DC-INDUSTRIE | November 2018

Intelligent Grid Management of DC Grids in Production

Verbundvorhaben: DC-Industrie – Intelligentes offenes DC-Netz in der Industrie für hocheffiziente Systemlösungen mit elektrischen Antrieben

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Agenda

Requirements for an intelligent grid management

Tasks of grid management

Expansion levels of grid management

Control concepts

The motivation for intelligent grid management is diverse

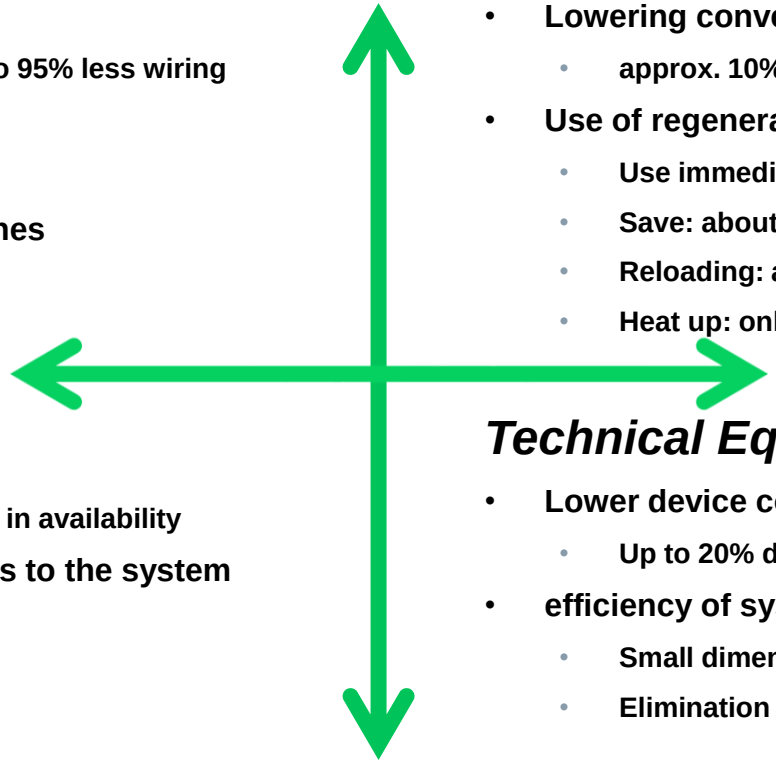
Potentials of Ultra-Efficient Power Distribution in Industrial DC grids:

Installation Potentials

- Lower wiring
  - Decentralized device arrangement: up to 95% less wiring
- Lower errors and service costs
- Space reduction of control cabinets
- Increasing the modularization of machines

Energetic Potentials

- Lowering conversion losses
  - approx. 10% due to elimination of conversion points
- Use of regenerative energy (12%)
  - Use immediately: about 90
  - Save: about 9%
  - Reloading: approx. 1%
  - Heat up: only in emergency cases



Availability Potentials

- Higher plant availability
  - Short grid failure: approx. 98% increase in availability
- Reduction in costs by avoiding damages to the system
- Peak power reduction

Technical Equipment Potentials

- Lower device costs
  - Up to 20% due to the elimination of power electronics Increase
- efficiency of system components
  - Small dimensioning: approx. 60% potential savings
  - Elimination of redundancies: approx. 30% potential savings

The requirements for grid management can be divided into four areas

Requirements for grid management:

- ***Operation***
  - When supplying several machines via a DC system, a secure supply must be ensured.
  - As little control as possible during operation
  - Energy flexibility: The energy supply must follow production
- ***Planning procedure, configuration and reconfiguration***
  - Rescheduling / additions need to be as easy and flexible as they are today (with AC)
  - Self-configurable or configurable with as less effort as possible
  - Stations can change step by step in the life cycle of the plant -> no reconfiguration of the energy grid
  - Communication should be as low and effortless as possible
- ***Requirements for durability & reliability***
  - Energy Management: No power failures due to additional ICT
- ***Economic and ecological efficiency***
  - Energy savings > 10% (compared to today, no recuperation)
  - Making external energy demand more flexible is an important goal

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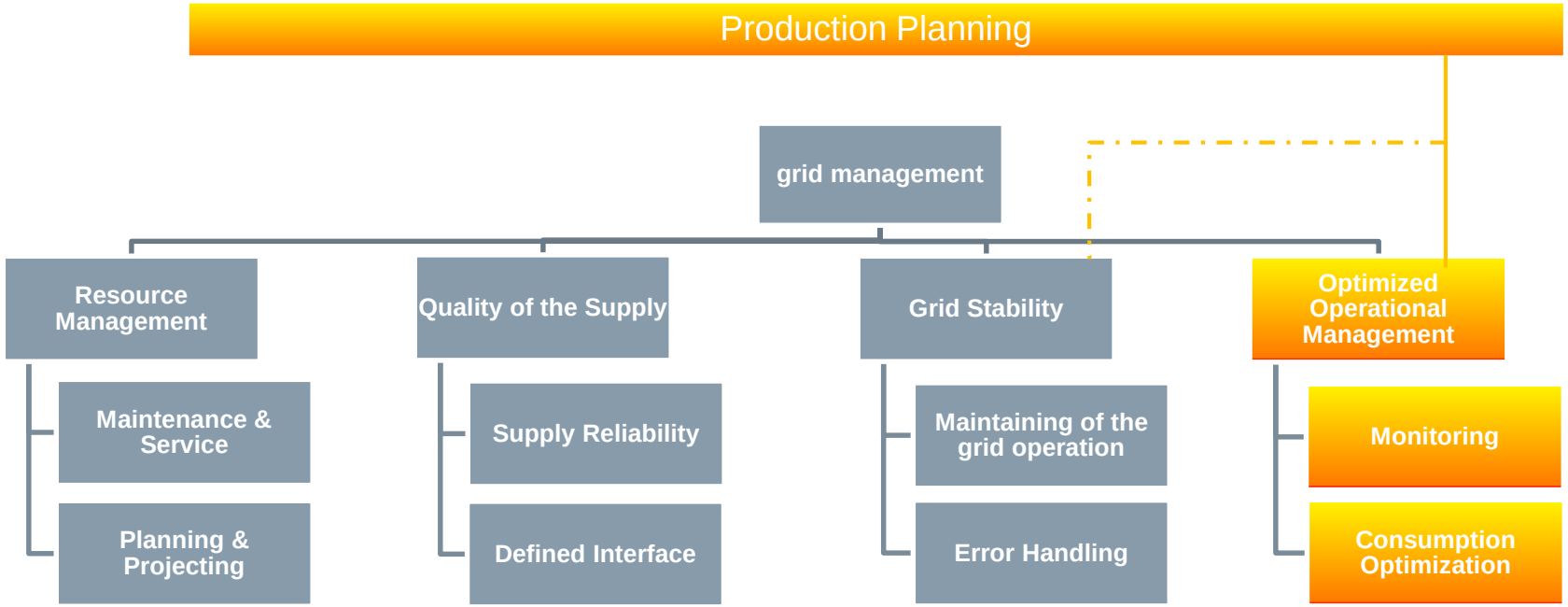
The tasks of grid management go beyond the simple energy supply

Tasks that are realized by grid management :



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Expanded levels of grid management

	basic combination	decentralized group regulation	Extended decentralized group control	central grid control
	irregular	Decentralized control via voltage-current control characteristic (characteristic-based control)	Decentralized group control + optional adaptation of the voltage-current control characteristic (characteristic-based control) by a grid manager	Central control - A grid manager specifies setpoints
Communication	none	none	Optionally via fieldbus communication (non-real-time)	Fieldbus communication (real time)
Information exchange	-	voltage band	voltage band	-

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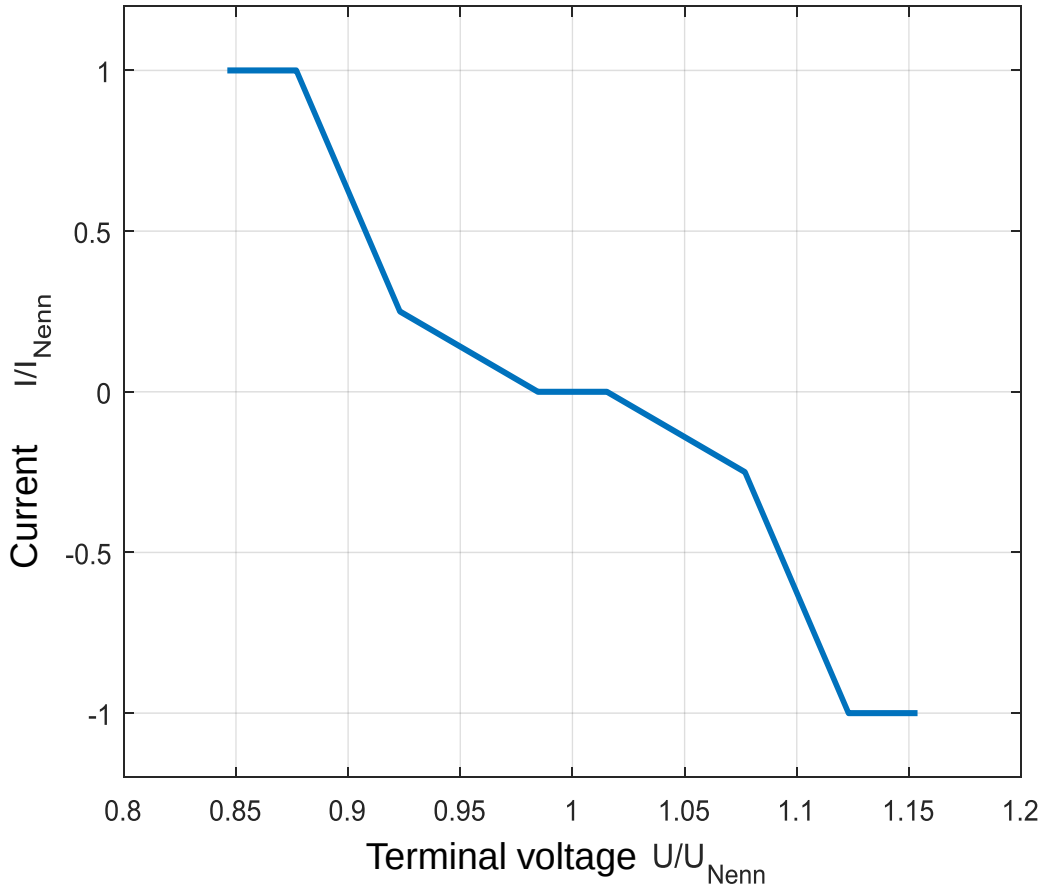
grid subscriber in the DC grid

Producer	Provision of energy
Prosumer	Optimized management
Consumer	Value-adding or necessary, not value-adding
DC-branch	Power flow control through fault management: Detecting and correcting / isolating occurring fault conditions Return of the grid in safe condition
Sensor	Additional status detection of the DC-BUS

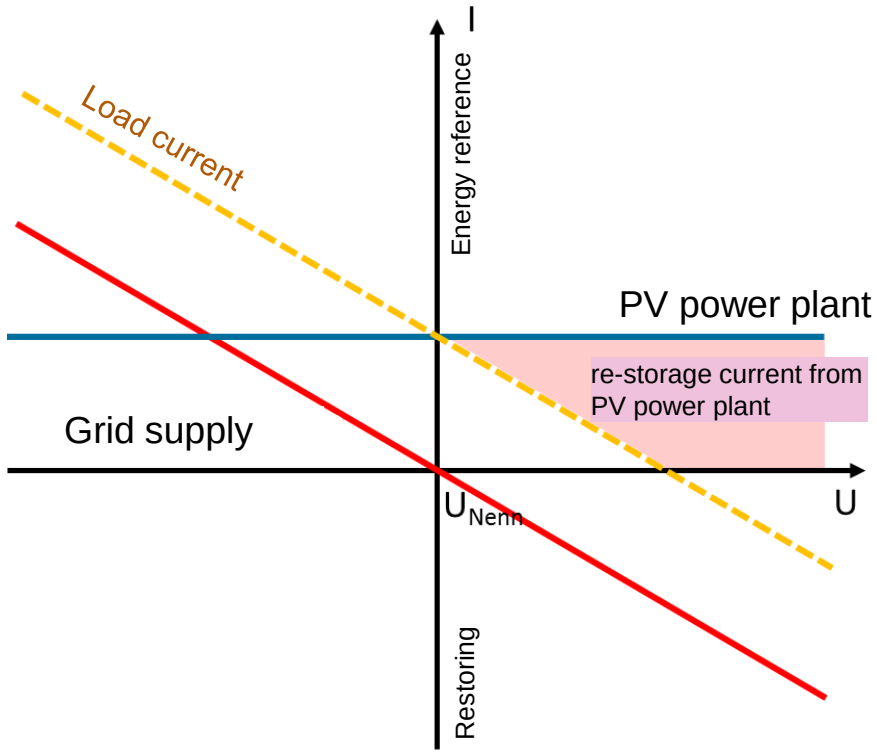
Characteristic-based control for decentralized grid management

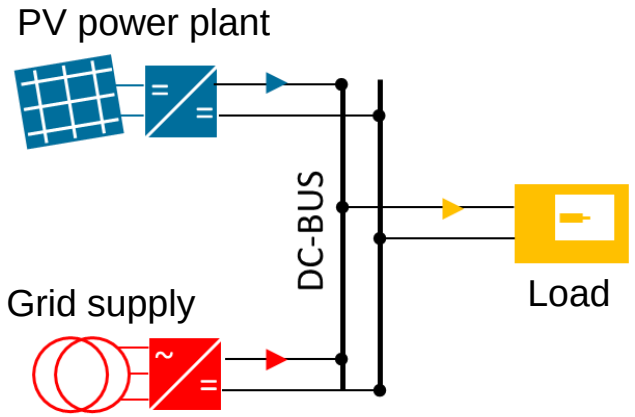


- The load balancing takes place in the expansion stage, decentralized as well as extended group control via a characteristic-based control.
- Every active device implements this regulation.
  - The active device realizes a quasi-stationary current-voltage characteristic at the DC bus connection terminal.
  - The characteristic-based control is set via interpolation points.
  - All power sources operate as voltage controlled current sources.

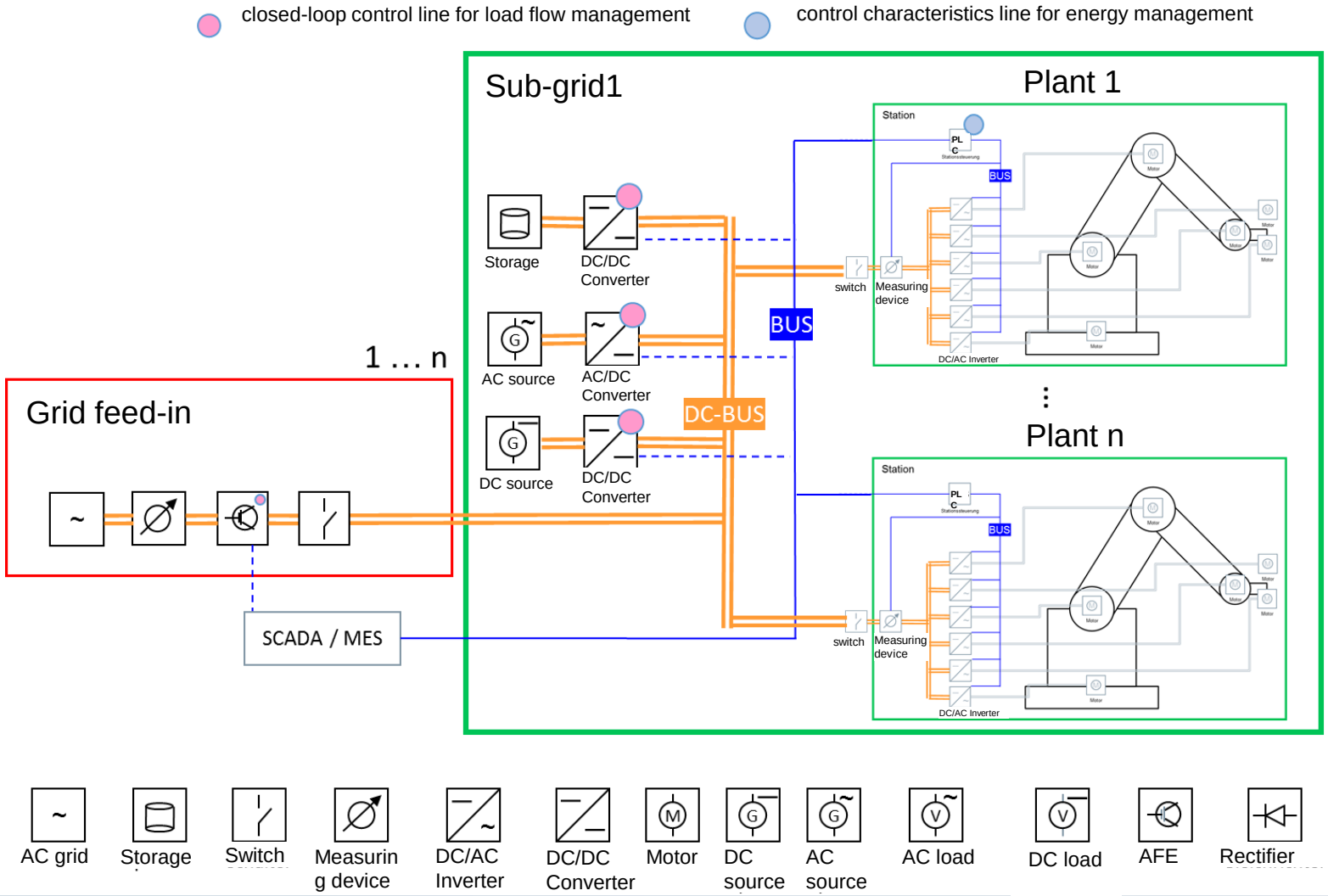
Exemplary application of the characteristic based control

Feed-in current of PV system and mains supply depending on the load current:





Decentralized grid management in plants



Conclusion and outlook

- The requirements for grid management were declared.
- The tasks of grid management have been defined.
- Four stages of grid management have been defined.
- Initial studies show that the functionality of the control system, prioritization and thus first economic optimization with characteristic curves are possible.

➢ Further investigations with regard to the stability will be carried out.

➢ The grid management will be implemented in demonstrators.

Thank you for your attention!

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