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 (<u>http://pfbach.dk/</u>). 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 2016¹
- Time Series for the Year 2016 at http://pfbach.dk/, 20 February 2017²
- ENTSO-E Data: Gaps and Inaccuracies, 4 March 2017³

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 Service⁴ (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 2018⁵.

The reopened MD allows time for the development of API⁶ 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:

Transmission Lines	
Data on capacity, scheduled trade, actual exchange and congestion income.	
Transmission Lines Data	PREVIEW
Tags: 1 hour resolution	
Additional Info	
Eig 1 Klick "Transmission Lines Data"	

Fig. 1 - Klick "Transmission Lines Data".

# / Organization	Organizations / TSO Electricity / Transmission Lines / Transmission Lines Data															
	Transmission Lines Data								T FILTER & EXTRACT							
	Total num	nber of ro	ws: 24	49,480												
	Hour UTC	Hour DK	Price Area	Connected Area	Import Capacity	Export Capacity	Scheduled Exchange Day Ahead	Scheduled Exchange Intraday	Physical Exchange Nonvalidated	Physical Exchange Settlement	Congestion Income DKK	Home Price DKK	Connected Price DKK	Congestion Income EUR	Home Price EUR	Connected Price EUF
	0	0	٥	0	٥	٥	0	\$	0	0	0	٥	0	0	٥	0
	2018-01-24 22:00Z	2018-01-24 23:00	DK2	SE4	None	None	None	None	None	None	None	None	None	None	None	None
	2018-01-24 22:00Z	2018-01-24 23:00	DK2	DK1	None	None	None	None	None	None	None	None	None	None	None	None
	2018-01-24 22:00Z	2018-01-24 23:00	DK2	DE	None	None	None	None	None	None	None	None	None	None	None	None
	2018-01-24 22:00Z	2018-01-24 23:00	DK1	SE3	None	None	None	None	None	None	None	None	None	None	None	None
	2018-01-24 22:00Z	2018-01-24 23:00	DK1	N02	None	None	None	None	None	None	None	None	None	None	None	None

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

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

HourUTC HourDK PriceArea ConnectedArea ImportCapacky ScheduledExchangeDayAhead ScheduledExchangeDayAhead ScheduledExchangeSettlement CongestionIncomeDKX HomePiceDKK ConnectedPriceDKK ConnectedPriceDKK ConnectedPriceDKK	heduled Phys	Physical Exchange E	Physical	Congestion	Home		Connection	Home	
HourDK PriceArea ConnectedArea ImportCapacity ScheduledExchangeDayAhead ScheduledExchangeDayAhead ScheduledExchangeSettlement CongestonIncomeDKK HomePreeDKK © © © © © © © © © © © © © © © © © ©	heduled Phys	Physical Exchange E	Physical	Congestion	Home		Connection	Home	
PriceArea ConnectedArea ImportCapacty ExportCapacty ScheduledExchangeDayAhead ScheduledExchangeIntraday PhysicalExchangeSettlement CongestenIncomeDKX HomeProcDKK © © © © © © © © © © © © © © © © © ©	heduled Phys	Physical Exchange E	Physical	Congestion	Home		Concession	Home	
ConnectedArea ImportCapacity ExportCapacity ScheduledExchangeDayAhead ScheduledExchangeDayAhead PhysicalExchangeSuttement CongestionIncomeDKK HomePriceDKK Capacity C	heduled Phy: change Exche	Physical Exchange E	Physical	Congestion	Home		Connection	Home	
ImportCapacity 80 ExportCapacity ScheduledExchangeDaryAhead ScheduledExchangeIntraday PhysicalExchangeStement CongestionIncomeDIXK e ected Import Export Day Exch Ahead Intra CongestionIncomeDIXK e e e e e e e e e e e e e e e e e e e	heduled Physicchange Excha	Physical Exchange E	Physical	Congestion	Home		Connection	Home	
ExportCapacty ScheduledExchangeDayAhead SdheduledExchangeTarday PhysicalExchangeSettlement CongestionIncomeDKX HomeProcDKX © © © © © © © © © © © © ©	heduled Phy cohange Excha	Physical Exchange E	Physical	Congestion	Home		Concession	Home	
ScheduledExchangeDayAhead ScheduledExchangeNorvaldated PhysicalExchangeSettlement CongestionIncomeDKK HomePriceDKK © © © © © © © © © © © © © © © © © ©	heduled Phy: cchange Excha	Physical Exchange E	Physical	Congestion	Home		Concestion	Home	
ScheduledExchangeIntraday PhysicalExchangeVorwaldated PhysicalExchangeSettlement CongestionIncomeDKK HomePriceDKK ConnectPCKK	heduled Physichange Excha	Physical Exchange E	Physical	Congestion	Home		Concession	Home	
PhysicalExchangeNorwaldated Scheduled PhysicalExchangeSettlement Exchange Sche CongestionIncomeDKK Import Export Day Exch HomeProcDKK ©	heduled Physichange Excha	Physical Exchange E	Physical	Congestion	Home		Concession	Home	
PhysicalExchangeSettlement Exchange Sche CongestionIncomeDKK lmport Export Day Exch HomePriceDKK capacity Capacity Ahead Intr ConnectedPriceDKK =	heduled Physichange Excha	Physical Exchange E	Physical	Congestion	Home		Concestion	Home	
ConjectionIncomeDIXK lected Import Export Day Exct Capacity Capacity Ahead Int ConnectedPreeDIXK = • • •	change Excha	Exchange E	Evchange				oongestion	nome	
HomeProceDKK 0 0 0 0	BLODIES IN		ettlement	Income	Price	Connected	Income	Price	Connect
ConnectedPriceDKK	ntraday Nonvalid	onvalidated Se	ettiement	DKK	DKK	Price DKK	EUR	EUR	Price Et
C	a.	÷	÷		9	e.,	÷.	•	
CongestionIncomeEUK	30. I				222				
HomePriceEUR None None None	None N	None	None	None	None	None	None	None	NO
ConnectedPriceEUR									

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.

E DATA	EXPLORER F	FILTER:	S 11 00:00 AND :	2017-10-31	23:59 🖋	x Price	Area = DK1	∕ ×							×
Total num	nber of ro	WS: 2,	,976 Connected	Import	Export	Scheduled Exchange Day	Scheduled Exchange	Physical Exchange	Physical Exchange	Congestion Income	Home Price	Connected	Congestion Income	Home Price	Connecte
Hour UTC	Hour DK	Area	Area	Capacity	Capacity	Ahead	Intraday	Nonvalidated	Settlement	DKK	DKK	Price DKK	EUR	EUR	Price EU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	٥	(
2017-10-31 23:00Z	2017-11-01 00:00	DK1	SE3	300.0	-300.0	300.0	None	None	298.3	-2,991.00	200.24	210.21	-402.00	26.91	28.2
2017-10-31 23:00Z	2017-11-01 00:00	DK1	N02	1,060.0	-1,060.0	459.6	None	None	475.0	-4,582.21	200.24	210.21	-615.86	26.91	28.2
2017-10-31 23:00Z	2017-11-01 00:00	DK1	DK2	600.0	-590.0	-590.0	None	None	-154.1	5,882.30	200.24	210.21	790.60	26.91	28.2
2017-10-31 23:00Z	2017-11-01 00:00	DK1	DE	1,500.0	-400.0	-134.2	None	None	-218.2	-1.18	200.24	200.30	0.00	26.91	26.9

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

Press "Download" (fig. 2) and select data format (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.

🛓 DOWNLOAD 👻
JSON
CSV
XLSX
XML
Downloads are limited to the most
recent 100000
rows

Fig. 5

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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.

StartDate	2017-01-01	HourUTC	HourDK	PriceArea	GrossCon	lectricBoilerCo	LocalPowerProd
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.ener	gidataservice.dk/datastore_search_sql?sql=S	ELEC 2017-01-01 02:00	2017-01-01 03:00	DK1	1.790,25	120,99	248,75

This is a corner of the download sheet:

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.

11115 15 0	COLLIC			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

This is a corner of the DK1 sheet:

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.energio	dataservice.dk/datastore_search_sql?sql=SELE	<u>c</u> 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

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FIG.	10 -	Sheel	VVILII	unne	SELLES	nom	LISPUL	FILES .

"**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.energ	gidataservice.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.energ	idataservice.dk/datast	ore search sql?sql=SEL	EC 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
			2017-10-01 00:00	2017-10-01 02:00	DK1	NO2	1.287,00	-1.287,00	449,60
	Refresh		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
PhysicalExchange	Settlement		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).

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: $(19.05 - 22.02)*450 = -1336.50 \in$.

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