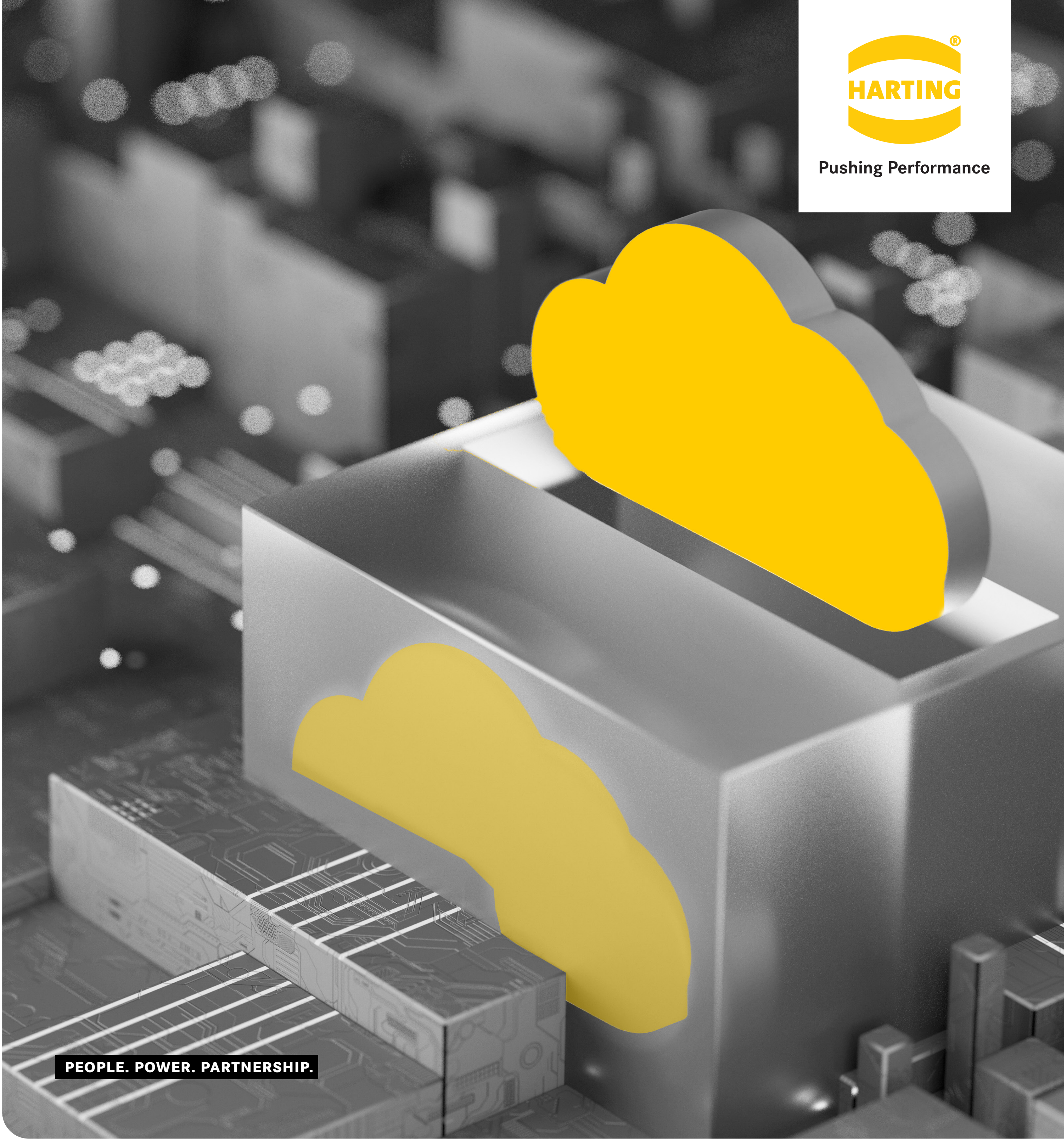


HARTING
Pushing Performance

Connector selection can improve energy efficiency by up to 50%

Learn how HARTING connectors can improve your power usage efficiency (PUE) through minimizing the power lost in your connections.

Connector selection can improve energy efficiency by up to 50%

HARTING
Pushing Performance

Table of contents

HARTING North America
1370 Bowes Road, Elgin, IL 60123 USA
www.HARTING.com; Will.Stewart@HARTING.com

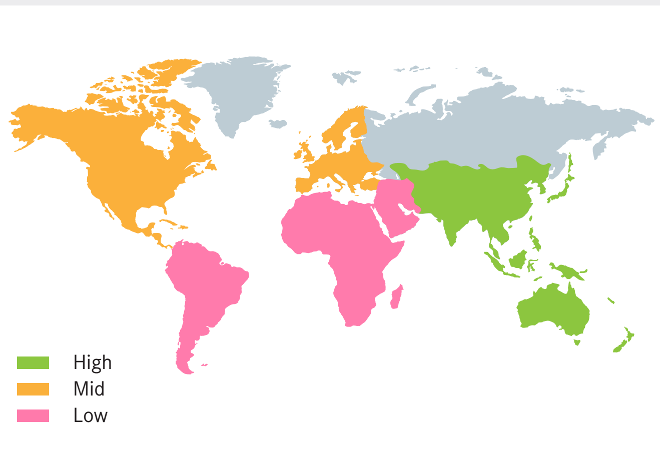
Connector selection can improve energy efficiency by up to 50%

1 Introduction

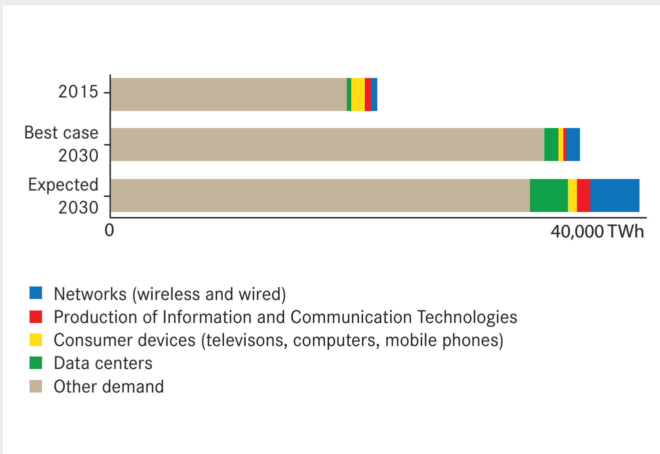
The worldwide data center market is experiencing explosive growth year over year. People and businesses are increasing their reliance on remote computing, phone/computer apps, and the Internet of Things at a staggering rate. The last years saw an accelerated reliance of the society on tasks that require a data center. With this growth in data center usage, the amount of energy needed to support data centers is consistently increasing and comprises a significant share of the worldwide electricity demand.

In parallel, decarbonization and the future of energy are topics on everyone's mind – not only in politics, but also among data center operators, manufacturers, and suppliers. The sustainable use of renewable energy, such as wind and solar, is just one step to reach the climate targets of the future. Another step is to increase the energy efficiency of our current consumption.

The following chapters will show you how HARTING connectors can increase your Power Usage Efficiency (PUE) through minimizing the power lost in your connections. Our analysis shows how data centers can save 50% of energy compared to other connectors and optimize the Total Costs of Ownership (TCO).



[SRC01] Hyperscale data center growth rate by region (up to 2024)



[SRC02] Global electricity demand growth rate (up to 2030)

HARTING North America
1370 Bowes Road, Elgin, IL 60123 USA
www.HARTING.com; Will.Stewart@HARTING.com

Connector selection can improve energy efficiency by up to 50%

HARTING
Pushing Performance

2 Hyperscale data center

Data centers are buildings whose core function is to centralize IT equipment to store and manage data. In order to make sure all this equipment is running correctly, they also require significant power and cooling infrastructure.

While many organizations host their own data centers – such as banks, hospitals, or government buildings – the current trend is to outsource your cloud requirements to hyperscale data centers.

The hyperscale sector is growing rapidly thanks to the benefits such as optimized energy efficiency and increased functionality, that they can offer to clients.

Synergy Group identified 430 hyperscale facilities in 2018 and 600 in 2020 [SRC04]. Amazon, Microsoft, and Google together accounted for over half of all major data centers in 2020. Alibaba and Facebook are also very active on this playing field.

Scale	Number of racks
Small	N < 1,000
Medium	1,000 ≤ N < 3,000
Large	3,000 ≤ N < 10,000
Hyper	N ≥ 10,000

HARTING North America
1370 Bowes Road, Elgin, IL 60123 USA
www.HARTING.com; Will.Stewart@HARTING.com

Connector selection can improve energy efficiency by up to 50%

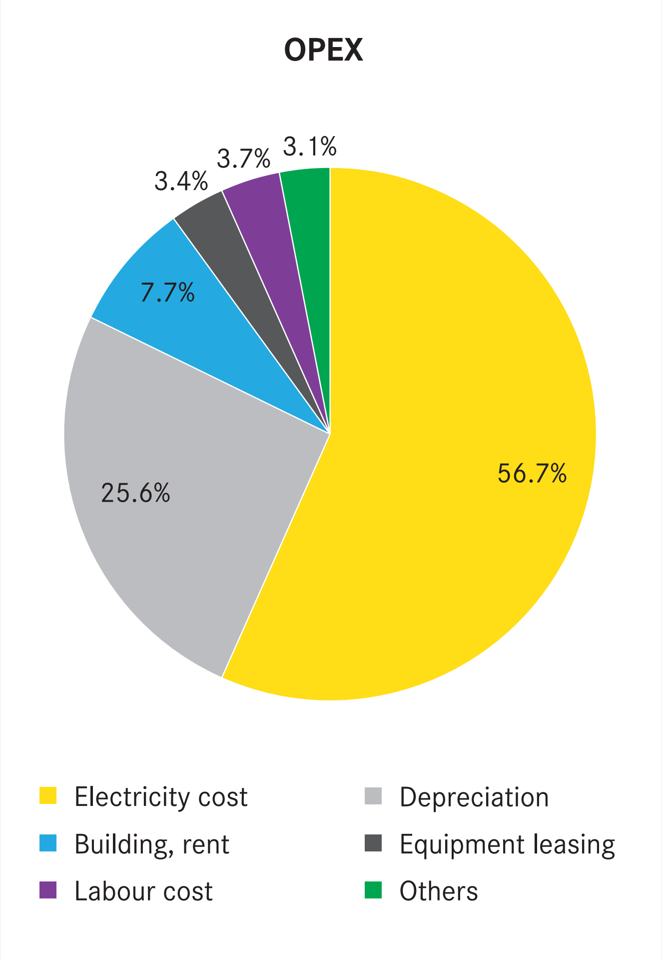
Pushing Performance

3 Power is critical

Operating a data center undeniably has its challenges. It is well known from the manufacturing sector that any down-time can cause significant losses in profits. Such a scenario for a data center owner or operator is an even bigger nightmare.

It's easy to imagine the cost effect if your favorite social media or everyday office application suddenly stops functioning. Data center outages can happen due to various reasons such as critical weather conditions, network failures, human errors, software issues, but also due to power infrastructure problems created inside the data center from either generator, UPS or PDU failures. Understandably for a hyperscale operator this risk should be minimized to zero.

The best answer today is the strategic investment and management of every single part of the so-called critical infra-structure in the data center (CAPEX). Power is one of the key factors to manage. IDC reports that energy consumption per server is growing by around 9% [SRC05] per year globally, on the one hand the servers are getting more compact to save installation space, and on the other hand their performance increase raises their energy requirement. The costs of this energy consumption can be more than 50% of the total data center operating expenses (OPEX) [SRC06].



[SRC06] Total data center operating expenses (OPEX)

HARTING North America
1370 Bowes Road, Elgin, IL 60123 USA
www.HARTING.com; Will.Stewart@HARTING.com

Connector selection can improve energy efficiency by up to 50%

HARTING
Pushing Performance

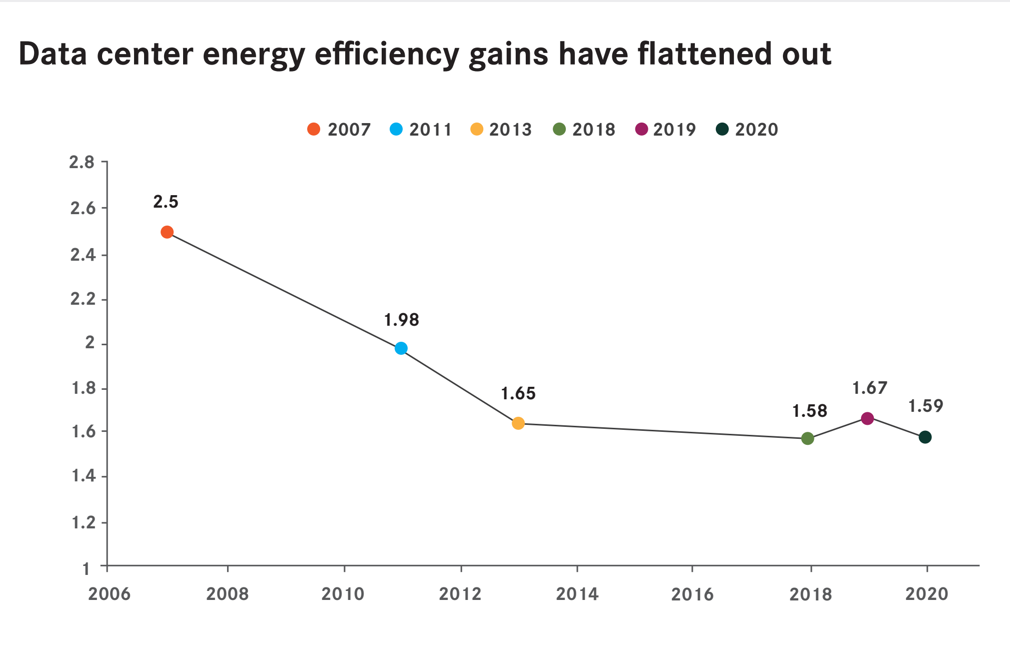
4 Impact of connectors to power usage efficiency (PUE)

PUE, or Power Usage Efficiency, is an important KPI for data center management. PUE compares the electricity usage of the entire data center with the electricity usage of only the IT equipment. For this benchmark to be useful, it should be monitored frequently.

$$PUE = \frac{\textit{Total Facility Power}}{\textit{IT Equipment Power}}$$

Every data center operator should strive to reduce PUE through implementation of new technologies. However, because PUE has gotten closer and closer to 1 in the last decade, it has become difficult to realize big gains in efficiency. Operators should investigate components in their subsystems in order to increase power efficiency.

Through using advanced connectivity solutions, plug and play systems can not only save installation time, but – as we will see in the upcoming chapters – they can have a positive effect on the total cost of ownership (TCO = CAPEX + OPEX). Increasing the power efficiency with new and innovative connectors, which further reduces the PUE, is possible.



PUE	Level of Efficiency
3.0	Very Inefficient
2.5	Inefficient
2.0	Average
1.5	Efficient
1.2	Very Efficient

[SRC07] Reported data center PUE figures in global Uptime Institute surveys from 2007 to 2020

HARTING North America
1370 Bowes Road, Elgin, IL 60123 USA
www.HARTING.com; Will.Stewart@HARTING.com

Connector selection can improve energy efficiency by up to 50%

5 Energy saving analysis

To calculate the exact effect of power usage from using connectors in data centers, the HARTING Technology Group has measured the power consumption of three different connector solutions in its independently accredited test laboratory in Zhuhai, China.

Previously, so-called CEE (IEC 60309) type plugs were commonly used for connecting power in data centers. At the same time, the HARTING Technology Group introduced a new connector concept to its partners in the data center market with a wide range of benefits. One of the connectors tested was this new concept, the HARTING Han-Eco® connector. The other two tested were the CEE plugs from different manufacturers.

The following table shows the results of the different voltage drops in the test environment:

Connectors with test current 63A						
Supplier	Max. Voltage drop (mV)			Avg. Voltage drop (mV)		
	Before	During	After	Before	During	After
HARTING	22.94	23.86	22.14	22.88	23.74	22.10
CEE plug 1 (Market Leader)	42.13	44.24	42.68	41.96	43.58	42.32
CEE plug 2	50.42	50.31	46.20	45.71	46.62	42.85

HARTING benefits compared to CEE plugs:

- Smaller size, shape fits on PDUs
- Modularity: 4 different sizes with various off-the-shelf alternatives and inserts
- Both AC and DC connectivity are possible
- Higher voltage up to 1,000V
- Higher variety of termination techniques available (screw, crimp, axial-screw, cage-clamp)
- Direct connection to PCB board available
- Position of male and female contacts is interchangeable within hoods and housings

HARTING Han-Eco® connector (6 + PE) compared to CEE plug (5+PE)

HARTING North America
1370 Bowes Road, Elgin, IL 60123 USA
www.HARTING.com; Will.Stewart@HARTING.com

Connector selection can improve energy efficiency by up to 50%

HARTING

Pushing Performance

The following table shows the respective resistances and power consumption calculated for one year in kWh. It also shows the energy savings achieved by using the Han-Eco® connector of the HARTING Technology Group compared to the CEE plugs:

HARTING
① Single phase, 63 A => $P_{loss} = 2 * I^2 * R = 2 * 63\,A^2 * 0.02374\,V / 63\,A = 2.99\,W$ $W_{loss\ per\ annum} = 2.99\,W * 24\,h * 365\,days = 26.20\,kWh/year$
② Three phases, 63 A => $P_{loss} = 3 * I^2 * R = 3 * 63\,A^2 * 0.02374\,V / 63\,A = 4.49\,W$ $W_{loss\ per\ annum} = 4.49\,W * 24\,h * 365\,days = 39.30\,kWh/year$
CEE plug 1 (Market Leader)
① Single phase, 63 A => $P_{loss} = 2 * I^2 * R = 2 * 63\,A^2 * 0.04358\,V / 63\,A = 5.49\,W$ $W_{loss\ per\ annum} = 5.49\,W * 24\,h * 365\,days = 48.10\,kWh/year$
② Three phases, 63 A => $P_{loss} = 3 * I^2 * R = 3 * 63\,A^2 * 0.04358\,V / 63\,A = 8.24\,W$ $W_{loss\ per\ annum} = 8.24\,W * 24\,h * 365\,days = 72.15\,kWh/year$
CEE plug 2
① Single phase, 63 A => $P_{loss} = 2 * I^2 * R = 2 * 63\,A^2 * 0.04662\,V / 63\,A = 5.87\,W$ $W_{loss\ per\ annum} = 5.87\,W * 24\,h * 365\,days = 51.46\,kWh/year$
② Three phases, 63 A => $P_{loss} = 3 * I^2 * R = 3 * 63\,A^2 * 0.04662\,V / 63\,A = 8.81\,W$ $W_{loss\ per\ annum} = 8.81\,W * 24\,h * 365\,days = 77.19\,kWh/year$

$$R = \frac{\text{Voltage drop}}{I} \qquad P_{loss} = I^2 * R$$

Single phase: 2 live conductors: L1, N => Three phases: 3 live conductors: L1, L2, L3 (balanced condition)

Current (A)	Type	Suppliers	Resistance (mΩ) / pin	Power consumption / connector / year (kWh)	Energy saving (%) vs. CEE plug 1	Energy saving (%) vs. CEE plug 2
63	Single phase	HARTING	0.377	26.20	46%	49%
		CEE plug 1 (Market Leader)	0.692	48.10		
		CEE plug 2	0.740	51.46		
	Three phases	HARTING	0.377	39.30		
		CEE plug 1 (Market Leader)	0.692	72.15		
		CEE plug 2	0.740	77.19		

As the test data shows, the HARTING connector saves 46-49% of energy over the CEE plug. This result reinforces that the HARTING solution, widely known for having operational benefits, also has substantial energy savings. In the next chapter we will look at how this saving is benefiting customers. It may require choosing a slightly more costly solution upfront, but there are substantial ROI cost savings gained after just a few years of usage.

HARTING North America
1370 Bowes Road, Elgin, IL 60123 USA
www.HARTING.com; Will.Stewart@HARTING.com

Connector selection can improve energy efficiency by up to 50%

Pushing Performance

6 Total costs of ownership (TCO = CAPEX + OPEX)

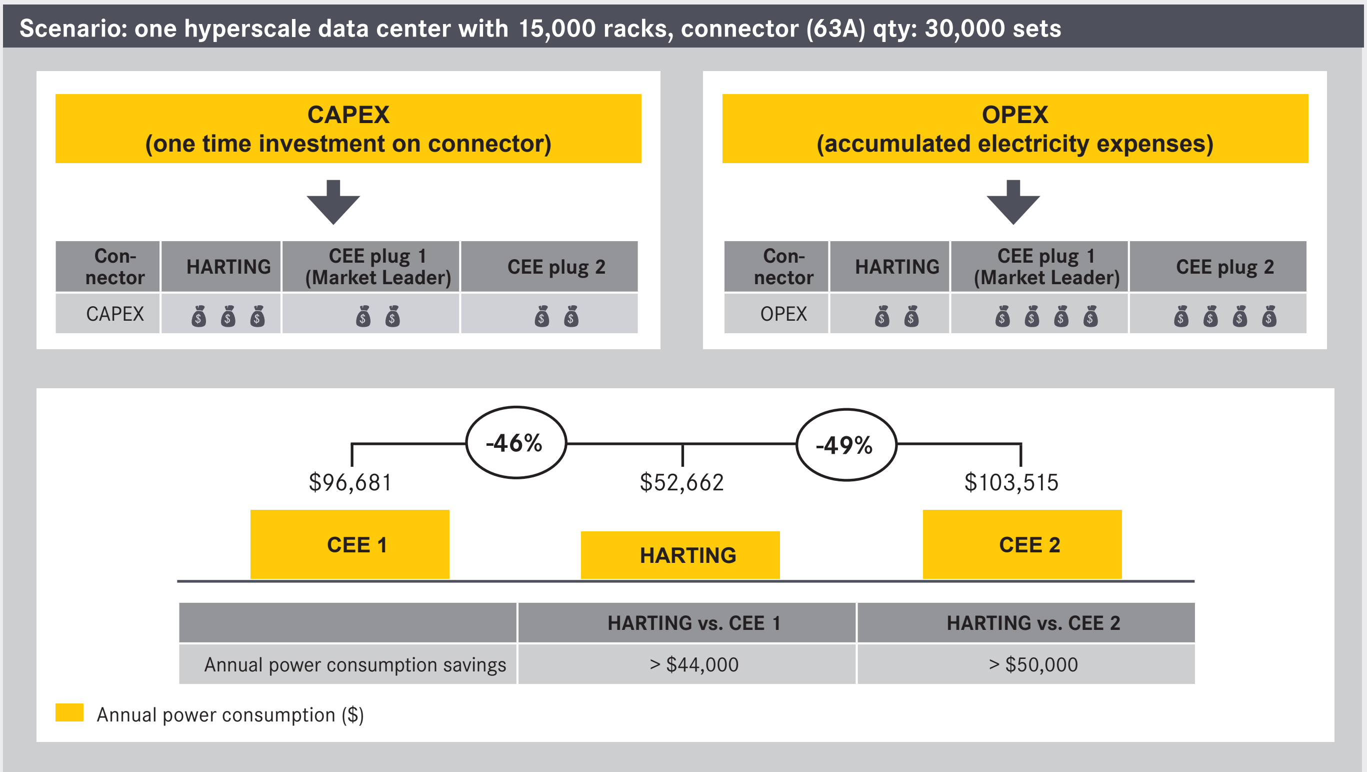
As we know, the PUE can be improved by using advanced connectivity in the power chain in data centers. The HARTING Han-Eco® connector uses up to 50% less energy compared to the traditional CEE plug solutions. To estimate the OPEX saving in one year for a data center operator, we can use our test data and compare the HARTING connector with the 'CEE plug 2'. In the US the industrial average kWh prices were $0.067 [SRC08]. The calculation scenario includes an example of a hyperscale data center with an average of 15,000 racks and assumes there are two connectors per rack for the power distribution unit (rPDU) connections.

HARTING connector: 26.2 kwh/year × $0.067 × 30,000 pcs = $52,662/year

CEE plug 2: 51.5 kwh/year × $0.067 × 30,000 pcs = $103,515/year

The yearly savings for the operator in OPEX is: $50,853

This way, the TCO is significantly optimized through the lifetime of a data center.



HARTING North America
1370 Bowes Road, Elgin, IL 60123 USA
www.HARTING.com; Will.Stewart@HARTING.com

Connector selection can improve energy efficiency by up to 50%

Pushing Performance

7 Conclusion

The amount of energy used by data centers is increasing every year. Data center owners are therefore looking to reduce their energy consumption, decrease environmental impacts and optimize their TCO. Thanks to their energy efficiency, the HARTING connectors are contributing to these goals by helping to optimize the PUE in data centers. Our test results show that the HARTING Han-Eco® connectors reduce energy usage by up to 50% compared to other traditional connectivity products.

Customer benefits at a glance:

- **Energy costs reduced by up to 50%** after optimizing connectivity
- **Longer lifetime** due to mechanical robustness
- **Reduced connectivity footprint** leads to space savings thanks to higher contact density and smaller interfaces
- **Increased flexibility** due to modular system with various off-the-shelf inserts
- **Time savings** due to complete cable solutions for the whole power chain from one supplier

Contact:
Will Stewart
Industry Segment Manager for Energy
at HARTING USA
William.Stewart@HARTING.com
+1 (224) 762-0527

References:

[SRC01] Mordor Intelligence, "Hyperscale data center growth rate by region (up to 2024)", 2020, https://www.mordorintelligence.com/industry-reports/hyperscale-datacenter-market

[SRC02] Nature.com, "Global electricity demand growth rate (up to 2030)", 2018, https://www.nature.com/articles/d41586-018-06610-y

[SRC03] recap-project.eu, "What Makes A Data Center 'Hyperscale'?" 2018, https://recap-project.eu/news/hyperscale-data-center/

[SRC04] Synergy Research Group, "Microsoft, Amazon and Google Account for Over Half of Today's 600 Hyperscale Data Centers", 2020, https://www.srgresearch.com/articles/microsoft-amazon-and-google-account-for-over-half-of-todays-600-hyperscale-data-centers

[SRC05] datacenterfrontier.com, "Data Centers Feeling the Heat! The History and Future of Data Center Cooling", 2020, https://datacenterfrontier.com/history-future-data-center-cooling/

[SRC06] www.iresearch.cn, "iresearch 2020 data center report", 2020, http://report.iresearch.cn/report/202012/3699.shtml

[SRC07] Uptime Institute, "Data center PUEs flat since 2013", 2020, https://journal.uptimeinstitute.com/data-center-pues-flat-since-2013/

[SRC08] Statista, "Average retail electricity price for industrial consumers in the United States from 1970 to 2020", 2021, https://www.statista.com/statistics/190680/us-industrial-consumer-price-estimates-for-retail-electricity-since-1970/

HARTING North America
1370 Bowes Road, Elgin, IL 60123 USA
www.HARTING.com; Will.Stewart@HARTING.com

Pushing Performance

HARTING Electric Stiftung & Co. KG
Wilhelm-Harting-Str. 1, 32339 Espelkamp
Germany
Phone: +49 5772 47-0
info@harting.com
www.harting.com

2022-05 | Whitepaper Energy efficiency for data centers | V2