

Net electricity flows 2024:

France consolidated its role as Europe's main exporter of electricity in 2024

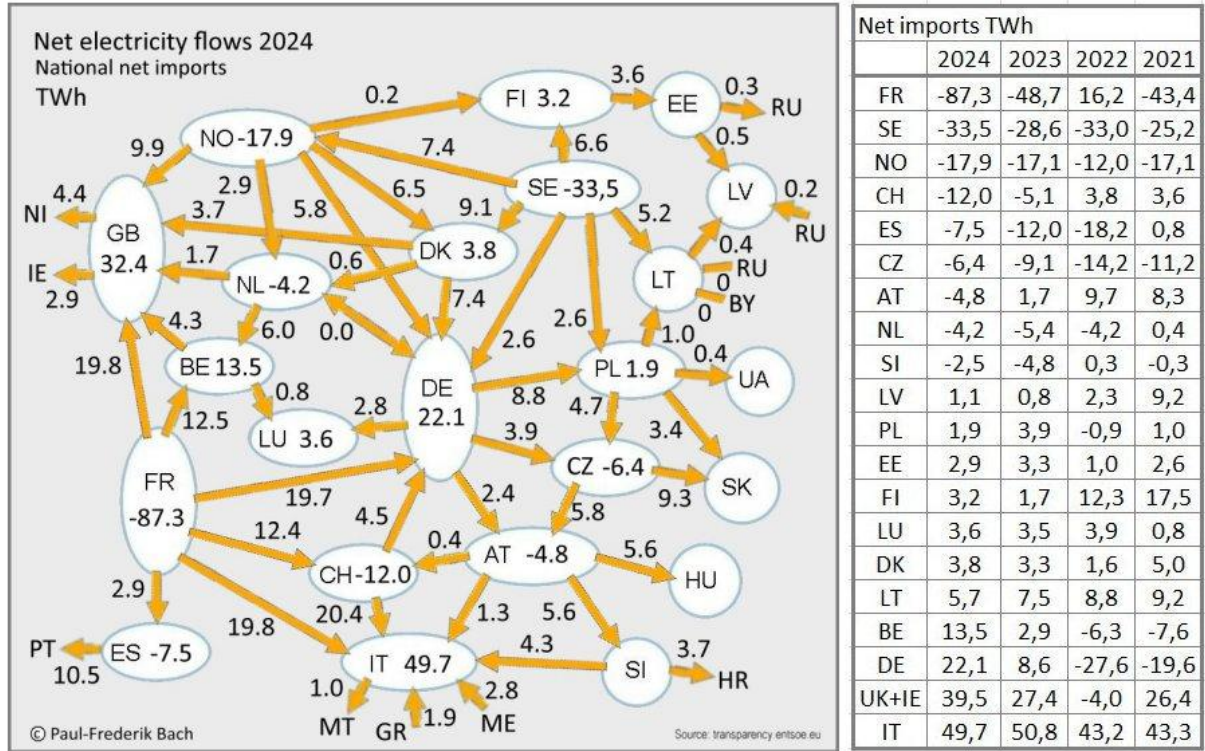


Fig. 1 - European exchange pattern 2024

European electricity exchanges in 2024 continued the trend from 2022 to 2023.

France has increased its nuclear production by 82 TWh since 2022. Low electricity consumption has contributed to the record high exports. Other important exporting nations are Sweden, Norway and Switzerland.

The largest importer is, as usual, Italy. Other significant importers are the British Isles, Germany and Belgium. Germany's balance deteriorated by 50 TWh since 2022.

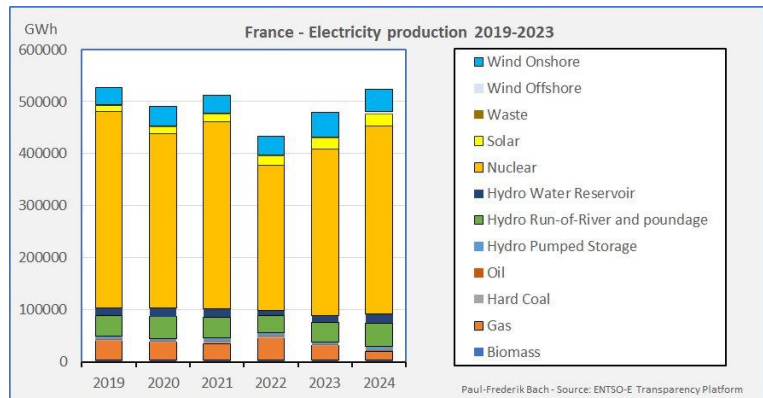


Fig. 2 - France's nuclear production is back to normal levels

Fig. 1 shows a main flow from Scandinavia towards Great Britain and the continent. From Northern Germany, a part is distributed further south through Poland, the Czech Republic and Austria. Another main flow goes from France in all directions.

High utilization of transmission despite low net flows

Some transmission connections exchange large quantities in both directions. This can result in low net exchanges, but it does not mean that the facilities in question are underutilized.

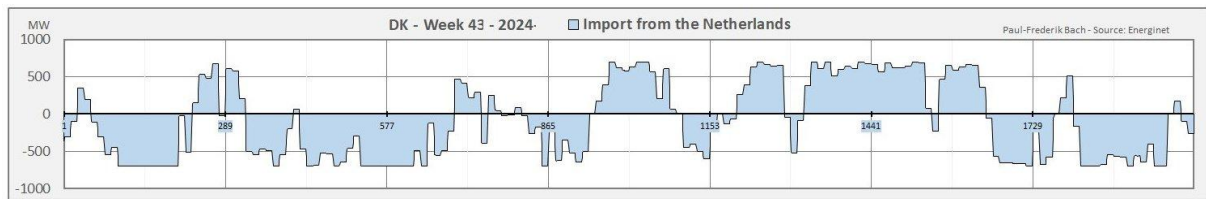


Fig. 4- Exchanges between the Netherlands and Denmark during week 43 2024

An example is the HVDC connection between the Netherlands and Denmark. Here the net exchange is an export from Denmark of 0.6 TWh, but it is the result of an export of 2.3 TWh and an import of 1.7 TWh, i.e. a total transport of 4.0 TWh. This gives a capacity factor of 65%.

A few cases are shown in fig. 4.

	Net exchange	Total transfer
2024	GWh	GWh
AT to DE	-2408	8552
NL to DE	-33	11719
CH to DE	4459	12167
GB to NL	-1676	4904
DK to NL	599	4015

Fig. 3 - European cases

Uncoordinated planning

The European transmission systems are generally highly utilized.

The long-term planning of electricity demand, production and transmission should be carefully coordinated.

The price variations and the amount of zero and negative prices indicate the grid problems.

The three elements should be kept in reasonable balance. This has not been successful in several countries. The reason is that political ambitions usually only include production. Line construction takes much longer than the installation of wind turbines and solar cells. This creates a permanent shortage of transmission capacity.

In Denmark's case, the flexible demand, which was supposed to produce hydrogen and balance the uneven production, is not yet a proven technology. That is why things have gone completely wrong in Denmark.

The bottlenecks create price variations and negative spot prices. Due to the increasing capacity of solar power, negative spot prices

2024	Avg. spot price	<= 0	2024	Avg. spot price	<= 0
EU Nordic	€/MWh	hours	EU Central	€/MWh	hours
DK1	70,50	405	Belgium	70,22	438
DK2	70,71	297	France	57,86	457
NO1	41,75	243	Germany-LU	79,47	522
NO2	49,81	221	Netherlands	77,16	513
NO3	27,92	172	Poland	95,85	211
NO4	22,64	150	Czech Rep.	84,66	340
NO5	40,59	140	Slovakia	92,77	316
SE1	24,94	672	Austria	81,29	326
SE2	24,54	767	Switzerland	75,63	293
SE3	35,67	699	Hungary	100,73	287
SE4	49,61	675	EU South	€/MWh	hours
FI	45,34	815	Portugal	61,15	294
EE	86,67	209	Spain	61,12	329
LV	86,94	208	IT North	104,18	0
LT	86,86	209	IT Centre N	105,83	1
			IT Sardinia	102,53	60
			IT Centre S	106,12	2
			IT South	105,44	4
			IT Sicily	102,35	6
			Greece	99,94	18
			Bulgaria	101,44	91
			Serbia	101,38	12
			Romania	102,54	129
			Croatia	94,54	221
			Slovenia	91,12	248

Fig. 5 – Average spot prices for European price zones. There are high numbers of hours with zero or negative spot prices, particularly in Finland, Sweden, the Netherlands and in Germany. Source: Entso-e Transparency Platform.

are now increasingly occurring in the middle of the day. This is particularly affecting the value of solar energy, as solar cell production takes place in the middle of the day.

Large drop in the commercial value of solar energy in 2024

Most discussions about cost of electricity production ignore the fact that the commercial value depends on the market price at the time of production. The cost per kWh is the standard benchmark.

However, the seller can earn more by producing when the market price is high. For each type of production, the average commercial value of the year's production can be calculated with a list of production per hour and the corresponding spot prices. It turns out that the differences are quite large.

Fig. 6 shows German results.

The price levels in 2022 and 2024 are rather different because 2022 was at the top of the gas supply crisis.

For both years, the value of consumption is set to 100%.

It is obvious from fig. 6 that dispatchable production achieves values above 100%, e.g. as an average in 2024 for all fossil fuel production 115%. The value of wind energy was higher in 2024 than in 2022, but still less than 100%. Solar energy dropped from 94% in 2022 to 57% in 2024. The corresponding solar energy values for Denmark are 102% in 2022 and 66% in 2024.

This loss of trade value is a serious blow to the solar energy industry. It could have been predicted by a simple system simulation. This clearly shows the lack of coherent planning.

The commercial value per MWh of the total German production was only 94% of load value in 2024. This fact suggests that Germany's net import must have been expensive in 2024. The value of the net import was 143 €/MWh or 174% of the load value.

37% growth in solar energy in Europe from 2022 to 2024

In 2024, several key European trends from the previous year continued (Fig. 7). The use of coal continued to decline to half of its 2022 level. In 2024, lignite accounted for 73% of its 2022 production. Gas-fired electricity generation increased slightly in 2024, but was only around 70% of its 2022 level.

Market values	2022	Per cent of	2024	Per cent of
Germany	€/MWh	load value	€/MWh	load value
Biomass	235,46	99%	80,74	99%
Lignite	250,99	106%	92,54	113%
Coal-derived gas	275,15	116%	67,51	83%
Gas	271,38	114%	97,45	119%
Hard Coal	205,10	86%	95,50	117%
Oil	225,84	95%	80,91	99%
Geothermal	298,91	126%	79,72	97%
Hydro Pumped Storage	236,72	100%	115,90	142%
Hydro Run-of-River and poundage	265,78	112%	78,75	96%
Hydro Water Reservoir	239,41	101%	104,20	127%
Other renewable	230,90	97%	80,11	98%
Solar	223,37	94%	47,38	58%
Waste	234,60	99%	79,63	97%
Wind Offshore	194,47	82%	71,65	88%
Wind Onshore	168,33	71%	64,89	79%
Other	234,48	99%	84,00	103%
Load/Consumption	237,30	100%	81,82	100%
All fossil production	262,43	111%	94,39	115%
Total production	232,22	98%	77,13	94%

Fig. 6 – Germany 2022 and 2024. Commercial values per type of production in 2024. Source: Entso-e Transparency Platform.

On the other hand, onshore wind grew by 27% compared to 2022, and solar power grew by 37%. Wind and solar power accounted for 43% of total electricity generation in 2024.

The growth in nuclear generation is broadly in line with the nuclear growth in France.

The share of production with fossil fuels has fallen from 34% in 2022 to 23% in 2024. This is going in the desired direction, but probably not as quickly as many would like.

Selected European countries	Total	Total	Total
	2022	2023	2024
Production type	GWh	GWh	GWh
Biomass	91.608	68.689	87.880
Lignite	176.729	134.451	129.320
Coal-derived gas	7.045	6.220	7.591
Gas	505.431	321.548	359.318
Hard Coal	205.480	142.129	107.416
Oil	9.005	11.280	8.061
Oil shale	4.147	1.996	1.697
Peat	3.619	2.617	1.837
Geothermal	5.610	5.534	5.225
Hydro Pumped Storage	37.507	49.773	60.850
Hydro Run-of-River and poundage	147.900	178.540	211.153
Hydro Water Reservoir	208.084	228.298	243.257
Marine	0	0	0
Nuclear	561.031	546.694	618.814
Other renewable	4.681	4.507	4.380
Solar	160.706	181.138	220.923
Waste	19.225	19.872	21.261
Wind Offshore	84.748	52.489	102.636
Wind Onshore	361.748	394.800	412.603
Other	54.982	70.953	72.492
			0
Total production	2.649.285	2.421.528	2.676.715
Fossil production	911.454	620.241	615.240
Load	2.645.100	2.393.645	2.668.434

Fig. 7 - Electricity generation 2022 to 2024

Annex 1 European electricity production overview 2023

(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				
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 European electricity production overview 2024

(Sources: ENTSO-E and Gridwatch)	2024	AT	BE	CH	CZ	DE	DK	EE	ES	FI	FR
60/40% assumed:		Austria	Belgium	Switzerland	Czech Republic	Germany	Denmark	Estonia	Spain	Finland	France
Production type		GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Biomass		1933	739		2220	36016	4010	434	3431	6340	3101
Lignite	Fossil				23044	70986			0		
Coal-derived gas	Fossil				104	1108		476	0		
Gas	Fossil	5987	11546		3391	56919	1854	36	42420	1233	17228
Hard Coal	Fossil	0			637	27337	3270		2978	1064	603
Oil	Fossil	0	1		12	3243	362		307	6	1394
Oil shale	Fossil							1697	0		
Peat	Fossil							0	0	1837	
Geothermal		0				204			0		
Hydro Pumped Storage		5268	1038	9597	1616	10391			8056		6787
Hydro Run-of-River and poundage		31937	245	2272	1032	15286		5	8814	13564	45893
Hydro Water Reservoir		4587		13925	1533	1866			23069		17439
Marine									0		
Nuclear			29732	22956	28040				52322	31062	360095
Other renewable		0			2389	705		4	660	110	
Solar		5837	8326	4300	3906	63226	3700	992	47319	1206	23321
Waste		878	2117		201	6481	841	117	1850	277	1848
Wind Offshore			7065			25680	9741		0		3954
Wind Onshore		9368	5535	142	696	111884	10700	1161	58973	19461	41910
Other		193	6100		611	1470		0	192	1475	
Total production		65990	72445	53191	69433	432801	34476	4922	250391	77635	523573
Fossil production		5987	11547	0	27187	159593	5486	2208	45705	4140	19225
Load		58717	80959	59629	60923	464430	36781	7953	232245	81965	429183

(Sources: ENTSO-E and Gridwatch)	2024	GB	IT	LT	LV	NL	NO	PL	PT	SE	SI	Total
60/40% assumed:		Great Britain	Italy	Lithuania	Latvia	Netherlar	Norway	Poland	Portugal	Sweden	Slovenia	GWh
Production type		GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Biomass		18085	5152	247	439	162	0	2363	3136		72	87880
Lignite	Fossil							32897			2393	129320
Coal-derived gas	Fossil		4853					1051				7591
Gas	Fossil	70260	93450	824	1602	29198	1629	16484	4919	4	333	359318
Hard Coal	Fossil	1540	3542			10386		56058	0			107416
Oil	Fossil	148	547					2040			0	8061
Oil shale	Fossil											1697
Peat	Fossil											1837
Geothermal			5021									5225
Hydro Pumped Storage		1698	5237	1247			2184	1098	6414		218	60850
Hydro Run-of-River and poundage		3627	40308	381	3191	0	30187	1525	8396		4488	211153
Hydro Water Reservoir			5835				106184	380	3615	64825		243257
Marine												0
Nuclear		38185				3384				48597	4440	618814
Other renewable							398	114				4380
Solar		4189	27735	1393	398	487	2	17345	4900	1851	491	220923
Waste			2829	685		2797	305				36	21261
Wind Offshore		40857	50			15204			86			102636
Wind Onshore		27238	21916	3286	273	7654	14531	23486	14050	40334	4	412603
Other			15732	280	0	36958	0	3262	250	5969		72492
Total production		205827	232207	8343	5903	106231	155422	158103	45766	161581	12476	2676715
Fossil production		71948	102392	824	1602	39584	1629	108531	4919	4	2727	615240
Load		249166	279084	12157	6980	115046	136833	163212	51365	131853	9952	2668434