maximum power that can be transmitted via PoE integrates well for the operation of DC grid infrastructures. Thus, the increase and growing acceptance of DC Grids is an important driver for the installation of PoE infrastructures.

POE AS SUBSTITUTE FOR OPERATIONAL TECHNOLOGY (OT)

In building management, devices and machines are typically subject to consistent monitoring. On the one hand, to detect faults at an early stage and to keep the extent of the costs for the necessary repairs as low as possible. On the other hand, downtimes in the operating process can often be avoided through monitoring. Operational

Figure 4

Classical Dali/KNX
Typical commercial installation



PoE base centralised implementation of LED

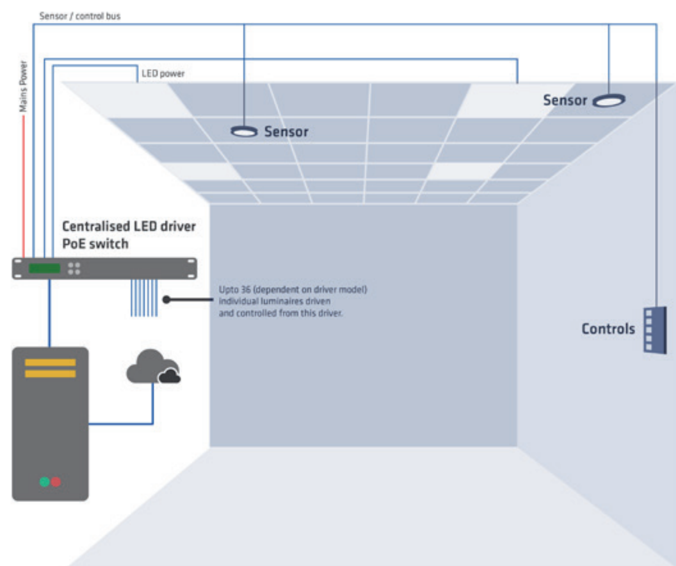


Table 1: PoE standards and the different levels of power they allow for

Standard	Type	Class	VPSE (min) supply voltage	Max. current per pair	PPSE max. power of the supplier	PPD max. power to the unit	Pairs
802.3af	Type 1	Class 1	44V	350mA	4W	3.84W	2
		Class 2	44V	350mA	7W	6.5W	2
802.3at	Type 2	Class 3	50V	600mA	15.4W	12.95W	2
		Class 4	50V	600mA	30W	25.5W	2
802.3bt	Type 3	Class 5	50V	500mA	45W	40W	4
		Class 6	50V	500mA	60W	51W	4
	Type 4	Class 7	52V	720mA	75W	62W	4
		Class 8	52V	860mA	90W	72W	4

technology (OT) plays an important monitoring role in this context. OT comprises hardware and software that is used to control and monitor devices and systems all over the managed building, including their processes.

Unlike IT-based monitoring models, OT uses proprietary technologies, interfaces and protocols. The operating technology virtually controls itself in a closed system according to its own protocol. If, on the other hand, equipment or machine control is carried out with the help of IT, error messages are sent to a central location. These are then rectified directly via control mechanisms or forwarded to another instance to solve the problem.

In the past, OT systems were isolated from the IT system usedin companies. However, digitalisation, industrial networking and the Internet of Things are increasingly causing a convergence of classic IT and OT. IT/OT convergence offers many advantages but is also associated with challenges and risks. Convergence is the basis for Industry 4.0 and enables solutions such as predictive maintenance and predictive monitoring. OT in critical infrastructures requires special protection. Typical requirements for OT are high reliability, security and availability. In addition, real-time capable processes must be possible. In order to integrate all systems, even those without a direct or difficult power connection, into the monitoring, PoE lends itself as a network infrastructure. This is also where a lot of potential for PoE lies.

POE COMPONENTS AND STANDARDS

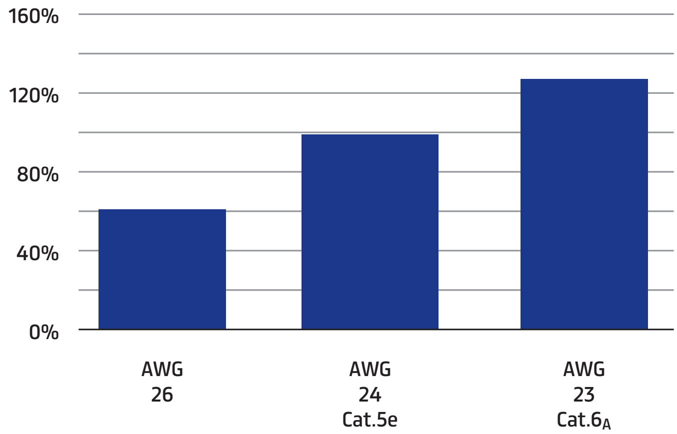
The backbone of PoE-based smart solutions is the cabling infrastructure with fail-safe, high-performance copper cables and connectors. This networks sensor devices and lighting elements with the PoE switches and gateways as well as LED drivers. In contrast to the classic installation with different types of cable, with PoE only one type of cable is sufficient, which is compatible with all PoE-based devices. Most of the electronics are in the central rack. Only small parts of the LED driver are installed in the ceiling, which, by the way, is where about 70 percent of PoE installations are located. **(Figure 4)**

With PoE topology, users have the choice between mid-span and end-span networks. The dominant end-span architecture uses a network switch that supports PoE. Mid-span, on the other hand, uses an external PoE injector installed between a non-PoE switch and a powered device (PD). Both types of architecture make the transition from the old network environment to a PoE network much easier.

PoE is defined in several standards which allow for different levels of power depending on the standard. **Table 1** provides an overview. After the IEEE 802.3af standard in 2003 and IEEE 802.3at in 2009, the IEEE adopted the IEEE 802.3bt standard in the third quarter of 2018. The most recent standard, also called Four-Pair-PoE, uses all wires of the network cable for power transmission. The

Table 2

Design	D [mm]	DC-LR [Ω/km]	Reach
AWG 26	0.404	282.64	62%
AWG 24	**0.515**	**173.86**	**100%**
AWG 23	0.575	136.78	127%



maximum achievable power is between 72 and 90 watts. Thanks to the high transmittable power, even larger end devices, such as IP-TV devices in full HD or thin clients, can be supplied with power via the data cable. Cable manufacturers are continuously working on further developing the PoE performance of network data cables, which are optimized for low loss energy transmission.

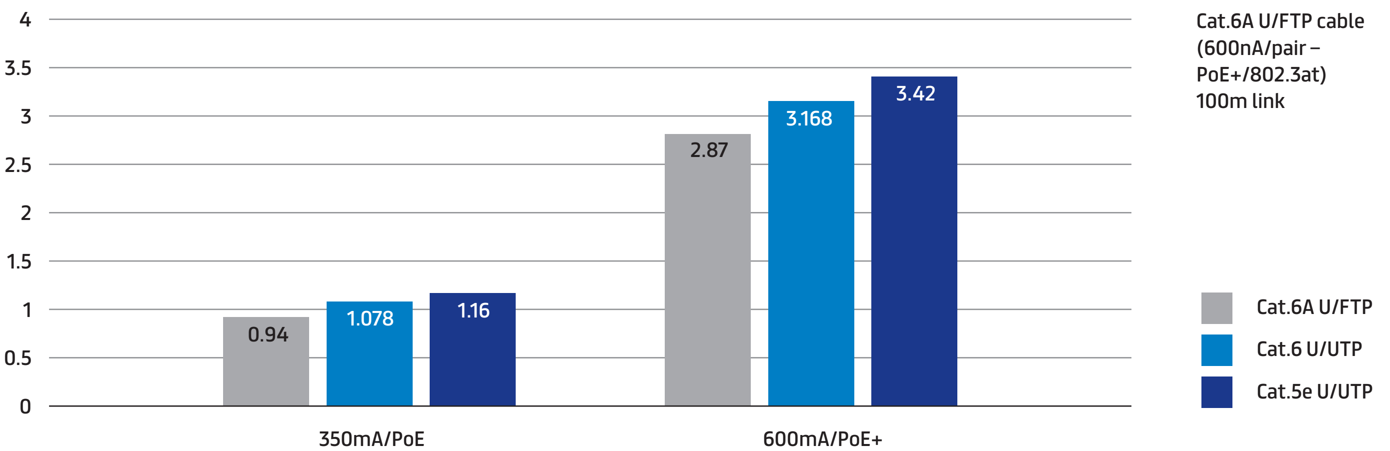
INFLUENCE OF POE ON THE CABLING

What should be considered when choosing the optimal cables for installing a PoE infrastructure? What factors influence the transmission performance? PoE generates some heat due to the conductive resistance of the cable. The bundle size and installation environment also have a direct influence on the heating of the cable. They can lead to a significant increase in temperature. The type of cable duct used, for example, is decisive here: Mesh cable duct, perforated perforated cable system or completely closed duct made of plastic. The cables in the open grid experience more cooling effect from the air than the cables in the closed duct. Here the heating is higher. The EN-50174-2 standard states under 4.5.4.2 that the degree of filling should not exceed 40 percent. This is because the heating increases as the number of cables in the closed cable duct increases. If the cable ducts are located above a heating system, the radiating heat also has an effect on performance. Planning and execution of the installation have a direct influence on the PoE capability of a cable.

Higher cable temperatures increase resistance and transmission loss. The result is a reduction in the link length of the cable. Due to the additional attenuation, signals may no longer be transmitted correctly or not at all to the receiver, and the data stream breaks off. In addition to the heating and cooling effect, cable-specific properties such as symmetry and cable construction have an influence on the PoE performance of a cable.

Figure 5

Power loss (W)



INCREASE POE EFFICIENCY, REDUCE POWER LOSS...

The maximum cable operating temperature must not exceed 60 °C. This is the only way to ensure that the cables remain PoE-capable and achieve the highest transmission efficiency. If the temperature exceeds this limit, the transmission properties lose accuracy and the cables no longer perform as expected. The reason is the softening of the insulation material and the associated loss of symmetry in the cable design.

The PoE reach is afected by DC loop resistance (DC-LR). The higher this is, the shorter the reach is. **Table 2** shows that the AWG 24 cable with a DC-LR of 173.86 Ω/km and outer conductor diameter D of 0.515 mm has a range of 100 percent. AWG 24 usually stands for Cat.5e cable and is the dominant cable infrastructure worldwide.
AWG 23 corresponds to Cat.6A or Cat.8.2 cabling. The outer conductor diameter is 0.57 mm and the DC-LR is 136.8 Ω/km. Thus the reach with AWG 23 is 28 percent higher than with AWG 24. Consequently, the thickest conductor has the longest reach. Larger conductor diameters improve the PoE range quadratically.

Overall, the power loss is lowest when the conductor diameter is largest. This is confirmed by **Figure 5:** Cat.6A U/FTP has 9,4 percent less power loss compared to Cat.6 U/UTP, and even 16,1 percent less compared to Cat.5e U/UTP. From this it can be deduced that thicker conductors have the lower power loss between PD and PSE and cables with large conductor diameters save more energy.

... AND INCREASE HEAT DISSIPATION

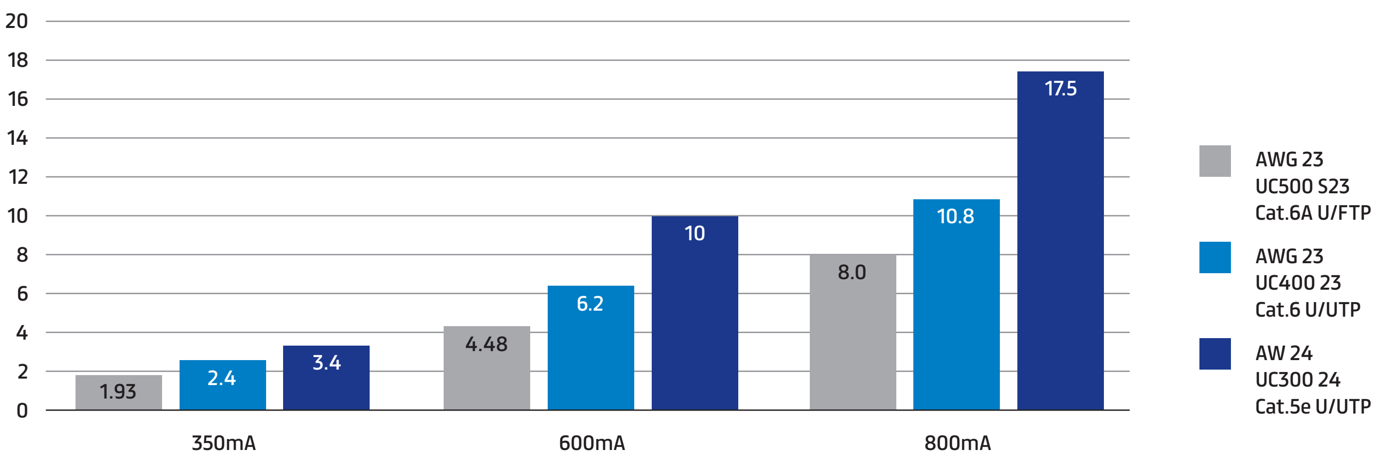
Another factor for increasing PoE efficiency is to keep heating as low as possible through high heat dissipation. The thermal insulation of the cables has a great influence. In addition, conductor diameter and cable shielding are strongly correlated with the temperature increase. **Figure 6** shows that with a typical Cat.5e U/UTP cable in AWG 24 compared to Cat.6A U/FTP AWG 23 cable.

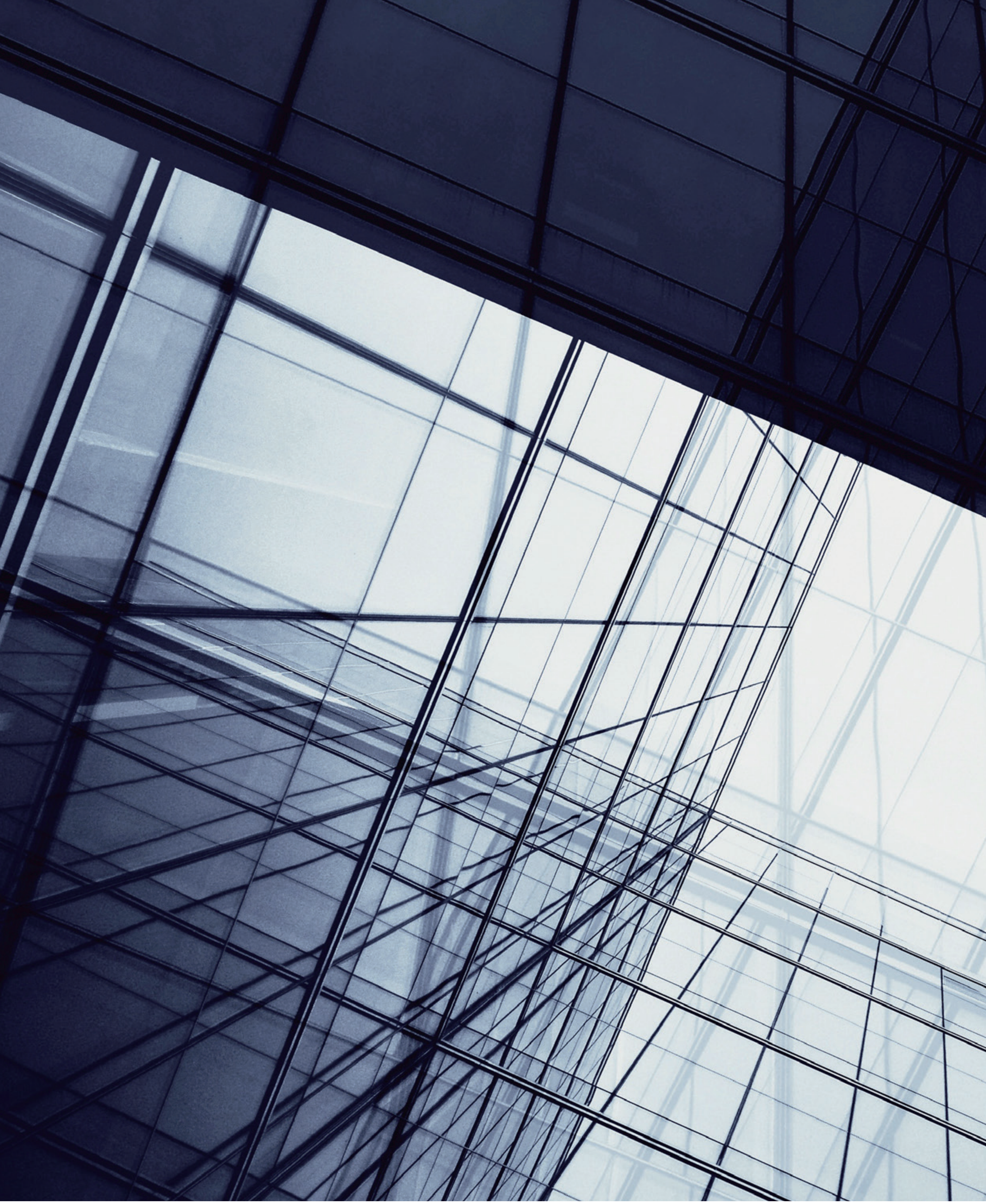
AWG23 COPPER CABLES MAKE THE RUNNING

From Cat.5e to Cat.8.2, all categories support the PoE standards 802.3af, at and bt. However, not with the same efficiency. Higher categories beyond Cat5e apply larger conductors in AWG23 which offer higher PoE efficiency. Their transmission properties result in the lowest power loss and cable heating and provide the higher energy output at permissible cable operating temperature. For the technical implementation of high-performance, fail-safe PoE infrastructures, AWG23 cables are proving to be a tried and tested means. The chances are good that PoE will become more and more established. Because Ethernet is ubiquitous. It is used around ten times more than any other communication protocols. And the number of ports installed worldwide, which is currently around 1 billion, is increasing continuously. These are good prospects. The signs are pointing to growth.

Figure 6

Temperature increase (°C)





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