

ENERGIAANDMETE KASUTAMINE

Alo Allik

EEES Erialapäev 29.11.2018



Tartu 2018

Mõisted

Small data –

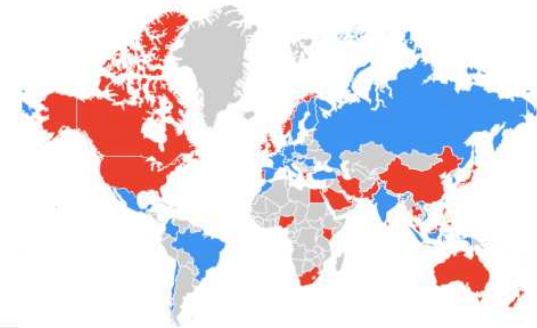
Andmed, mille maht on piisavalt ülevaatlik, et neid saab hallata näiteks Exceli abil.

Big data (suurandmed) –

an accumulation of data that is too large and complex for processing by traditional database management tools.

Andmed, mille maht on liialt suur ja ülesehitus niivõrd keerukas, nii, et nende haldamiseks ei piisa tavalisest kontoritarkvarast.

Suurandmed, Google Trends



big data
Otsingutermin

Renewable
Otsingutermin

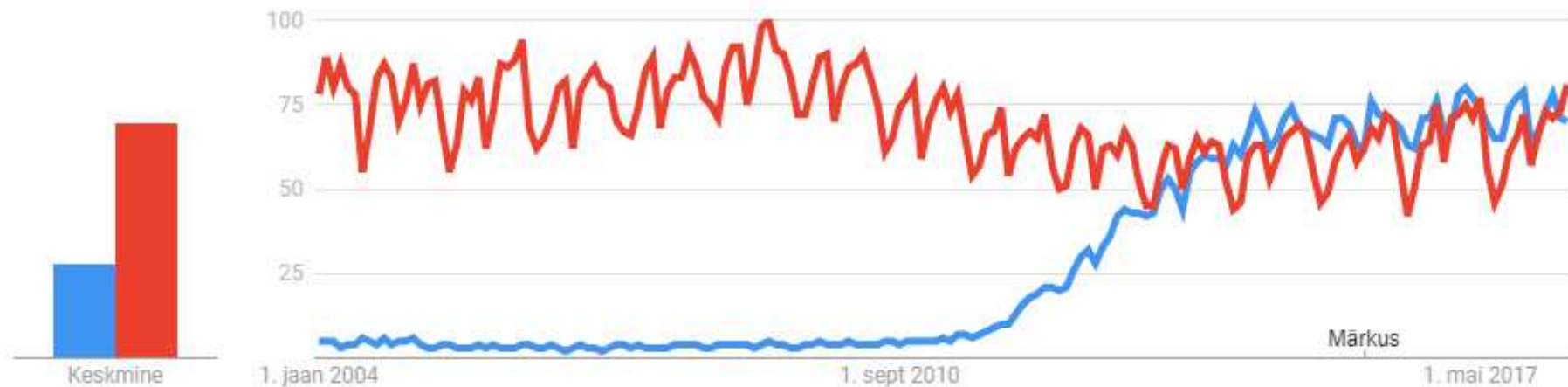
Kogu maailm ▼

2004 - praeguseni ▼

Kõik kategooriad ▼

Veebiotsing ▼

Huvi ajaperioodi jooksul ?

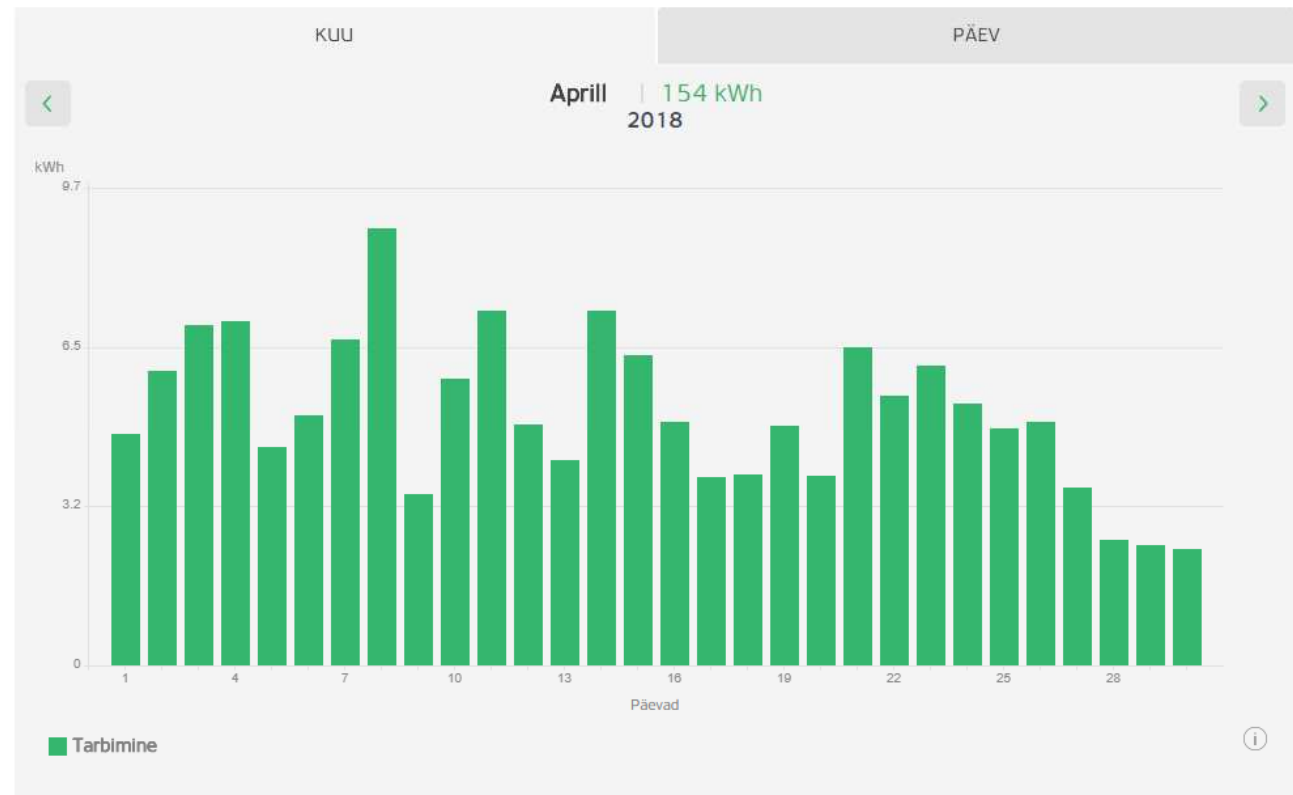


<https://trends.google.com>

Kaugloetavad elektritarbimise andmed

- AVALEHT
- ELEKTER
- MAAGAAS
- PÕLEVKIVIÕLI
- VEEL
- TARK TARBIMINE
- TAASTUVENERGIA
- TEHNOLOOGIA
- KESKKOND
- ÜHISKONDLIK TEGEVUS
- KARJÄÄRIKESKUS
- ETTEVÕTTEST
- UUDISED
- E-TEENINDUS**

- E-TEENINDUS
- ARVED
- LEPINGUD
- TARBIMISAJALUGU**
- NÄIDUD
- TEAVITUSED
- SEADED



Tarbimismaht kuus

Kokku:
154kWh

Minu elektrihind

Muutuv: börsihind + 0.29 senti/kWh

Tarbimisajalugu

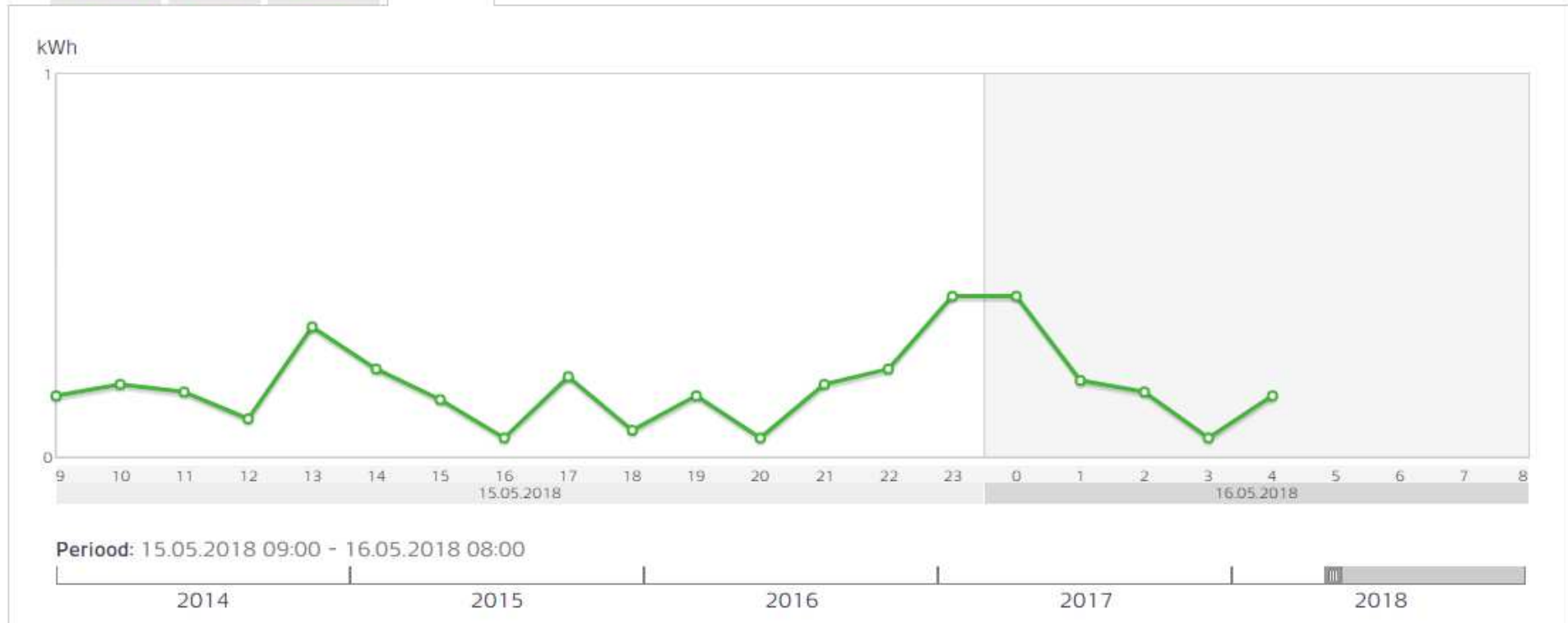
AASTAD

KUUD

PÄEVAD

TUNNID

Sündmuse lisamine Vaatan sündmuste nimekirja

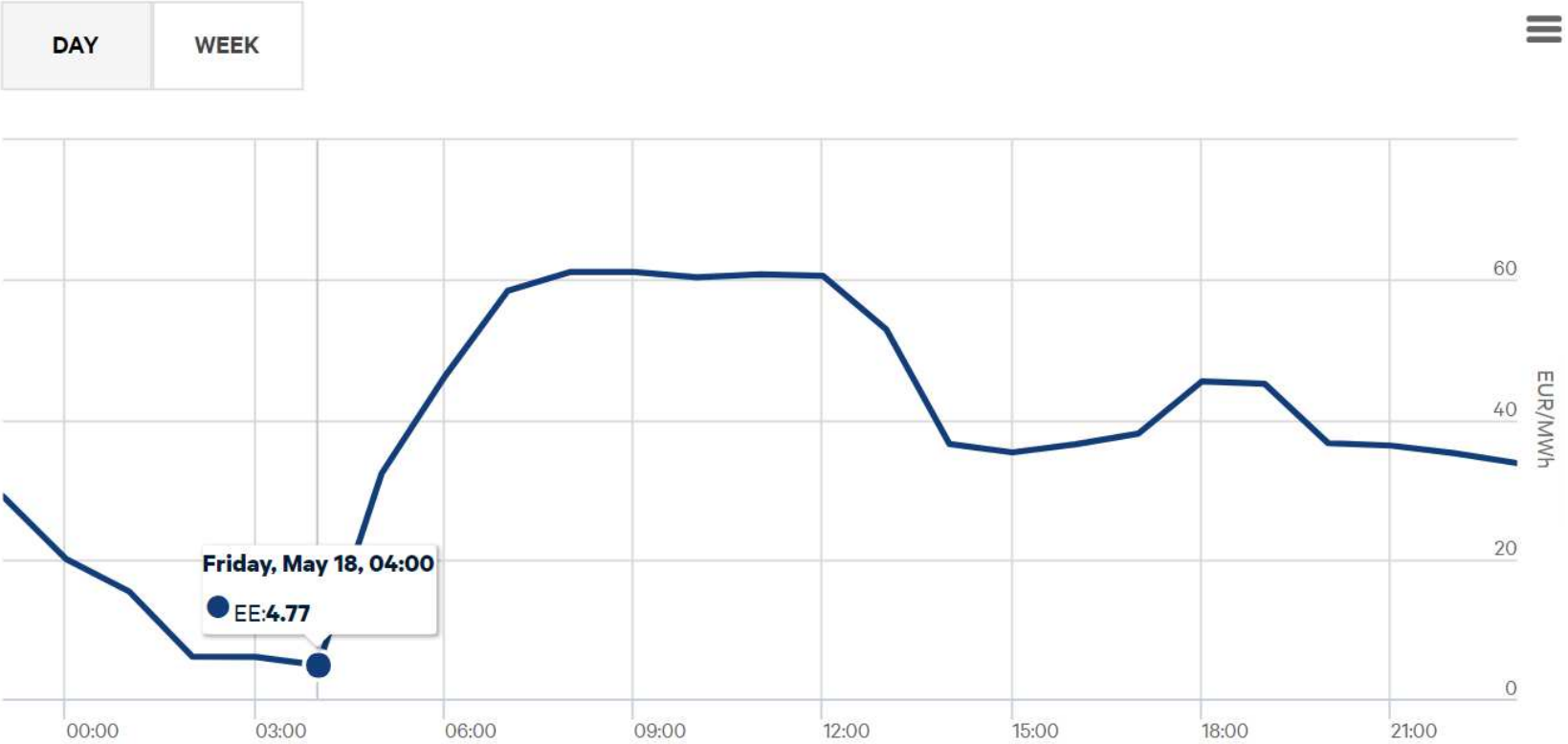


<https://www.energia.ee/e-teenindus/avaleht>

Elektri hind

NORD POOL MARKET DATA TRADING SERVICES THE POWER MARKET

Day-ahead prices i



<https://www.nordpoolgroup.com/Market-data1/Dayahead/Area-Prices/ALL1/Hourly/?view=chart>

Keskmistamise
period

Andmete resolutsioon ja maht

Aastane
andmepunktide arv

-	<ul style="list-style-type: none">Elektrivõrguga liitumise tasu, 20. saj esimene pool	0
1 kuu	<ul style="list-style-type: none">Näidu teatamine kord kuus. Enne elektri vabaturuga liitumist, kuni 2013 a.	12
1 h	<ul style="list-style-type: none">Nordpool Spot elektrihinna resolutsioon aastal 2018	8760
15 min	<ul style="list-style-type: none">Finer time resolution in Nordic power markets : A Cost Benefit Analysis (Copenhagen Economics, 2017)	35040
1min	<ul style="list-style-type: none">Allik, A.; Uiga, J.; Annuk, A. (2014). Deviations between wind speed data measured..., Agronomy Research	525600
1s	<ul style="list-style-type: none">Allik, A., Märss, M., Uiga, J., Annuk, A. (2016). Optimization of the inverter size..., Renewable Energy	$3.15 \cdot 10^7$
250 ms	<ul style="list-style-type: none">Allik, A., Annuk, A. (2017). Interpolation of Intra-hourly Electricity Consumption and Production Data, ICRERA2017, San Diego, USA.	$1.26 \cdot 10^8$
≤ 100 ms	<ul style="list-style-type: none">? (näiteks 20 ms)	$\geq 3.15 \cdot 10^8$



Keskmistatud andmed vs tegelik olukord

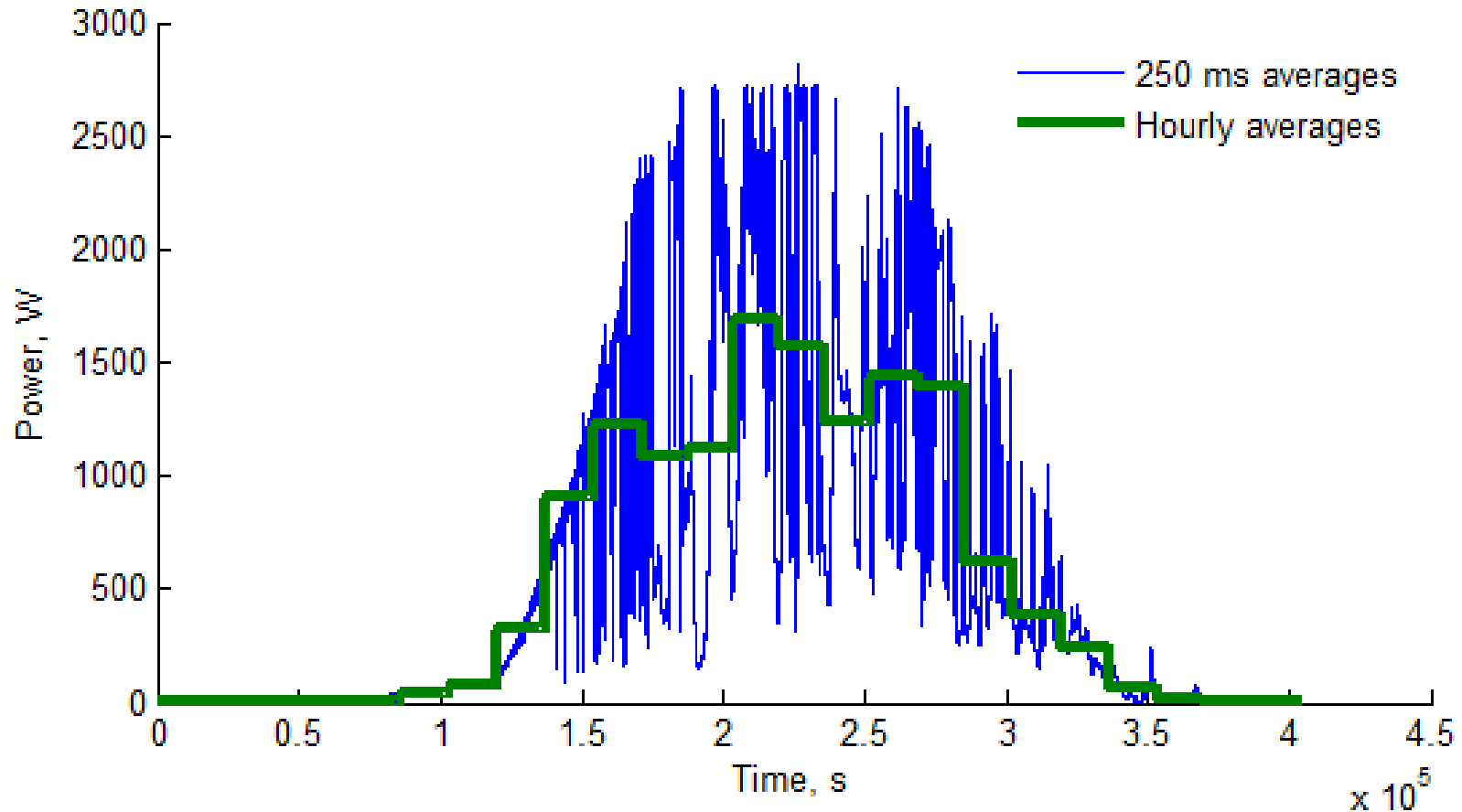


Fig. 1. Example PV data with 250 ms and hourly integration periods on a day with alternating clouds.

Matlab

MATLAB R2017b - academic use

HOME PLOTS APPS VARIABLE VIEW

Open Rows Columns Transpose
New from Selection Print 1 1 Insert Delete Sort

C:\Users\al.LT621\Downloads

Variables - ConsumptionSec
CapacitorExcess ConsumptionSec
86400x9 double

	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	554.7500						
2	0	0	1	0	0	607.7500						
3	0	0	2	0	0	607.2500						
4	0	0	3	0	0	607.5000						
5	0	0	4	0	0	607.7500						
6	0	0	5	0	0	607.2500						
7	0	0	6	0	0	608						
8	0	0	7	0	0	603						

Workspace

Name	Value
BatteryCapacity	10
BatteryExcess	345600x1 double
BatteryPower	1.4000
BatterySOC	345600x1 double
CapacitorCapacity	0.0528
CapacitorExcess	345600x1 double
CapacitorSOC	345600x1 double
Consumptiondatetime	345600x1 double
consumptiondatevec	345600x7 double
ConsumptionMs	345600x1 double
ConsumptionMs2	345600x2 double
ConsumptionSec	86400x9 double
dateJune	405300x1 double
datevec	405300x7 double
Fig1	10x3 double
GridExchange	345600x1 double
GridExchangeEnergy	345600x1 double
i	345600
j	1
June1ConsumptionSec	86400x1 double
June1Date	413256x1 double
June1DateSecondsDateNum	405300x1 double
June1WT	406172x1 double
Marker3second	405300x1 double
PV	405300x1 double
RateOfChange	405300x1 double
SecondsToMilliseconds	405300x1 double
t	345600x1 double
tout	350596x1 double
WT	405300x1 double
WTorig	405300x1 double
WTproduction	345600x1 double
WTproduction2	345600x2 double

Command Window

New to MATLAB? See resources for [Getting Started](#).

New MATLAB Graphics System
MATLAB R2014b introduces a new MATLAB graphics system, with new default colors, fonts, and styles, and many new features. Some existing code may need to be revised to work in this version of MATLAB.
[Learn more](#)

```

end

% Järgneva ploki abil leiame akusse mitte mahtuva energia iga ajaühiku kaupa.
BatteryExcess= zeros(1,size(GridExchange,2)); % Looime tühja maatriksi, millesse sisestame järgnevate töökäikude
for i=2:size(GridExchange,1); % i on indeks ehk ridade arv. Ridu on sama palju kui võrguga energiavahetuse n
    j=1:size(GridExchange,2); % määrame ära mitu tulpade on maatriksis, j on tulpade indeks.
    BatteryExcess(i,j)=BatterySOC(i-1,j)-GridExchangeEnergy(i,j); %Leiame energia andmise ja võtmise akust.
    if any((BatterySOC(i-1,j)-GridExchange(i,j))>BatteryCapacity); % leiame ajahetked kus energia ei mahu enam akusse
        BatteryExcess(i,j)--GridExchange(i,j);% -((BoilerSOC(i-1,j)+Peaks(i,j)-BoilerEnergyConsumption(i,j))+BoilerCa
    else %kommentaari
        BatteryExcess(i,j)=0; %ülejääänud juhtudel (kui akusse mahub energiat) ei lähe energia võrku.
    end
end
end

```

Ramp Rate

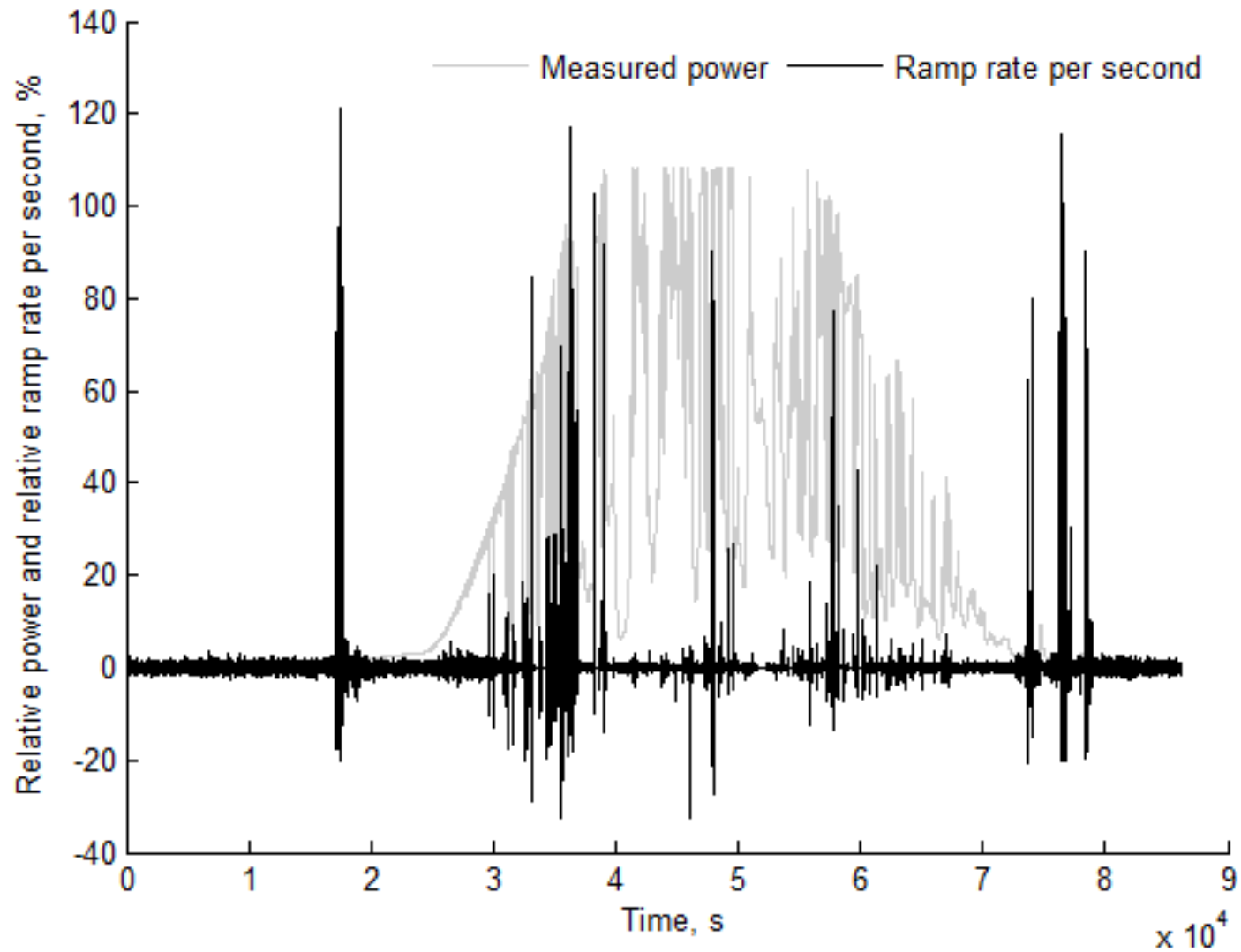


Fig. 3. Output power in relation to nominal power and ramp rate in relation to previous time step during a sample day.

Self Consumption of PV electricity

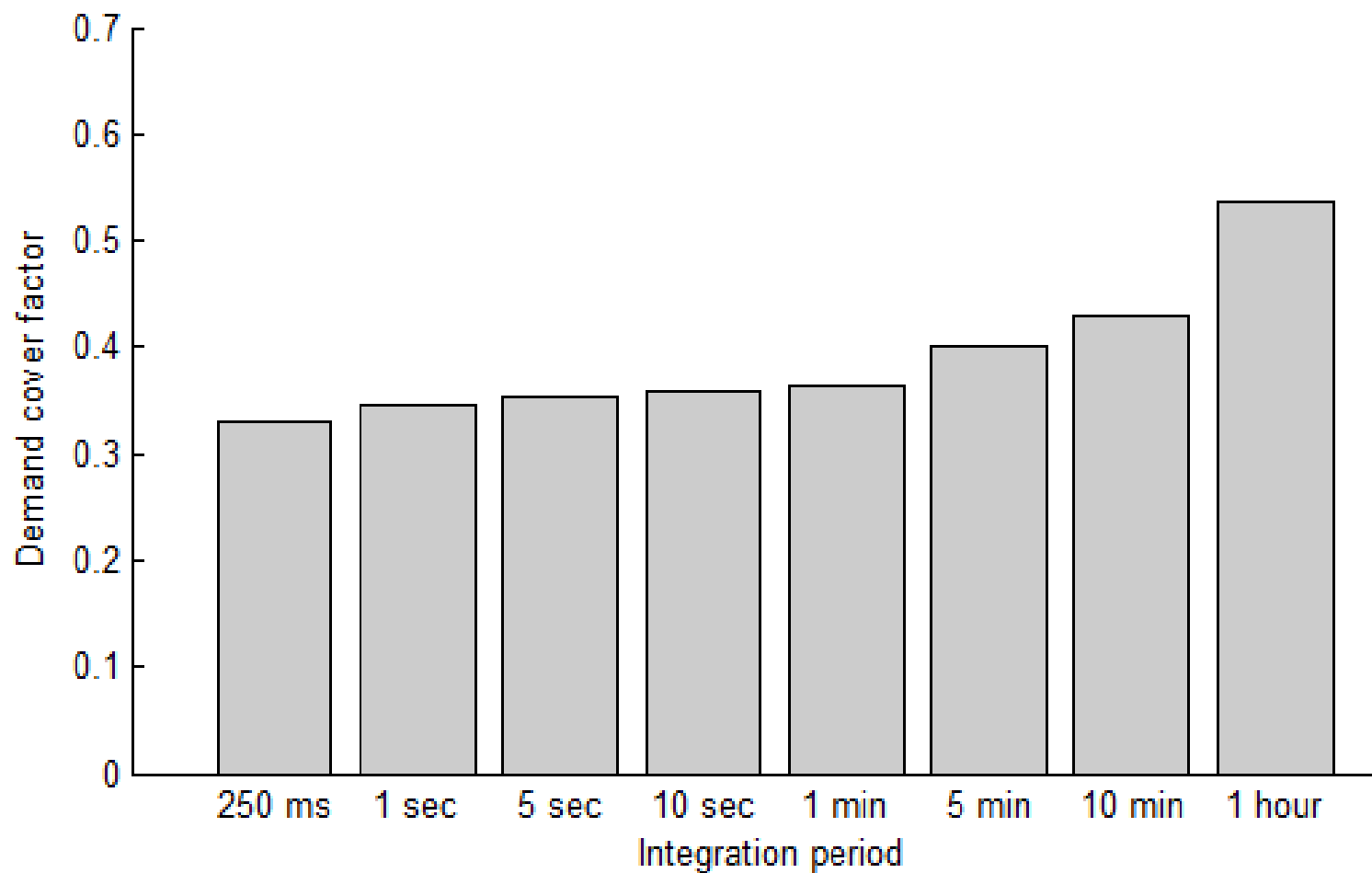


Fig. 5. Apparent demand cover factors on different time resolutions.

Allik, A., Annuk, A. (2017). Interpolation of Intra-hourly Electricity Consumption and Production Data. *6th International Conference on Renewable Energy Research and Applications*, San Diego, United States of America.

Päikesepaneelide hinnad

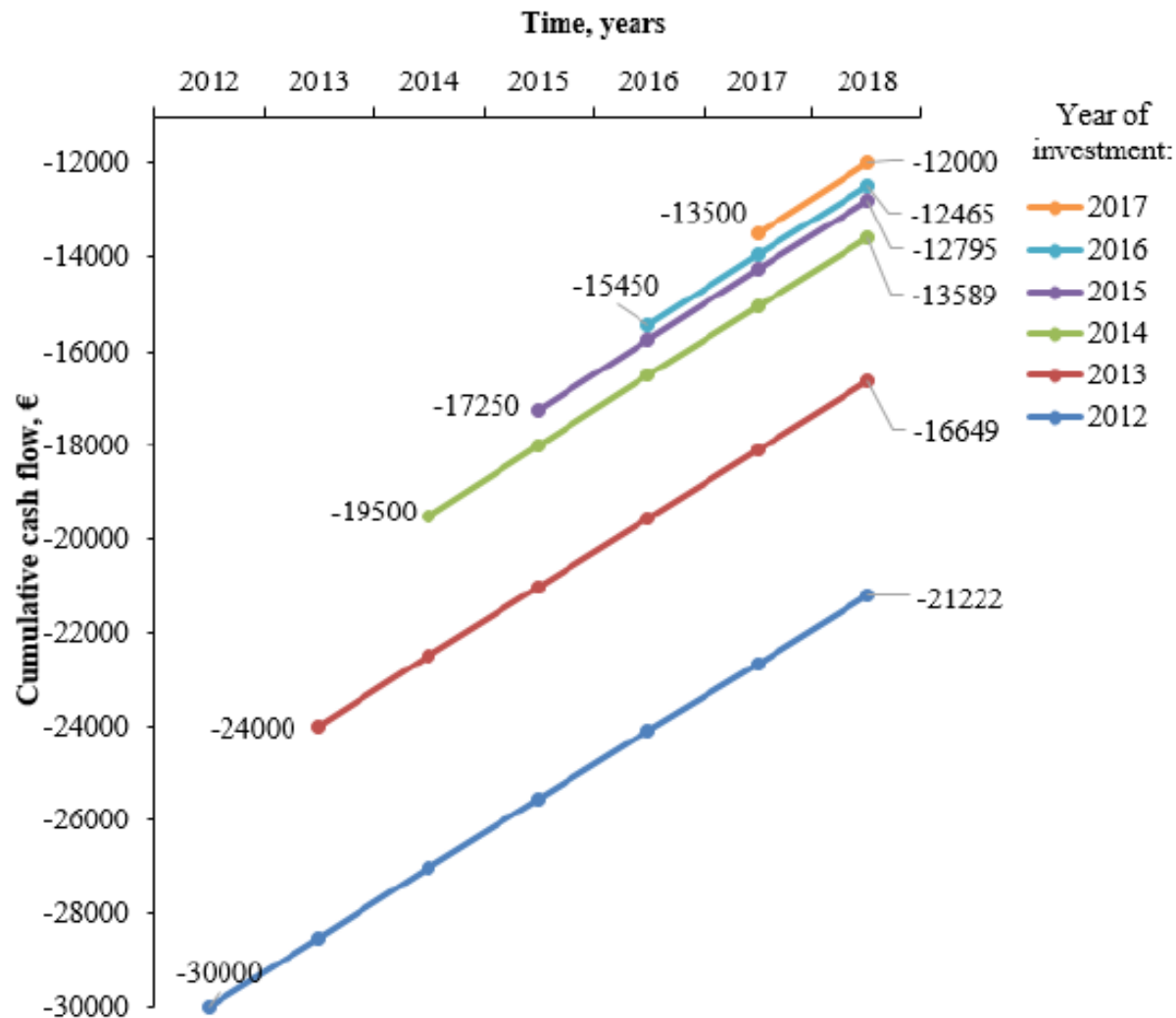


Fig. 6. Cumulative cash flows of 15 kW PV plants built in different years from 2012 to 2017. (Allik, et al.)

HOUSEHOLD ELECTRICAL LOAD PATTERN

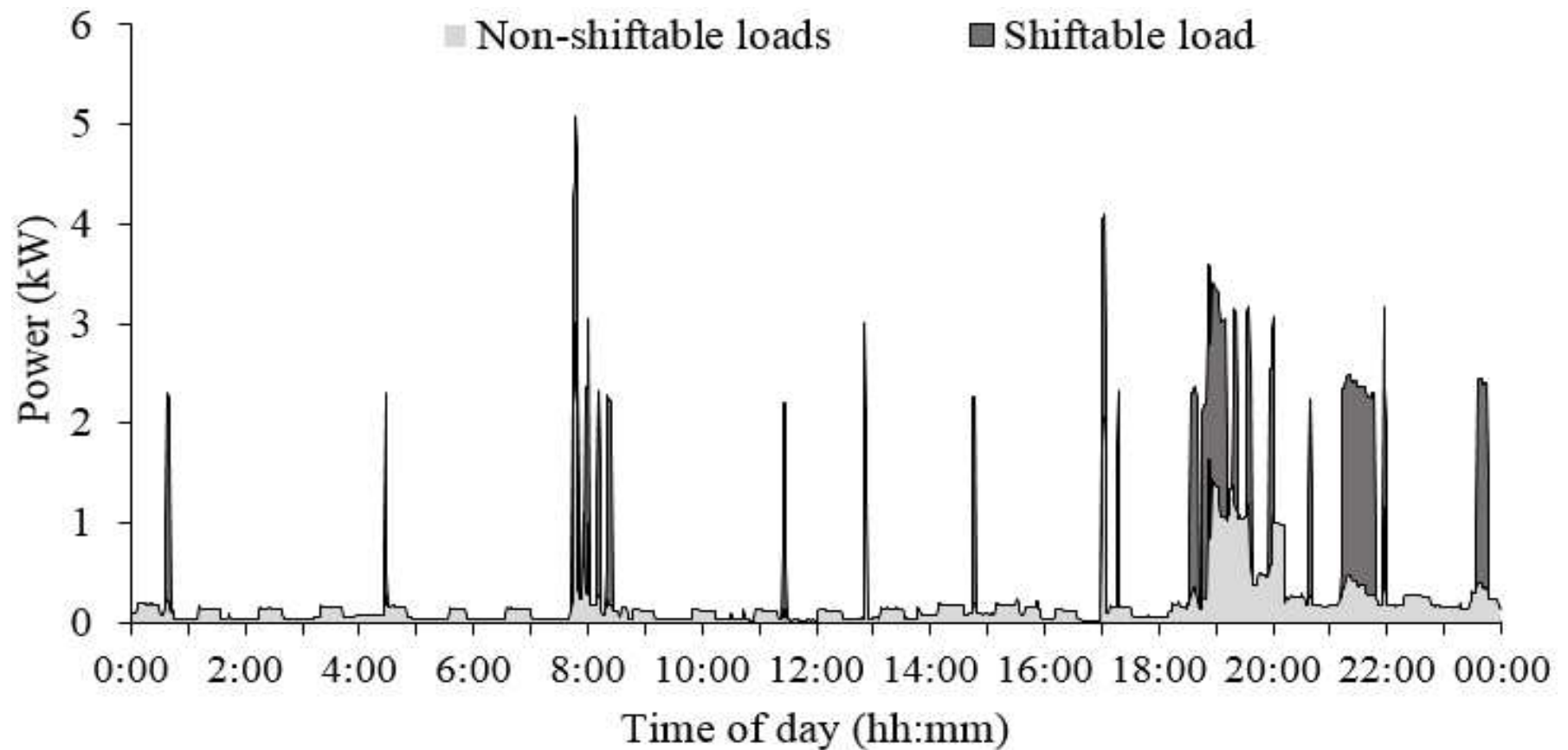


Figure 7. Consumption pattern of the example household during a typical workday (1-minute integration period).

Erinevad komponendid elektritarbimises

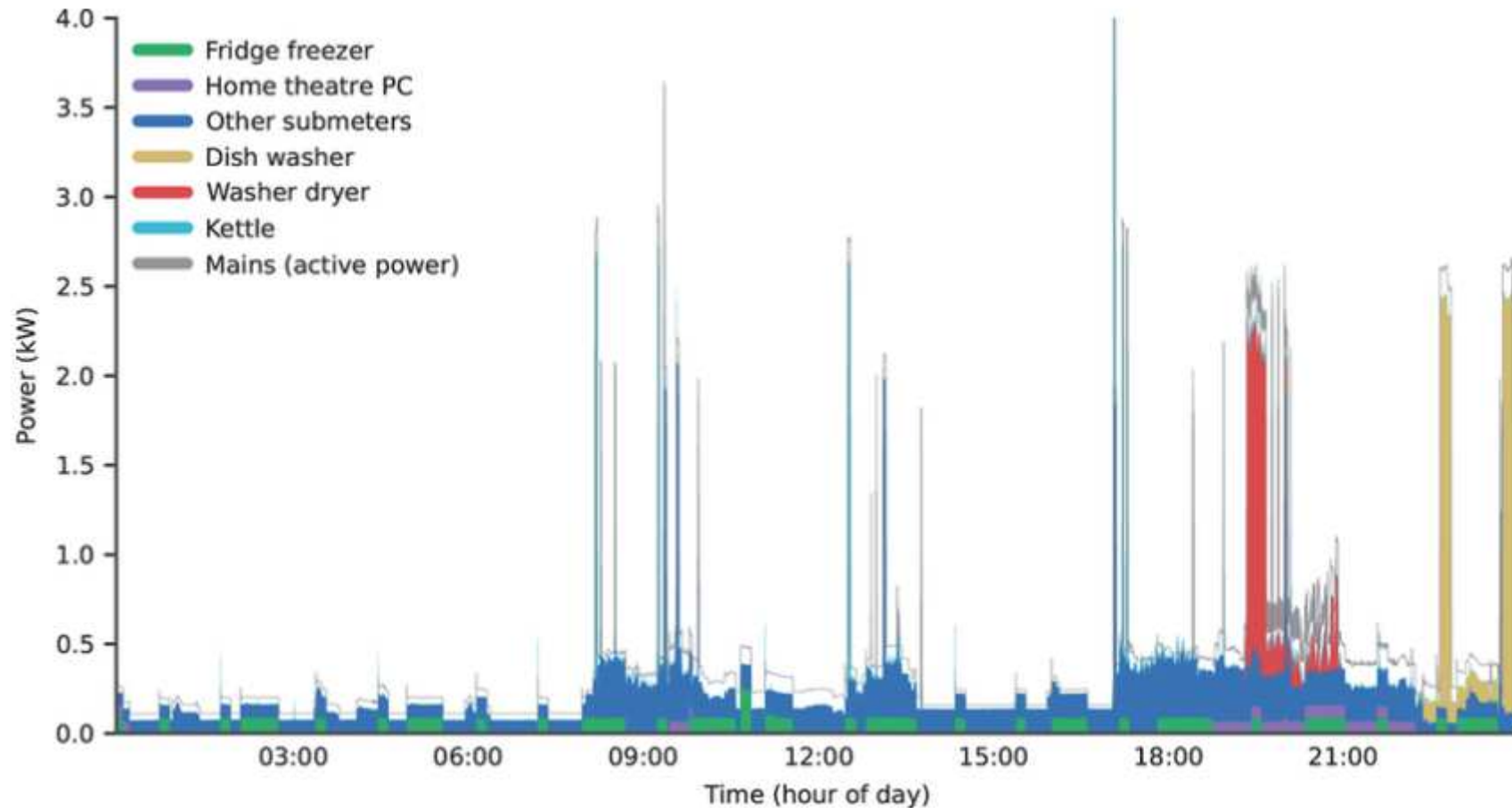


Fig. 8. Domestic electricity consumption. Jack Kelly, William Knottenbelt, 2015, The UK-DALE dataset, domestic appliance-level electricity demand and whole-house demand from five UK homes

Elektri tarbimine vs muud andmed

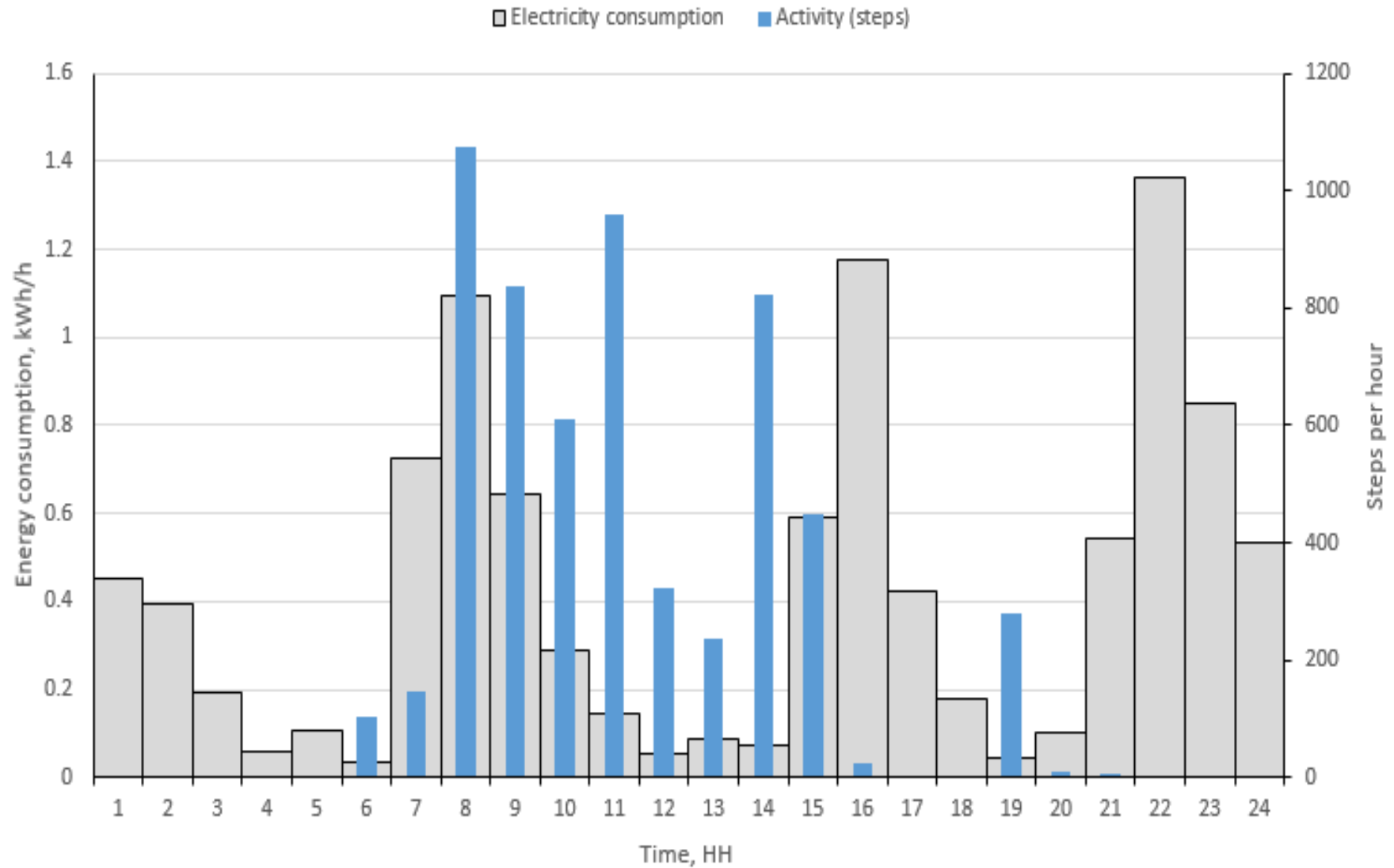


Fig.9. Inimese liikumine ja elektritarbimine

LOAD AUTOCORRELATION

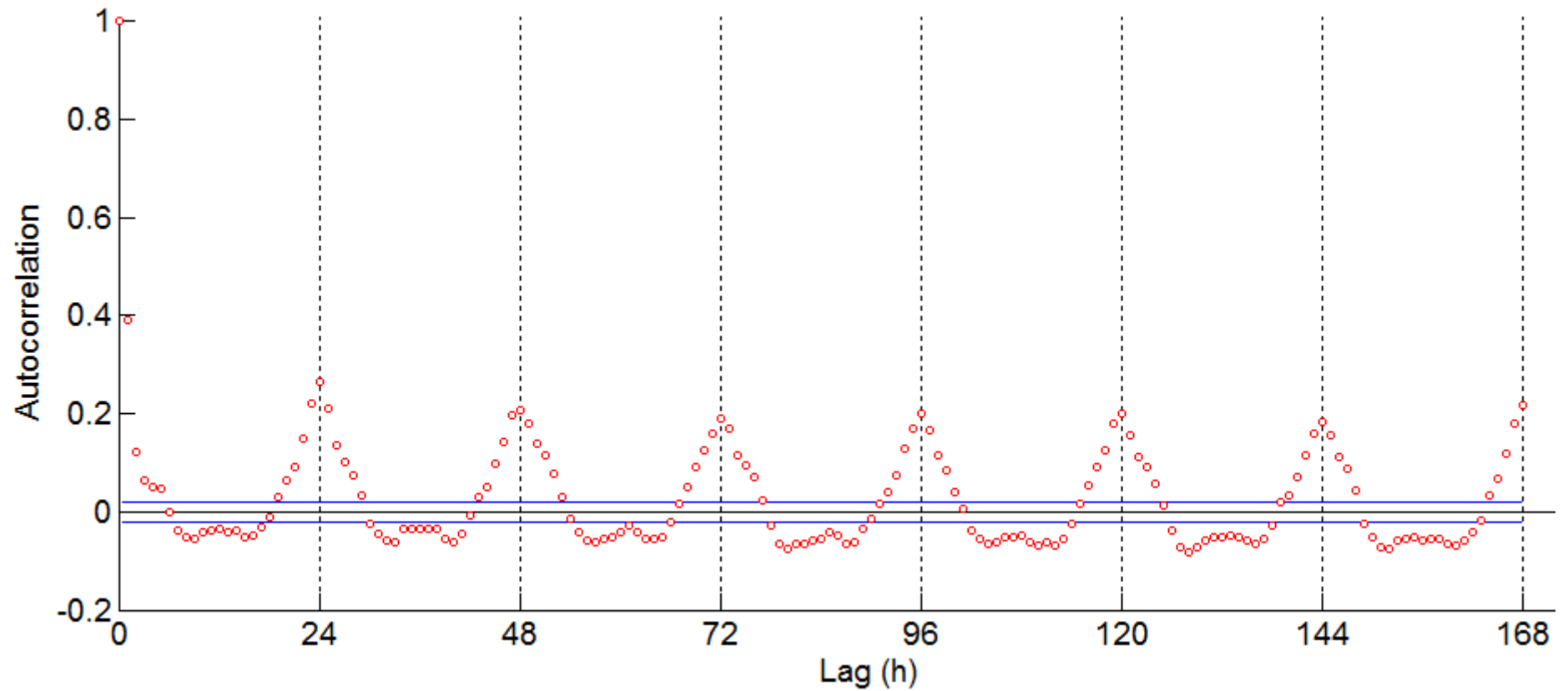


Figure 10. Autocorrelation of hourly electricity consumption of the water heater with 95% confidence intervals.

INDUSTRIAL ELECTRICAL LOAD PATTERN

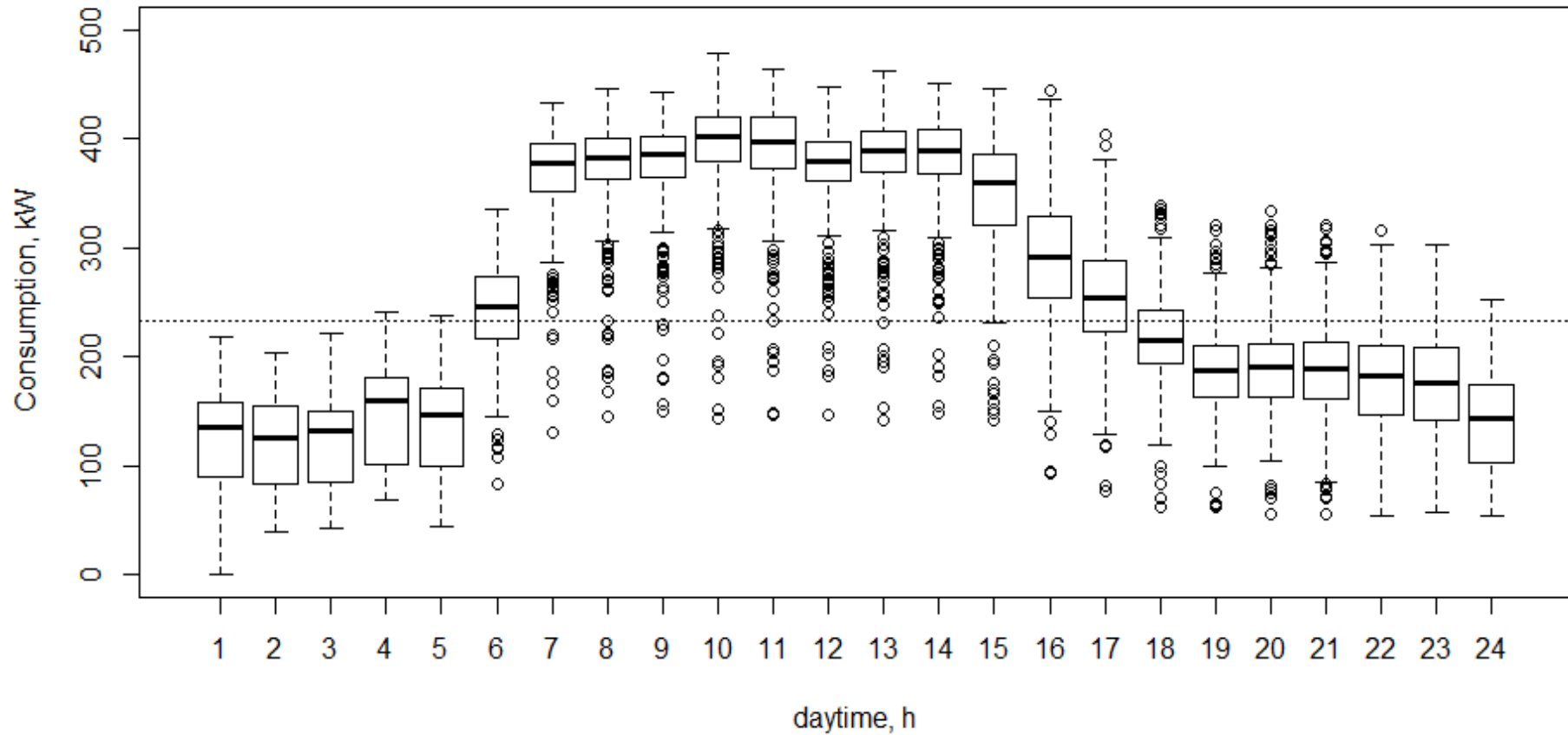


Figure 11. Boxplot of the hourly electricity consumption in the examined industrial enterprise during workdays in the year 2012, the dotted line represents the peak load threshold (III).

INDUSTRIAL PEAK POWER MITIGATION

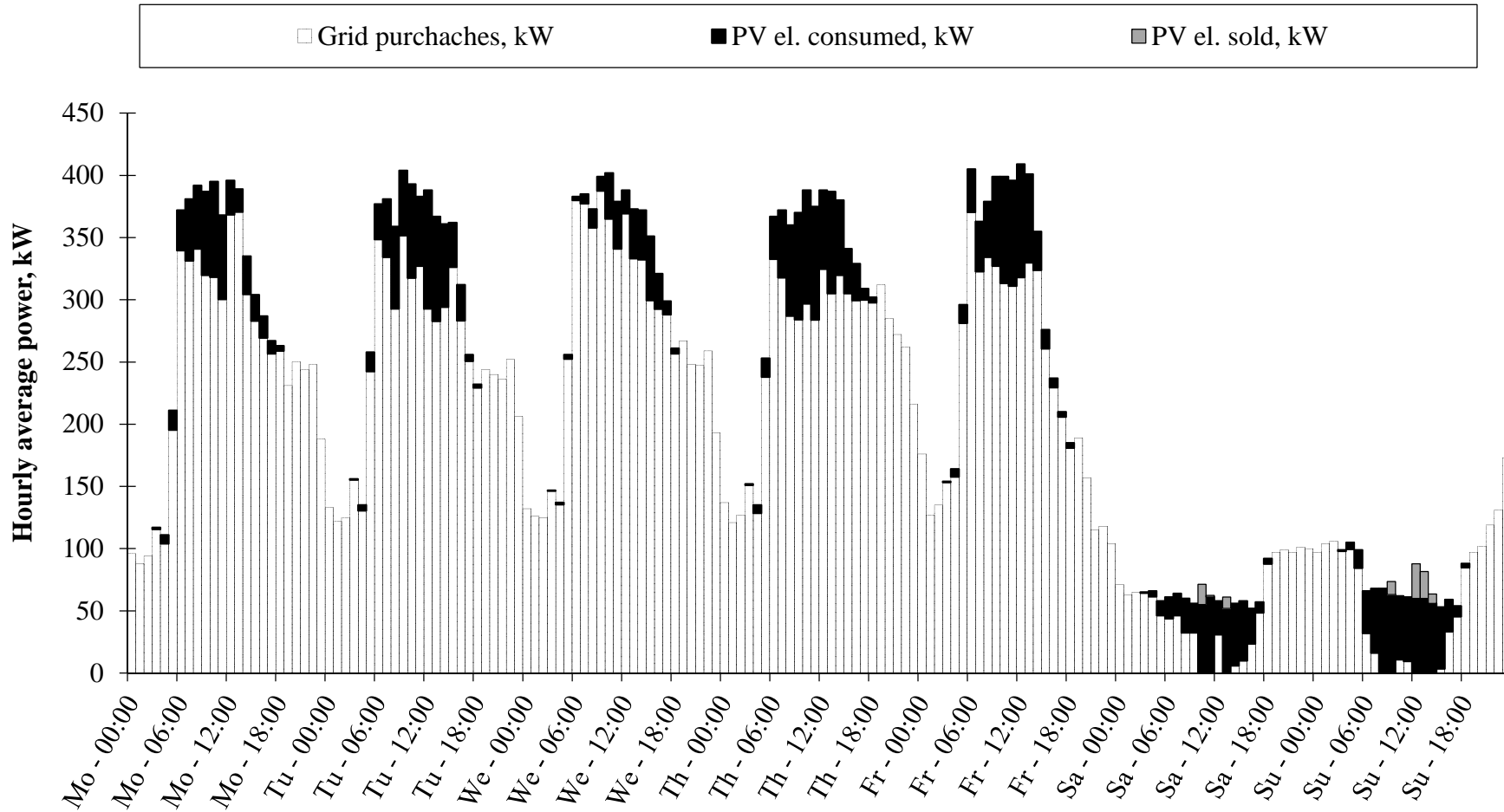


Figure 12. Electricity consumption from the grid and PV-electricity generation during a summer week (30.07.2012 – 05.08.2012).

Kokkuvõte

- a) Energeetikas kogutavate andmete maht kasvab eksponentsiaalselt.
- b) Resolutsioon on väga oluline.
- c) Ka energeetikas kehtib majandusest tuntud Pareto printsiip.
- d) Salvestite kasutamine võrku ühendatud majapidamistes muutub tulevikus tasuvamaks.

Täna!

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