

Introduction - Power grid and his operation

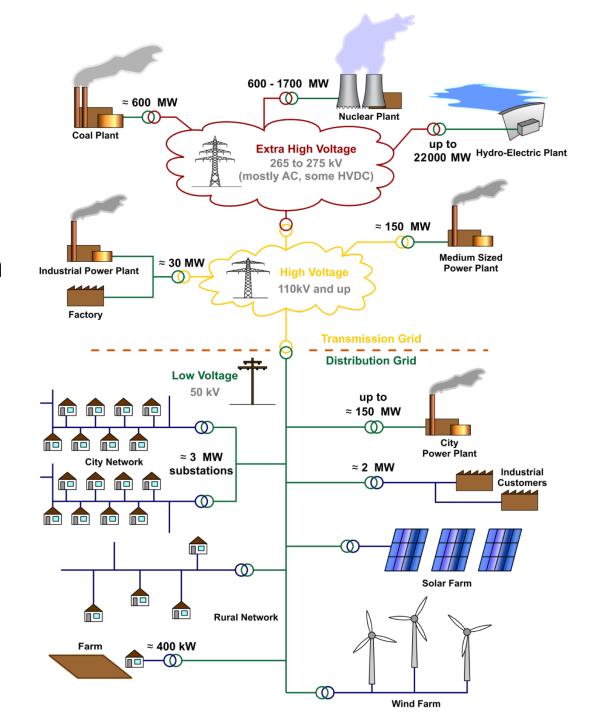
- Electrical (power) grid interconnected network of power lines and associated equipment used to deliver electricity from producers to consumers.
- Production (Generation): typically done in power plants (e.g. coal, nuclear, water based)
 - often far away from consumers, long distance is caused by several factors, such as economy, health, security, environmental.
- Electricity delivery generally occurs at two levels
 - **Transmission**: carries the power for long distances (e.g. hundreds of kilometers) and uses higher voltages for more effective transmission
 - Distribution: focused on delivery for individual consumers and uses lower voltages for safer and easier distribution.
- Electricity consumption



- Power grid & distributed energy resources (DER)
 - The typical chain in power grid is generation -> transmission -> distribution -> consumption.
 - Besides this traditional concept there exist concept of distributed energy resources (DER).
 - Here, the power is generated close to the consumption point, e.g. in the same building.
 - Typically, these resources are small and environment friendly.
 - They typically use solar energy, natural gas, or wind.

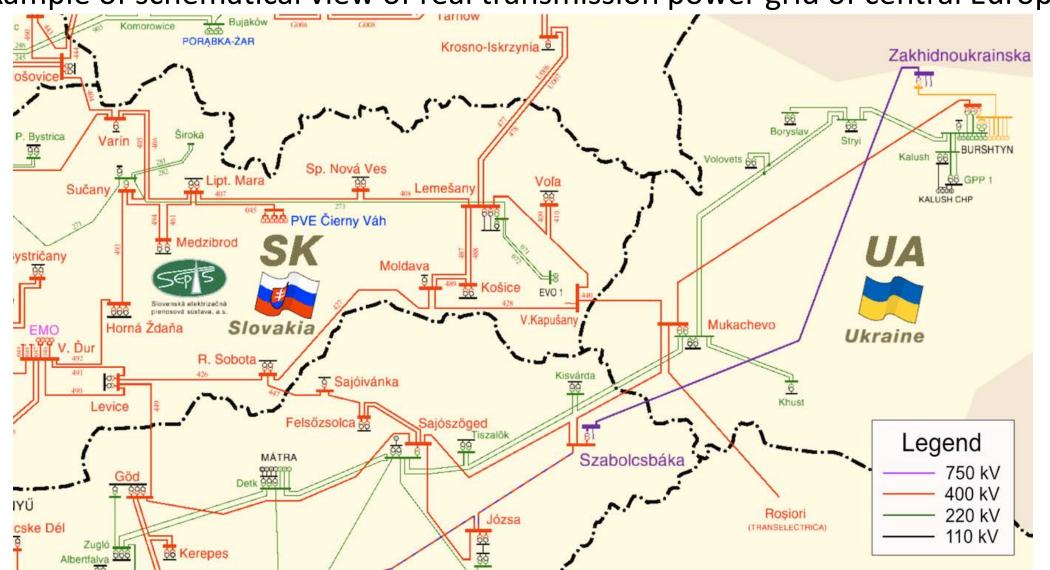


- Basic scheme of electric power grid with energy generation, transmission, distribution, consumption and DER
- Exact voltage naming and exact split point between transmission/distribution can differ, based on country





Example of schematical view of real transmission power grid of central Europe



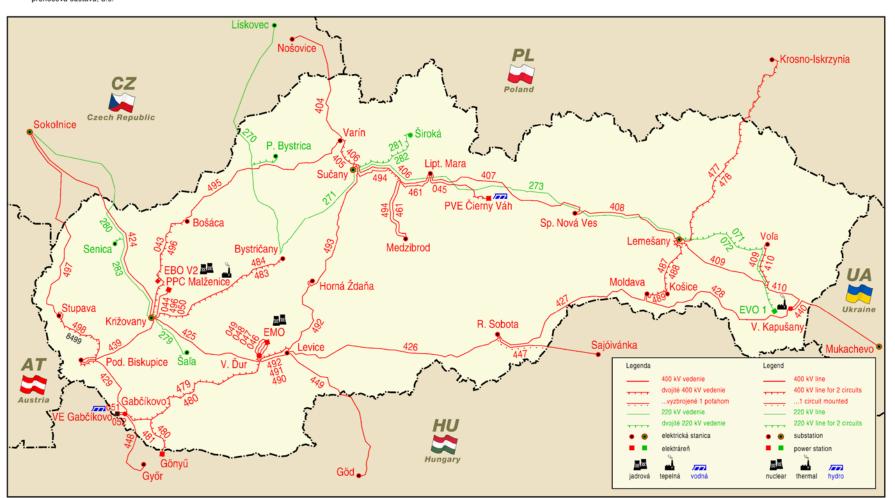


Example of transmission power grid - exact positioning on map



Mapa Prenosovej sústavy Slovenskej republiky Map of Power System of The Slovak Republic







- Power grid and his operation
 - The transmission part in each country is operated by transmission system operators (TSO)
 - The distribution is performed by distribution system operators (DSO).
 - The distribution operators can be regional (above 100 000 consumption points) or local
 - In Europe, there are above 3500 DSO companies.
 - In some countries (e.g. as Czechia, Slovakia, Hungary) three largest DSO deliver more than 60% of power.



DSO situation in EU

	Country	Code	Number of DSOs	Number of legally unbundled DSOs
	Austria	AT	126	11
	Belgium	BE	16	12
	Bulgaria	BG	4	4
-	Croatia	HR	1	1
	Cyprus	CY	1	1
=	Czech Rep.	CZ	290	3
	Denmark	DK	40	10 4
	Estonia	EE	34	1
#	Finland	FI	77	9
	France	FR	144	6
	Germany	DE	883	80
	Greece	GR	1	1
=	Hungary	HU	6	6
	Ireland	IE	1	1
	Italy	IT	128	8
=	Latvia	LV	11	1
	Lithuania	LT	6	1
	Luxembourg	LU	4	1
*	Malta	MT	1	O ⁵
	The Netherlands	NL	6	6
	Norway	NO	119	7
(Poland	PL	184	5
0	Portugal	PT	13 ⁶	1
	Romania	RO	51	8
	Slovakia	SK	3	3
-	Slovenia	SI	1	17
6	Spain	ES	354	5
-	Sweden	SE	170	6
•	Switzerland	СН	630	0
×	United Kingdom	UK	14	6

Low concentration concentration concentration ainly small, local ISOS, the three largest accounting for more than 60% of distributed power and several local DSOs Stributed power Medium concentration concentration One dominant DSO (more than 80% of distributed power) and several local DSOs NORWAY	concentration ainly small, local SOs. The three largest DSos ually deliver less than 50% of striibuted power A mix of DSOs, with the elargest accounting for more than 60% of distributed power Concentration One dominant DSO (more than 80% of distributed power) DSO company distributed power NORWAN NORWAN RELAND UNITED KINGDOM CONCENTRATION ONE Obsoluted power NORWAN NORWAN RELAND UNITED KINGDOM GERM	concentration ainly small, local SOs. The three largest DSOs allly deliver less than 50% of stributed power A mix of DSOs, with the elargest accounting for more than 60% of distributed power BYON CONCENTRATION One dominant DSO (more than 80% of distributed power) A mix of DSOs, with the elargest accounting for more than 60% of distributed power and several local DSOs NORWAY NORWAY REAND UNITED KINGDOM GERM	concentration ainly small, local SOs. The three largest DSOs ually deliver less than 50% of striibuted power A mix of DSOs, with the elargest accounting for more than 60% of distributed power A mix of DSOs, with the three largest accounting for more than 60% of distributed power STREAND NORWAN IREAND UNITED NORWAN AIGOLA RELAND One dominant DSO (more than 80% of distributed power) DSO company distributed power NORWAN AIGOLA RELAND AIGOLA RELAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA RELAND AIGOLA GERM AIGOLA FRANCE SMITZELAND ONE OTHER THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA RELAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power STREAND NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power NORWAN NORWAN AIGOLA STREAND ONE THAN BOW of DSO company distributed power NORWAN NORWAN AIGOLA STREAND ONE THAN BOW of DSO company DSO
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