

Net electricity flows in 2023:

## France is back as Europe's main power exporter

French nuclear power generation grew by 15%

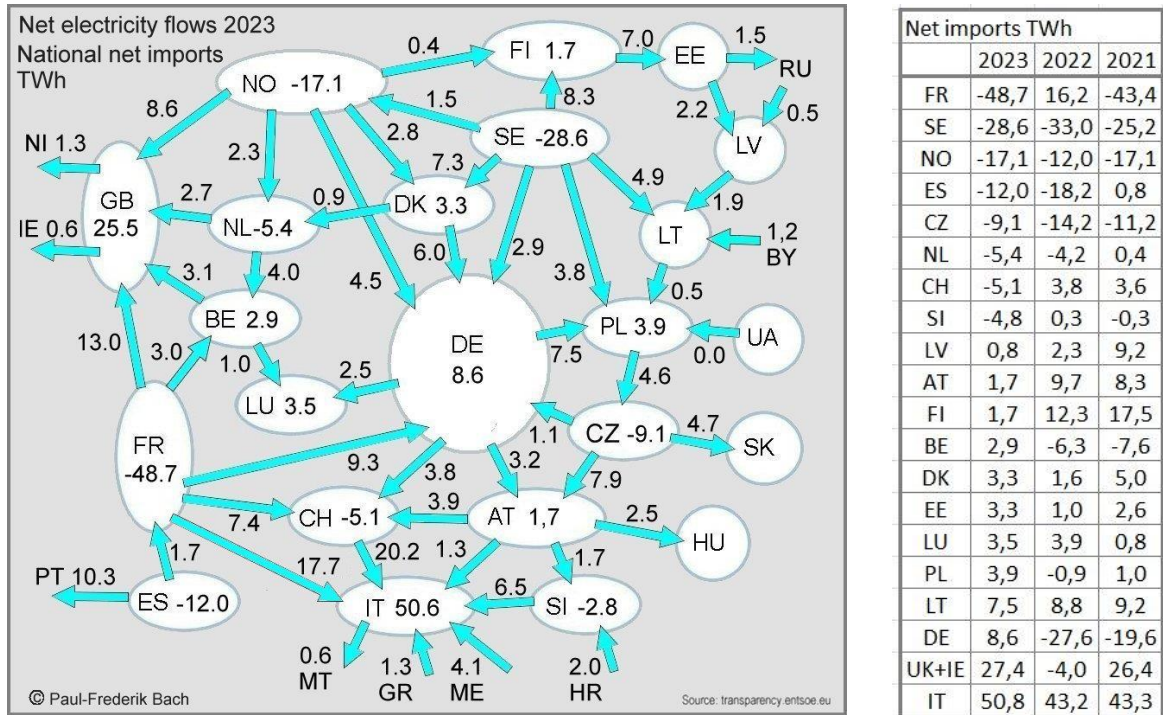


Fig. 1 - European exchange pattern 2023

The European electricity exchange patterns again changed significantly from 2022 to 2023.

The French electricity balance changed by 65 TWh from import to export, while Germany and the British Isles changed from export to import.

England is back in the role of importer, while Germany has been an exporter until 2023.

A year ago, it looked as if France's nuclear power production was in a permanent decline, but in 2023 the trend reversed. Together with a significantly increased production of wind and solar power, nuclear power brought France back into the role of net exporter.

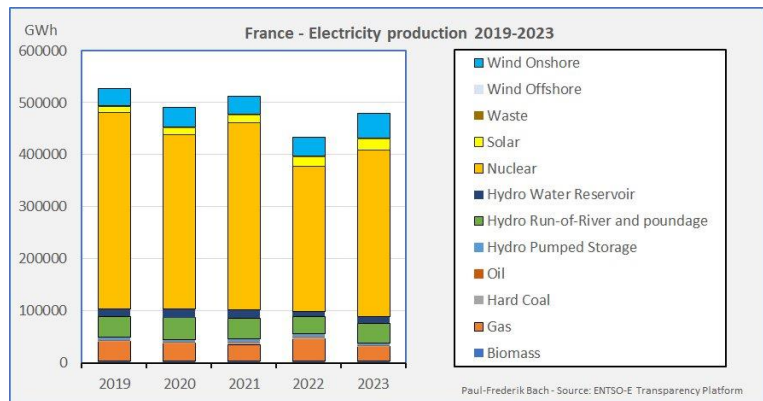


Fig. 2 - Significant increase of French electricity production in 2023

The last few years of data show that the transmission grid in Europe must be able to mitigate the effects of several stochastic impacts on the power system.

We have seen the combination of gas shortages and dry years in the hydropower countries mobilize thermal reserves. Long-term production problems in the electricity sector can affect any country and create the need to move large amounts of energy between countries.

On top of these variations come short-term fluctuations as a result of uncontrollable variations in production from wind and solar power.

The variations create increased need for electricity transport followed by bottlenecks in the transmission grids, which in turn lead to differences in market prices. Therefore, increased differences in market prices are indicators of the state of the network. Large price differences are signs of the need for grid reinforcements.

Since it can take more than 10 years to prepare and build large lines, there should be a long-term mutual coordination of facilities for the production, transport and consumption of electricity.

### Inconsistent data

Net import per country was calculated from the exchange data. Net import can also be found from annual production and consumption. These data are in fair agreement for most countries, but unfortunately, there are some inconsistencies.

Most data for ENTSO-E's Transparency Platform are collected from control centers as *non-validated data*. Data are missing for some hours, and estimated data are used for other hours. The advantage is that non-validated data are available soon after the operating hour. It may take weeks or months before the final *settlement data* are available, and one or two years until the publication of official national statistics.

There is no realistic alternative to the Transparency Platform when electricity data for many European data are needed. Therefore, it is necessary to read the conclusions in this note with reservations.

After Brexit, data for UK electricity generation is no longer available on the Transparency Platform. Corresponding data is available from British sources, but consistency with data from EU countries cannot be ensured.

### Eased supply situation in 2023

In 2022, Europe's electricity production was characterized by weak winds, low rainfall in the hydropower areas and new patterns for gas supply.

2023 was different. Data for 2023 was collected for 21 European countries (fig. 3 and annex 1 and 2).

Change from 2022 to 2023	Total	Total	
	2022	2023	Change
Production type	GWh	GWh	GWh
Biomass	76606	68689	-7.916
Lignite	176729	134451	-42.277
Coal-derived gas	7045	6220	-824
Gas	399382	321548	-77.834
Hard Coal	202898	142129	-60.770
Oil	9928	11280	1.352
Oil shale	4147	1996	-2.151
Peat	4064	2617	-1.447
Geothermal	5610	5534	-77
Hydro Pumped Storage	41449	49773	8.324
Hydro Run-of-River and poundage	146875	178540	31.665
Hydro Water Reservoir	216190	228298	12.108
Marine	0	0	0
Nuclear	539658	546694	7.036
Other renewable	4681	4507	-174
Solar	155674	181138	25.463
Waste	19224	19872	648
Wind Offshore	47729	52489	4.760
Wind Onshore	344980	394800	49.820
Other	55020	70953	15.933
Total production	2457889	2421528	-36.361
Fossil production	804192	620241	-183.952
Load	2461316	2393645	-67.670

Fig. 3 – Significant production changes from 2022 to 2023 for 21 selected European countries

The supply situation has clearly improved from 2022 to 2023. More rainfall provided more energy from the hydroelectric plants (+52 TWh/+13%). More wind and probably also an increased capacity gave more wind energy (+55 TWh/+14%). There was also clear growth in solar energy (+25 TWh/+16%). Finally, reduced consumption of electricity contributed to the improvement (-68 TWh/-3%).

This enabled a significant decrease in the use of fossil energy (-184 TWh/-21%). The largest reductions were natural gas (-78 TWh/-20%), hard coal (-61 TWh/-30%) and lignite (-42 TWh/-24%).

The nuclear production increased by 1% in spite of the closure of nuclear power plants in Germany. Nuclear power was the largest source of electricity generation in 2023 (23% of consumption). Hydropower supplied 19%, wind power 19% and natural gas 13%. This was followed by hard coal and lignite, both with 6% of consumption.

### Frequently negative spot prices in Northern Europe in 2023

An overview of European spot prices (fig. 4) shows that Northern Europe has the lowest prices, but on the other hand, the most hours with negative spot prices.

The Nordic price zones had between 100 and 467 hours with negative spot prices in 2023. Only four countries in Southern Europe had between 11 and 96 hours with negative spot prices.

The standard deviation reflects the volatility of spot prices. The figures suggest that volatility is roughly the same across Europe.

The spot market has become more turbulent since before the energy crisis in 2021-2022 (Fig. 5). New fluctuating production across Europe is likely to prevent the spot market from returning to previously stable conditions.

EU 2023	Average spot price	Standard deviation			
	€/MWh	€/MWh	Neg. hours	Max €/MWh	Min €/MWh
Nordic					
DK1	86,68	48,85	285	524	-440
DK2	81,14	50,11	231	524	-60
NO1	66,90	44,64	381	332	-62
NO2	79,36	36,29	174	262	-62
NO3	38,56	32,76	401	332	-10
NO4	29,95	26,18	375	332	-10
NO5	67,02	43,35	374	262	-7
SE1	39,97	34,13	434	332	-60
SE2	39,98	34,12	434	332	-60
SE3	51,67	45,27	429	332	-60
SE4	64,81	50,59	368	332	-60
FI	56,44	56,65	467	777	-500
EE	90,66	55,78	129	777	-60
LV	93,76	54,54	100	777	-57
LT	94,31	54,86	100	777	-57
Central					
Belgium	97,04	46,03	227	330	-120
France	96,63	45,69	152	276	-135
Germany-LU	94,96	47,71	306	524	-500
Netherlands	95,61	49,17	321	464	-500
Poland	111,56	37,67	43	216	-14
Czech Rep.	100,56	44,06	136	444	-69
Slovakia	104,49	45,97	90	444	-24
Austria	101,91	44,56	113	437	-500
Switzerland	107,23	40,67	76	269	-143
Hungary	106,58	48,28	74	437	-500
South					
Portugal	88,13	39,99	0	220	0
Spain	86,96	41,39	0	220	0
IT North	127,72	35,77	0	295	3
IT Centre N	128,45	36,16	0	298	3
IT Sardinia	123,19	42,15	0	298	0
IT Centre S	126,35	37,22	0	298	0
IT South	125,00	37,64	0	298	0
IT Sicily	126,01	38,87	0	400	0
Greece	118,99	50,19	0	385	0
Bulgaria	103,62	50,45	11	400	-1
Serbia	103,24	42,59	0	318	0
Romania	103,50	50,92	32	437	-23
Croatia	103,49	46,01	94	430	-500
Slovenia	104,09	45,49	96	426	-500

Fig. 4 – Different price levels in 2023

Spot price standard deviations					
€/MWh	2019	2020	2021	2022	2023
Sweden 3	10,38	19,27	59,36	127,86	45,27
Germany	15,50	17,51	73,61	143,08	47,71
France	14,01	16,11	84,23	146,27	45,69
Spain	10,89	11,41	74,64	69,86	41,39
Greece	11,77	17,02	75,72	115,99	50,19

Fig. 5 – More turbulent markets (selected zones)

## Annex 1 Production overview 2022

(Sources: ENTSO-E and Gridwatch)	2022	AT	BE	CH	CZ	DE	DK	EE	ES	FI	FR	GB
60/40% assumed:		Austria	Belgium	Switzerland	Czech Republic	Germany	Denmark	Estonia	Spain	Finland	France	Great Britain
Production type		GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Biomass		2497	1948		2416	39609	4106	1204	4038	5950	3532	15000
Lignite	Fossil				30486	103526			0			
Coal-derived gas	Fossil				142			364	0			
Gas	Fossil	10099	20025		5296	53490	2139	34	77100	1794	42288	111867
Hard Coal	Fossil	0			2687	62895	5089		7898	3808	3047	4303
Oil	Fossil	0	9		32	1040	317		1127	46	1835	0
Oil shale	Fossil							4147	0			
Peat	Fossil							9	0	3610		
Geothermal		0				194			0			
Hydro Pumped Storage		5146	1230	5717	972	10603			2623		5271	1932
Hydro Run-of-River and poundage		24089	99	1855	994	11257		18	6743	12369	33233	3348
Hydro Water Reservoir		3937		8112	1081	1124			15037		9771	
Marine									0			
Nuclear			41743	23581	29319	32824			56033	24102	277995	44720
Other renewable		0			2358	1029		27	841	26		
Solar		975	6420	3040	2368	55441	2111	514	31074		17962	8042
Waste		876	2224		185	6423	1301	123	2256	181	1409	
Wind Offshore			6519			24746	8452		0			37019
Wind Onshore		7184	4375	150	641	100601	10523	684	58668	11104	36911	24679
Other		193	5299		130	2303		0	260	611		
Total production		54996	89892	42456	79109	507104	34038	7122	263698	63599	433254	250910
Fossil production		10099	20034	0	38644	220950	7545	4553	86124	9258	47171	116170
Load		61439	81726	64621	64423	483036	34330	8172	235814	79219	443324	261698

(Sources: ENTSO-E and Gridwatch)	2022	IE	IT	LT	LV	NL	NO	PL	PT	SE	SI	Total
60/40% assumed:		Ireland	Italy	Lithuania	Latvia	Netherlands	Norway	Poland	Portugal	Sweden	Slovenia	
Production type		GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Biomass			5518	366	326	159	0	1613	3324		63	76606
Lignite	Fossil							42717			2800	176729
Coal-derived gas	Fossil		6045					493				7045
Gas	Fossil	5841	116675	499	1099	36257	1251	9056	16435	5	454	399382
Hard Coal	Fossil	1724	20724			19310		75716	0			202898
Oil	Fossil	924	2391					2207			2	9928
Oil shale	Fossil											4147
Peat	Fossil	445										4064
Geothermal			5417									5610
Hydro Pumped Storage		158	3125	553			1547	1267	3237		251	41449
Hydro Run-of-River and poundage		503	22933	397	2659	0	24274	1456	3997		3040	146875
Hydro Water Reservoir			3344				102560	90	1454	69680		216190
Marine										0		0
Nuclear						3931				50132	5311	539658
Other renewable							399					4681
Solar			22386	352		371		9290	2543	825	267	155674
Waste			288	353		3361	244				91	19224
Wind Offshore			20			7913			78			47729
Wind Onshore		7786	20042	1474	172	5425	14818	18776	12887	32757	4	344980
Other		38	17908	60	248	19215	0		181	8574		55020
Total production		17420	246817	4055	4503	95943	145093	162680	44136	161973	12282	2457889
Fossil production		8935	145835	499	1099	55568	1251	130188	16435	5	3256	804192
Load		13121	286244	12167	6812	100386	131609	172393	50363	132117	13369	2461316

## Annex 2 Production overview 2023

(Sources: ENTSO-E and Gridwatch)	2023	AT	BE	CH	CZ	DE	DK	EE	ES	FI	FR	GB
60/40% assumed:		Austria	Belgium	Switzerland	Czech Republic	Germany	Denmark	Estonia	Spain	Finland	France	Great Britain
Production type		GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Biomass		1401	948		2243	38241	3766	493	3097	5295	3241	13380
Lignite	Fossil				25135	77844			0			
Coal-derived gas	Fossil				181			450	0			
Gas	Fossil	6380	15281		3310	50144	1936	45	54384	1807	28004	87006
Hard Coal	Fossil	0			1774	39750	3330		3941	1944	877	2776
Oil	Fossil	0	1		85	3148	324		433	8	1670	0
Oil shale	Fossil							1996	0			
Peat	Fossil							0	0	2270		
Geothermal		0				186			0			
Hydro Pumped Storage		5104	891	6943	1050	11150			6904		4939	1669
Hydro Run-of-River and poundage		30294	217	2130	1071	13427		5	7244	14340	37336	3247
Hydro Water Reservoir		4256		10962	1240	992			16992		13294	
Marine									0			
Nuclear			31288	23765	28716	6738			54366	32676	318791	38283
Other renewable		0			2365	975			709	18		
Solar		2348	7194	3538	2780	55236	3019	692	40432	850	21514	4121
Waste		876	2066		236	6654	908	133	2184	131	837	
Wind Offshore			7879			23518	8296		0		1110	38021
Wind Onshore		8259	6269	168	708	118671	11153	804	61056	14016	46944	25347
Other		193	5975		661	1789		0	96	635		
Total production		59110	78009	47506	71554	448464	32731	4629	251840	73990	478557	213850
Fossil production		6380	15283	0	30484	170885	5590	2490	58759	6029	30551	89782
Load		57925	78902	61071	60908	456713	34478	8071	229287	78947	425437	245797

(Sources: ENTSO-E and Gridwatch)	2023	IE	IT	LT	LV	NL	NO	PL	PT	SE	SI	Total
60/40% assumed:		Ireland	Italy	Lithuania	Latvia	Netherlands	Norway	Poland	Portugal	Sweden	Slovenia	
Production type		GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Biomass			4249	285	221	192	0	2116	2901		47	68689
Lignite	Fossil							31473			2142	134451
Coal-derived gas	Fossil		5074					515				6220
Gas	Fossil	7548	95798	638	1354	31124	1463	12431	9900	2	282	321548
Hard Coal	Fossil	1116	12147			11978		65271	0			142129
Oil	Fossil	1634	1438					2539			0	11280
Oil shale	Fossil											1996
Peat	Fossil	347										2617
Geothermal			5348									5534
Hydro Pumped Storage		254	3811	535			1751	1613	4829		227	49773
Hydro Run-of-River and poundage		708	31319	391	3712	0	27901	1813	6633		3562	178540
Hydro Water Reservoir			4590				106670	152	3246	65903		228298
Marine												0
Nuclear						3771				46584	4615	546694
Other renewable							429					4507
Solar			24189	655		547		13224	3611	1306	263	181138
Waste			2192	420		2956	278				69	19872
Wind Offshore			53			11552			80			52489
Wind Onshore		9695	23266	2406	252	8106	13901	22114	12856	34156	4	394800
Other		7	16442	130	151	37436	0		181	7258		70953
Total production		21310	229916	5459	5690	107662	152394	153260	44237	155209	11210	2421528
Fossil production		10646	114458	638	1354	43102	1463	112229	9900	2	2424	620241
Load		16850	276235	11717	6468	108686	134493	166102	50737	130619	9288	2393645