

France was Europe's Power House in 2019

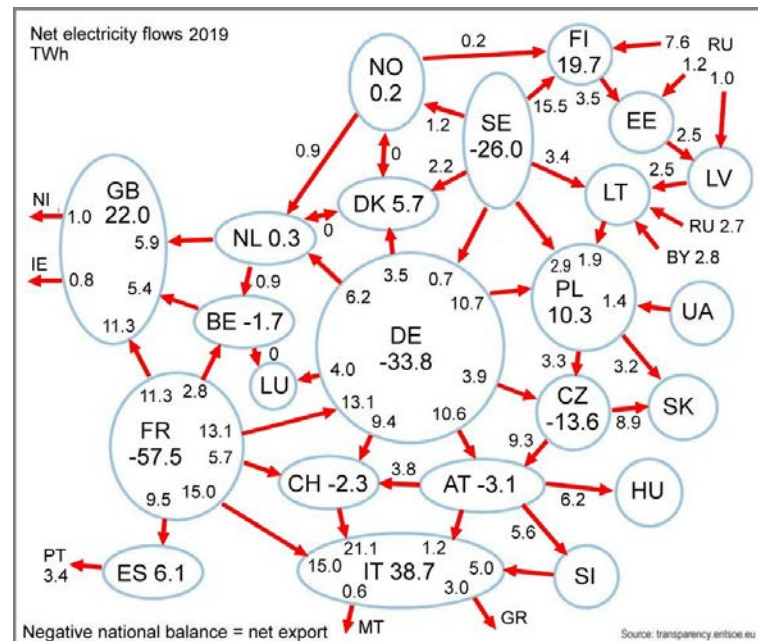


Fig. 1 - France, Germany and Sweden form an axis of surplus

Net electricity flows

The pattern of physical electricity flows has not changed much from previous years. Germany is exporting in all directions except towards France. France sends electricity to Italy, partly via Germany and Switzerland. Four countries have imported 12.5 TWh from Russia.

Users of previous year's diagrams have rightly said that net flows do not show the full story. A zero-flow is not the same as poor utilisation of a line. However, fig. 1 is a compromise between clarity and complexity. Instead of a more complex figure, tables of exchanges have been added for selected countries as annex 3.

The main exporting countries are France, Germany, Sweden and the Czech Republic. The main importing countries are Italy, Great Britain, Finland and Poland.

Spot prices and bottlenecks

There is a considerable difference in hourly day-ahead prices (or spot prices) across Europe. Price differences at borders indicate barriers to trade (bottlenecks or congestions). Therefore, it is interesting to analyse hourly spot prices together with cross-border exchanges.

Fig. 1 shows an overview of the spot price levels in 2019. Annex 2 is a table with average, maximum and minimum hourly spot prices. The standard deviation is a

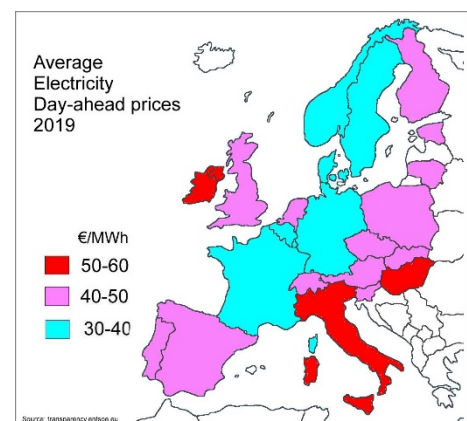


Fig. 2 - Spot price levels in 2019

measure of the amount of variation for each set of spot prices. Norway has rather stable spot prices, while for instance Ireland has experienced much larger variations.

Some countries (Sweden, Norway and Denmark) have more than one price zone. It is indicated by a number (SE1, SE2 etc.). These zones must be analysed individually. This note will be followed by a separate congestion analysis for the Scandinavian price zones.

Detection of bottlenecks

The increasing penetration of wind and solar power creates more electricity transport, which in turn requires more transmission capacity. Unfortunately, it is much easier to build wind turbines than to install new transmission lines in Europe. Therefore, the crucial question is, if or when congestion causes so much trouble that further installation of wind and solar power must wait for the necessary grid reinforcements.

The type of trouble can be curtailment of renewable generation and increasing cost of protective measures (fig. 3).

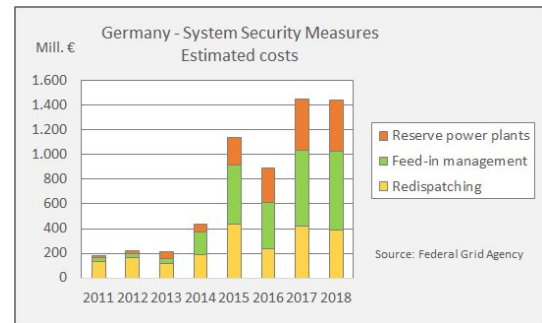


Fig. 3 - Cost of security measures in Germany

The spot prices are necessary to get an impression of locations and impact of bottlenecks. The method was presented in my recent note about the German interconnections in 2019¹.

Annex 3 characterizes the trade barriers at the borders in three ways (see example table 1):

- Number congested hours
- Congestion fees
- Utilization

Spain									
Congested	of which		Estimated		Flow against		of which		Utilization
2019	import	export	revenue		price signals	import	export		
	hours	hours	Mill. €	€/MWh	hours	hours	hours	hours	
FR-ES	6585	5691	894	158	10,52	23	1	22	47%
PT-ES	347	54	293	4	0,39	0	0	0	30%
			162	6,36					
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh	

Table 1 - Example of a congestion analysis

We consider the day-ahead trade at a border to be restricted if the difference between the two prices exceeds the defined threshold, which has been set at one €/MWh. The tolerance reflects an assumed inaccuracy of the preliminary Entso-e data, which have been used.

The estimated revenue (or congestion fee) has been calculated as the price difference multiplied by the exchange. This value can be ambiguous, because any of the two factors can be low or zero, but a large value always indicates a demand for more capacity for trading.

Table 2 is an overview for the top-12 most utilized interconnections. Annex 1 shows the complete list. The utilization has been estimated as the transferred energy in both directions divided by the possible transfer at the highest recorded transfer in one hour in any of the two directions.

Borders		
2019	Utilization	Techno-logy
SE3-FI	79%	HVDC
UA-PL	72%	?
GB-FR	71%	HVDC
DK2-DE	69%	HVDC
GR-IT	69%	HVDC
NL-GB	69%	HVDC
NL-DK1	69%	HVDC
LT-PL	62%	HVDC
SE4-PL	62%	HVDC
GB-BE	61%	HVDC
NO2-NL	60%	HVDC
DK2-DK1	58%	HVDC

Table 2 - High utilization the HVDC-links

¹ http://pfbach.dk/firma_pfb/references/pfb_spot_prices_and_congestions_in_europe_in%202019.pdf

It is not possible to define criteria for the worst acceptable congestion because the reinforcement costs can be very different. The HVDC-links² are the most expensive transmission elements. They must have a high utilization in order to keep the transport cost per MWh at a reasonably low level.

Bottlenecks in European power grids

The transmission grid is the backbone of a power system. It provides long-distance transport of electricity, and it must have a certain overcapacity as reserve for unexpected, but likely events. Decisions on reinforcements of local grid are usually based on security criteria, while joint business arrangements are typical reasons for decisions on reinforced or new interconnections.

Congestions do occur in a well-designed transmission grid. Therefore, bottlenecks should not necessarily be regarded as problems, but when the capacity is sold out too frequently, the trade could be seen as unreasonably reduced.

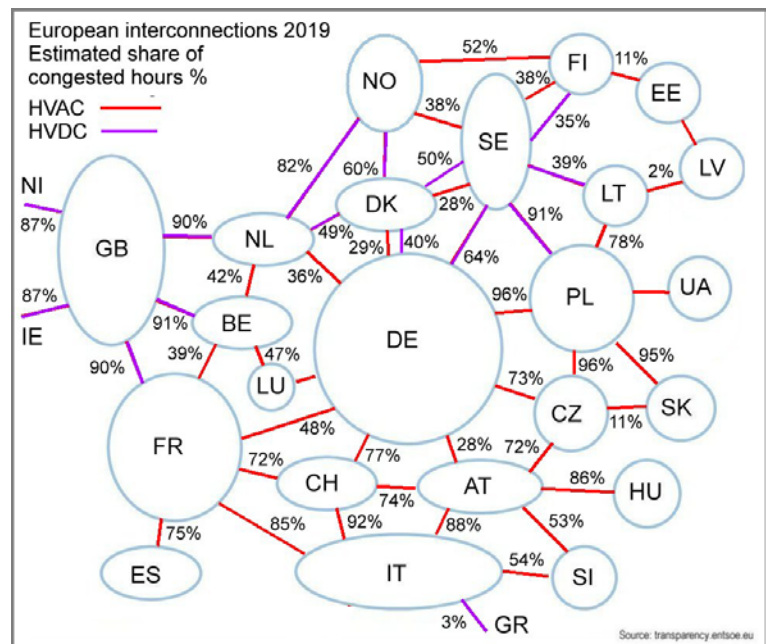


Fig. 4 – Share of hours with limited commercial capacities in 2019

Fig. 4 shows the part of the year with trade limitations for selected interconnection. HVDC lines are expensive elements, which in many cases are operated with a high utilization.

In certain parts of Europe there seems to be only modest reserves for serving the additional transport of fluctuating power from new wind and solar power. Phase shifting transformers have been installed in some countries in order to control the power flow in the AC-grid. They can move bottlenecks around, but they do not add much to the total transfer capability.

Spot price differences do not show bottlenecks within a price zone. Germany and Luxemburg make one single price zone with internal congestions. Germany has large transmission projects under construction. The German problem is that too much wind power has been installed in Northern Germany before the commissioning of new transmission lines.

Bottleneck fees

Bottlenecks between price zones create “customs borders” for electricity traders. The result of a price difference is a revenue to the owners of the interconnector; see “Lucrative bottlenecks” from 2016³. The fee for trading across a border in a specific hour depends on demand for trade and on available commercial capacity.

² HVDC: High Voltage Direct Current

³ http://pfbach.dk/firma_pfb/pfb_lucrative_bottlenecks_2015_03_29.pdf

Table 3 is a list of the highest average bottleneck fees in 2019.

The transmission system operators must set the commercial transfer capabilities with consideration for system security. They could also consider other matters, such as local congestions or maximization of revenue. Such other considerations are not acceptable, but they are difficult to detect.

The revenues are important elements of the economy for the transmission system operators. Reinforcements may reduce the price differences and the grid owners' profits. Therefore, it is important to analyse reinforcement projects with consideration for socio-economics rather than for profit maximization.

Congested 2019	Estimated revenue	Average fees
	Mill. €	€/MWh
PL-DE	135	13,41
IT-FR	202	13,25
HU-AT	77	12,27
GR-IT	38	12,26
IT-AT	15	11,98
IE-GB	48	11,56
FR-GB	139	10,93
IT-CH	232	10,88
GB-BE	61	10,86
FR-ES	158	10,52
SI-AT	60	10,11
NL-GB	66	10,01

Table 3 – Highest average bottleneck fees

Different commercial and physical flows

Table 1 also shows the number of hours, when the physical flow across a border defies the price signal, and the expensive zone exports electricity to the cheap zone. The commercial arrangement are not publicly known. In some cases, the explanation is that conditions have changed between day-ahead planning and actual operation, and regulating power markets must adjust the dispatch of power. Another explanation is that electricity follows physical laws in the meshed European grids and ignores commercial agreements.

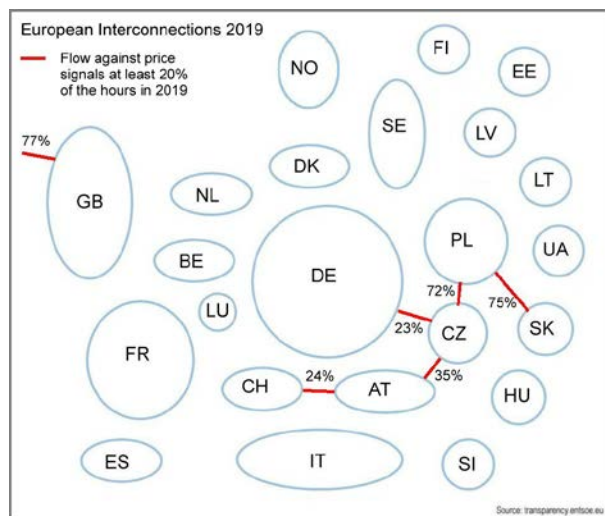


Fig. 5 - Flows against price signals more than 20% of 2019

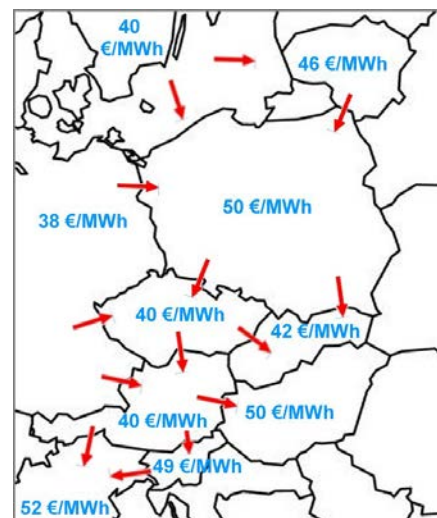


Fig. 6 - The eastern corridor, average spot prices and flow directions

The increasing European electricity exchanges have created unwelcome transits through some European countries, particularly along the eastern corridor through Poland and the Czech Republic (fig. 5).

Annex 1

Selected European interconnectors

Overview 2019, sorted by utilization

Borders			Source: ENTSO-E				
2019	Import	Export	Net imp.	Max imp.	Max exp.	Utilization	Techno-
	GWh	GWh	GWh	MWh/h	MWh/h		logy
SE3-FI	8221	57	8164	1203	1134	79%	HVDC
UA-PL	1377	0	1377	218	0	72%	?
GB-FR	704	12023	-11319	1978	2036	71%	HVDC
DK2-DE	1292	2343	-1051	585	600	69%	HVDC
GR-IT	55	3028	-2972	496	513	69%	HVDC
NL-GB	6200	348	5852	1090	1050	69%	HVDC
NL-DK1	650	605	46	703	681	69%	HVDC
LT-PL	2280	383	1897	490	494	62%	HVDC
SE4-PL	3077	187	2889	600	597	62%	HVDC
GB-BE	126	5486	-5360	999	1044	61%	HVDC
NO2-NL	2359	1467	892	707	732	60%	HVDC
DK2-DK1	208	2845	-2637	600	598	58%	HVDC
LU-DE	0	4033	-4033	0	790	58%	
RU-FI	7583	0	7583	1506	9	57%	
SE1-FI	7592	304	7288	1577	1106	57%	
PL-DE	6	10070	-10064	508	2026	57%	
IT-AT	1	1215	-1214	139	260	53%	
SE3-DK1	1844	1381	463	715	720	51%	HVDC
IT-CH	121	21230	-21109	2069	4807	51%	
NI-GB	1463	490	973	454	382	49%	HVDC
IT-FR	98	15135	-15037	2528	3563	49%	
IE-GB	1689	2480	-791	882	984	48%	HVDC
FR-ES	12255	2727	9528	3613	3643	47%	
NO2-DK1	3285	3277	8	1533	1619	46%	HVDC
SK-CZ	66	8917	-8851	837	2225	46%	
EE-FI	274	3796	-3523	1016	1016	46%	HVDC
SI-AT	148	5781	-5633	1047	1554	44%	
CZ-AT	9296	6	9290	2614	281	41%	
SE4-DK2	3439	1712	1727	1395	1484	40%	
HU-AT	18	6236	-6217	427	1825	39%	
DK1-DE	1681	4080	-2399	1454	1792	37%	
DE-AT	11084	494	10590	3666	1860	36%	
FR-DE	14827	1718	13110	5223	3000	36%	
SI-IT	5141	170	4972	1675	1220	36%	
SE4-DE	1306	565	741	611	596	35%	HVDC
MT-IT	18	655	-637	128	220	35%	
DE-CH	13012	3611	9401	5909	3894	32%	
NL-BE	5422	4495	927	3605	3395	31%	
SK-PL	25	3244	-3219	436	1188	31%	
PT-ES	3521	6925	-3405	3982	3474	30%	
CH-AT	565	4315	-3750	1211	1891	29%	
DE-CZ	5599	1652	3947	2860	2365	29%	
FR-BE	6013	3229	2784	3687	2992	29%	
NL-DE	2946	9135	-6189	4423	5074	27%	
FR-CH	7686	2011	5675	4190	2895	26%	
NO4-FI	243	55	188	144	96	24%	
PL-CZ	3430	155	3275	1749	786	23%	
LU-BE	92	184	-92	218	293	11%	

Annex 2

European spot prices 2019

			Source: ENTSO-E	
Spot prices				
2019	Average	Max	Min	St.dev.
	€/MWh	€/MWh	€/MWh	€/MWh
AT	40,08	121,46	-59,78	13,06
BE	39,41	121,46	-500,00	17,97
CH	40,94	108,11	-39,45	12,32
CZ	40,20	109,30	-48,14	13,51
DE	37,68	121,46	-90,01	15,51
DK1	38,50	109,45	-48,29	13,16
DK2	39,84	109,45	-48,29	12,66
EE	45,86	200,03	0,47	15,81
ES	47,71	74,74	0,03	10,85
FI	44,04	199,98	0,47	15,27
FR	39,53	121,46	-20,54	13,95
GB	49,02	149,17	-3,38	13,42
HU	50,37	138,82	0,02	18,79
IE	50,25	365,04	-11,86	23,76
IT	52,26	113,07	1,00	12,70
LT	46,12	200,03	0,47	15,81
LU	37,68	121,46	-90,01	15,51
NI	50,25	365,04	-11,86	23,76
NL	41,22	121,46	-9,02	11,25
NO2	39,27	109,45	5,86	8,23
NO4	38,31	80,75	1,38	7,56
PL	49,94	115,32	1,18	17,68
PT	47,90	74,74	0,01	10,79
SE1	37,94	107,67	0,47	9,87
SE3	38,36	109,45	0,47	10,36
SE4	39,81	109,45	0,47	11,28
SI	48,78	200,02	-20,23	18,17
SK	41,51	120,10	-25,00	14,75

Exchanges and congestions for selected European countries 2019

Austria								
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
CZ-AT	9296	8700	6	60	9290	2614	281	41%
DE-AT	11084	7623	494	1137	10590	3666	1860	36%
HU-AT	18	116	6236	8644	-6217	427	1825	39%
IT-AT	1	15	1215	8745	-1214	139	260	53%
SI-AT	148	521	5781	8239	-5633	1047	1554	44%
CH-AT	565	2030	4315	6730	-3750	1211	1891	29%
Total	21114		18047		3066			
Congested								
2019	of which		Estimated		Flow against		of which	
	import		export		price signals		import	
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
CZ-AT	6318	6278	40	-1	-0,06	3058	3030	28
DE-AT	2459	2239	220	51	4,40	57	33	24
HU-AT	7536	83	7453	77	12,27	1246	18	1228
IT-AT	7729	13	7716	15	11,98	143	7	136
SI-AT	4685	28	4657	60	10,11	6	6	0
CH-AT	6504	1504	5000	13	2,67	2141	384	1757
				215	5,48			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Belgium								
Source: ENTSO-E								
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
FR-BE	6013	4954	3229	3806	2784	3687	2992	29%
NL-BE	5422	4573	4495	4187	927	3605	3395	31%
LU-BE	92	1397	184	7363	-92	218	293	11%
GB-BE	126	351	5486	8409	-5360	999	1044	61%
Total	11653		13393		-1740			
Congested								
2019	of which		Estimated		Flow against		of which	
	import		export		price signals		import	
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
FR-BE	3436	1575	1861	18	1,97	959	204	755
NL-BE	3691	1818	1873	27	2,74	818	738	80
LU-BE	4140	793	3347	0	0,71	726	17	709
GB-BE	7940	241	7699	61	10,86	87	31	56
				106	4,25			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Switzerland								
Source: ENTSO-E								
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
AT-CH	4315	6722	565	2038	3750	1891	1211	29%
FR-CH	7686	6307	2011	2453	5675	4190	2895	26%
DE-CH	13012	5899	3611	2861	9401	5909	3894	32%
IT-CH	121	243	21230	8517	-21109	2069	4807	51%
Total	25134		27418		-2285			
Congested								
2019	of which		Estimated		Flow against		of which	
	import		export		price signals		import	
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
AT-CH	6504	4994	1510	13	2,67	2141	1757	384
FR-CH	6347	4632	1715	32	3,29	1730	1212	518
DE-CH	6733	4651	2082	131	7,85	1165	764	401
IT-CH	8048	207	7841	232	10,88	673	182	491
				408	7,76			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Annex 3, p.2

Czech Republic		Source: ENTSO-E						
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
AT-CZ	6	59	9296	8701	-9290	281	2614	41%
DE-CZ	5599	6059	1652	2701	3947	2860	2365	29%
PL-CZ	3430	7865	155	895	3275	1749	786	23%
SK-CZ	66	290	8917	8470	-8851	837	2225	46%
Total	9102		20021		-10919			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
AT-CZ	6318	40	6278	-1	-0,06	3058	28	3030
DE-CZ	6418	4613	1805	34	4,63	1984	1312	672
PL-CZ	8419	7540	879	-29	-8,03	6552	6374	178
SK-CZ	957	18	939	13	1,45	23	18	5
				17	0,59			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Germany		Source: ENTSO-E						
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
AT-DE	494	1135	11084	7625	-10590	1860	3666	36%
CZ-DE	1652	2700	5599	6060	-3947	2365	2860	29%
DK1-DE	1681	3422	4080	5338	-2399	1454	1792	37%
DK2-DE	1292	3396	2343	5364	-1051	585	600	69%
FR-DE	14827	6765	1718	1995	13110	5223	3000	36%
LU-DE	0	0	4033	8760	-4033	0	790	58%
NL-DE	2946	2576	9135	6184	-6189	4423	5074	27%
PL-DE	6	34	10070	8726	-10064	508	2026	57%
SE4-DE	1306	3501	565	5259	741	611	596	35%
CH-DE	3611	2861	13012	5899	-9401	3894	5909	32%
Total	27817		61638		-33822			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
AT-DE	2459	220	2239	51	4,40	57	24	33
CZ-DE	6418	1804	4614	34	4,63	1984	672	1312
DK1-DE	2561	1008	1553	20	3,48	130	0	130
DK2-DE	3488	1008	2480	16	4,41	129	59	70
FR-DE	4226	2820	1406	54	3,28	1195	1195	0
LU-DE	0	0	0	0	0,00	0	0	0
NL-DE	3177	605	2572	60	4,97	450	125	325
PL-DE	8388	32	8356	135	13,41	1138	11	1127
SE4-DE	5634	2557	3077	12	6,58	96	47	49
CH-DE	6733	2082	4651	131	7,85	1165	401	764
				513	5,73			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Annex 3, p.3

Western Denmark		Source: ENTSO-E						
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
DE-DK1	4080	5332	1681	3428	2399	1792	1454	37%
DK2-DK1	208	1243	2845	7517	-2637	600	598	58%
NL-DK1	650	1366	605	7394	46	703	681	20%
NO2-DK1	3285	4625	3277	4135	8	1533	1619	46%
SE3-DK1	1844	4422	1381	4338	463	715	720	51%
Total	10068		9790		278			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
DE-DK1	2561	1550	1011	20	3,48	130	130	0
DK2-DK1	1705	67	1638	5	1,80	80	29	51
NL-DK1	4259	444	3815	4	3,53	46	33	13
NO2-DK1	5242	2718	2524	49	7,43	251	180	71
SE3-DK1	4369	2271	2098	17	5,13	432	270	162
				95	4,80			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Eastern Denmark		Source: ENTSO-E						
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
DK1-DK2	2845	7353	208	1407	2637	598	600	58%
DE-DK2	2343	5345	1292	3415	1051	600	585	69%
SE4-DK2	3439	5313	1712	3447	1727	1395	1484	40%
Total	8627		3212		5415			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
DK1-DK2	1705	1535	170	5	1,80	80	51	29
DE-DK2	3488	2477	1011	16	4,41	129	70	59
SE4-DK2	2443	1717	726	19	3,66	83	38	45
				40	3,41			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Spain		Source: ENTSO-E						
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
FR-ES	12255	6929	2727	1831	9528	3613	3643	47%
PT-ES	3521	3104	6925	5656	-3405	3982	3474	30%
Total	15775		9653		6123			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
FR-ES	6585	5691	894	158	10,52	23	1	22
PT-ES	347	54	293	4	0,39	0	0	0
				162	6,36			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Annex 3, p.4

Finland		Source: ENTSO-E						
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
EE-FI	274	1299	3796	7461	-3523	1016	1016	46%
NO4-FI	243	5471	55	3289	188	144	96	24%
RU-FI	7583	8591	0	169	7583	1506	9	57%
SE1-FI	7592	7769	304	991	7288	1577	1106	57%
SE3-FI	8221	8434	57	326	8164	1203	1134	79%
Total	23913		4213		19700			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
EE-FI	957	7	950	14	3,56	9	0	9
NO4-FI	4541	2908	1633	2	6,56	1027	405	622
RU-FI	8752	8583	169					
SE1-FI	3335	3333	2	65	8,29	2	0	2
SE3-FI	3102	3072	30	54	6,49	0	0	0
				136	6,60			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

France		Source: ENTSO-E						
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
BE-FR	3229	3801	6013	4959	-2784	2992	3687	29%
DE-FR	1718	1993	14827	6767	-13110	3000	5223	36%
IT-FR	98	204	15135	8556	-15037	2528	3563	49%
ES-FR	2727	1795	12255	6965	-9528	3643	3613	47%
CH-FR	2011	2452	7686	6308	-5675	2895	4190	26%
GB-FR	704	861	12023	7899	-11319	1978	2036	71%
Total	10487		67939		-57453			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
BE-FR	3436	1861	1575	18	1,97	959	755	204
DE-FR	4226	1405	2821	54	3,28	1195	0	1195
IT-FR	7440	93	7347	202	13,25	88	47	41
ES-FR	6585	861	5724	158	10,52	23	22	1
CH-FR	6347	1715	4632	32	3,29	1730	518	1212
GB-FR	7842	537	7305	139	10,93	201	96	105
				603	7,69			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Great Britain		Source: ENTSO-E						
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
BE-GB	5486	7355	126	1405	5360	1044	999	61%
FR-GB	12019	7891	704	869	11315	2036	1978	71%
IE-GB	1689	4228	2480	4532	-791	882	984	48%
NL-GB	6200	7663	348	1097	5852	1090	1050	69%
NI-GB	1463	4634	490	4126	973	454	382	49%
Total	26856		4148		22708			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
BE-GB	7940	6748	1192	61	10,86	87	56	31
FR-GB	7842	7300	542	139	10,93	201	105	96
IE-GB	7578	3685	3893	48	11,56	450	228	222
NL-GB	7886	7094	792	66	10,01	364	182	182
NI-GB	7578	3989	3589	-19	-9,76	6777	3606	3171
				295	9,50			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

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Italy								
Source: ENTSO-E								
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
AT-IT	1215	8745	1	15	1214	260	139	53%
FR-IT	15135	8556	98	204	15037	3563	2528	49%
GR-IT	55	336	3028	8424	-2972	496	513	69%
MT-IT	18	695	655	8065	-637	128	220	35%
ME-IT	13	109	1	8651	12	253	106	1%
SI-IT	5141	8018	170	742	4972	1675	1220	36%
CH-IT	21230	8517	121	243	21109	4807	2069	51%
Total	42809		4073		38736			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
AT-IT	7729	7716	13	15	11,98	143	136	7
FR-IT	7440	7347	93	202	13,25	88	41	47
GR-IT	8336	299	8037	38	12,26	982	108	874
MT-IT	8759	695	8064					
ME-IT	8759	109	8650					
SI-IT	4759	4359	400	36	6,81	607	555	52
CH-IT	8048	7841	207	232	10,88	673	491	182
Total				523	11,32			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

Netherlands								
Source: ENTSO-E								
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
BE-NL	4495	4185	5422	4575	-927	3395	3605	31%
DE-NL	9135	6184	2946	2576	6189	5074	4423	27%
DK1-NL	605	1239	650	7521	-46	681	703	20%
GB-NL	348	892	6200	7868	-5852	1050	1090	69%
NO2-NL	2359	4698	1467	4062	892	707	732	60%
Total	16941		16684		257			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
BE-NL	3691	1872	1819	27	2,74	818	80	738
DE-NL	3177	2572	605	60	4,97	450	325	125
DK1-NL	4259	562	3697	4	3,53	46	13	33
GB-NL	7886	621	7265	66	10,01	364	182	182
NO2-NL	7217	3844	3373	25	6,57	289	179	110
Total				182	5,42			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh

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Poland			Source: ENTSO-E					
Borders								
2019	Import		Export		Net imp.	Max imp.	Max exp.	Utilization
	GWh	Hours	GWh	Hours	GWh	MWh/h	MWh/h	
CZ-PL	201	1249	2939	7511	-2738	814	1666	22%
DE-PL	10070	8726	6	34	10064	2026	508	57%
LT-PL	2280	6214	383	2546	1897	490	494	62%
SK-PL	25	297	3244	8463	-3219	436	1188	31%
SE4-PL	3077	6317	187	2443	2889	600	597	62%
UA-PL	1377	7711	0	1049	1377	218	0	72%
Total	17030		6760		10270			
Congested		of which		Estimated		Flow against	of which	
2019		import	export	revenue		price signals	import	export
	hours	hours	hours	Mill. €	€/MWh	hours	hours	hours
CZ-PL	8419	1241	7178	-26	-8,33	6345	259	6086
DE-PL	8388	8356	32	135	13,41	1138	1127	11
LT-PL	6853	4968	1885	11	4,27	1171	718	453
SK-PL	8320	296	8024	-22	-6,72	6602	116	6486
SE4-PL	7998	5896	2102	31	9,35	917	810	107
UA-PL	8760	7711	1049					
				129	5,75			
Tolerance:	1,00	€/MWh				Tolerance:	1,00	€/MWh