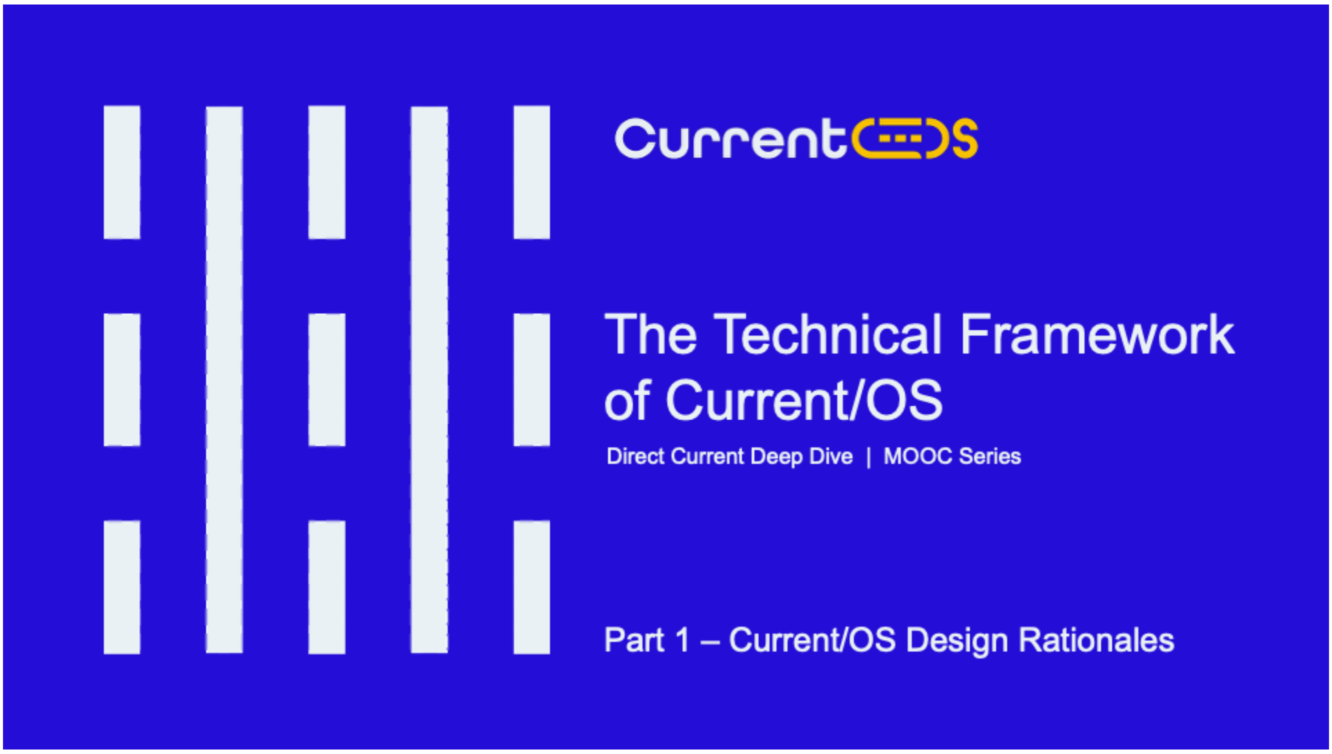


Welcome to the Direct Current Deep Dive Series: the Technical Framework of Current OS" , a MOOC designed to dive into the principles behind Current OS technical decisions and their role in defining the standard for Direct Current electrical systems, also commonly referred to as DC-coupled systems, or DC microgrids

This video is part 1 of a six-part series. Explore the remaining videos on the Current OS YouTube Channel to continue learning about the world of Direct Current.

In this video, we'll establish the context and reasoning behind Current OS work, explain the underlying principles that drive Current OS's technical choices, highlighting why so many companies have joined forces in this collaboration within Current OS.

Quick note: from now on, we’ll refer to Direct Current as DC and Alternating Current as AC for simplicity.

What we observe today is that the world is increasingly electrifying in direct current.

Renewable energy sources such as solar and wind, together with their associated storage systems, naturally generate DC.

On the load side, electric vehicles operate internally on DC, as well as all electronics, data center racks, LED lighting as well as many A-class appliances that need a variable speed on their motor to achieve the performance level, thus converting AC into DC upstream the frequency drive.

This naturally raises the question: are we right to interconnect an entire ecosystem of DC-native devices—both sources and loads—using an AC distribution system? Or should we have a DC installation with AC to DC conversion upstream, at the edge of the building or installation?

Current/OS mission is to explore this new approach and ensure reliable and sustainable DC power distribution in buildings and installations.

The primary role of Current/OS is to build a consensus for shared DC electrical rules among our partners.

Current/OS is a nonprofit organization defining standards for DC microgrid installations, also commonly referred to as DC-coupled systems.

Current/OS is a global, open partnership bringing together a large community of stakeholders, such as load manufacturers, equipment manufacturers, electricity stakeholders, installers, integrators, construction firms, certification companies, trade groups, universities, and more.

Our partnership includes industry leaders such as ABB, Eaton, Schneider Electric, Tridonic, UL Solutions, Siemens, Daikin, Trane, MR, Hisense, Gree — just to name a few—alongside niche experts and innovative startups.

Current/OS holds Liaison A status with the IEC Systems Committee for Low Voltage Direct Current, and UL Solutions is on the Board, underscoring our commitment to international standardization.

Together, our partners represent 30 countries across North America, Europe, and Asia, with more joining every month.

Current/OS partners actively participate in working groups, shaping the technical standards for DC distribution.

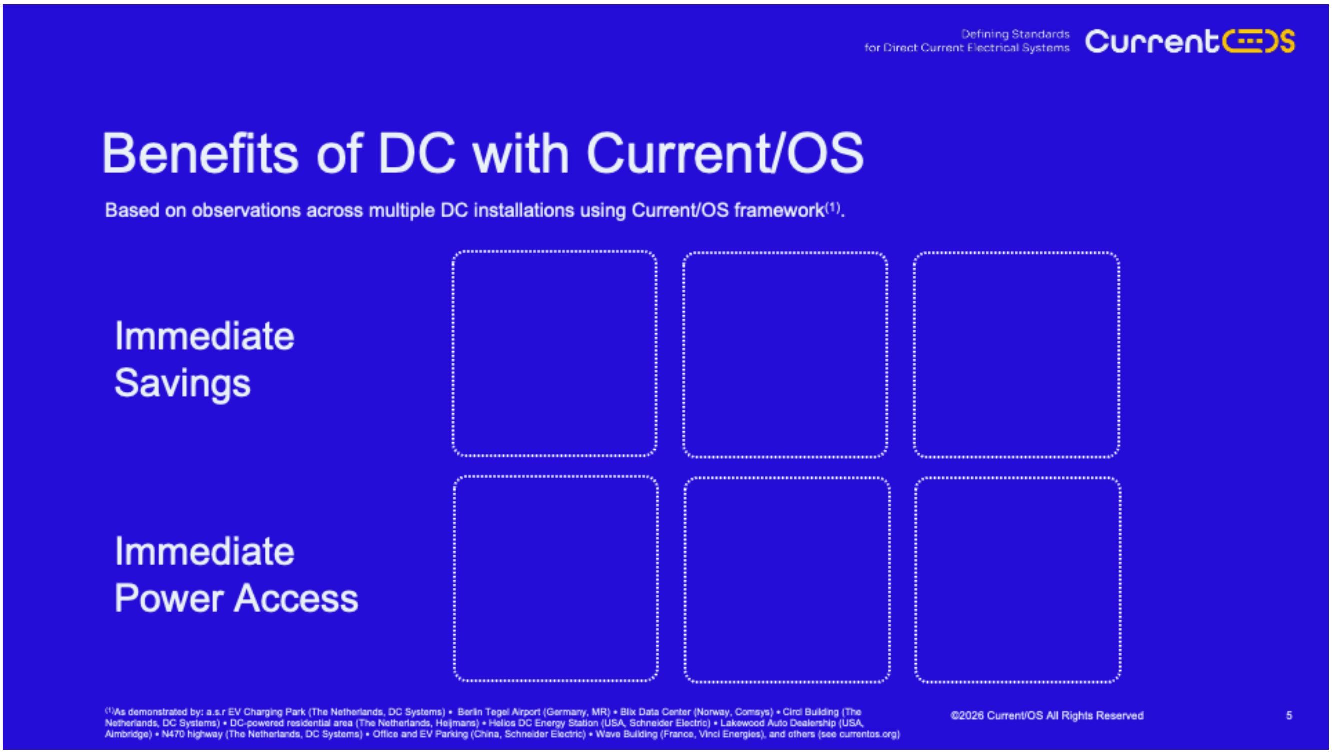
Current/OS welcomes new members to join this effort, contributing to the future of DC distribution standards.

The electrical rules developed by Current/OS are far from theoretical. They are continuously refined through real-world DC installations implemented by our partners.

These projects allow Current/OS to continually learn and refine the DC standards we’ve been defining, while demonstrating the unique benefits of DC systems.

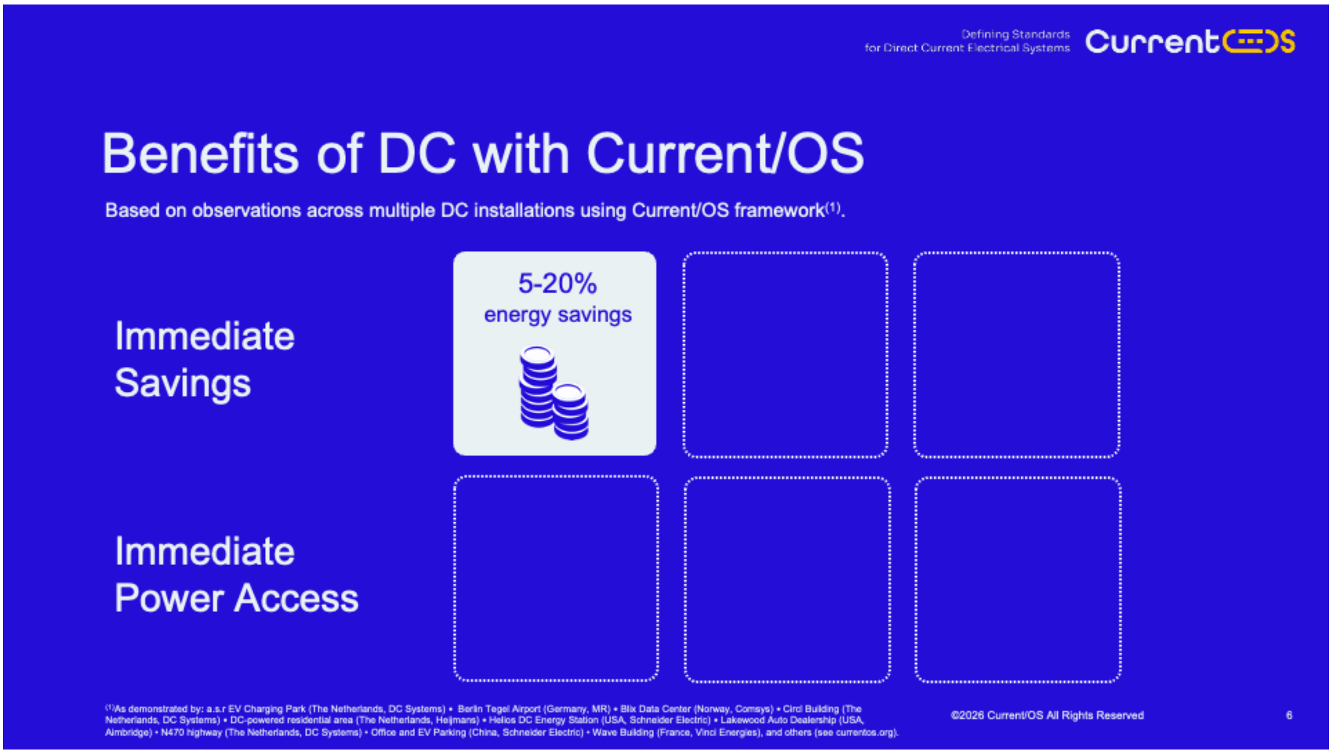
Examples of these projects include EV charging stations in parking lots, office buildings, housing estates, data centers, street lighting as well as university buildings.

Current/OS is also an associated partner in Shift 2 DC, a €11M+ European Union-funded program deploying DC solutions across four key domains: office buildings, data centers, ports, and industrial facilities.

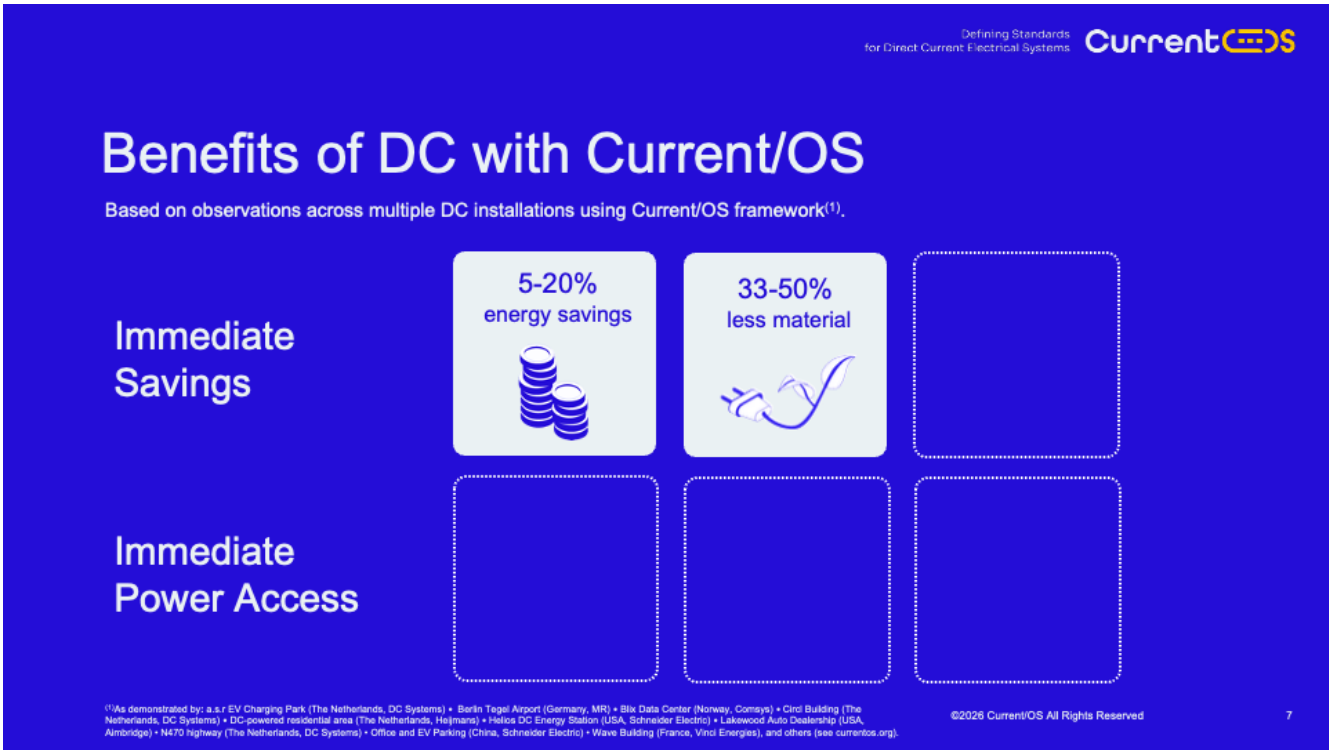


From these real-world projects, we have identified concrete areas where Current/OS delivers measurable benefits, making direct current a key technology for the energy transition. The figures shown here are based on observations across multiple installations using the Current/OS framework. While each installation highlights different advantages, the overall results are consistent and compelling.

We observe two categories benefits: immediate savings and mostly, immediate power access. Let’s start with immediate savings.



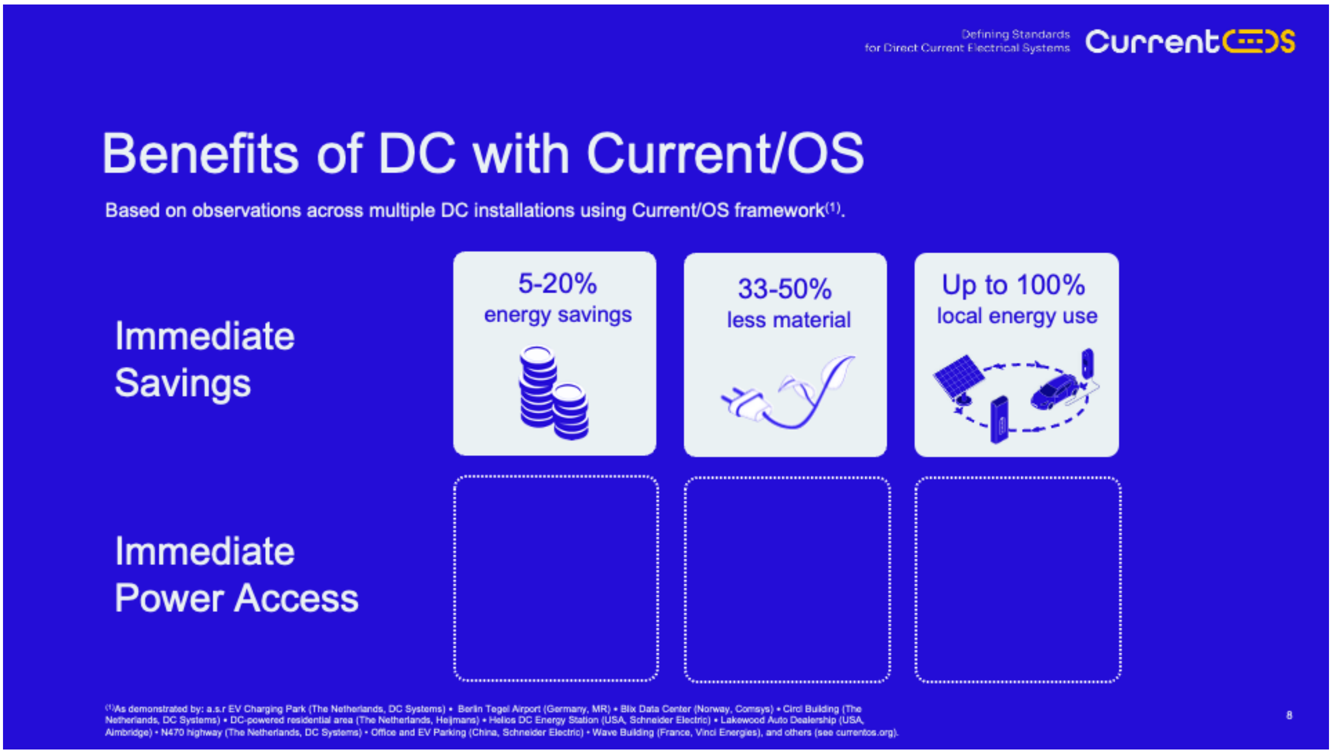
First, 5 to 20% energy savings driven by eliminating of AC-DC conversion losses. These efficiency gains are particularly significant at partial load. DC systems also enable regenerative energy recovery, further improving overall efficiency and reducing consumption.



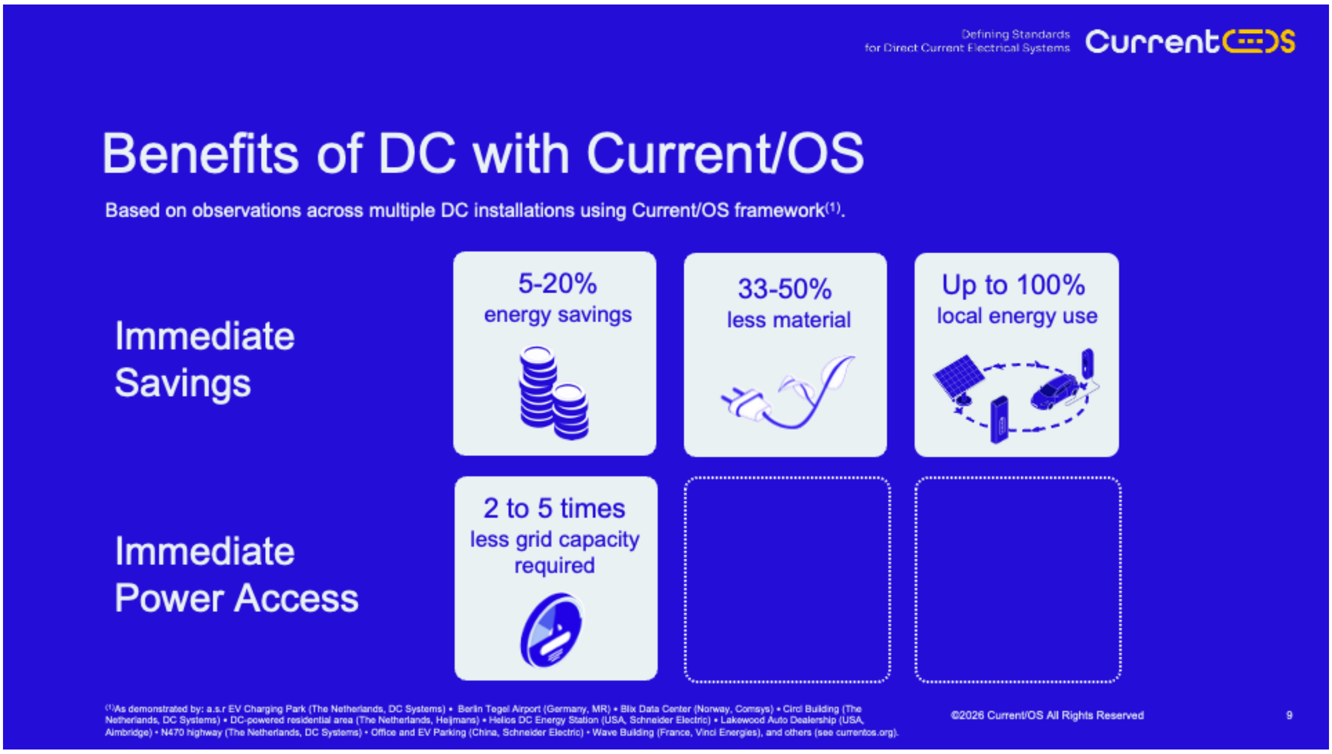
Second, 33% to 50% less material. This starts with copper savings. DC systems require only two conductors, compared to three in AC systems. Additional savings come from shorter cable length due to simpler architectures, and thinner cable cross-sections enabled by higher voltage and lower currents. Altogether, copper needs drop by 33% to 50% depending on the installation type.

There are also broader material benefits too. Improved efficiency reduces the need for PV capacity and battery storage. Operating in DC extends converter lifetime by avoiding repeated conversions and components stress.

Simpler architectures reduce the need for electrical cabinets, by 75% in some large-scale installations, thanks to longer cable runs. Electronics can connect to DC plugs. Directly Due to simpler system design and fewer electrical cabinets, maintenance costs drop by 30%.



Third, DC with Current/OS enables to use up to 100% of local energy, by maximizing self-consumption and optimizing storage. With Current/OS distributed power management, devices respond seamlessly to the system voltage level. Preset droop control priorities enable precise, continuous adjustments in energy usage, storage, and provision.



Now, let’s look at immediate power access benefits, unique to DC installations implemented with Current/OS. In the context of the global energy transition,

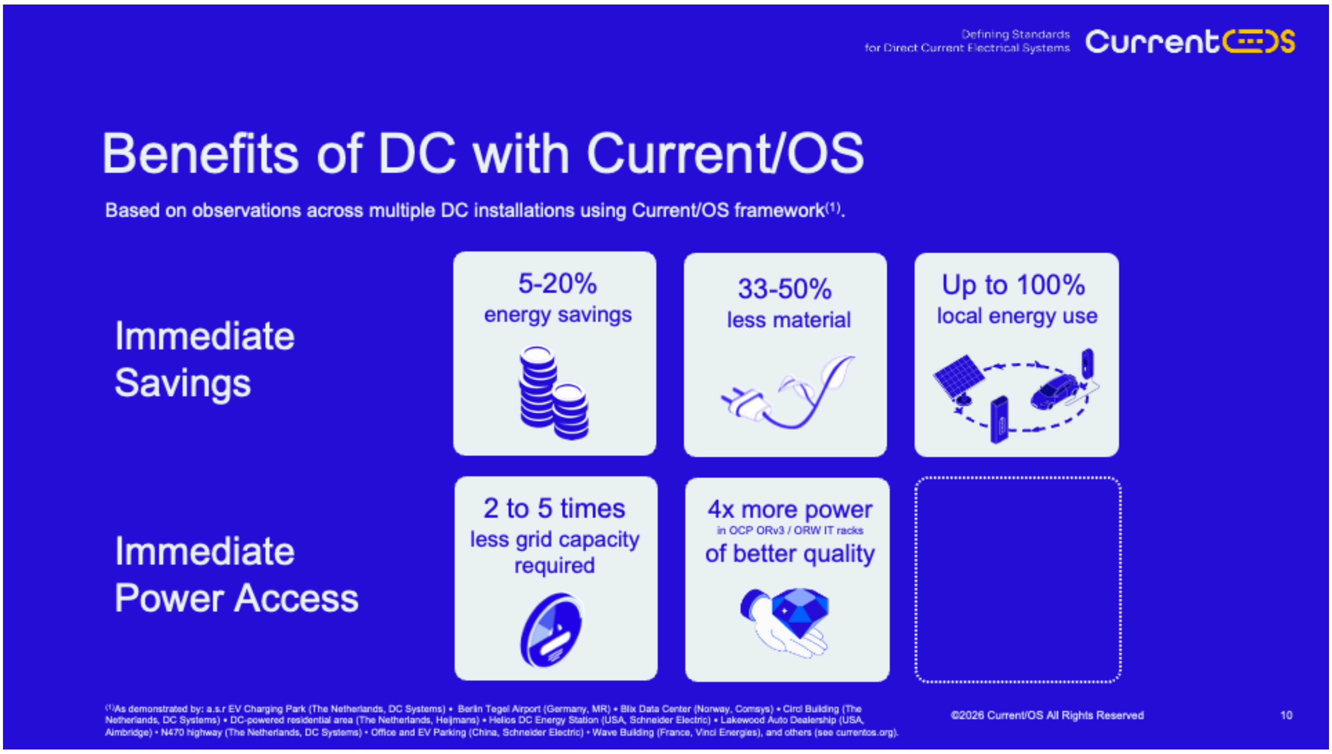
Electric power grids need to accommodate an increasing number of renewable energy sources (RES), storage facilities, heat generation and car charging facilities at all voltage levels.

The need for **connectivity (power)** is outpacing the **transport capacity (energy)** of power grids.

Building stations and substations is taking too much time and is too costly.

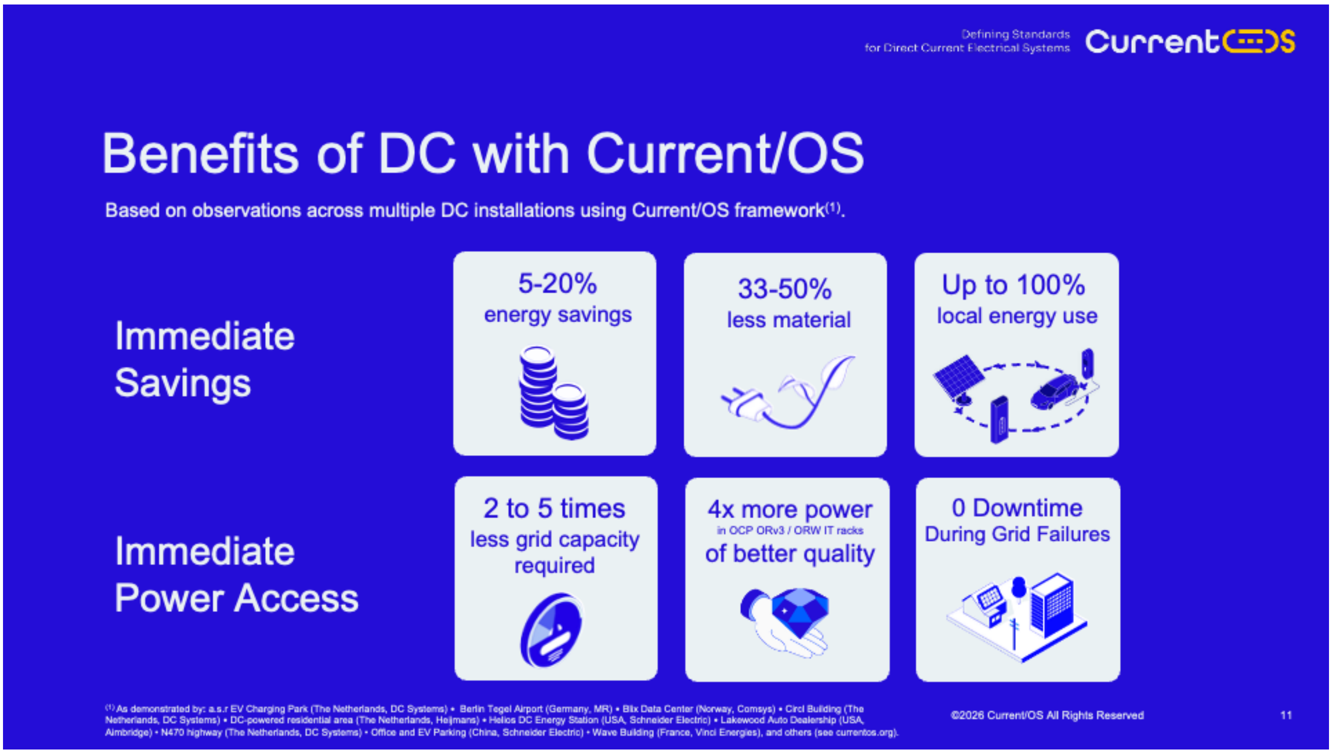
Control of power is becoming increasingly difficult and power grids have more and more difficulties connecting and managing the rising level of power. The legacy grid is not suited for managing power flows from such a high number of power sources and power sinks including energy storages.

Direct Current with Current/OS enables installations to require 2 to 5 times less grid capacity, operating with higher installed power than the public grid connection would allow. This relieves projects from grid constraints and costly substations upgrade delays. Current/OS enables lower peak demand and reduced grid injections. This avoids peak-related costs and penalties, all the while contributing to grid stability.



Second, 4 times more power and better quality power.

Current OS DC installations concentrate power, as expected in AI data centers applications, even compared to the most up-to-date AC architectures. For applications such as data centers, this is a crucial advantage of DC.



Finally, seamless transition during grid events. DC electrical system can operate autonomously. We know for example that switching from a public grid supply to a genset supply requires specific transfer systems. With Current/OS, behind the interlinked converter, the system remains powered with no visible interruption when power grid fails, and reconnection occurs smoothly when the grid returns. Transitions are seamless in both directions.

There are four guiding principles underlying all of Current/OS's technical decisions. They are: overcome DC safety concerns, defining a multi-vendor system, streamline the design and build of DC microgrids, and achieve unprecedented resilience and flexibility in energy systems.

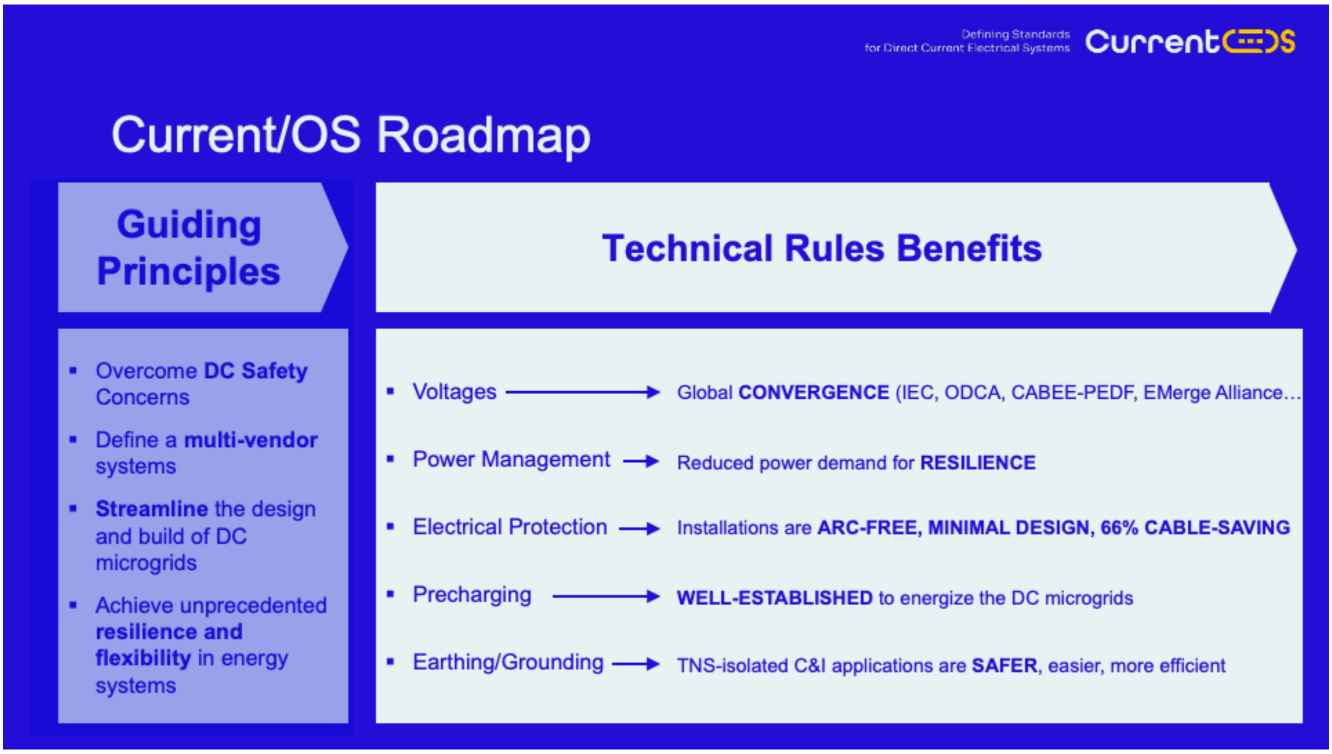
First, addressing DC safety concerns. Safety perception remains a significant challenge with direct current, as many electricians are cautious about adopting it. Demonstrating that today's technology has resolved DC safety concerns is crucial for its widespread acceptance.

Second, creating a multi-vendor system. Today, many manufacturers offer DC microgrid solutions, but these are often proprietary. This means that photovoltaic converters, battery chargers, and AC DC converters from different brands cannot interoperate. Current OS aims to create a truly open ecosystem, where products from different brands can work seamlessly together.

Third, making DC installations simple for any professional. DC must be accessible and easily scalable to all industry intermediaries, from design offices planning buildings to installers handling projects of all sizes. DC microgrids should be easy to expand. In AC systems, extending a microgrid setup is often complex and requires simultaneous coordination between electricians and automation engineers, as two separate systems need to evolve in parallel. Current OS seeks to simplify this process, leveraging DC to provide scalable, flexible solutions.

Finally, DC is taking building energy resilience to unseen levels as seen on the DC Benefits slide, solving the new challenges of distributed energy sources. AC systems are optimized for consuming energy from the public grid. However, they become complex when local energy sources are involved. We know for example, switching from a public grid supply to a genset supply requires specific transfer systems. When we develop local energy sources without limitation, we have to combine multiple solar panel arrays on rooftops and parking lots, with distributed battery storage, and even vehicles batteries can become backup power sources for a building. As local sources multiply, buildings gain in resilience and flexibility, however new challenges arise that AC systems struggle to address. Current OS aims to resolve these issues with DC systems, that enable a seamless integration of distributed energy sources.

These 4 guiding principles translate into technical rules, detailed in this presentation, regarding voltages, power management, electrical protection, pre-charging and earthing (or grounding). Note that Earthing is commonly used in British English, while Grounding is more familiar in American English. For consistency, we'll use Earthing throughout this presentation. We understand that this might sound unfamiliar to our American audience and appreciate your understanding.



The technical rules have clear benefits

For voltages, the technical rules actually define voltage bands—not just a single number—with the goal of achieving global convergence among DC consortiums.

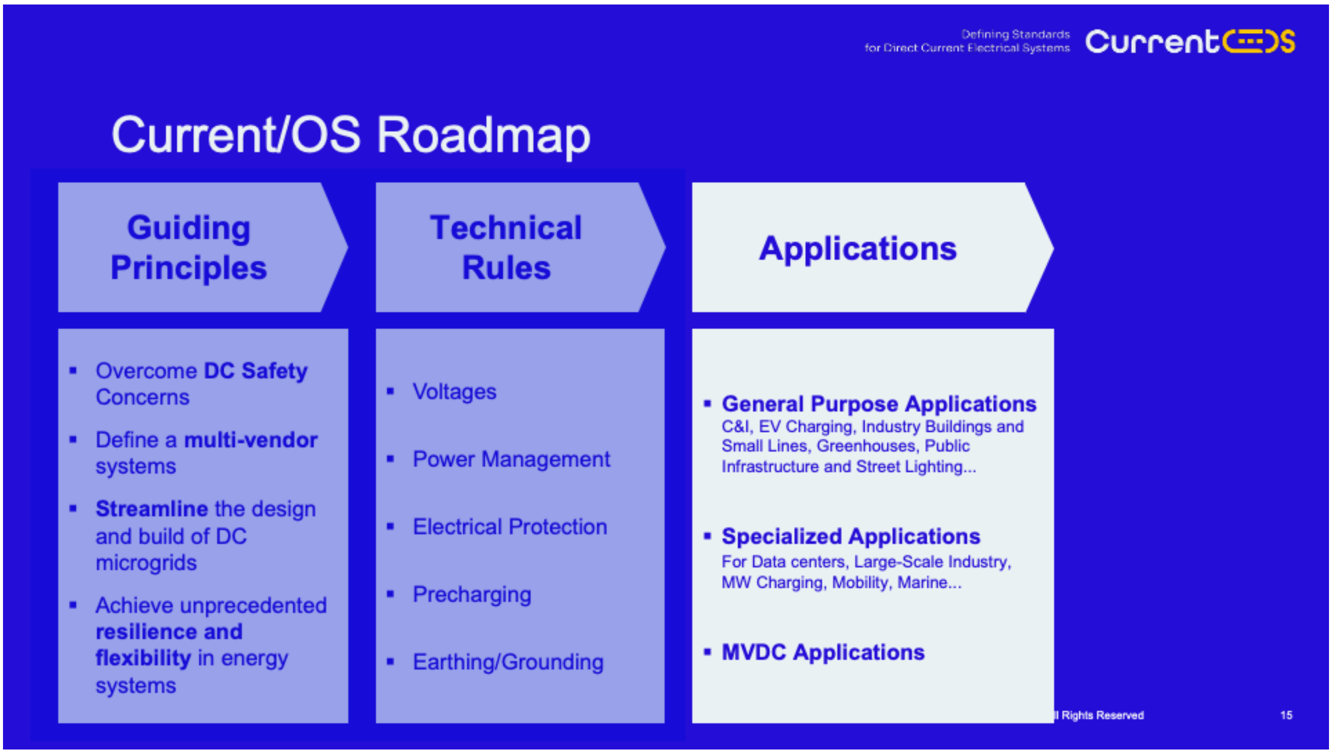
For power management, Current OS establishes distributed control, which significantly reduces the power demand on the public grid, ensuring its resilience. This reduction makes installations far less reliant on the capacity availability from the public grid. It also ensures a smooth integration with the AC grid.

Third, for electrical protection, the technical rules introduce a zoning system. Current/OS recommends the ultrafast protection of electronic circuit breakers. It drastically lowers incident energy levels, making installations arc-free. It greatly simplifies system design, reducing this step to a minimal work. These circuit breakers also enable savings on cabling across various applications.

Additionally, Current OS organizes the pre-charging and disconnecting process in loads, a necessary and well-established method for safely energizing DC microgrids.

Finally, the technical rules include provisions for earthing (or grounding), recommending the TNS system alongside isolation between AC and DC installations. This approach is specifically tailored to the requirements of commercial buildings and installations to ensure installations are safer, easier to design, and more efficient.

Together, these technical rules form a robust framework that is published in Current OS System Reference Document, optimizing the design and implementation of DC microgrids, setting a new standard for safe, efficient, resilient and sustainable power systems.



Current OS Technical Rules have been defined for multiple applications, including:

General Purpose Applications cover commercial and industrial C&I buildings, EV Charging, light industrial lines, greenhouses, public infrastructure , and street lighting. This market prioritizes simplicity of design, ease of installation, replicability, and solutions that are widely recognized and trusted.

On the other hand, **Specialized Applications** include data centers, large-scale industrial projects, installations, and certain high-power EV charging systems. Their priority is to optimize a specific performance dimension—such as energy efficiency, power density, serviceability, or system reliability. Each project or organization may prioritize different criteria.

MVDC Applications are yet another type of application.

Current/OS provides a common technical framework with design approaches tailored to these different application types.

Projects in the General Purpose segment typically have low to moderate technical complexity and are installed and maintained by local electricians and construction professionals. Since these installations involve many vendors, a third-party conformity assessment is expected.

For this market, Curren/OS technical rules provide **a General Purpose LVDC System**, with a standardized architecture optimised to operate across a wide range of situations. The result is a plug-and-play approach to designing and installing, offering high replicability, and ease of installation with seamless implementation by professionals in the field and cost-effective deployment and operations.

Instead, **Projects in the Specialized Application** segment require project-specific architectures done by experts, with high to very high technical complexity.

For this market, Current OS technical rules are implemented jointly with highly specialized integrators, and a pre-selected set of products. The rules are tailored to meet the precise technical objectives of each project or customer. They are operated and maintained by dedicated and specifically trained teams.

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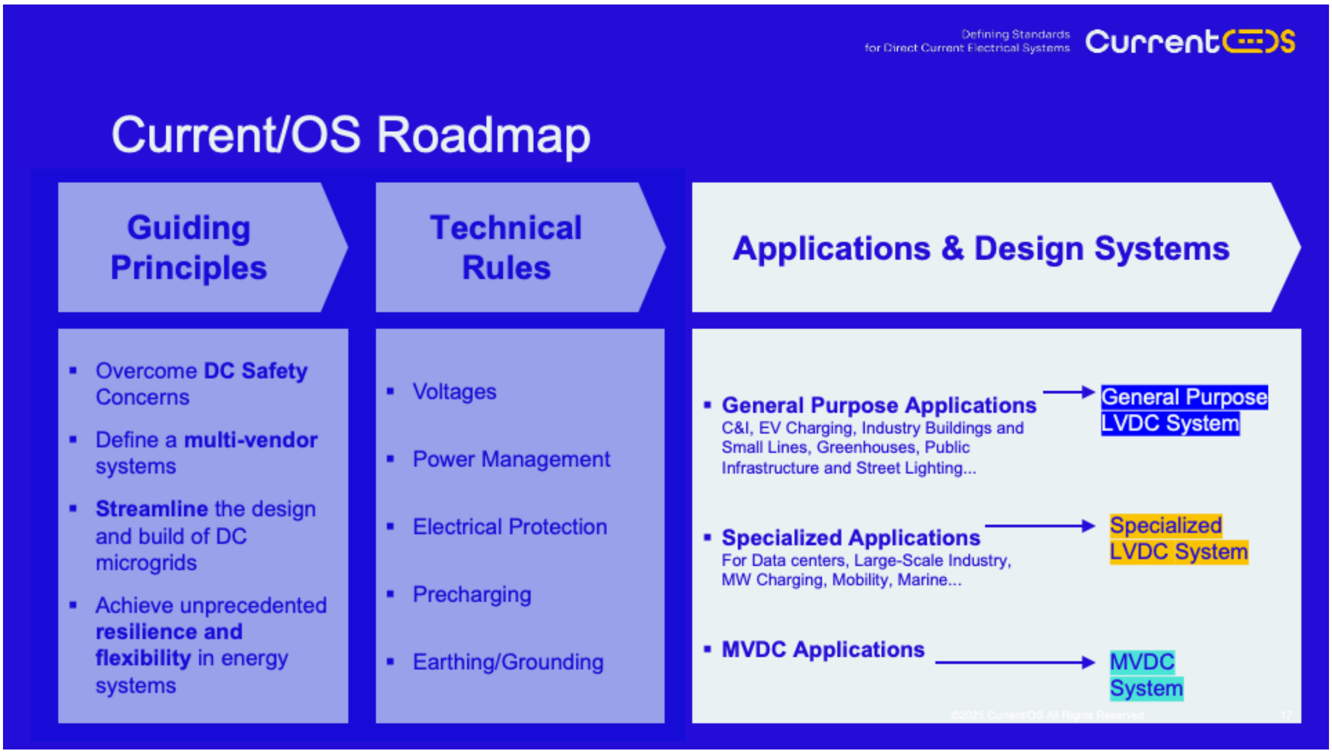
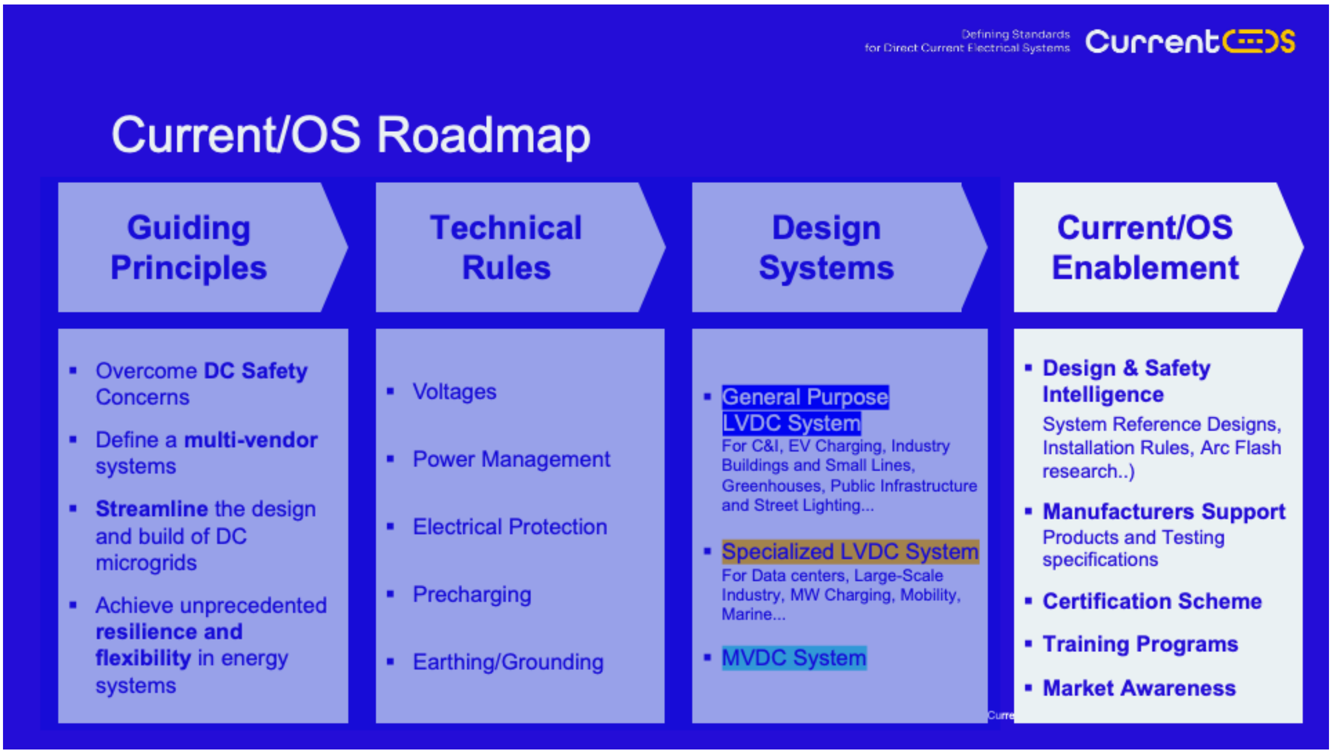
Designed by experts



MVDC use cases rules are under work at the time of publication.

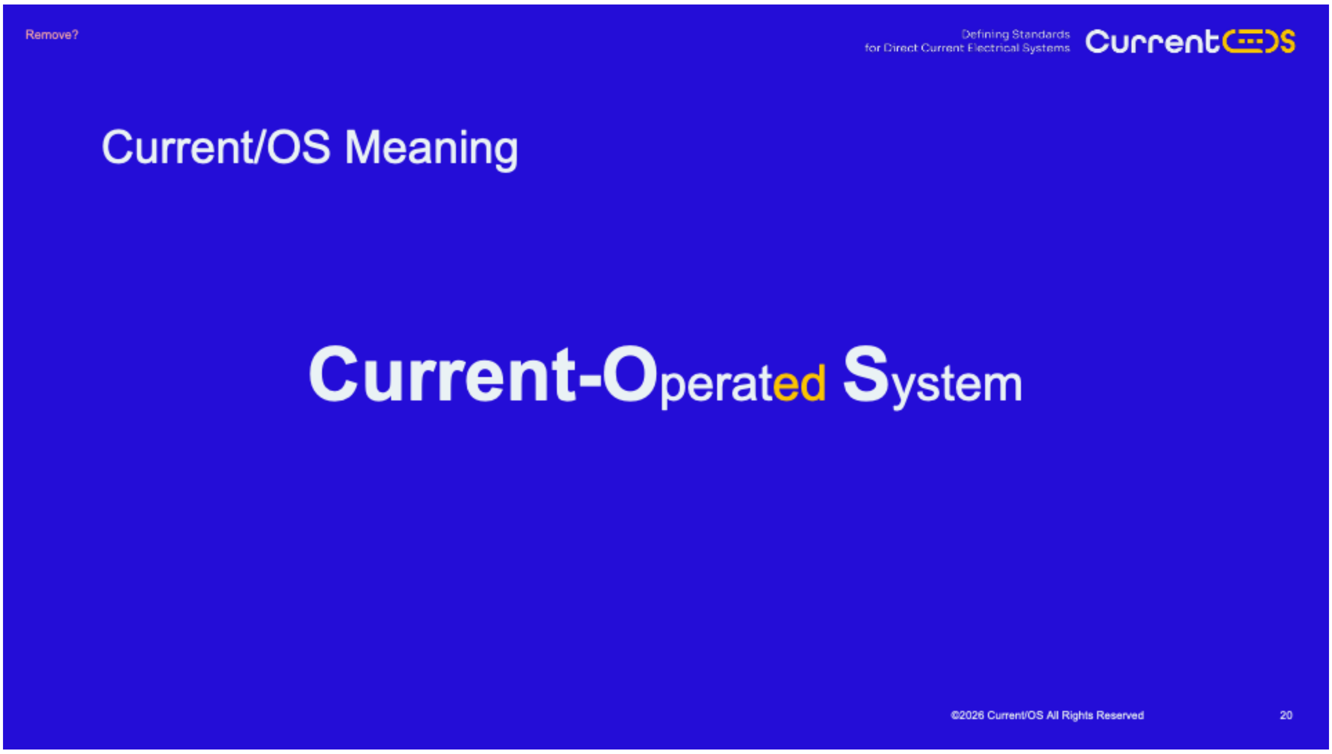


Current OS goes beyond defining technical rules for Direct Current. What we offer is a complete enablement framework to help partners design, deploy, certify, and scale DC systems with confidence.

Current OS provides shared design and safety intelligence, clear product and testing specifications to support manufacturers, verified by the Current OS Certification Scheme. Training programs complement this approach.

Finally, we support market awareness by sharing use cases, lessons learned, and technical insights through webinars, conferences, and publications — helping DC move from early adoption to scalable market reality.


Defining Standards for Direct Current Electrical Systems
Current/OS
Current/OS Roadmap
Guiding Principles
Technical Rules
Design Systems
Current/OS Enablement
Overcome DC Safety Concerns
Define a multi-vendor systems
Streamline the design and build of DC microgrids
Achieve unprecedented resilience and flexibility in energy systems
Voltages
Power Management
Electrical Protection
Precharging
Earthing/Grounding
General Purpose LVDC System
For C&I, EV Charging, Industry Buildings and Small Lines, Greenhouses, Public Infrastructure and Street Lighting...
Specialized LVDC System
For Data centers, Large-Scale Industry, MW Charging, Mobility, Marine...
MVDC System
Design & Safety Intelligence
System Reference Designs, Installation Rules, Arc Flash research..)
Manufacturers Support
Products and Testing specifications
Certification Scheme
Training Programs
Market Awareness



We will discover in the next videos of this MOOC how Current/OS electrical rules were defined and how they operate. Before that, you might be wondering what Current/OS means?

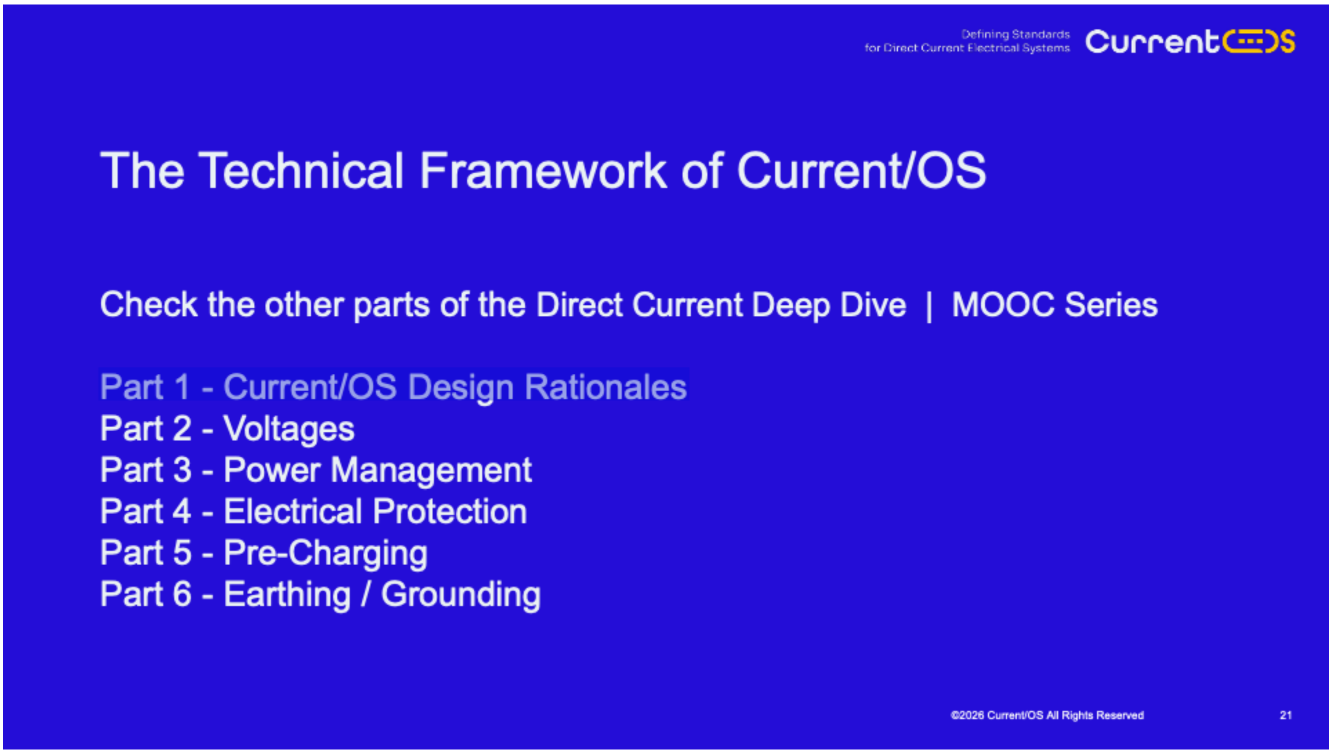
It stands for “Current-OperatED System”, reflecting its core principle: electricity governs the system.

The name is also a playful nod to Operating Systems—unlike them, Current/OS can ensure installation power delivery without digital communication. Basic power availability does not rely on critical digital systems.

For installations using Current/OS, voltage indicates available power, allowing devices to adapt their behavior dynamically.

For example, devices can accelerate or slow down based on demand, manage their load efficiently, or feed power back into the grid.

From solar panels and electric vehicles chargers to LED lights and electronics, all loads within the installation operate seamlessly together, creating a highly efficient and resilient solution.



This concludes the introduction of Current OS.

Want to learn more? Check out the other five Current/OS MOOC videos covering voltages, power management, electrical protections, precharging and earthing

Thank you for watching, see you in the next video!

Connect with the Current/OS team

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currentos.org

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