



Follow and visit us



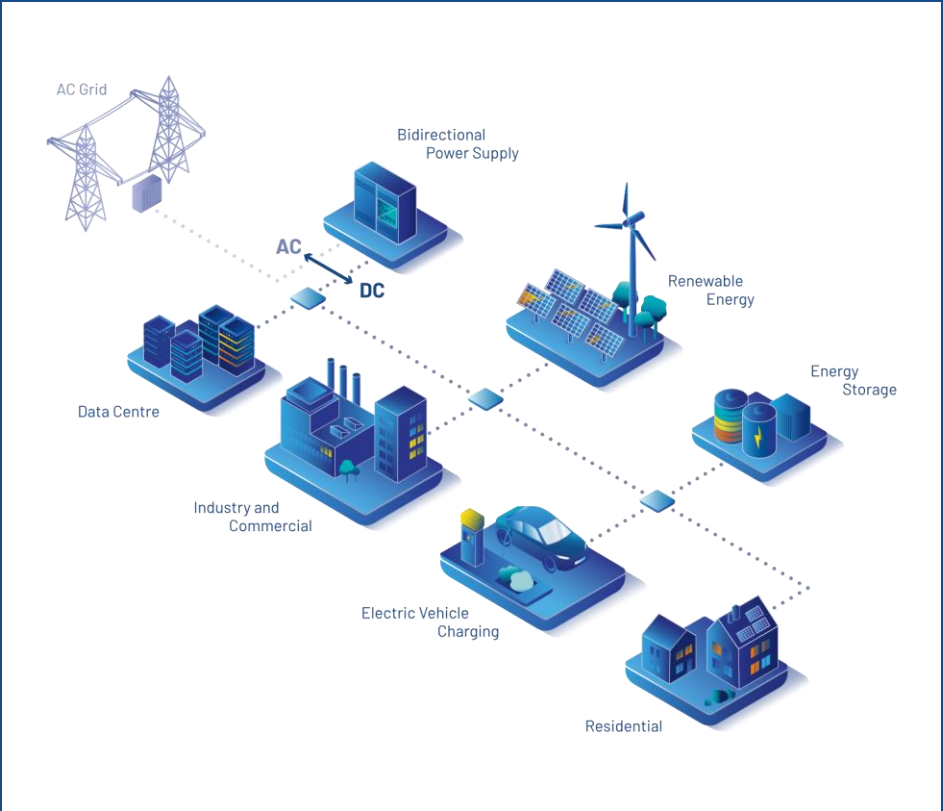
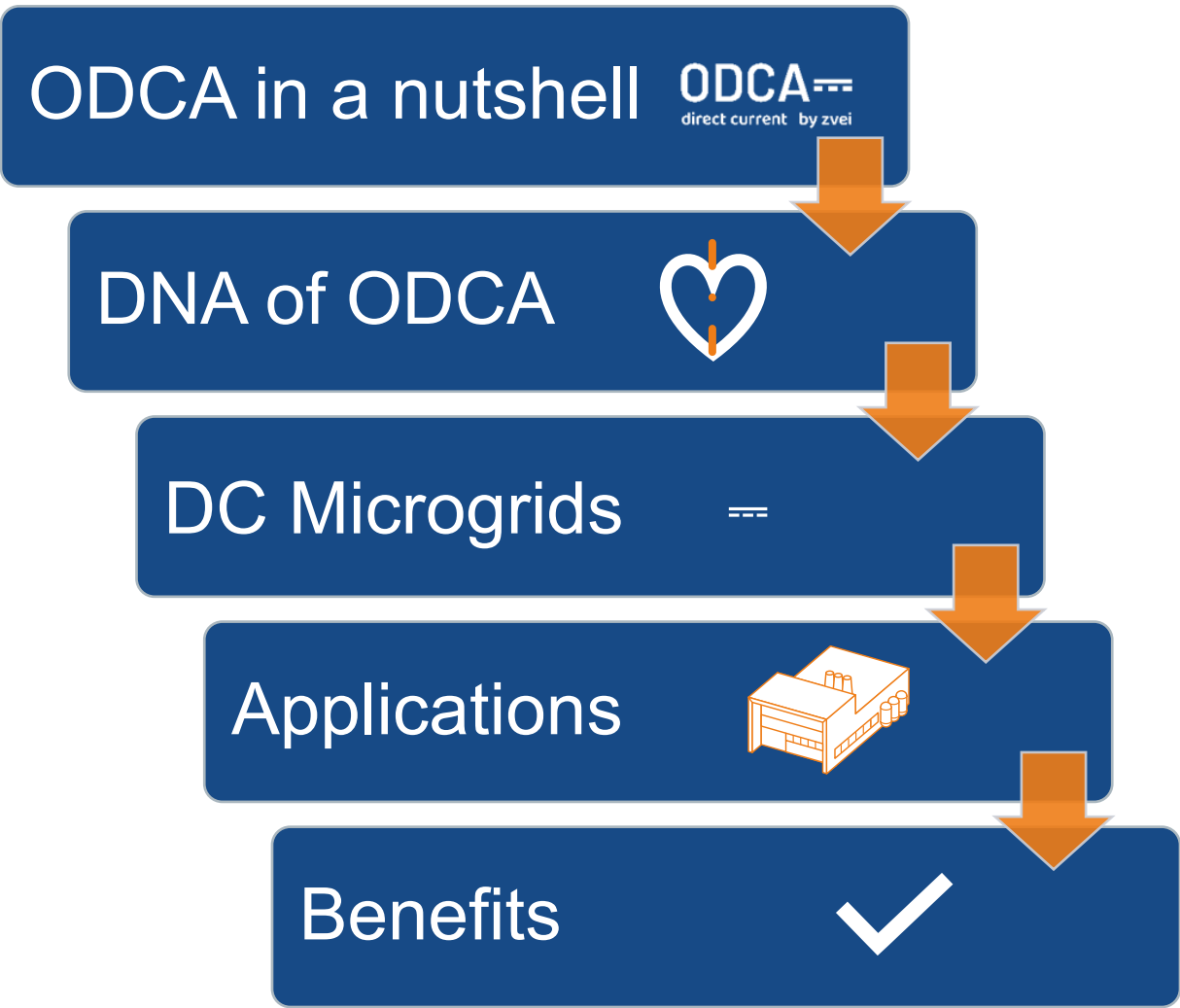
Open Direct Current Alliance

Overview, characteristics, technology, applications, benefits

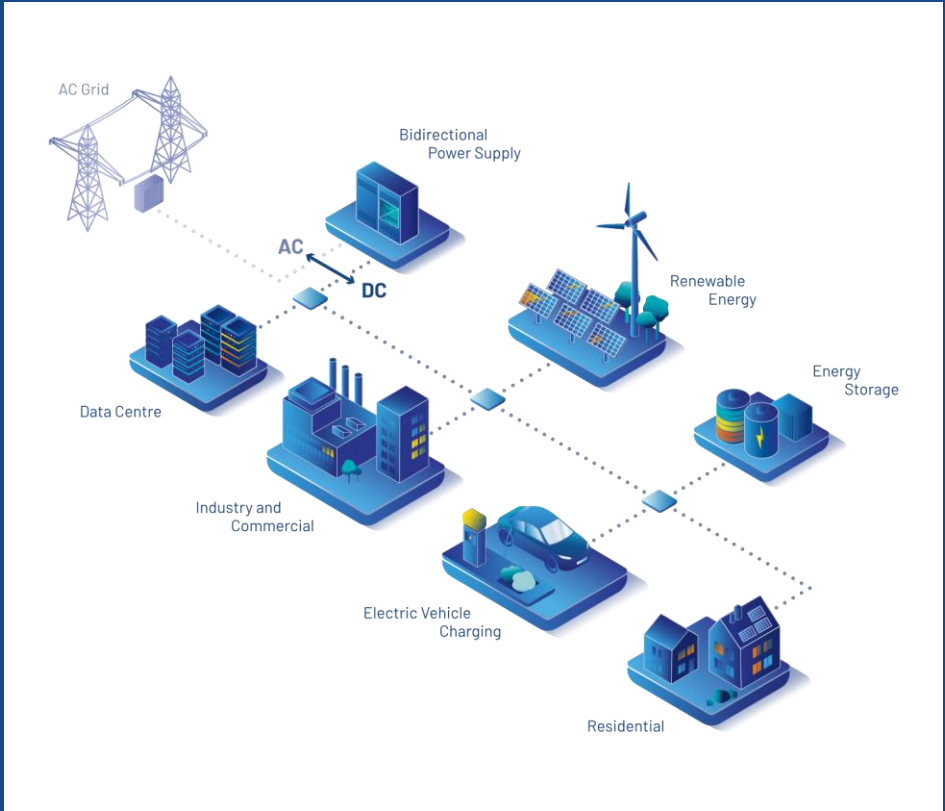
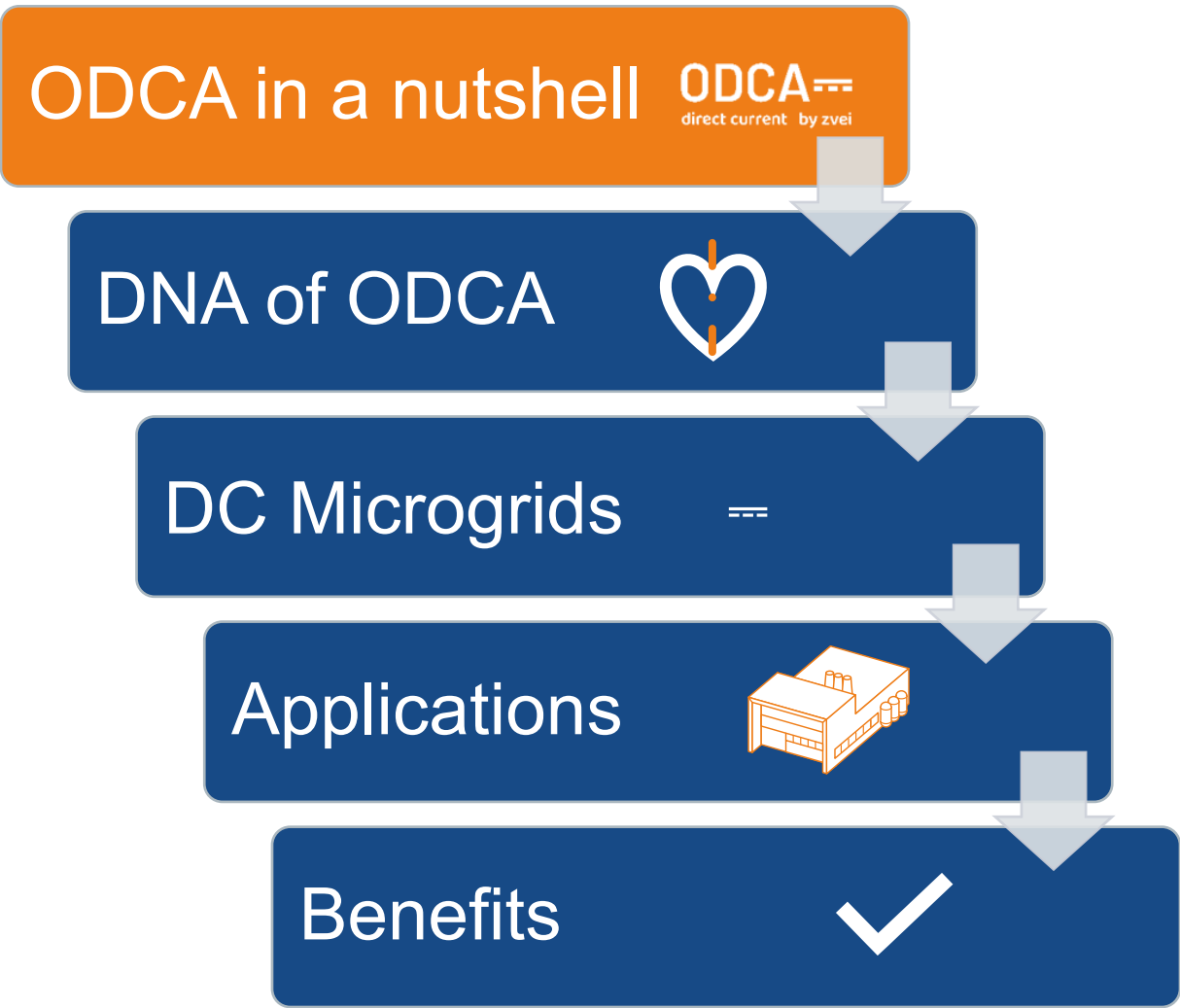
Dr. Hartwig Stammberger | Eaton | Open DC Alliance | Aug 2025

ODCA 
direct current by zvei

Content



Content



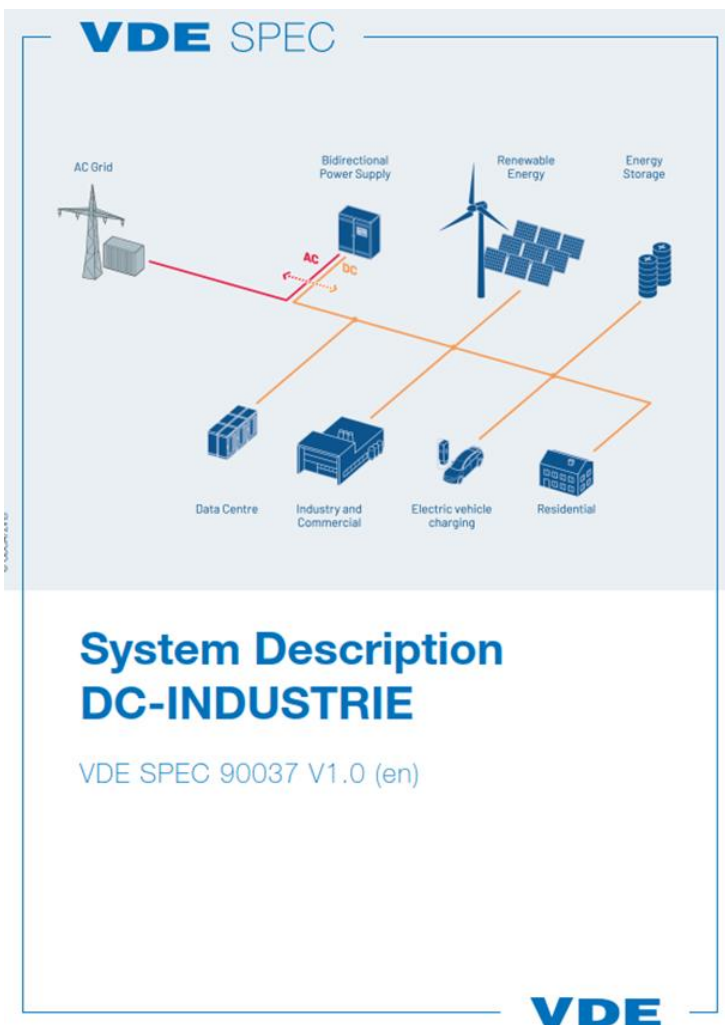
Open Direct Current Alliance ODCA – Who are we?



Plenary meeting March 2025

- **International non-profit organization**
- With **80+** members
- In **16** countries
- On **3** continents
- Main office – **dedicated staff**
- **5** active working groups

Open Direct Current Alliance ODCA – What do we do?



- **Publish system description**

- Free access

- Recognized by German standards organization VDE

- **Networking**

- Knowledge exchange

- Best practice sharing

- Contribute to IEC & UL standardization



ODCA: Vision and Mission



Vision

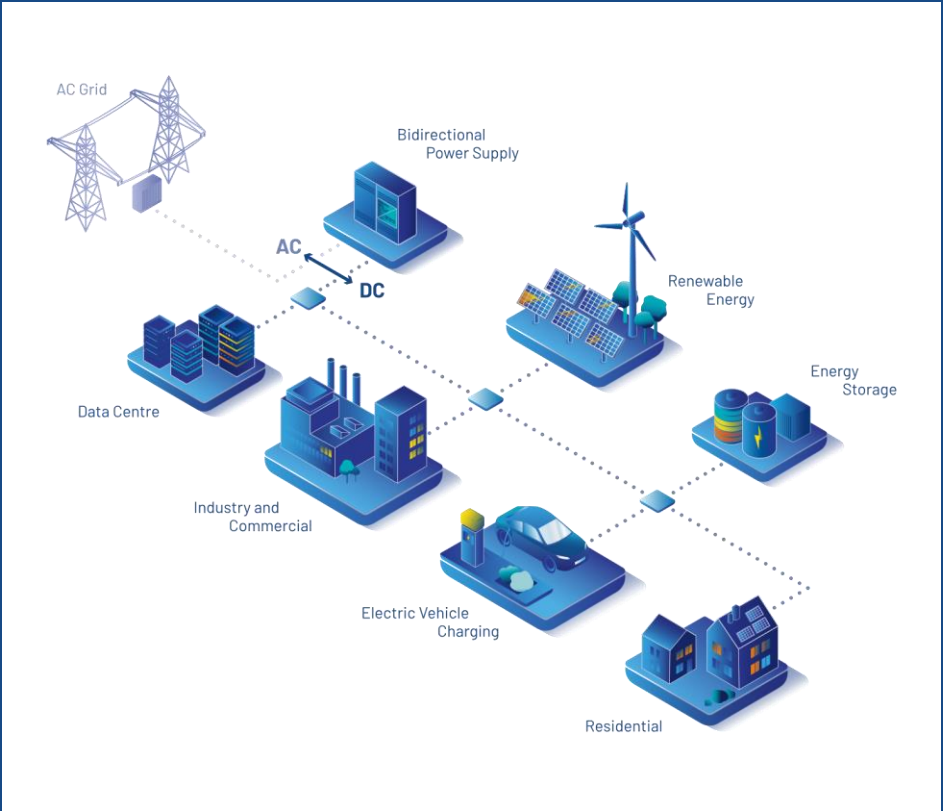
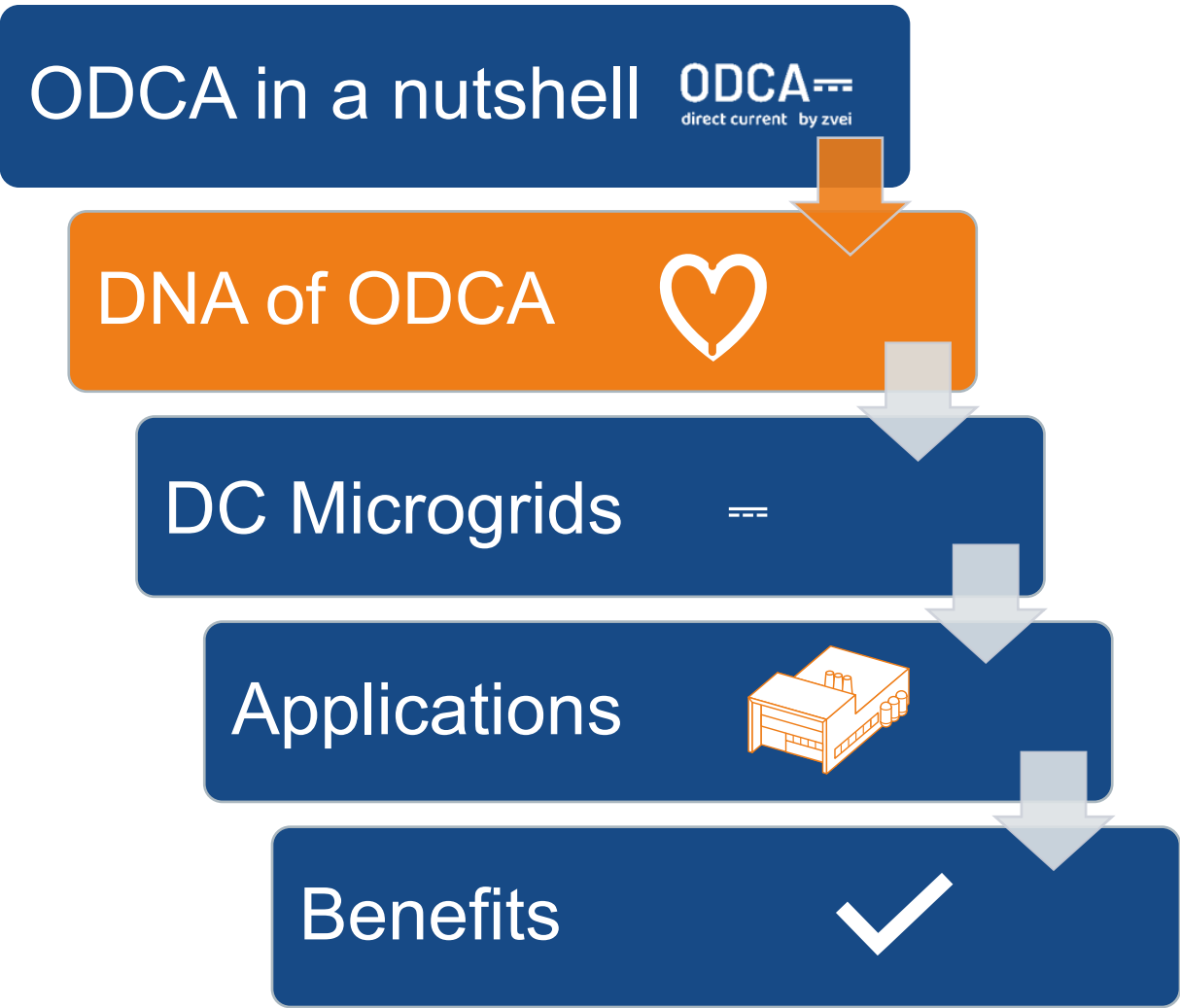
- DC contributes to a sustainable world



Mission

- Establish an international DC ecosystem

Content



Our **organizational** DNA

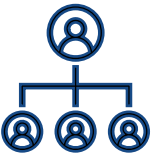


Open technology

- System description freely available
- Based on existing certification
- Liaison with global standardization

Organization

- **Full-time independent staff**
- Transparent working groups
- **Elected board** & working group chairs

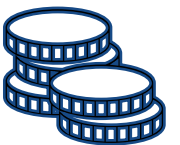


Equal access

- **One member – one vote**
- Same rights for all
- Bringing together the entire DC ecosystem

Membership fees

- **According to company size**
- Everyone contributes

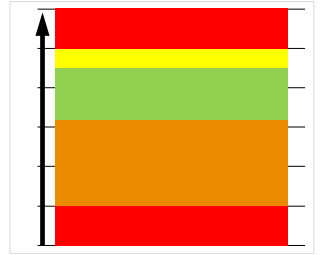


Our **technical** DNA – overview



Symmetry

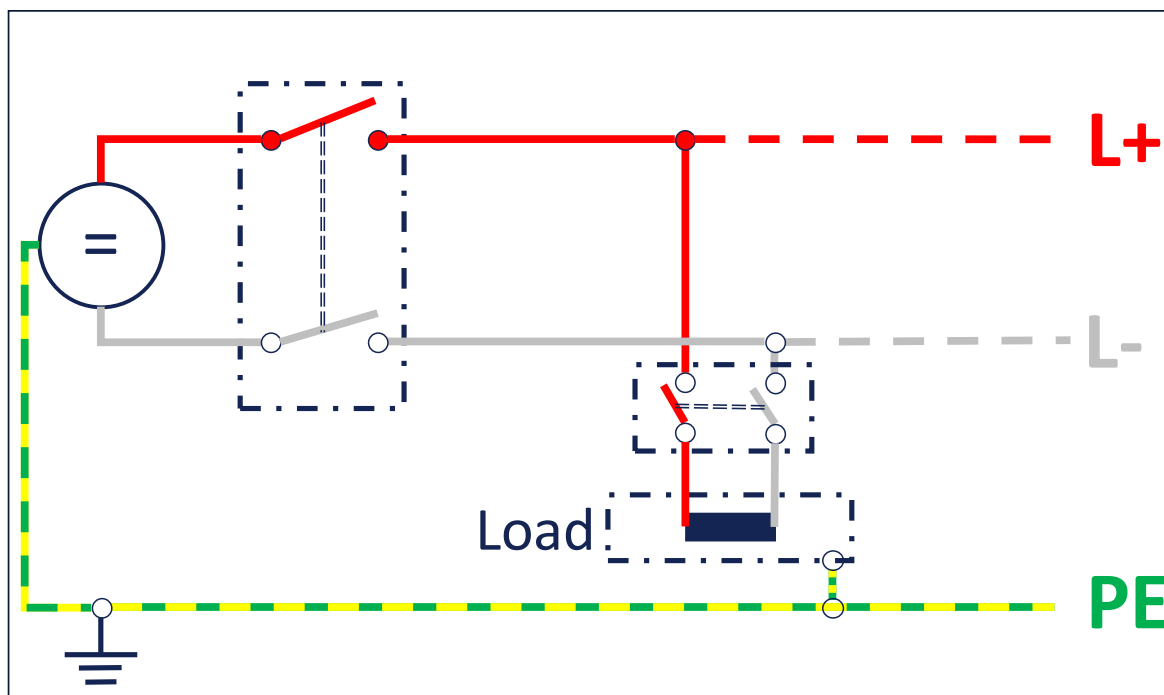
Voltages



Power
management

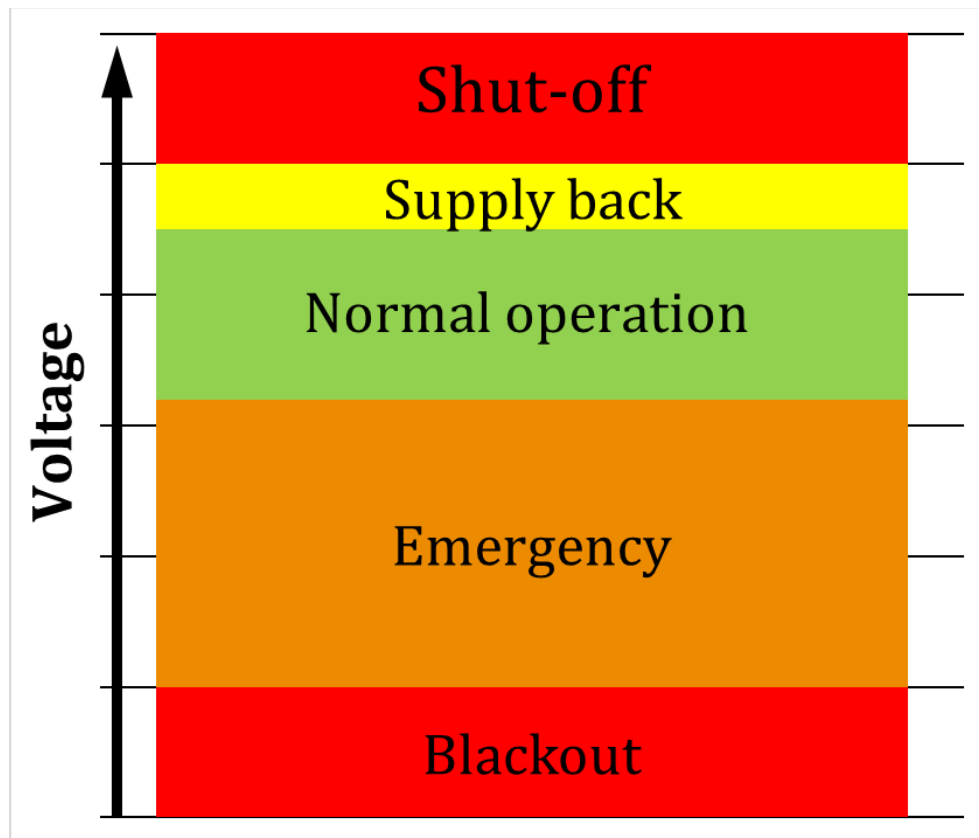
Protection





Symmetrical system

- L+ and L-
- Simple wiring
- Simple control
- Simple protection
- Smaller insulation distance
- No active wire at / near ground potential

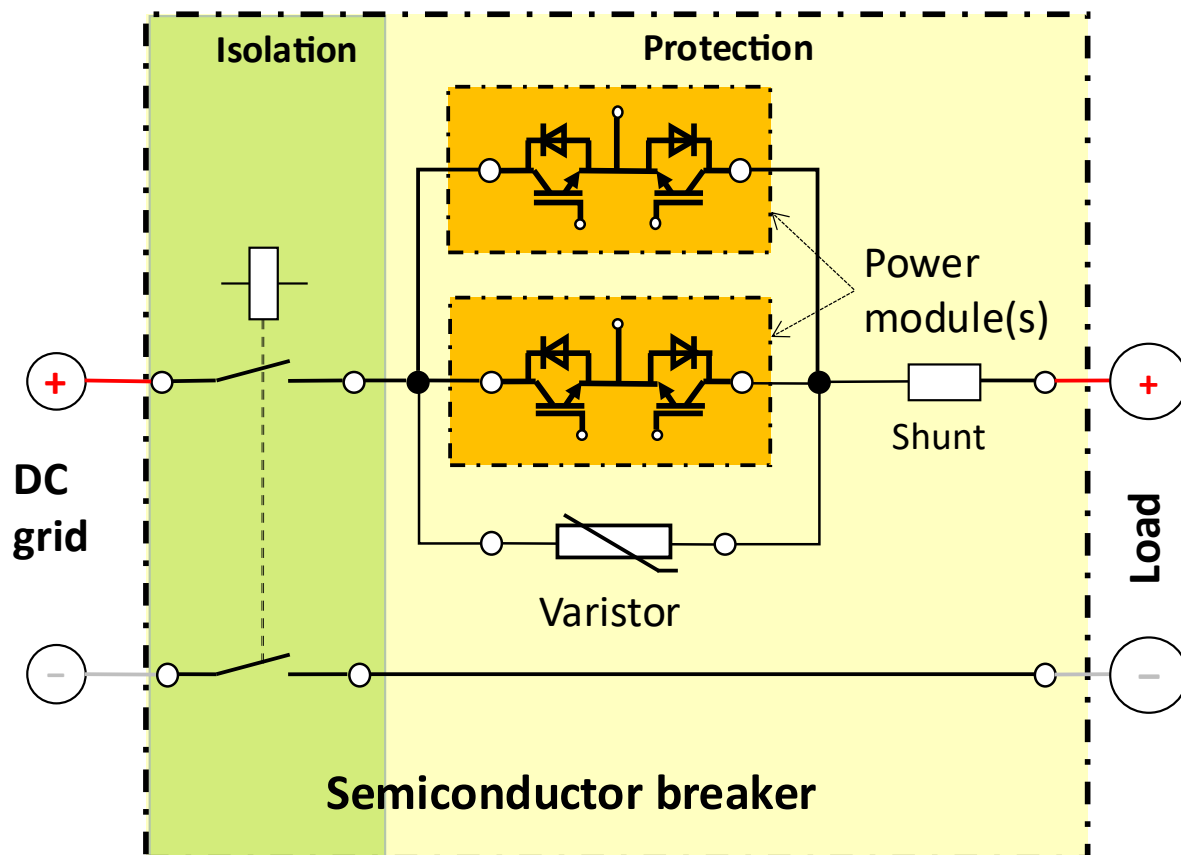


- **Voltage band**
 - Full function in green band
 - Based on IEC TR 63282
 - Compatible to AC voltage levels



- **Power management**
 - Droop curve
 - Measure voltage → control power

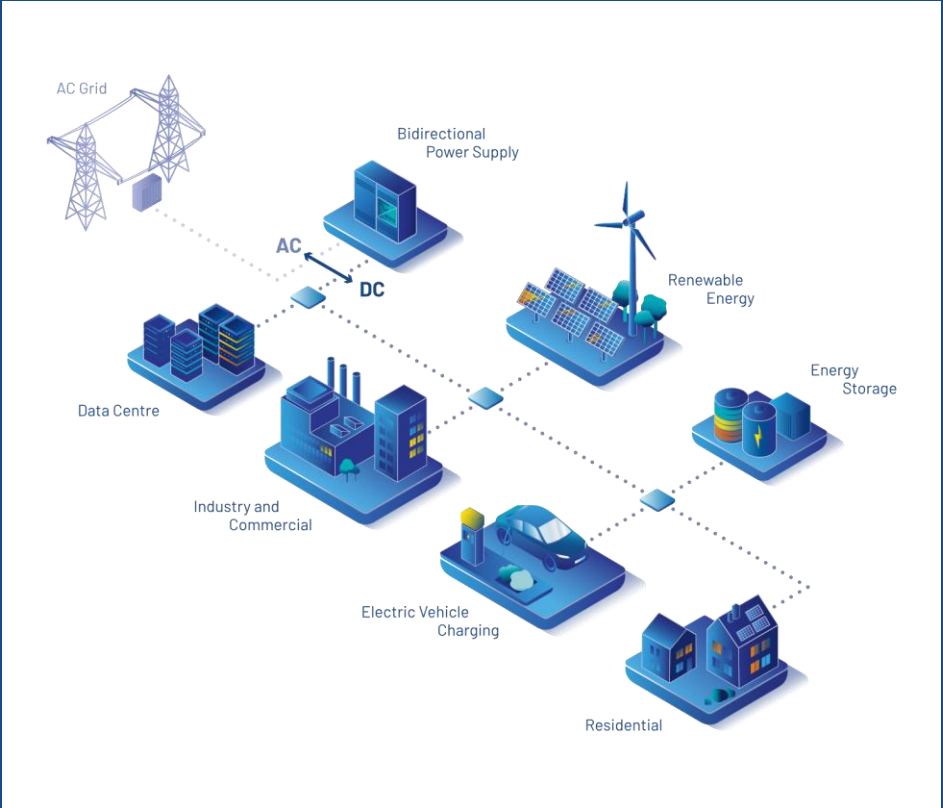
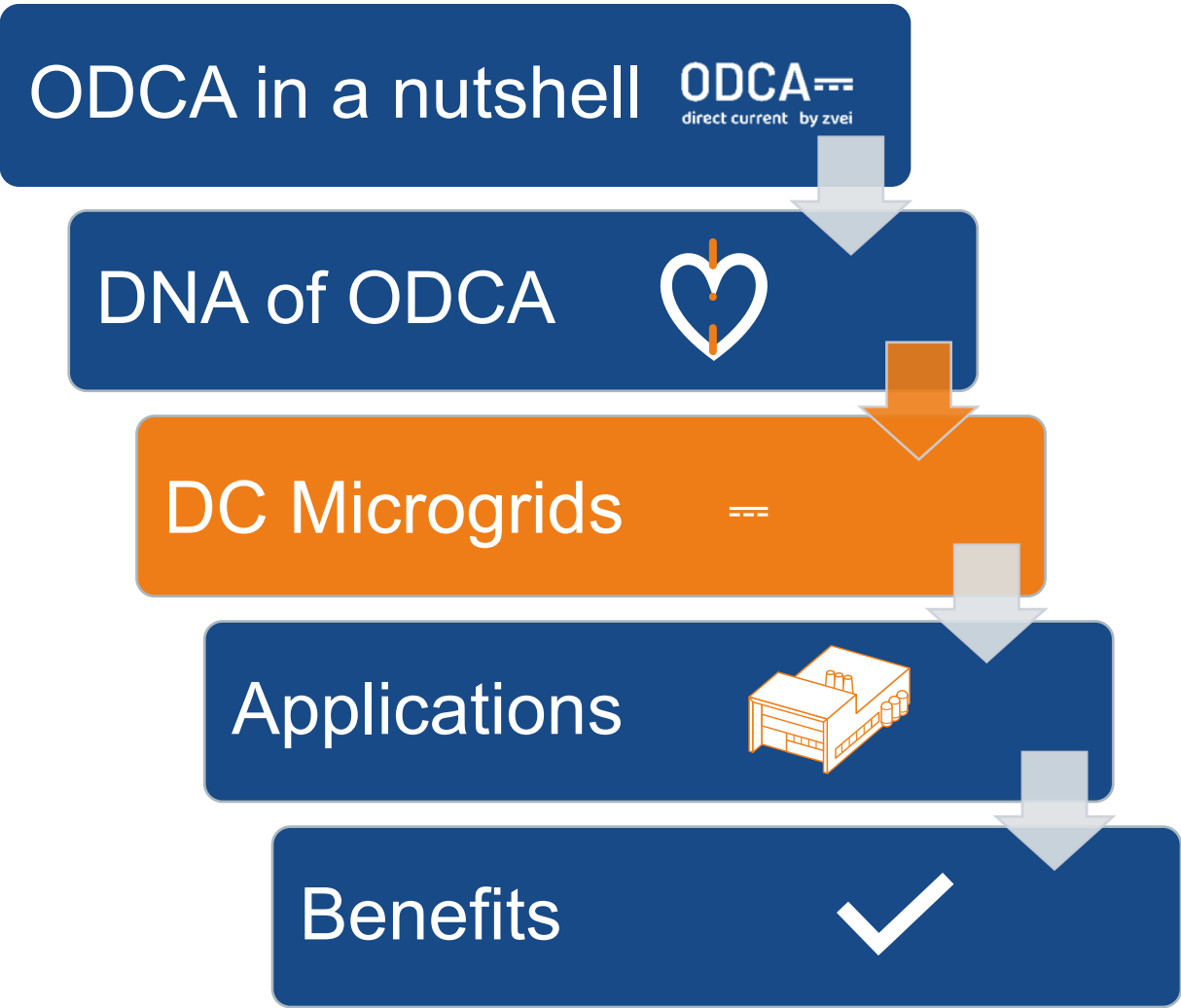




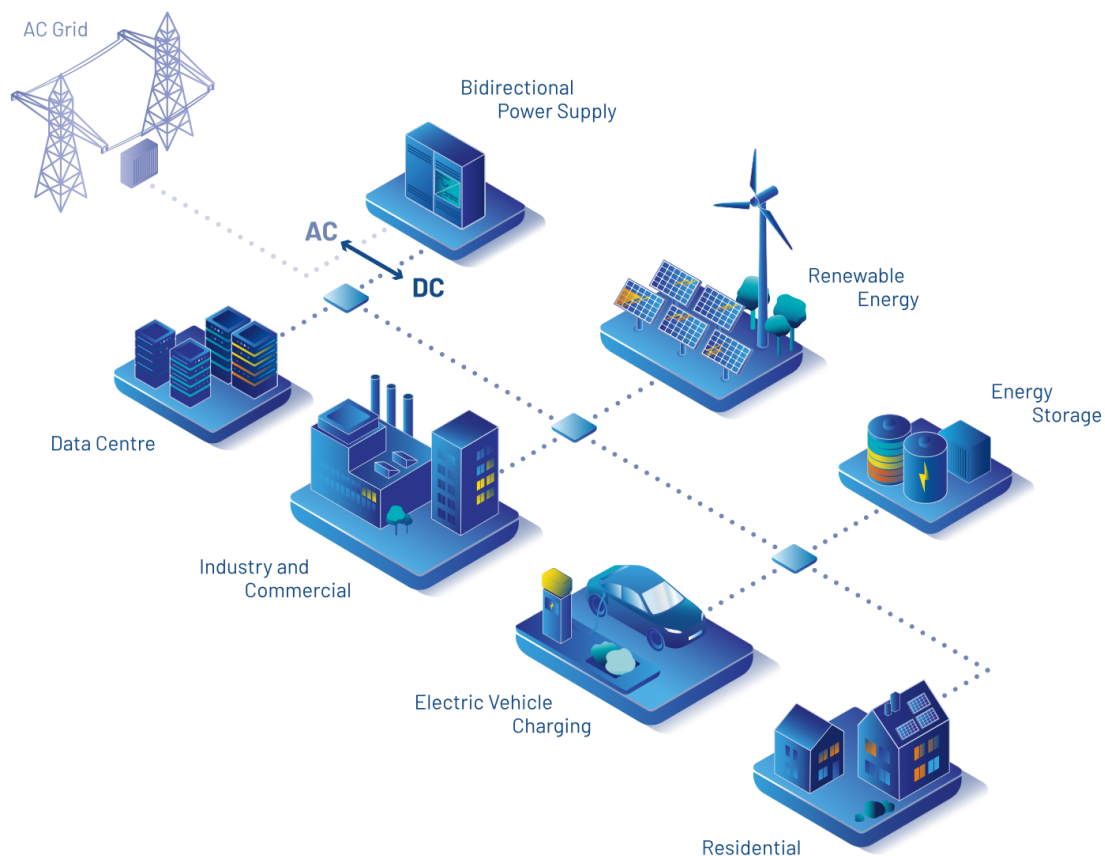
- **Protection**
 - Electronic solution preferred
 - Same safety rules as for AC



Content

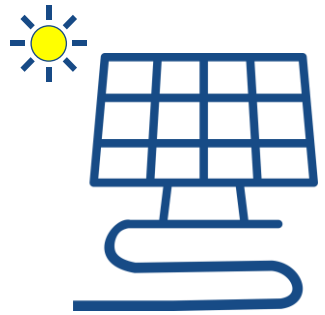


Topology of a DC grid

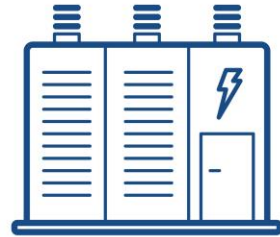


- DC link connects sources and loads with each other
- Central bi-directional connection to AC supply grid
- Reduce conversion steps

DC is already (almost) everywhere



Photovoltaics



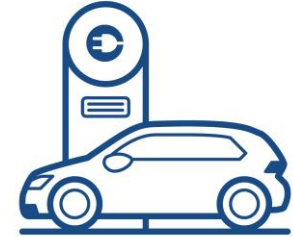
Battery storage



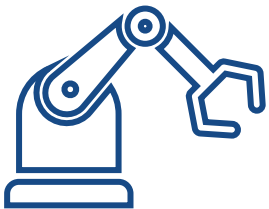
Wind energy



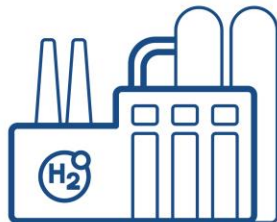
Rail



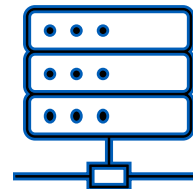
E-cars



Industry



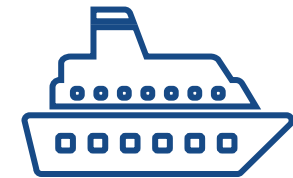
H₂ Electrolyser



Data & IT

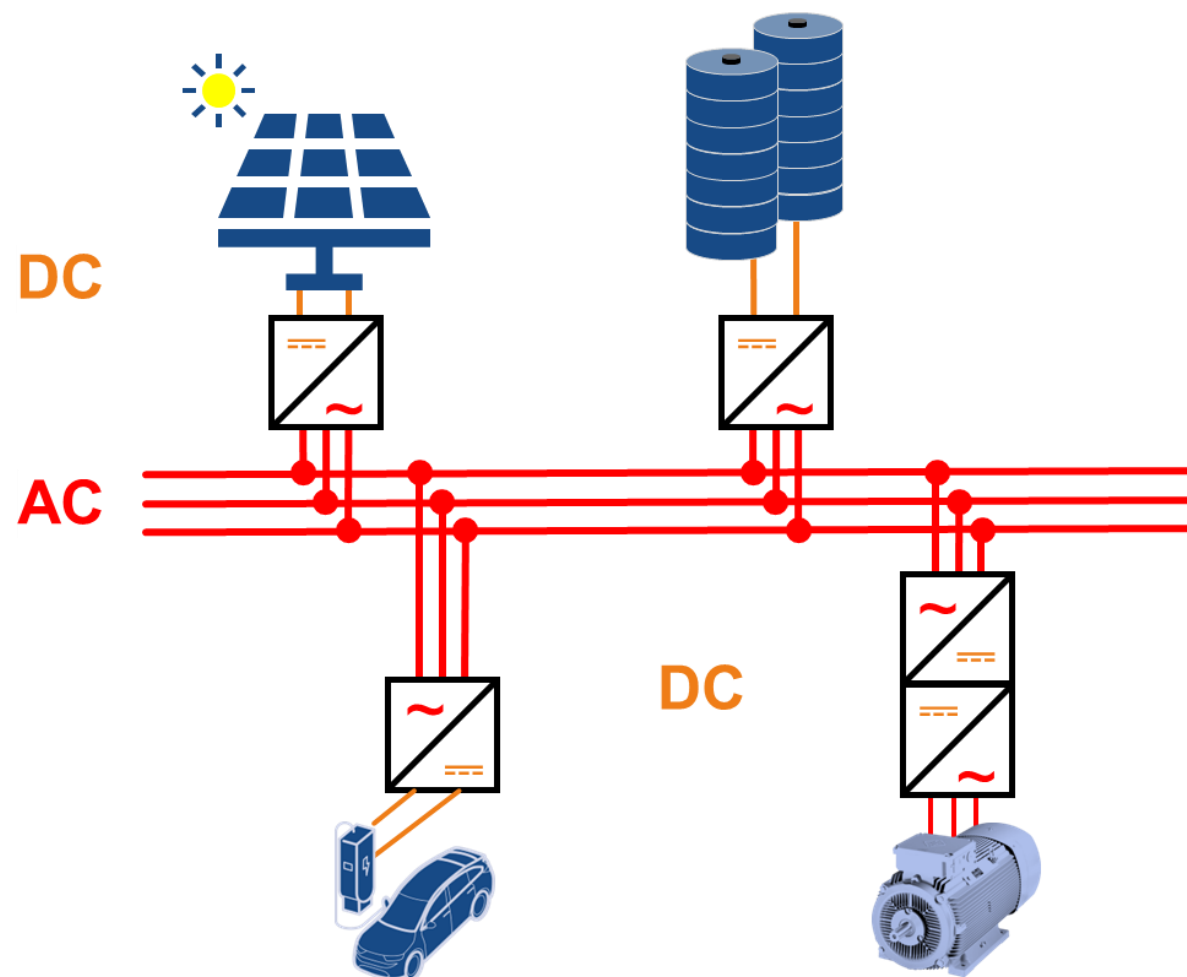


Lighting



Marine

Traditional AC supply

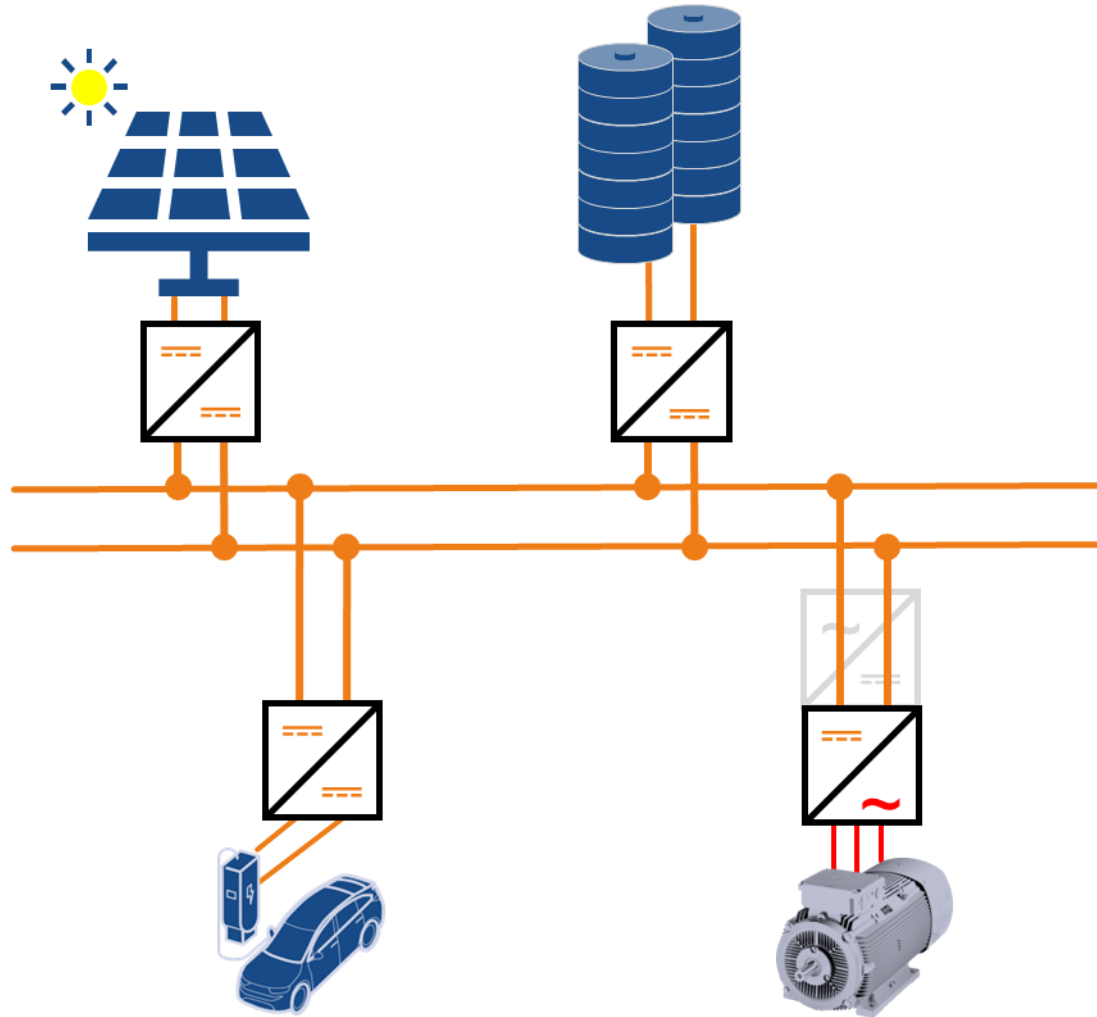


Multiple conversion steps
from direct current DC to
alternating current AC and
vice-versa

- Many devices
- Many resources
- More cabling
- Higher maintenance
- Higher power loss

In one word: **Waste**

DC Microgrid



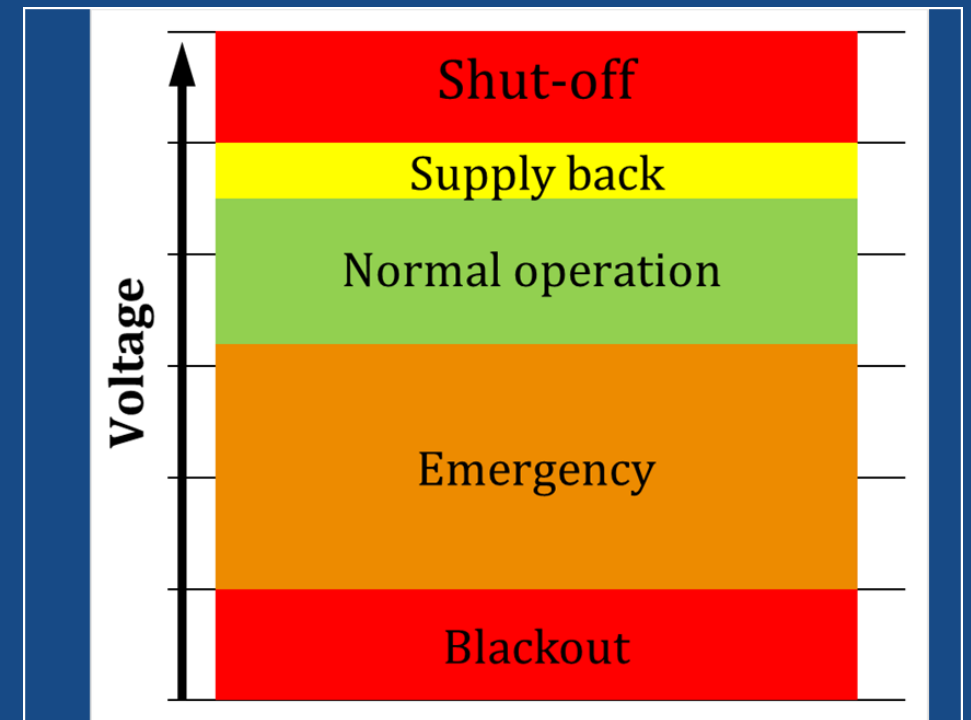
DC connection

- Fewer conversion steps
- Fewer resources
- Higher efficiency
- Less maintenance
- Higher resilience

Simply put: **Better solution**

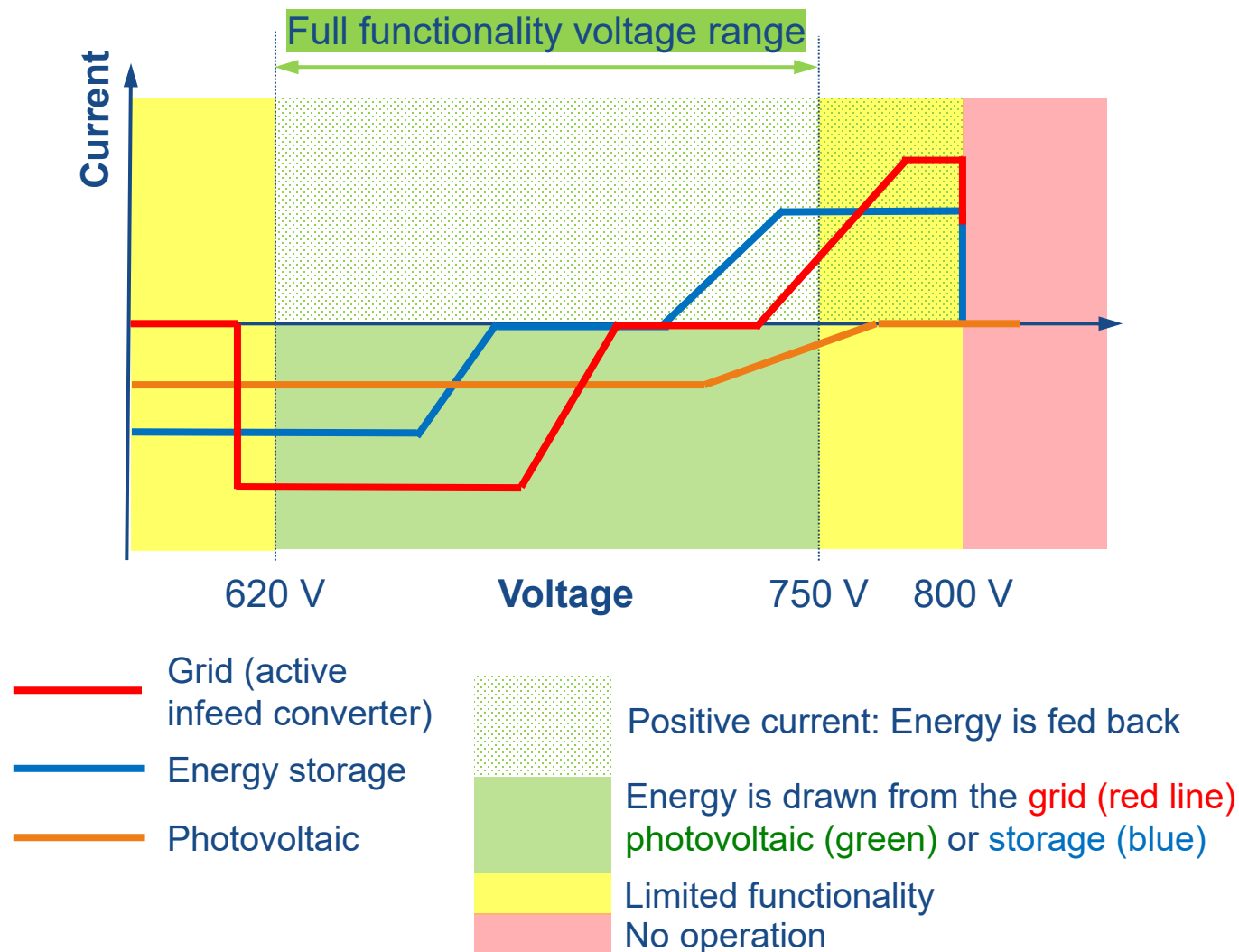
Voltage and voltage bands

- DC grids operate in **voltage bands**
 - No need to stay at a fixed value
 - Different from AC frequency (50 / 60 Hz)
- The DC grid has “**breathing room**” in the green band
 - 620 V to 750 V for 3-phase 400 V AC
- In DC, **voltage mirrors power balance**
 - Supply < load → voltage drops ↘
 - Supply > load → voltage rises ↗



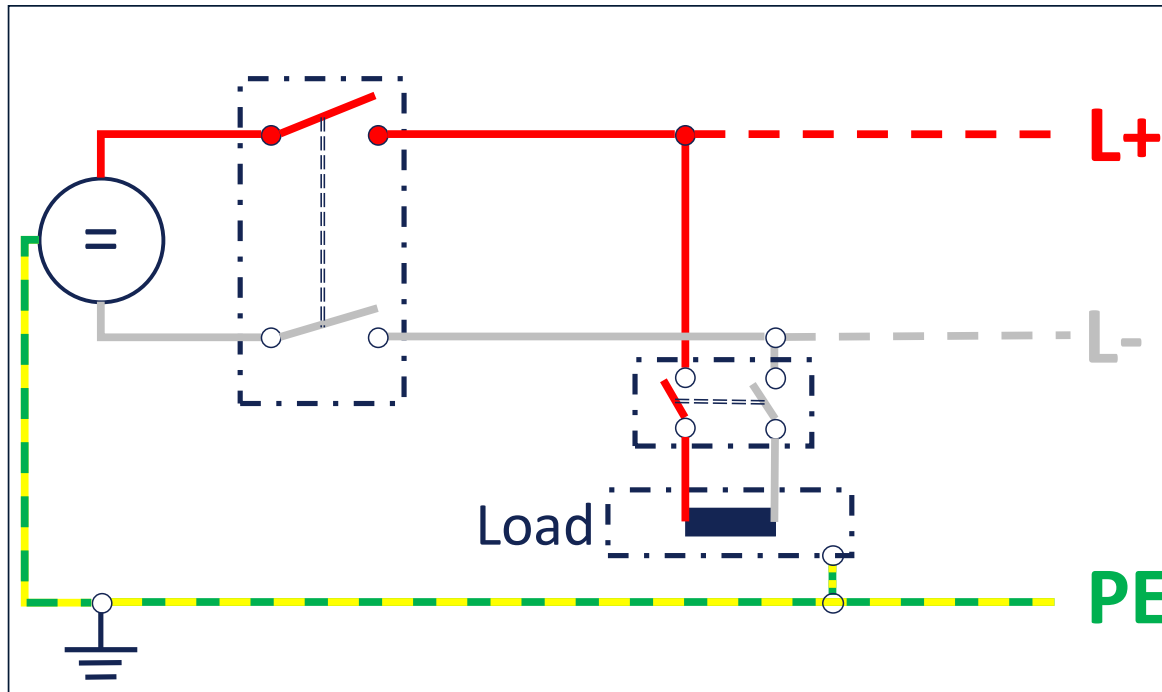
Power management with droop curves:

$$i = f(u)$$



- DC voltage change is indicator for power balance
 - Supply < load → voltage drops ↘
 - Supply > load → voltage rises ↗
- Power balancing
 - Active components measure voltage at their terminals ...
 - ... and adjust power output to pre-defined current-voltage “droop-curve”
- No communication needed – voltage carries the information!

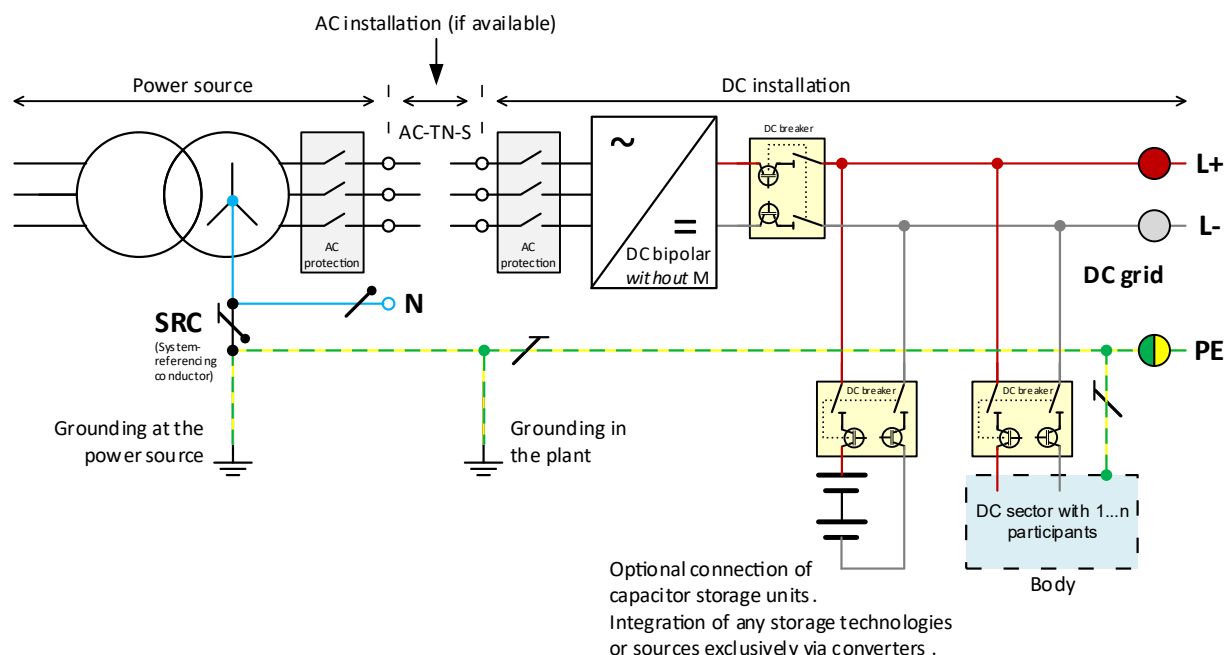
Symmetrical system L+ and L-



- **Two active wires**
 - No mid point conductor
 - Symmetrical voltages to ground (PE)
 - Simpler wiring
 - Simple control: one voltage only
 - Smaller insulation distance: $U_n/2$ to ground
- Like 3~AC w/o neutral

Grounding: AC-side grounding

DC system with AC-side grounding on TN-S system



Ground reference for the DC system is the star point of the AC transformer.
AC/DC converters without galvanic isolation as rectifier or as switching converter (AIC).
Fast overcurrent protection in both poles (L+ and L-).

NOTE 1 Additional grounding of the PE in the installation may be provided (base grounding)

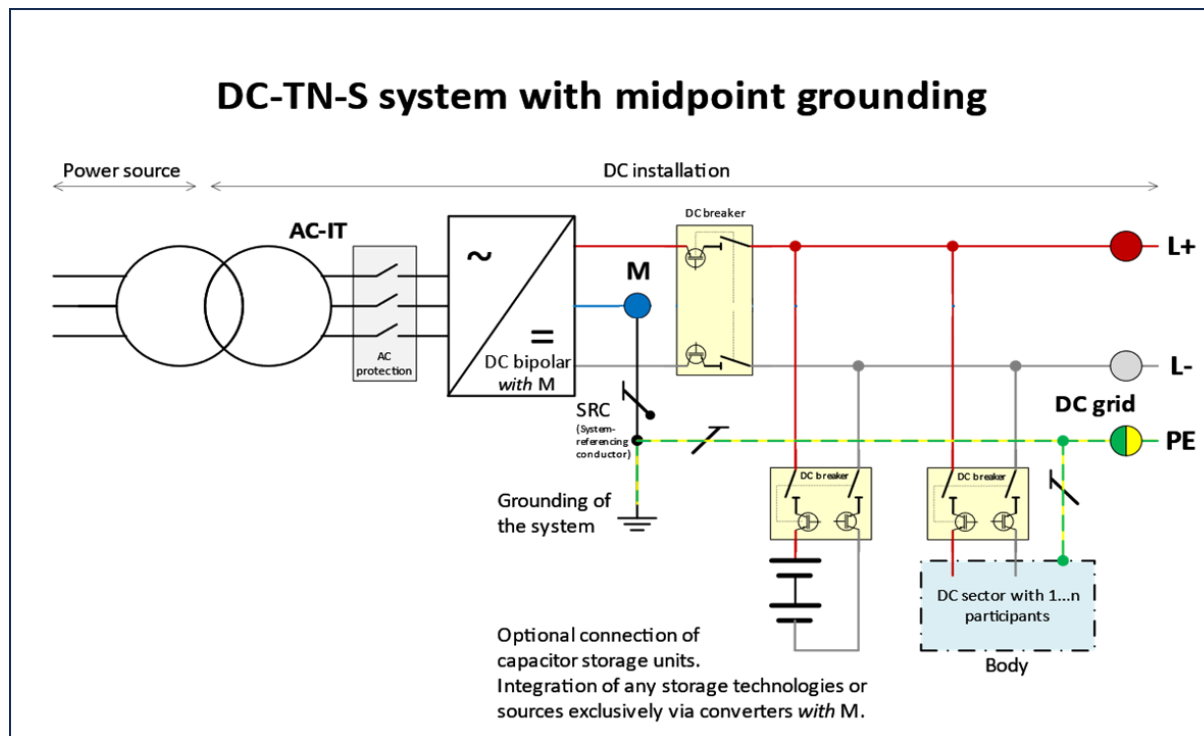
NOTE 2 In case of loss of the AC power source(s), the DC grid changes to an IT system

© Martin Ehlich | Lenze SE | 08.05.2024

Source: [ODCA system description](#), Fig. 7.1 / [VDE SPEC 90037](#)

- Star-point ground of (AC) transformer is used
- Two-wire DC system
 - L+ and L-
 - No mid point conductor
- AC applications can be used behind the same transformer
- New IEC 60364-1 will include this grounding option

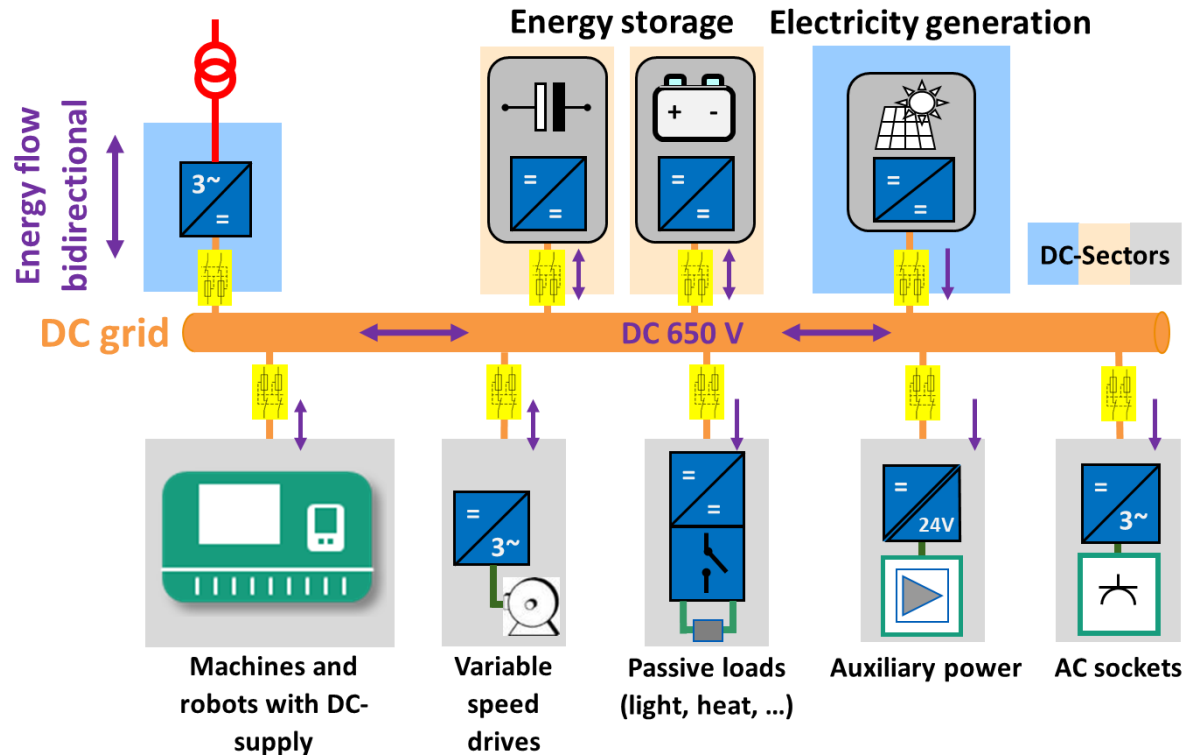
Grounding: DC-side grounding & IT system



Source: [ODCA system description](#), Fig. 7.6 / [VDE SPEC 90037](#)

- Properties
 - Isolated to AC
 - **Grounded on DC side: M**
 - Two-wire DC system
 - L+ and L-
 - **Mid point conductor not distributed**
 - Symmetrical voltages to PE
- Other topologies possible
 - IT system

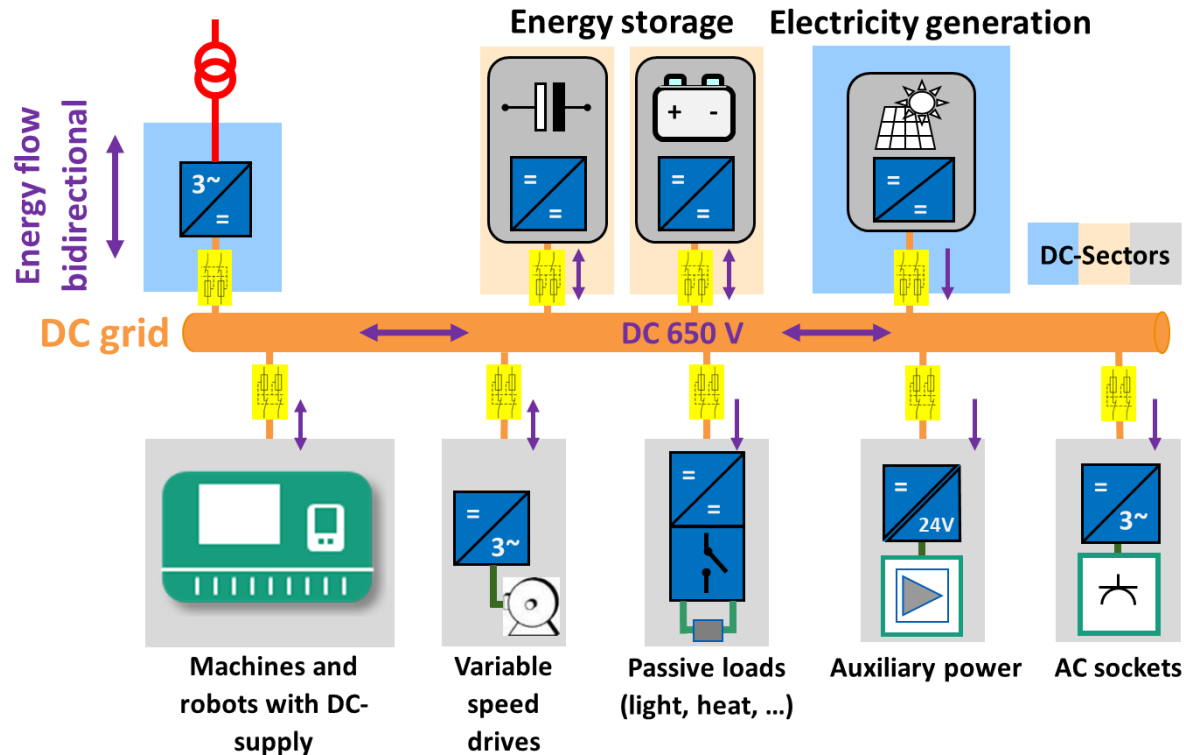
Protection devices



Source: [ODCA system description](#), Fig. 5.1 / [VDE SPEC 90037](#)

- **General** requirements
 - Conduct current
 - Detect fault currents
 - Interrupt operational & fault currents
 - Isolate
- **No difference between AC and DC**

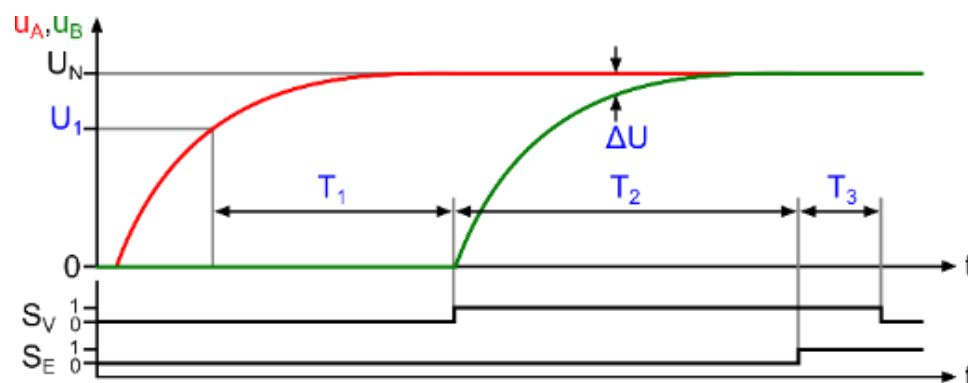
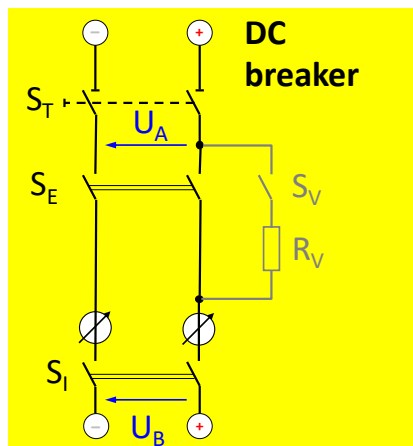
Protection devices



Source: [ODCA system description](#), Fig. 5.1 / [VDE SPEC 90037](#)

- **Special DC** requirements
 - Inrush current of capacitors
 - Limit pre-charge current
- Many distributed sources, capacitive grid
 - Rapid rise of short-circuit current
 - Ultrafast operation
- No strict “top-down” energy flow
 - Detect direction of current for selectivity
- No natural current-zero crossing
 - Force current to zero

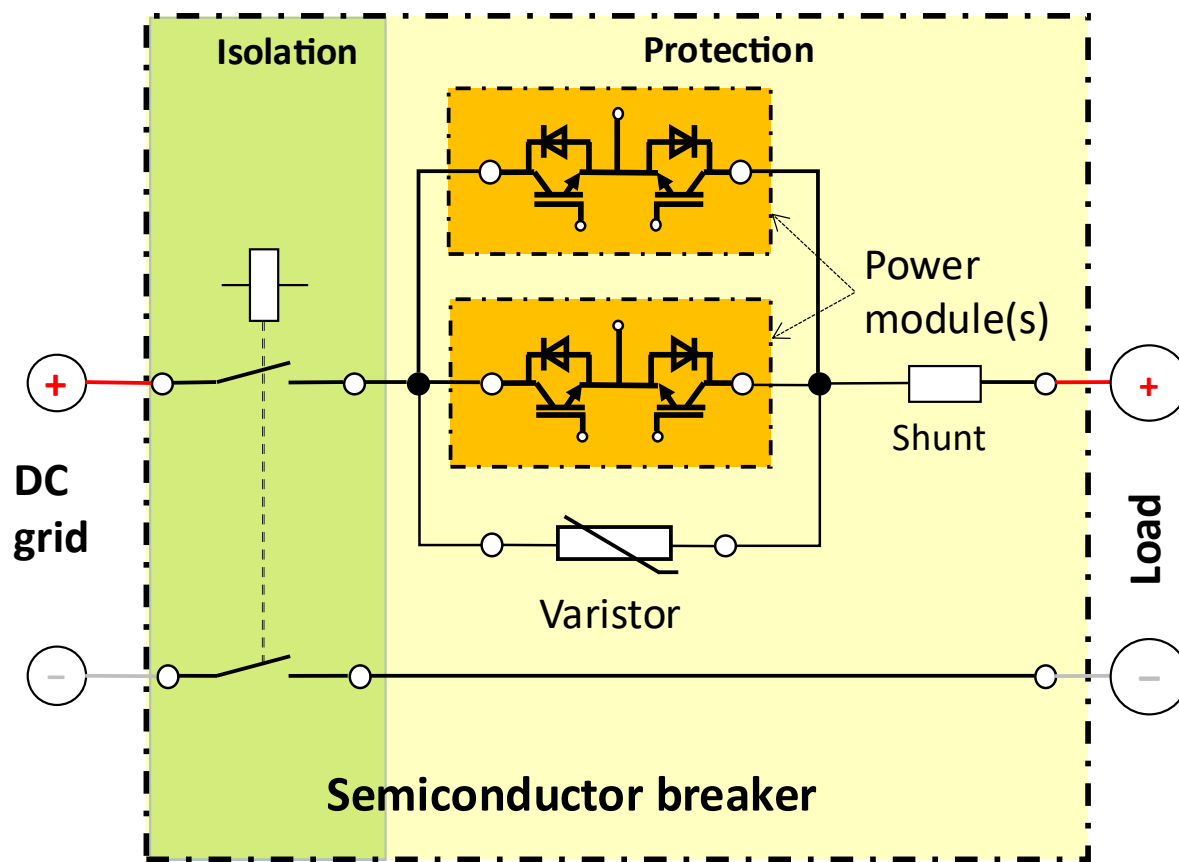
Protection devices: Pre-charging



Source: [ODCA system description](#), Fig. 8.2 / [VDE SPEC 90037](#)

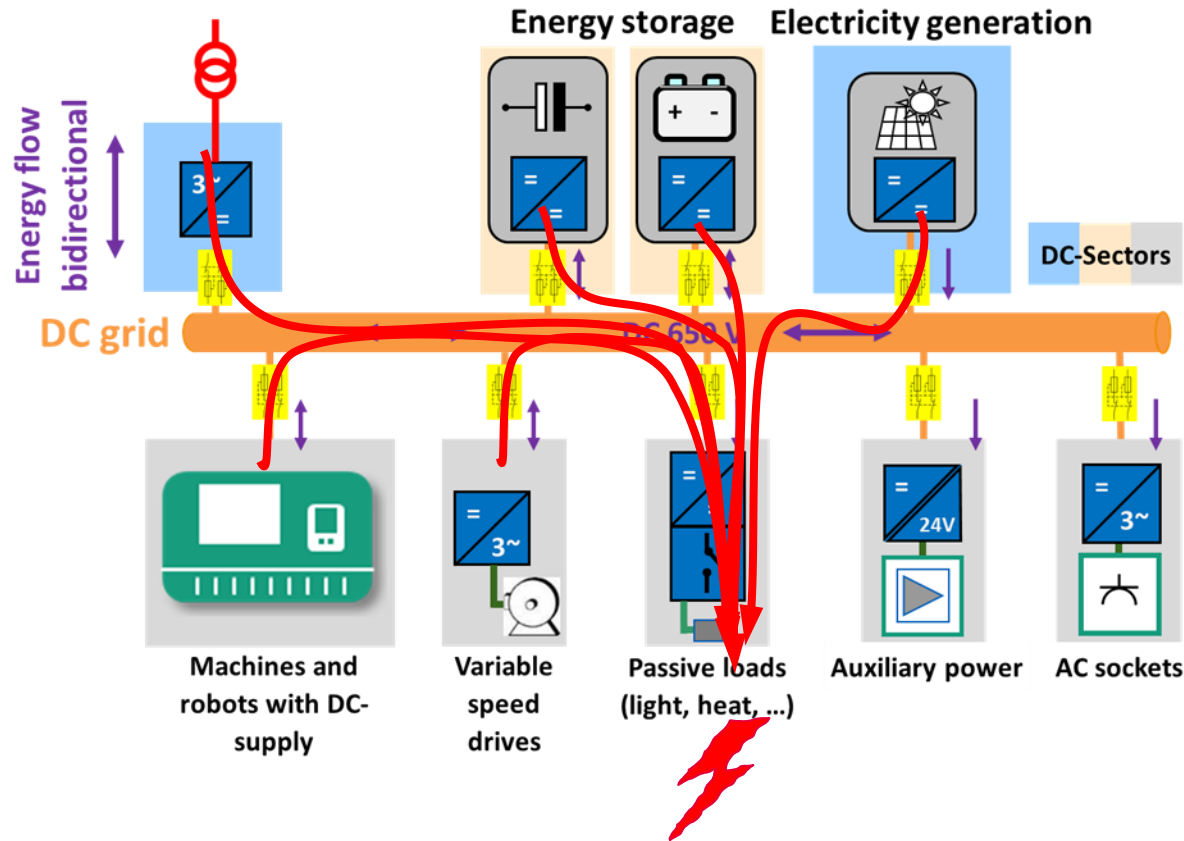
- Uncharged capacitors in a sector
 - Pull high charging current upon switch-on
 - Will trip the breaker if not limited
 - Pre-charging scheme needed
- Voltage controlled pre-charging scheme
 - Input voltage U_A exceeds threshold → triggers pre-charging
 - Output voltage U_B rises → Pre-charge sequence ends when $\Delta U = U_A - U_B$ falls below threshold

Protection devices: Semiconductor circuit breaker



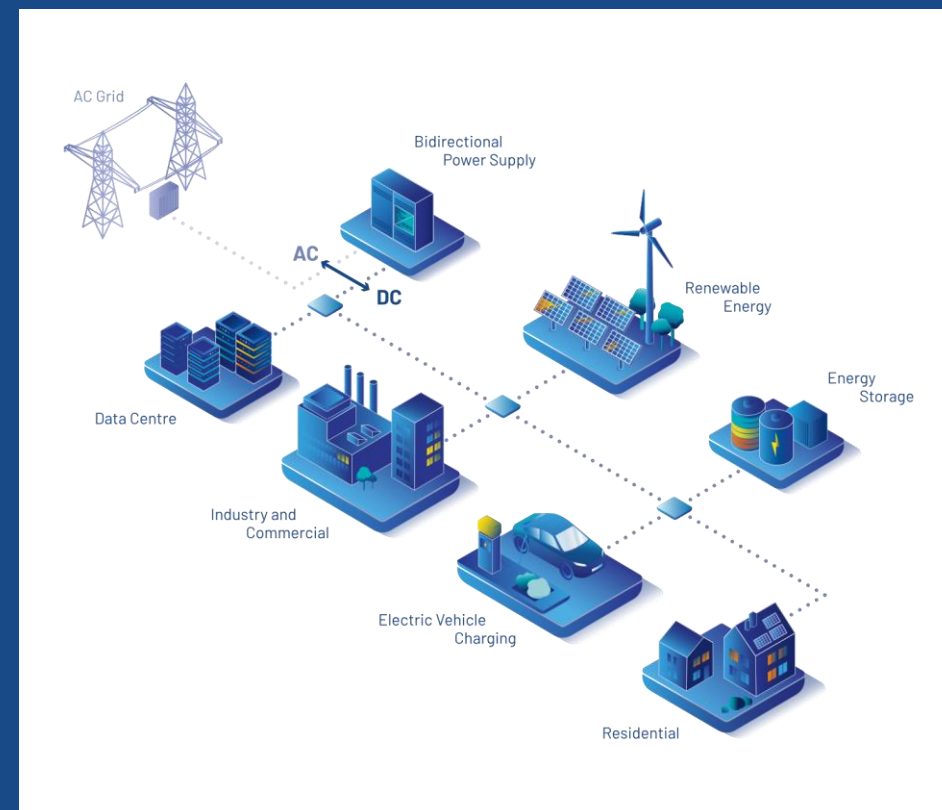
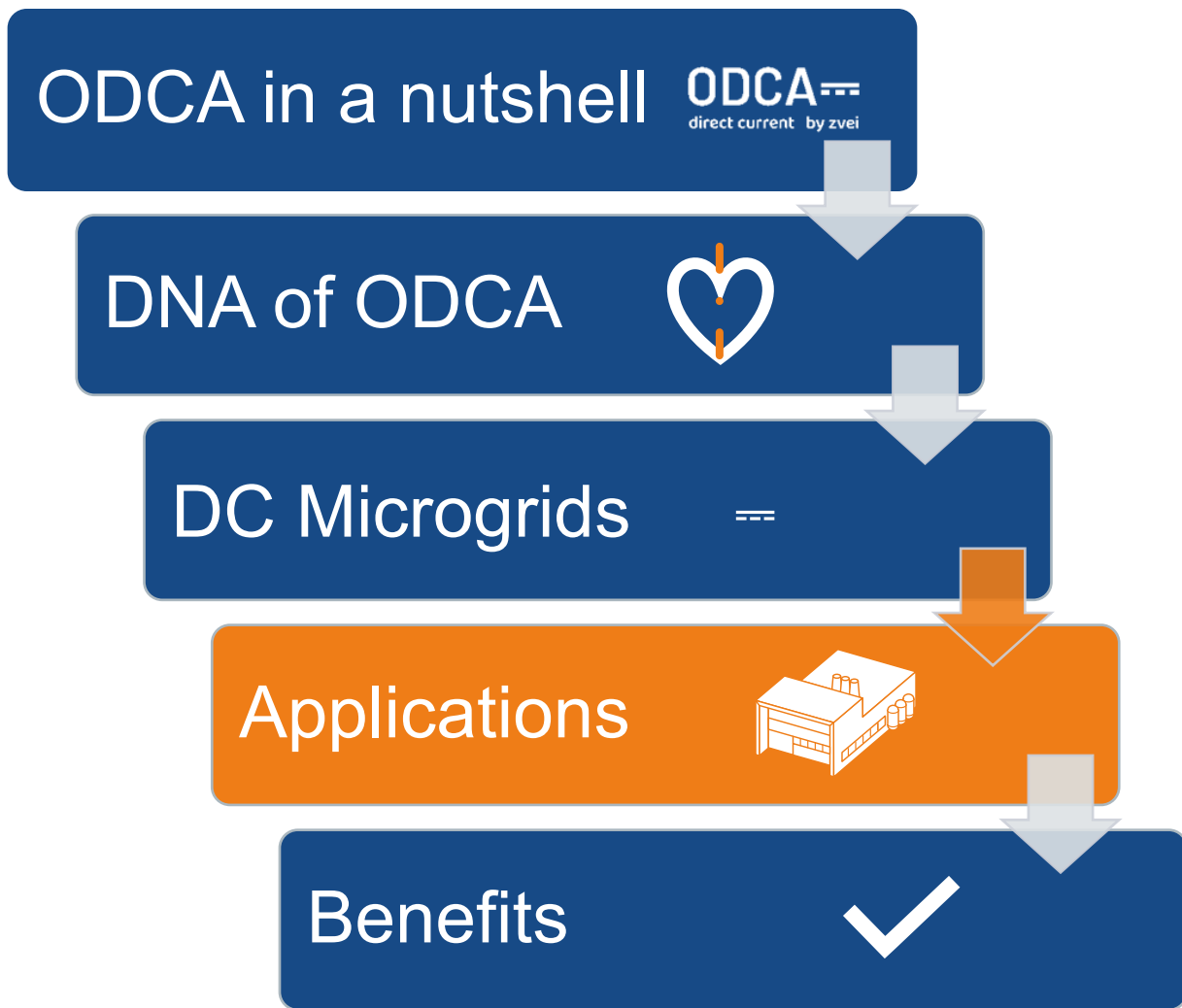
- Rationale for fast operation
 - Ensure operation of healthy parts of the system (voltage drops below green band)
 - Avoid discharging of storage devices
- Solution
 - Power semiconductors shut-off
 - Varistor limits voltage and dissipates circuit energy
 - Isolation contacts disconnect w/o current
- Other functions
 - Detection of over- & undervoltage
 - Energy measurement
 - Communication
- Properties
 - Fast ($< 100 \mu\text{s}$ switch-off time)
 - **Very low fault energy: $\ll 1\%$ of mechanical breaker**

Protection devices: Selectivity



- All sources feed a fault
 - Capacitors in DC-links
 - Storage
 - In-feed ...
- Only breaker of faulty sector shall interrupt
 - More challenging than in top-down (AC) structure
 - Breakers of parallel sectors shall not trip
- Solution
 - Semiconductor breakers needed
 - Technical options
 - Detect direction of current flow and delay tripping for reverse current
 - Balance rated current of parallel DC sectors.
 - More parallel sectors improve selectivity

Content



Application Schaltbau NeXT Factory



- 1.3 MWp PV
- Battery storage
- 10 MWh thermal storage
- E-car charging

- > 70% self-consumption of 1.3 MWp PV
- 85% peak power reduction in fully automated storage & retrieval system
- 30% peak-power reduction overall
- 35% lower energy cost
- ODCA concept was base for regulatory approval

© Schaltbau GmbH: <https://www.schaltbau.com/en/about-us/current-events/news-and-press/press-releases/schaltbau-opens-next-factory-in-velden/>

Application Phoenix Contact AES Arena



Sources: ODCA LinkedIn Post 27. May 2025;

<https://www.cenelec.eu/media/CEN->

[CENELEC/Events/Events/2023/AES/aes_presentation_possel-doelken_2023-12-04.pdf](https://www.cenelec.eu/media/CEN-)

- 650 V DC grid
- Positive overall energy balance
 - 2.5 GWh/a generated
 - 1.9 GWh/a needed
- Thermal-electric sector coupling
 - 1500 m³ ice storage
 - Uses phase-change energy (solid-to-liquid) for seasonal storage (winter → summer)

Application Mercedes-Benz Factory 56

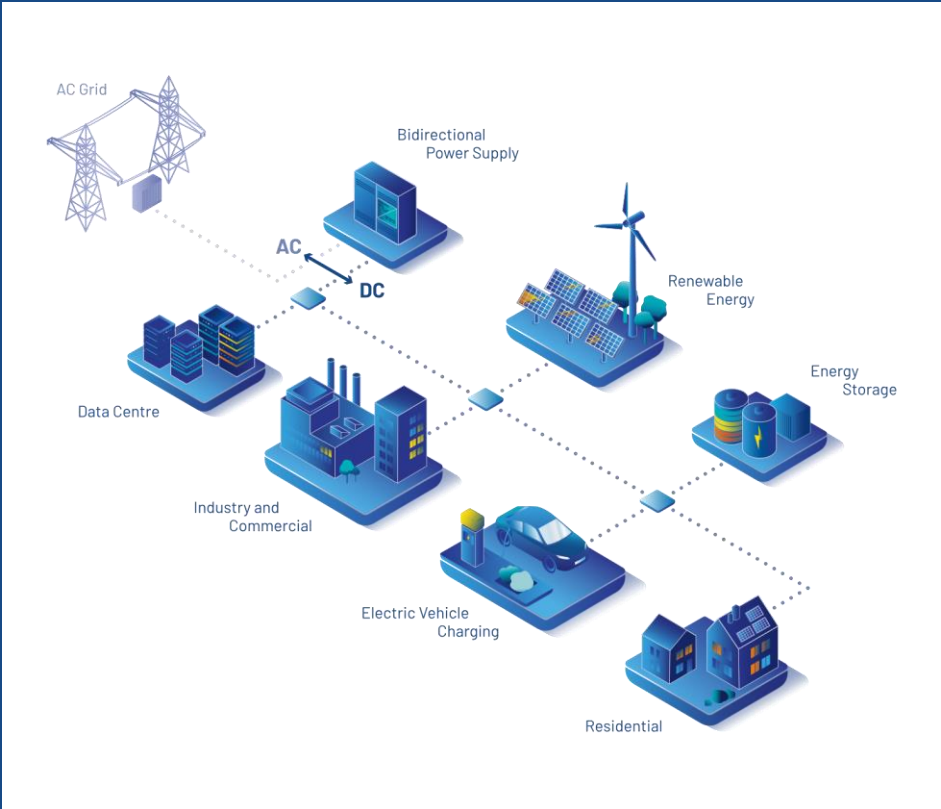
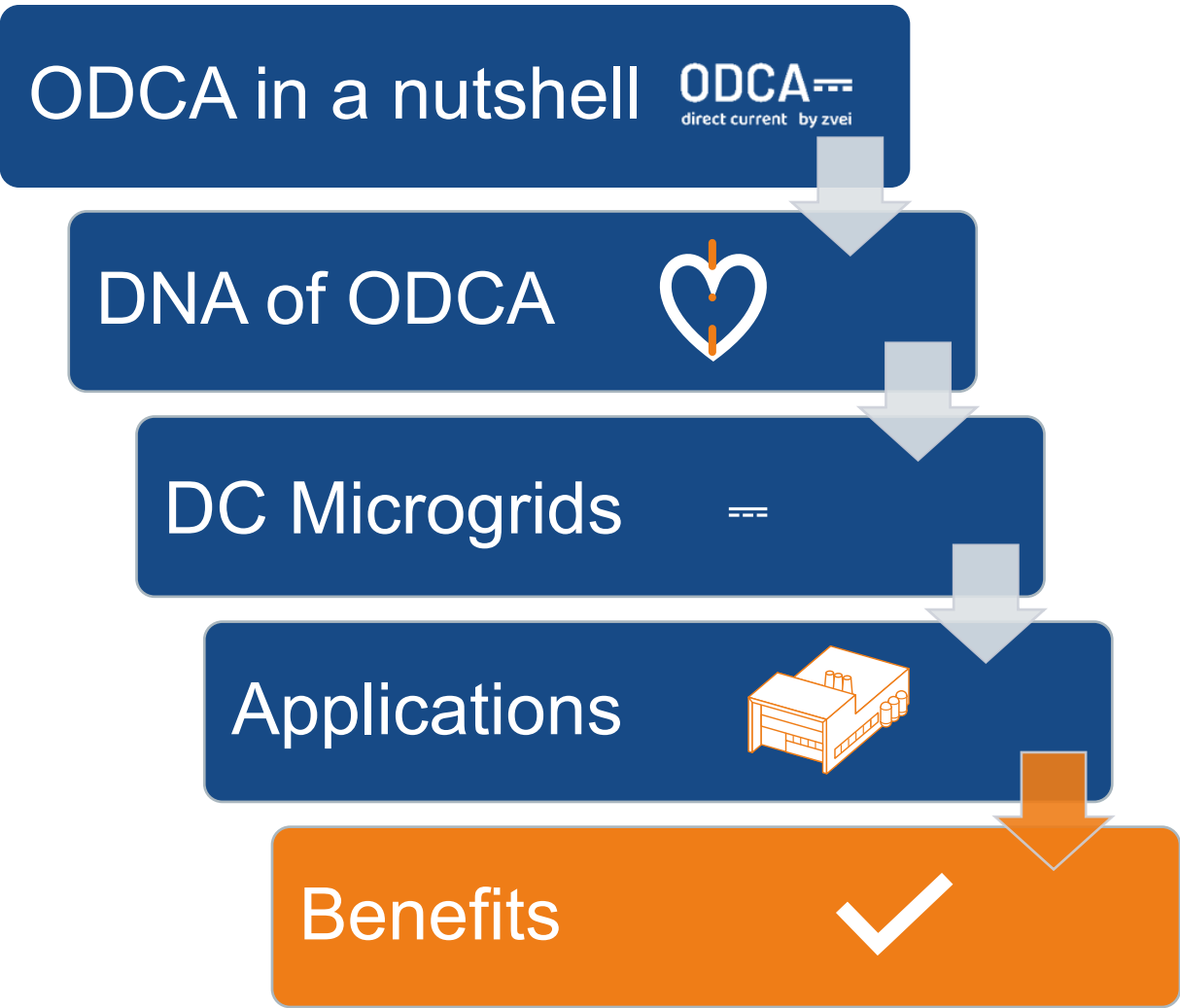


- 220 000 m² production area
- **2 MW DC grid for building infrastructure**
- Heating and air conditioning
- **Battery storage for load shifting**
- **Low-voltage Direct Current defined as standard!**
 - In factory automation
 - In building infrastructure
 - Mercedes-Benz world-wide standard “integra.8”

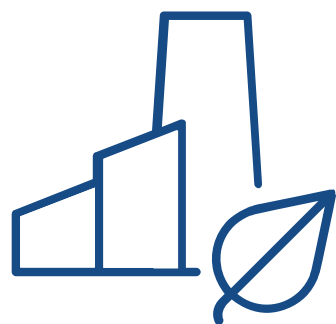
Source: <https://odca.zvei.org/>

Source: Dr. Davis Meike: Markt & Technik DC Konferenz, 23. Oct. 2024, Munich

Content



Benefits summary of DC Microgrids



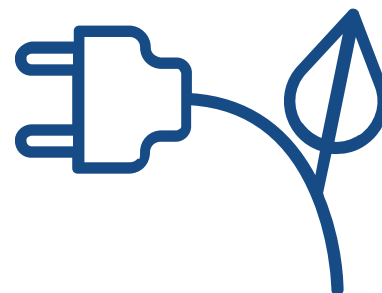
Resource efficient

- ✓ 50 % less copper (cabling)
- ✓ Fewer components



Energy efficient

- ✓ 10 % reduction achieved
- ✓ Full recovery of braking energy (lifts, robots, ...)



Direct integration of green energy

- ✓ Reduce grid connection load



Resilient

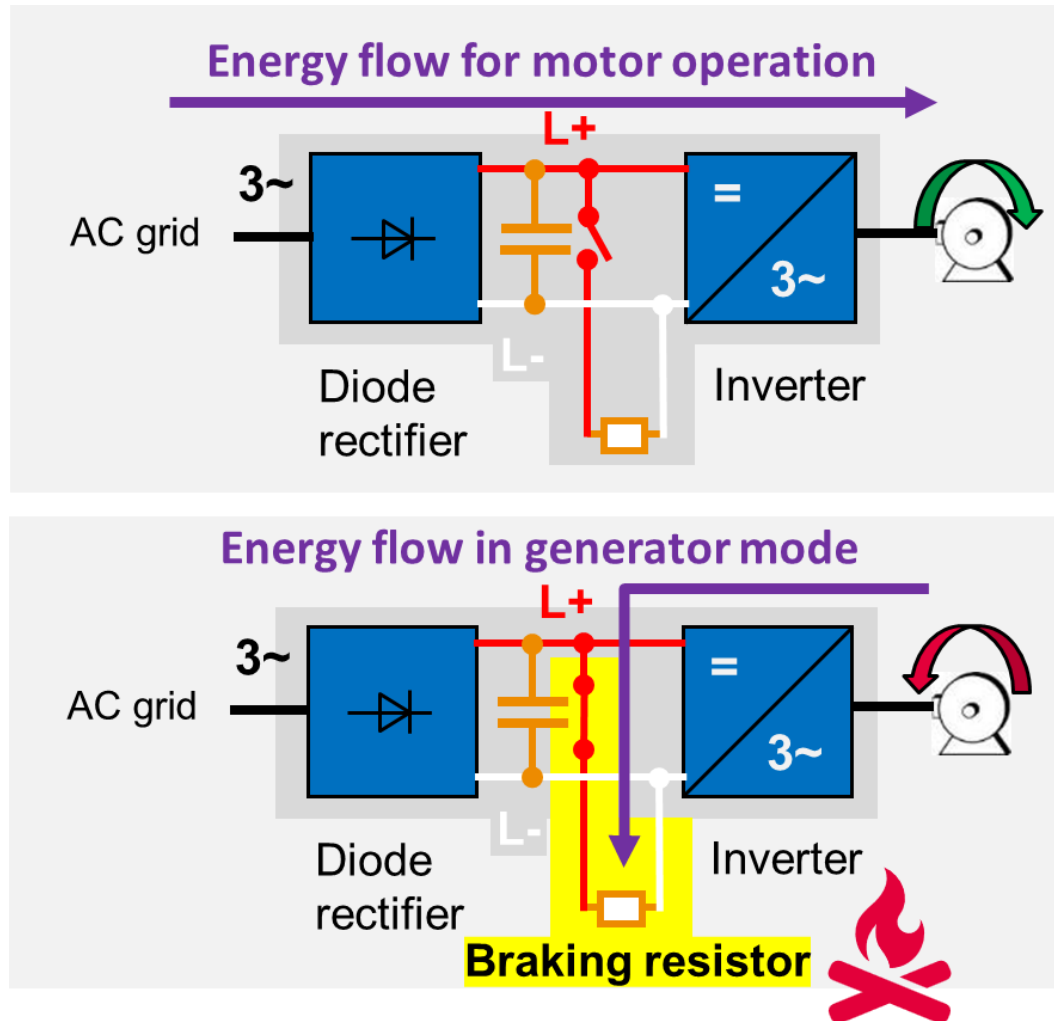
- ✓ Backup power
- ✓ Lower failure risk



Peak Power reduction

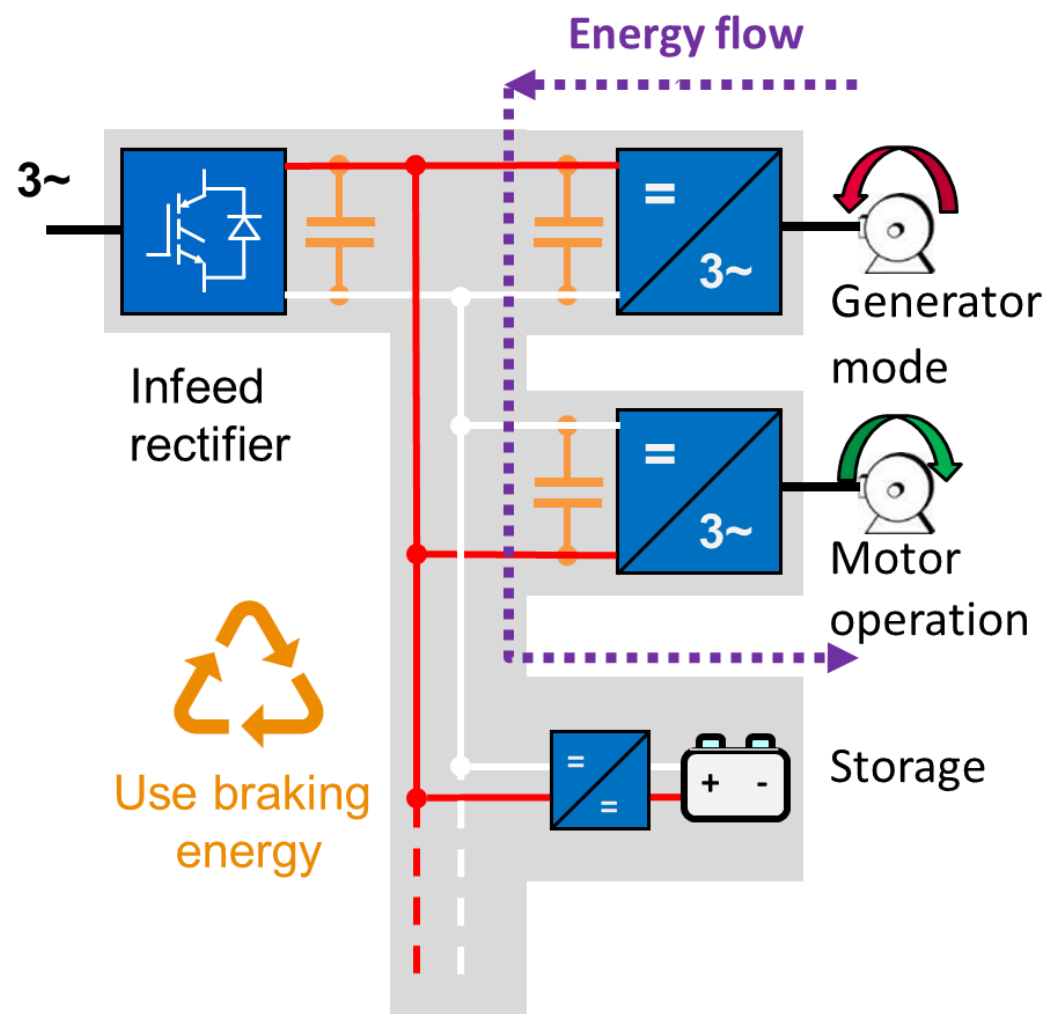
- ✓ 80% achieved
- ✓ “Grid friendly”
- ✓ Lower power bill

AC disadvantage: Braking energy is wasted



- Frequency converters are optimized for motor operation
- In generator mode (slowing down), the inverter needs to get rid of the stored energy.
- Typically, the energy is converted to heat in braking resistors

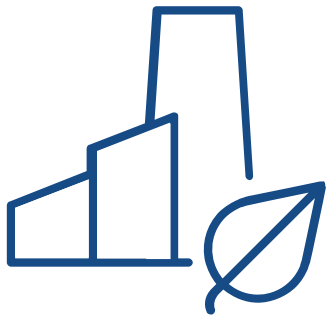
DC benefit: Braking energy is used



- Less effort
 - AC/DC conversion for each drive is redundant
 - Fewer components
- **100% recuperation of braking energy**
 - Into different motor
 - Into storage device
- No need to “cool-away” the braking energy → additional saving

WE CAN DO BETTER – WITH DC!

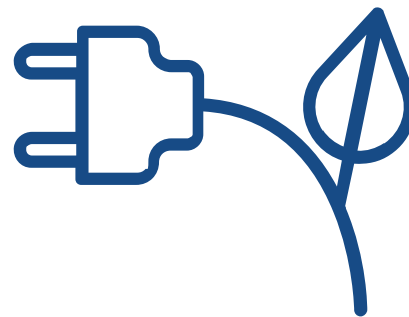
For more
information:



Resource
efficient



Energy
efficient



Direct
integration of
green energy

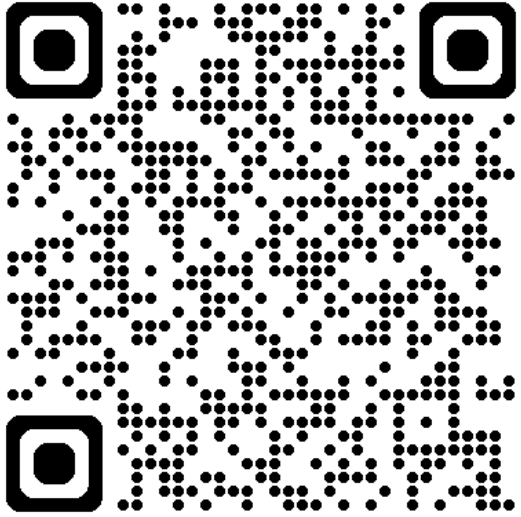


Resilient



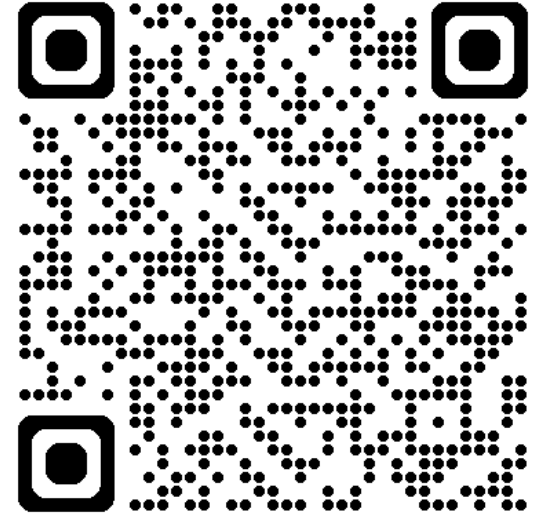
Peak power
reduction

in



<https://www.linkedin.com/showcase/opendcalliance/>

ODCA 
direct current by zvei



<https://odca.zvei.org/>