New Download Tools for Danish Time Series

For several years, I have provided data from selected European countries as hourly time series on my web site (http://pfbach.dk/). Better sources have emerged within the last three years. Therefore, 2016 will be the last year in my collection.

I have mentioned the new opportunities in the following notes:

- Data for European Power System Analyses, 16 December 2016[1]
- Time Series for the Year 2016 at http://pfbach.dk/, 20 February 2017[2]
- ENTSO-E Data: Gaps and Inaccuracies, 4 March 2017[3]

For many years, a comprehensive range of Danish time series has been available from the Market Data (MD) page at https://energinet.dk/. Energinet has developed a more modern database, Energy Data Service[4] (EDS), which was supposed to replace the popular Market Data.

MD was closed down on the 14th December 2017. EDS offers much more options, but at the cost of a time consuming manual download of data. The date was inconvenient because the new problems delayed work on analyses of Danish electricity supply for the year 2017. Several users have missed the MD page, so it was temporarily reopened on the 26th January 2018[5].

The reopened MD allows time for the development of API[6] tools for fast download.

Datasets in Energy Data Service

The 22 datasets in EDS are maintained by three organizations:

- TSO Electricity (18 datasets)
- TSO Gas (3 datasets)
- Gas Storage Denmark (1 dataset)

The 18 datasets on electricity include:

- Electricity Balance Non-Validated
- Auction of Capacities, PTR DK1-Germany
- aFRR, automatic Frequency Restoration Reserves, DK1
- mFRR, Frequency Restoration Reserves manual, DK1
- mFRR, Frequency Restoration Reserves manual, DK2
- Elspot Prices
- Transmission Lines
- Electricity Balance
- Realtime Market
- Nordpool Market

[1] http://pfbach.dk/firma_pfb/references/pfb_time_series_2016_12_14.pdf
[2] http://pfbach.dk/firma_pfb/references/pfb_entsoe_time_series_2017_02_15.pdf
[3] http://pfbach.dk/firma_pfb/references/pfb_entsoe_data_quality_2017_03_03.pdf
[4] https://www.energidataservice.dk/en/
[5] http://osp.energinet.dk/_layouts/Markedsdata/framework/integrations/markedsdatatemplate.aspx?language=en
[6] An application programming interface (API) is a set of subroutine definitions, protocols, and tools for communication between various software components..

- Auction of Capacities, PTR DK2-Germany
- CO2 Emission Prognosis
- CO2 Emission
- FCR, Frequency Containment Reserves, DK2
- FCR, Frequency Containment Reserves, DK1
- Fixed Residual Consumption
- Production per Municipality
- Consumption per Municipality

Manual download of EDS data

After the selection of for instance “Transmission Lines”, the following image appears:

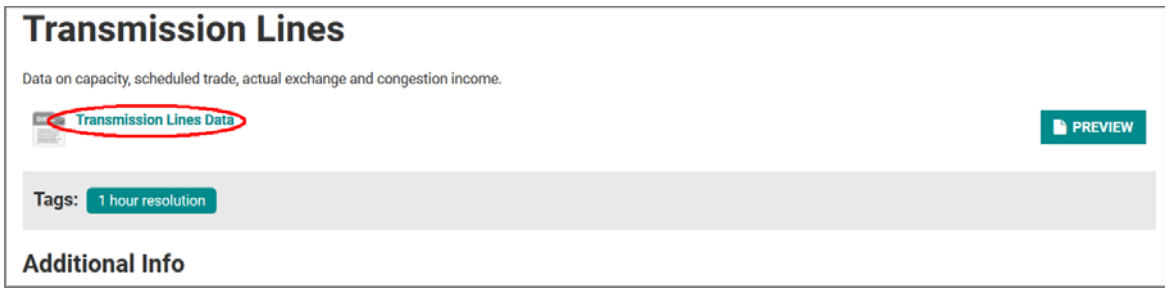

Fig. 1 - Klick "Transmission Lines Data".

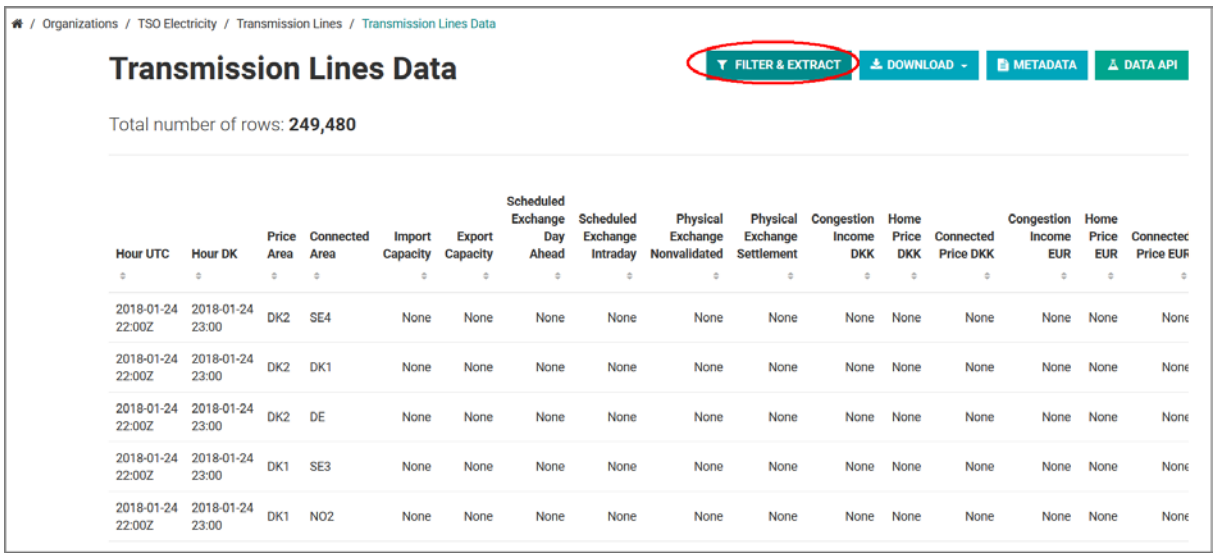

Fig. 2 - The next step is to delimit the selection by defining a filter

It is possible to define filters for each column of the table (fig. 3).

The number of hours for download can be reduced (from e.g. 249,480 rows) to for instance one year by putting limits on either “Hour UTC” or “Hour DK” (use “Interval”).

The transmission lines in the dataset are interconnectors from one of the two Danish price areas (DK1 and DK2) to another price area:

- DK1 to DE (Germany)
- DK1 to SE3 (Sweden)
- DK1 to NO2 (Norway)
- DK1 to DK2

- DK2 to SE4 (Sweden)
- DK2 to DE (Germany)

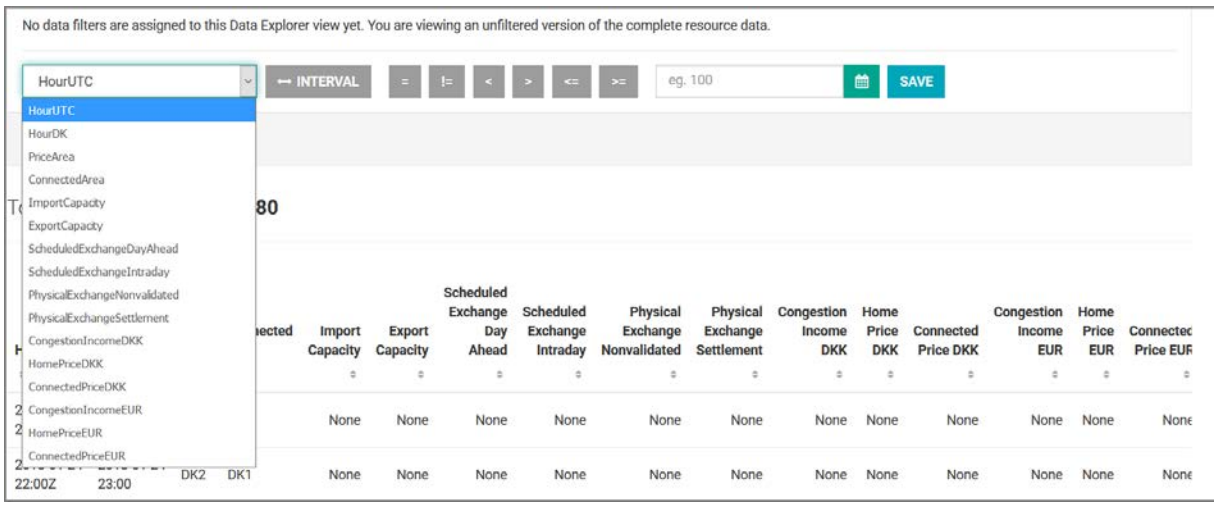

Fig. 3 - The filter can make selections in all columns

After the selection of October 2017 and the price area DK1, the number of rows has been reduced to 2976.

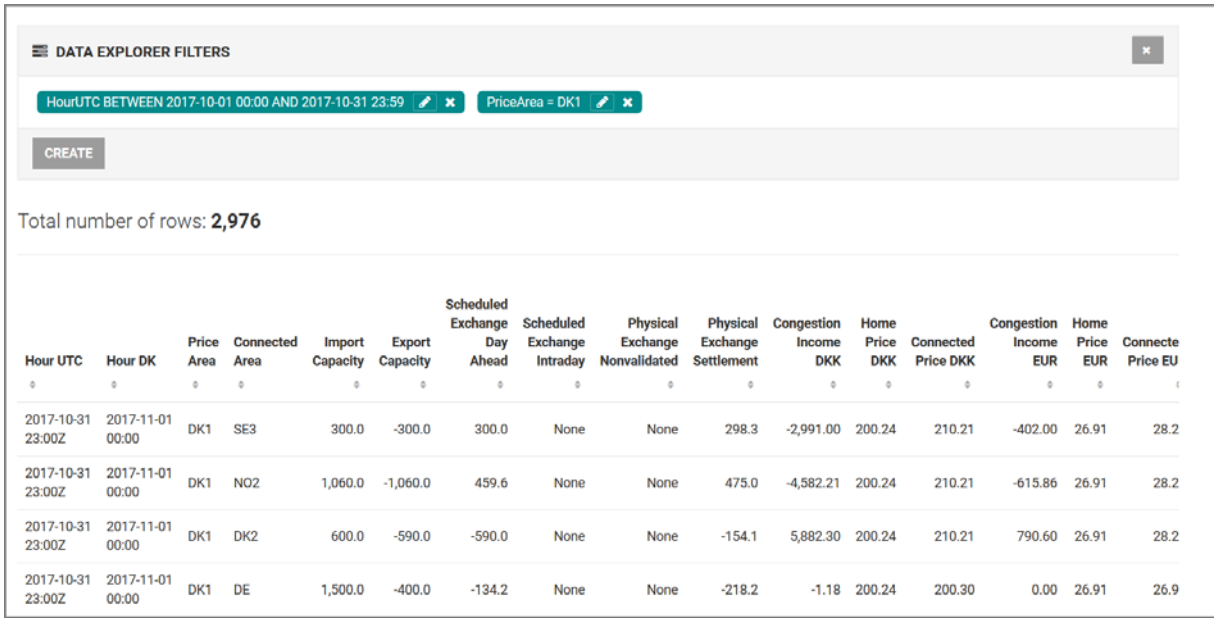

Fig. 4 - Default sorting: newest data first. Sequence can be changed below headlines (⬍).

Press “Download” (fig. 2) and select data format (fig. 5).

Fig. 5

The EDS update on 2 February 2017 has considerably reduced the waiting times in connection with filter definition. Nevertheless, creating a simple time series may require complex filters.

Therefore, the use of API tools may still be interesting.

API Tools for Download of EDS Data

I had to develop a few API tools because EDS was far too slow for manual download in the previous versions. The purpose was to have a fast and simple method for generating regular hourly time series with data about the Danish power systems.

"**Electricity Balance Data**" was my first API-tool.

This is a corner of the download sheet:

StartDate	2017-01-01		HourUTC	HourDK	PriceArea	GrossCon	lectricBoilerCo	LocalPowerProc
EndDate	2018-01-01		2017-01-01 00:00	2017-01-01 01:00	DK2	1.334,88	3,37	165,89
URL	https://api.energidataservice.dk		2017-01-01 00:00	2017-01-01 01:00	DK1	1.946,89	141,60	248,77
PriceArea			2017-01-01 01:00	2017-01-01 02:00	DK1	1.839,38	102,72	248,46
Res Id			2017-01-01 01:00	2017-01-01 02:00	DK2	1.279,51	6,17	167,27
https://api.energidataservice.dk/datastore_search_sql?sql=SELEC			2017-01-01 02:00	2017-01-01 03:00	DK1	1.790,25	120,99	248,75

Fig. 6 – There are separate rows per hour for DK1 and DK2

Due to time-shift problems, I shall use primarily UTC-time henceforward. The corresponding Danish time will appear in a separate column.

The tool generates three additional sheets with regular time series for DK1, DK2 and for DK.

This is a corner of the DK1 sheet:

Source:	Energinet	Area:	DK1		GrossCon includes:					
DateUTC	HourUTC	DateDK	HourDK	GrossCon	ElectricBoilerCon	LocalPowerProd	CentralProd	OffshoreWindPower	OnshoreWindPower	SolarPowerProd
				MWh/h	MWh/h	MWh/h	MWh/h	MWh/h	MWh/h	MWh/h
01-01-2017	1	01-01-2017	2	1947	142	249	449	836	1881	0
01-01-2017	2	01-01-2017	3	1839	103	248	471	884	1610	0
01-01-2017	3	01-01-2017	4	1790	121	249	739	846	1367	0
01-01-2017	4	01-01-2017	5	1718	97	249	657	808	1163	0

Fig. 7 - Time series with one row per hour.

I have added the hint, that gross consumption includes electricity, consumed by electric boilers. It may become desirable to know the traditional consumption. This requires subtraction of new types of consumptions, which are being introduced in order to improve the utilization of fluctuating production from wind and solar power, e.g. electric boiler consumption.

Source:	Energinet	Area:	DK		GrossCon includes:					
DateUTC	HourUTC	DateDK	HourDK	GrossCon	ElectricBoilerCon	ControllableProd	WindPowerProd	SolarPowerProd	NetImport	Balance
				MWh/h	MWh/h	MWh/h	MWh/h	MWh/h	MWh/h	MWh/h
01-01-2017	1	01-01-2017	2	3282	145	1345	3529	0	-1592	0
01-01-2017	2	01-01-2017	3	3119	109	1354	3316	0	-1551	0
01-01-2017	3	01-01-2017	4	3019	128	1619	3051	0	-1650	0
01-01-2017	4	01-01-2017	5	2913	106	1530	2814	0	-1430	0

Fig. 8 - The national balance, hour by hour

The national sheet (fig. 8) distinguishes between controllable production, wind power, solar power and net exchange. These groups may be useful for illustrating how power variations from fluctuating production are absorbed.

"**Elspot Prices**" include hourly spot prices for the Nordpool system price and for 6 price areas: SYSTEM , DK1, DK2, DE, NO2, SE3 and SE4.

Fig. 9 shows the top of the download sheet with one row per hour and price area.

StartDate	2017-10-01		HourUTC	HourDK	PriceArea	SpotPriceEUR
EndDate	2017-11-01		2017-10-01 00:00	2017-10-01 02:00	DE	19,05
URL	https://api.energidataservice.dk		2017-10-01 00:00	2017-10-01 02:00	NO2	22,02
PriceArea			2017-10-01 00:00	2017-10-01 02:00	DK2	19,05
Res Id			2017-10-01 00:00	2017-10-01 02:00	SYSTEM	24,41
https://api.energidataservice.dk/datastore_search_sql?sql=SELEC			2017-10-01 00:00	2017-10-01 02:00	DK1	19,05
			2017-10-01 00:00	2017-10-01 02:00	SE3	25,28
			2017-10-01 00:00	2017-10-01 02:00	SE4	25,28

Fig. 9 - The raw output from "Elspot Prices".

The tool sets up another sheet with one column per price area.

Source:	Energinet		Spot Price							
DateUTC	HourUTC	DateDK	HourDK	SYSTEM	DK1	DK2	DE	NO2	SE3	SE4
				€/MWh	€/MWh	€/MWh	€/MWh	€/MWh	€/MWh	€/MWh
01-10-2017	1	01-10-2017	3	24,41	19,05	19,05	19,05	22,02	25,28	25,28
01-10-2017	2	01-10-2017	4	24,35	22,15	22,15	22,15	22,15	25,09	25,09
01-10-2017	3	01-10-2017	5	24,36	22,90	22,90	22,90	22,90	25,07	25,07
01-10-2017	4	01-10-2017	6	25,12	23,10	23,10	23,10	23,10	26,05	26,05

Fig. 10 – Sheet with time series from "Elspot Prices".

"**Transmission Lines**" has a large amount of data. It includes nine issues for each of the six transmission links and for each hour.

StartDate	2017-10-01	HourUTC	HourDK	PriceArea	ConnectedArea	ImportCapacity	ExportCapacity	ScheduledExchangeDayAhead
EndDate	2017-11-01	2017-10-01 00:00	2017-10-01 02:00	DK1	DE	1.500,00	-440,00	-46,80
URL	https://api.energidataservice.dk	2017-10-01 00:00	2017-10-01 02:00	DK2	DE	600,00	-585,00	32,50
PriceArea		2017-10-01 00:00	2017-10-01 02:00	DK1	SE3	680,00	-300,00	-300,00
Res Id		2017-10-01 00:00	2017-10-01 02:00	DK1	DK2	600,00	-590,00	-441,80
https://api.energidataservice.dk/datastore_search_sql?sql=SELEC		2017-10-01 00:00	2017-10-01 02:00	DK2	DK1	590,00	-600,00	441,80
		2017-10-01 00:00	2017-10-01 02:00	DK2	SE4	200,00	-350,00	-350,00
Refresh		2017-10-01 00:00	2017-10-01 02:00	DK1	NO2	1.287,00	-1.287,00	449,60
		2017-10-01 01:00	2017-10-01 03:00	DK2	DK1	590,00	-600,00	235,90
		2017-10-01 01:00	2017-10-01 03:00	DK1	DE	1.500,00	-540,00	60,00
Selected:		2017-10-01 01:00	2017-10-01 03:00	DK1	DK2	600,00	-590,00	-235,90
PhysicalExchangeSettlement		2017-10-01 01:00	2017-10-01 03:00	DK1	NO2	1.287,00	-1.287,00	498,00

Fig. 11 - The first three of nine issues are visible on this extract.

After the download, a combobox appears (fig. 12).

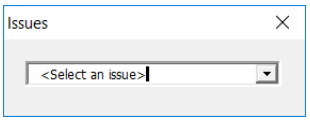

Fig. 12

The drop-down menu includes:

- ImportCapacity
- ExportCapacity
- ScheduledExchangeDayAhead
- ScheduledExchangeIntraday
- PhysicalExchangeNonvalidated
- PhysicalExchangeSettlement
- CongestionIncomeEUR
- HomePriceEUR
- ConnectedPriceEUR

Usually, I need only to look at one issue at a time, and I saw no reason to produce six or nine new sheets. Therefore, the tool generates only one sheet showing data for the selected issue for all six links (fig. 13). This decision could be changed, when needed.

Source:	Energinet	CongestionIncomeEUR						
DateUTC	HourUTC	DateDK	HourDK	DK1-DE	DK1-SE3	DK1-NO2	DK1-DK2	DK2-SE4	DK2-DE
				€	€	€	€	€	€
01-10-2017	1	01-10-2017	3	0	1869	-1335	0	2181	0
01-10-2017	2	01-10-2017	4	0	882	0	0	1029	0
01-10-2017	3	01-10-2017	5	0	651	0	0	760	0
01-10-2017	4	01-10-2017	6	0	885	0	0	1033	0
01-10-2017	5	01-10-2017	7	0	189	-139	0	221	0
01-10-2017	6	01-10-2017	8	0	0	734	0	0	0
01-10-2017	7	01-10-2017	9	0	2808	7233	0	826	0
01-10-2017	8	01-10-2017	10	0	6072	13423	0	1786	0
01-10-2017	9	01-10-2017	11	0	6358	13514	0	1870	0
01-10-2017	10	01-10-2017	12	0	6385	13977	0	1878	0

Fig. 13 - The congestion income indicates full loaded links

It is confusing that congestion incomes on DK1-NO2 can be negative. The explanation can be found by downloading the following issues: ScheduledExchangeDayAhead, HomePriceEUR and ConnectedPriceEUR:

- Scheduled exchange during hour 1: 450 MWh (import from Norway)
- Home price €/MWh: 19.05 (Danish spot price)
- Connected price €/MWh: 22.02 (Norwegian spot price)

Something went wrong in the spot market procedure for that hour. The spot prices indicate that Denmark should sell electricity to Norway. Calculated congestion income: (19.05 – 22.02)*450 = -1336.50 €.

Other tools for conversion of EDS data into time series will be developed, when needed.