Electrical stations (substations)

By purpose
- transformer stations
- switching stations
- converter stations
- compensation stations

By position in ES
- power plants
- transmission system – switching, transformer
- consumption – industry, distribution
- converters – transmission, consumption

Rated voltages
- LV: 110 230 400 500 660 V
- MV: 3 6 10 22 35 kV
- HV: 110 220 400 750 kV
Basic elements of substation equipment

1) Busbars – conductors carrying power to individual branches
2) Branches – equipment for carrying power to grid lines

Instrument equipment in branches
- switch (circuit breaker – CB)
- busbar disconnector
- outlet disconnector
- voltage and current transformers (VT, CT)
- measurement equipment, protections

Rated busbar currents

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<th>4</th>
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<th>6,3</th>
<th>8</th>
<th>10</th>
<th>12,5</th>
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<th>20</th>
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Recommended set of short-circuit endurance (ČSN 38 1754, ČSN 33 3015)

*Rated switching-off current* $I_{nvyp}$ (kA) – RMS value, its heat impacts must be survived by an electrical equipment for a given time ($t = 2$ s) without any damaging influencing its operation capability

\begin{align*}
6,3 & \quad 8 & \quad 12,5 & \quad 16 & \quad 20 & \quad 25 & \quad 31,5 & \quad 40 & \quad 50 & \quad 63
\end{align*}

*Rated dynamic current* $I_{dyn}$ (kA) – peak short-circuit current, its dynamic impacts must be survived by an electrical equipment without any damaging influencing its operation capability

\begin{align*}
16 & \quad 20 & \quad 31,5 & \quad 40 & \quad 50 & \quad 63 & \quad 80 & \quad 100 & \quad 125 & \quad 160
\end{align*}

\[
I_{dyn} = 1,8 \cdot \sqrt{2} \cdot I_{nvyp}
\]
SIMPLE BUSBAR SYSTEM

INLET BRANCHES

LONGITUDINAL BUSBAR SWITCH

A

OUTLET BRANCHES

A'
DOUBLE LONGITUDINAL DIVIDED BUSBAR SYSTEM

INLET BRANCH

CROSS BUSBAR SWITCH

OUTLET BRANCHES
Multiple busbar system and their dividing for higher reliability and flexibility.
Double system on MV level less often, in CR yes.

Combined switches – saving in switches number
Auxiliary busbar
- possibility to operate a branch also during its CB failure (inspection)
MAIN BUSBAR AS AN AUXILIARY BUSBAR (+ BY-PASS)

A

B = P

SWITCH UNDER INSPECTION
NO BUSBAR CONFIGURATION – „H“
MORE SWITCHES FOR 1 BRANCH
(higher reliability x costs)

A

B

2 SW / 1 BR

1,5 SW / 1 BR
SECONDARY BRANCHES MV

LONGITUDINAL BUSBAR DIVIDING (DISCONNECTOR)

DISC.

CB

LONGITUDINAL SWITCH

COMBINED SWITCH LONGITUDINAL AND CROSS

DISC.

CB

CROSS SWITCH
SECONDARY BRANCHES MV - MEASUREMENT

![Diagram of secondary branches MV - measurement](image-url)
Branches from HV substations

Main
- generator
- transformer
- outlet for overhead line
- outlet for cable line

Secondary
- main busbars switch
- auxiliary busbars switch
- voltage measurement
- spare
GENERATOR BRANCHES

- BUSBAR DISCONNECTORS
- CIRCUIT BREAKERS
- VT, CT
- BLOCK TRANSFORMERS
- GENERATORS
SUBSTATION SELF-CONSUMPTION SUPPLYING

110/22 kV

22 kV

22/0,4 kV

0,4 kV
Electrical stations realization

1) Outside
2) Inside
   a) cells
   b) cabinets
   c) halls
   d) gas-insulated (GIS)
Cells
Cabinets
10 kV
Sliding CB
22 kV
Cell substations
+ highly clear arrangement
+ high operational reliability
+ high transmitted power
+ high short-circuit endurance
- high construction difficulty, costs

Cabinet substations
+ unification, variability
+ possibility of sliding CB (accessibility)
+ low construction costs
+ low space requirements
- lower reliability
- lower short-circuit endurance
- more difficult construction of double busbars
Gas insulated (GIS) – SF6
Chotějovice 400 kV
Transformer stations

- placement
  - outside – ground, tower
  - inside – cell

-position in ES
  - production – MV/HV – block station
  - transmission – HV/HV – connecting
  - consumption – HV/MV, MV/LV – industry, public
  - insulating – 1/1

insulation
  - dry
  - oil – with reservoir
DC supply

1) protection relays
2) CB control circuits
3) signal lights and relays
4) hf equipment
5) emergency el. drives
6) emergency and spare lights

Voltage levels

\[24 \quad 48 \quad 60 \quad 110 \quad 220 \text{ V}_{\text{DC}}\]