Analysis of the state of the art and performance of more than one decade of residential PV in Brussels (11.000+ PV installations)

Session 1: PV in grids

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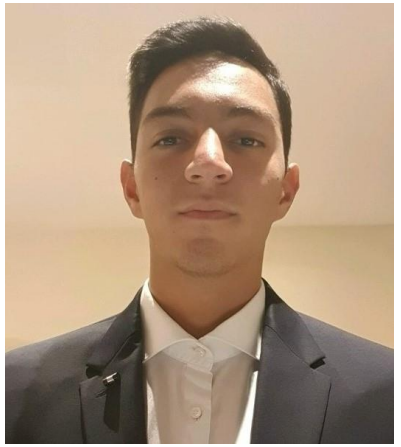


EDUCATION

- Bachelor’s degree in Electro-mechanical engineering
- Master’s degree in Electro-mechanical engineering with specialization in Renewable energy

WORK EXPERIENCE

- Solar energy engineer at LuciSun for 6 months

Objectives and structure

Study carried out by the Consortium *LuciSun - Becquerel Institute - SUN7*

On behalf of Brugel (The Brussels regulatory authority in the areas of electricity, gas and water price control)

Objectives:

- State of the art of PV in the Brussels region
- Update the regulations based on the results
- Improve practices and performances of the Brussels PV park

Structure:

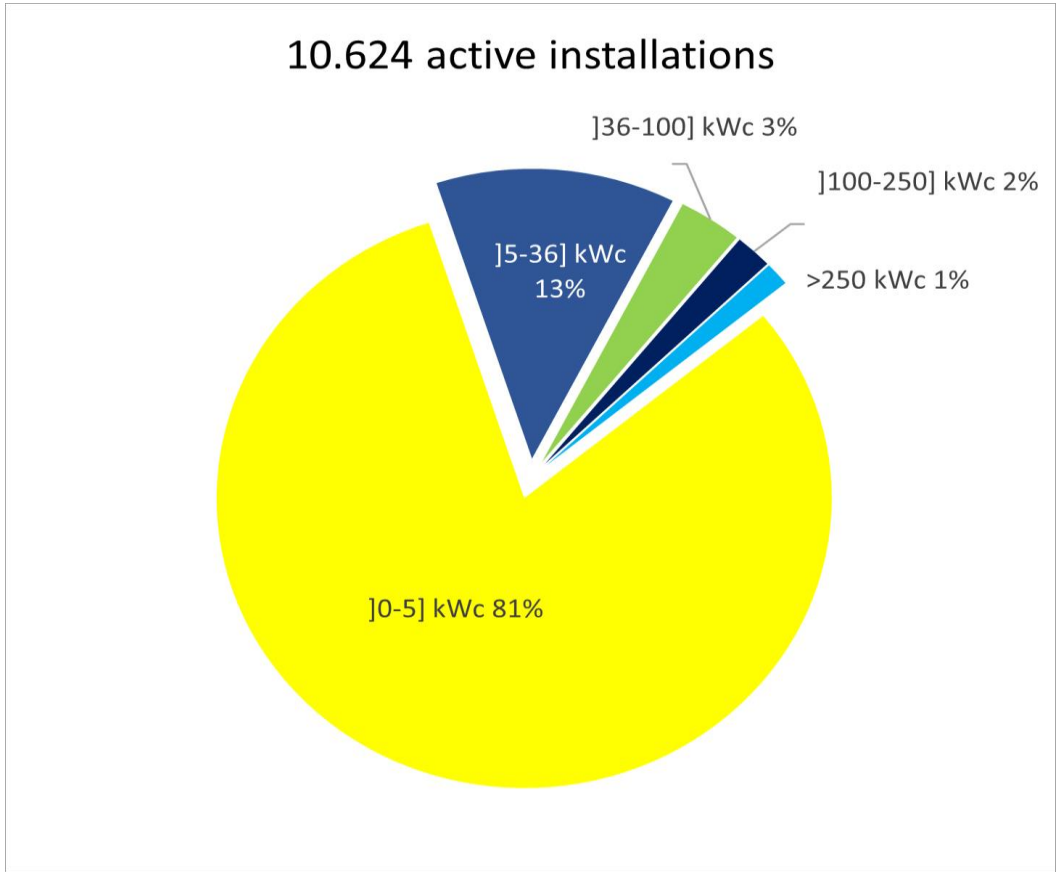
- State of the current park
- Material installed
- Installation price
- Performance assessment

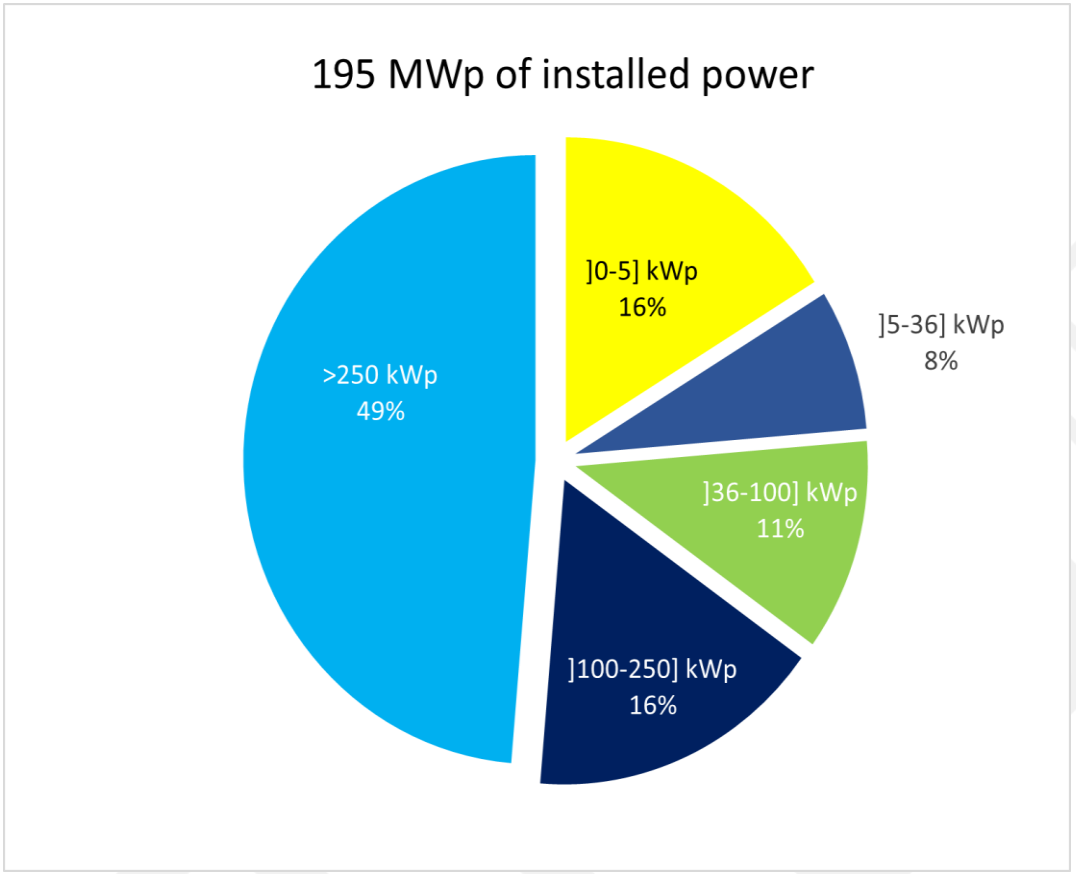
Input data

Databases:

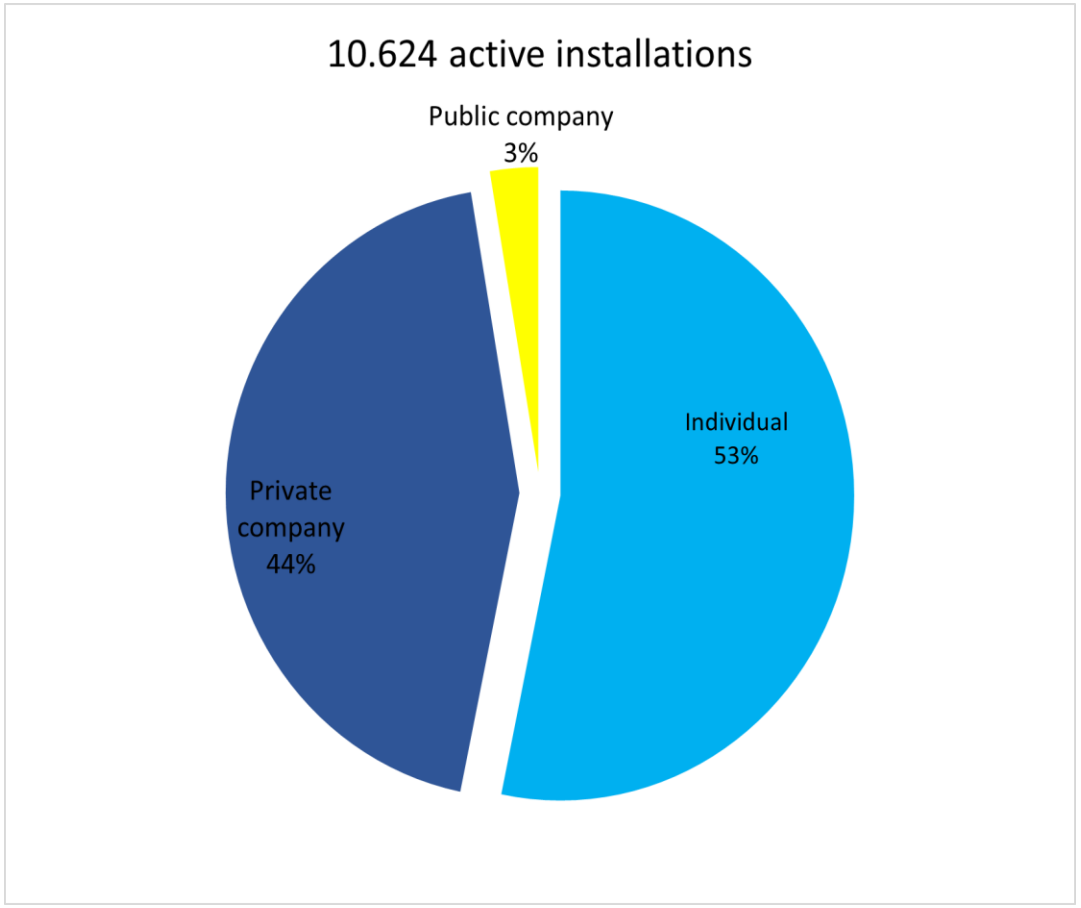
- Technical information of the installations (peak power, cost, surface, module brand, etc.)
- Production data, collected mainly on a quarterly basis.
- Period analysis: 2008 – 2020 (with 2020 as the reference year for reasons of data availability

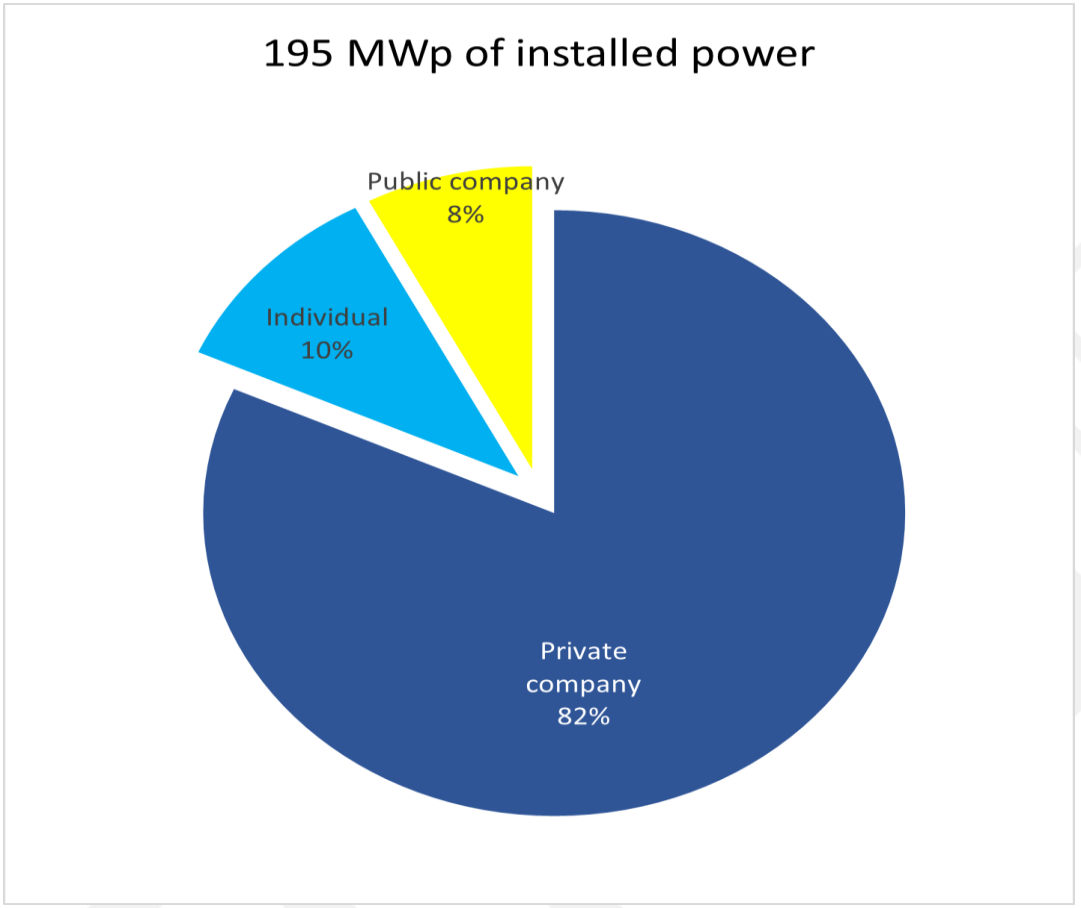
Installation and power share between power categories



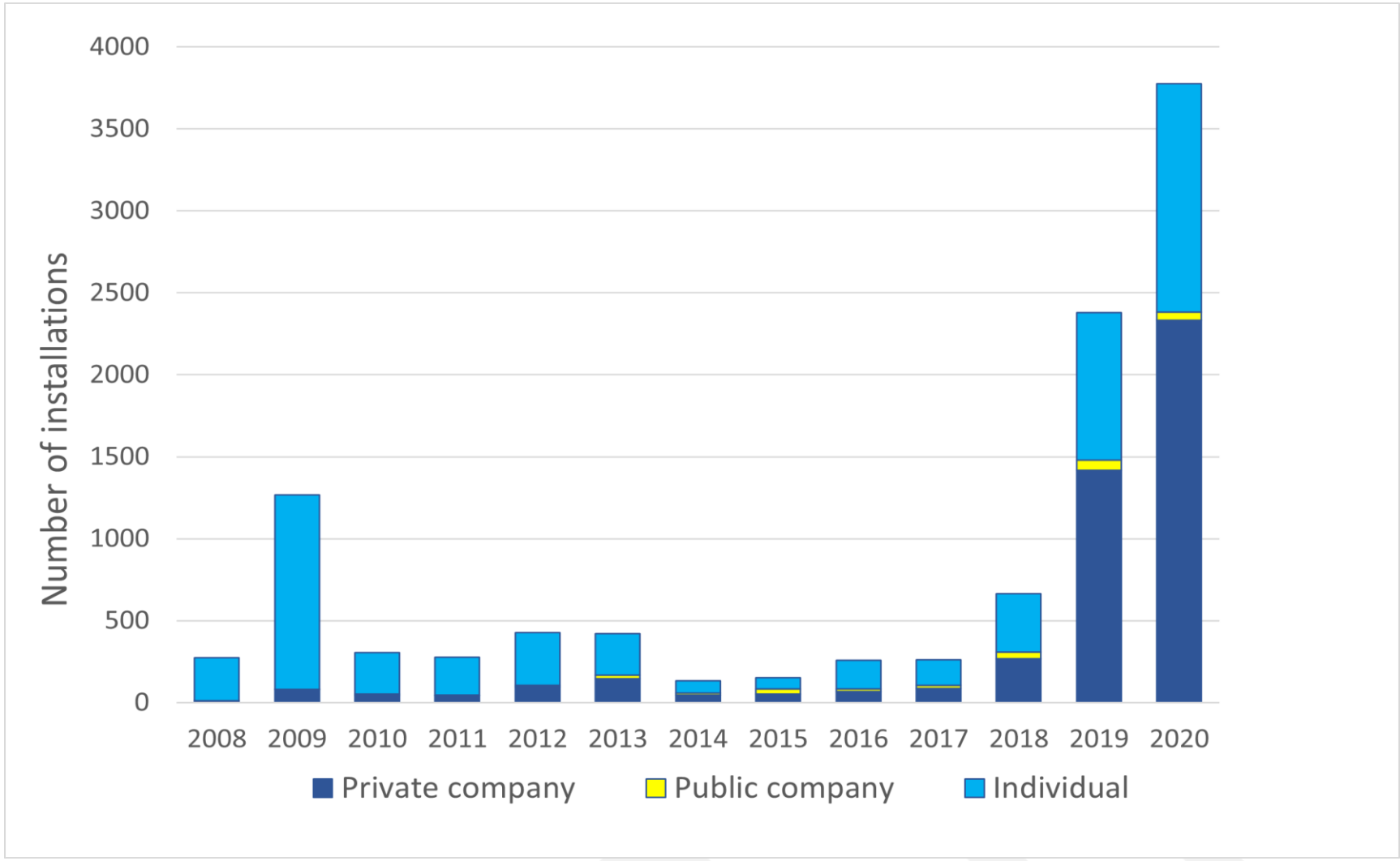


Installation and power share between holder types



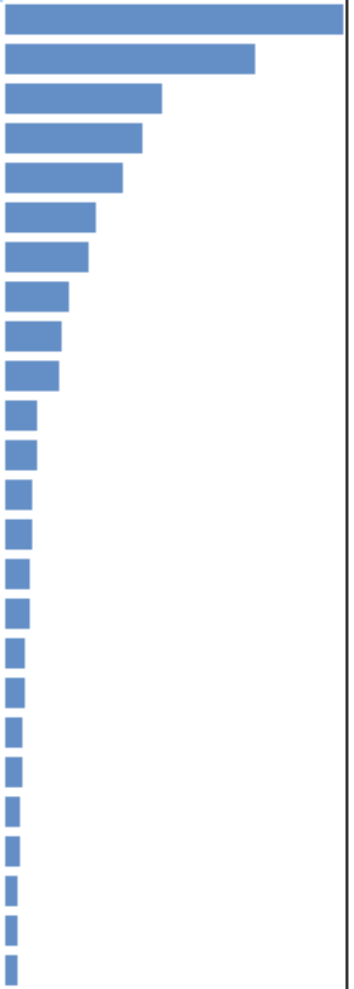


Increase in the number of installations by private companies



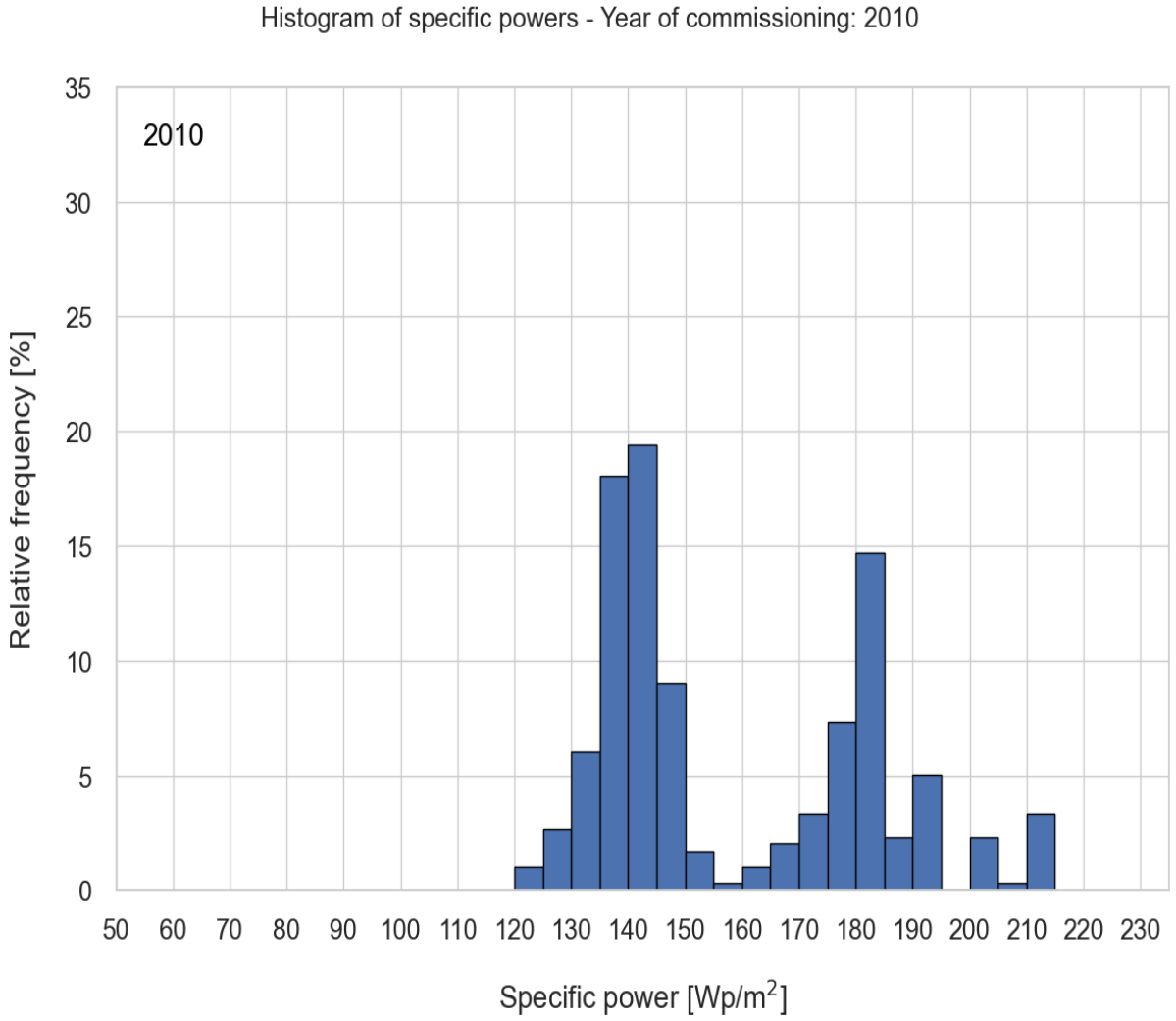
Chinese manufacturers dominate the PV module market

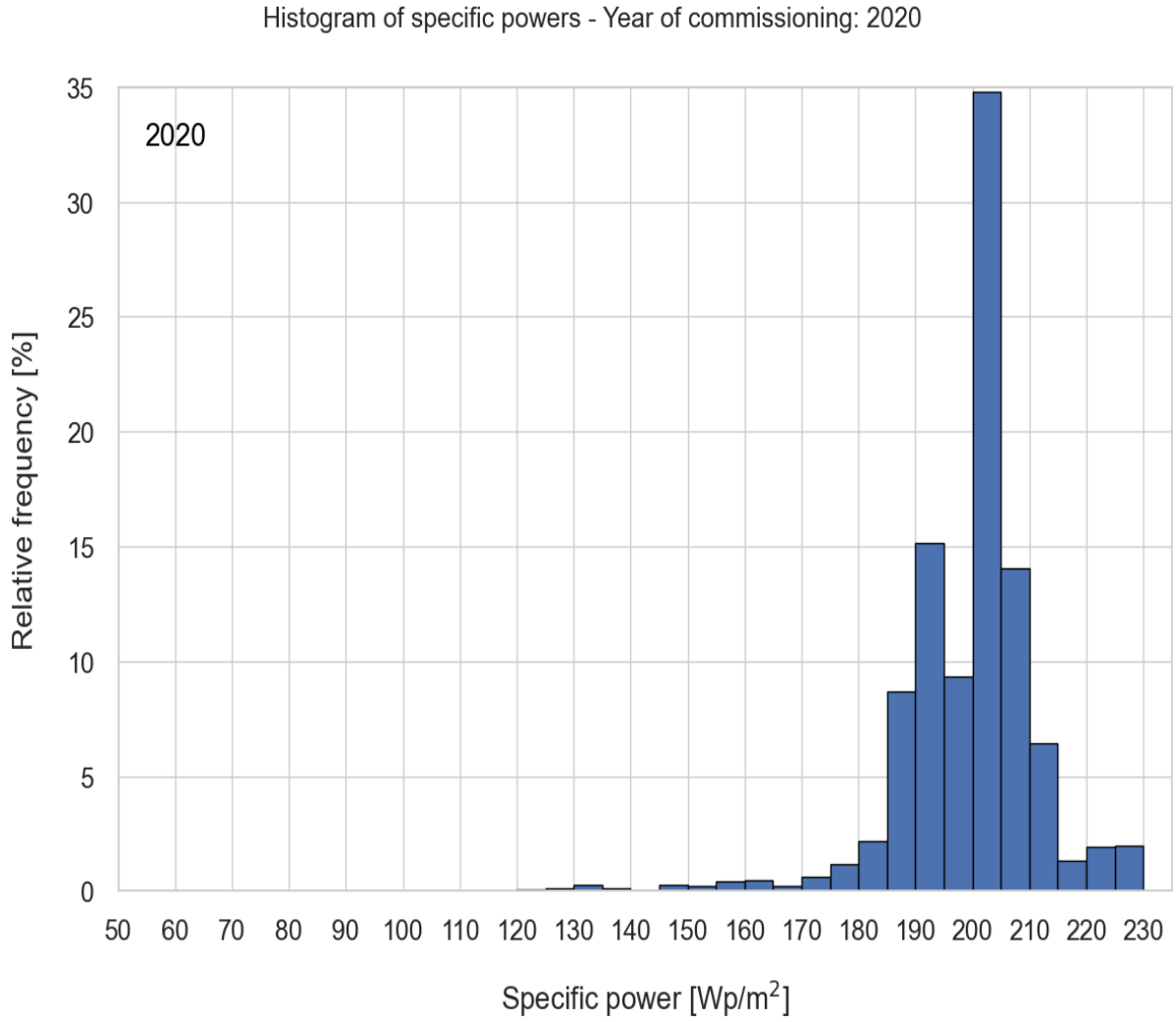
	Total
JA Solar	31,704
Trina Solar	23,421
Sunpower	14,817
Hanwha (Qcells)	12,843
Yingli	10,916
REC	8,458
Longi	7,899
LG	6,087
Canadian Solar	5,284
EnergyVision (EV)	4,962
Suntech	3,085
CSUN	3,081
EXE	2,564
AUO	2,512
Risen Energy	2,319
LDK Solar	2,295
ET Solar	1,938
Espy	1,749
Panasonic	1,635
Talesun	1,538
BYD (Build Your Dreams)	1,399
Renesola	1,294
IBC Solar	1,218
S-Energy	1,206
Astronergy	1,205
Total	155,432 kWp



NDA (-):	2%	3,558 kWc
Others:	17%	32,729 kWc
Sample:	100%	195,277 kWc

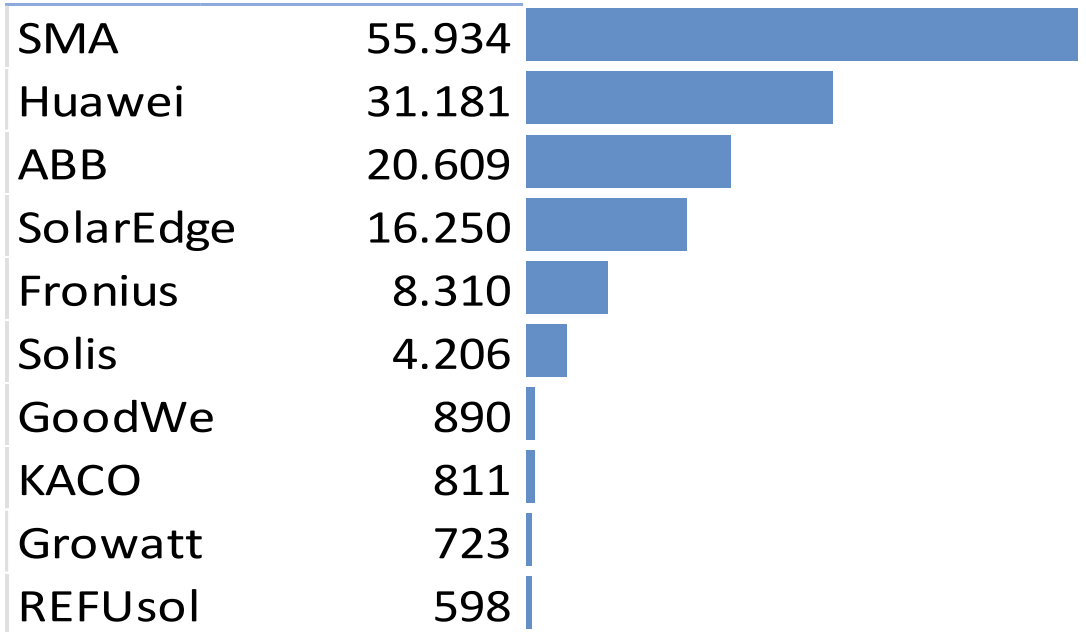
Specific power of PV modules increasing over the years



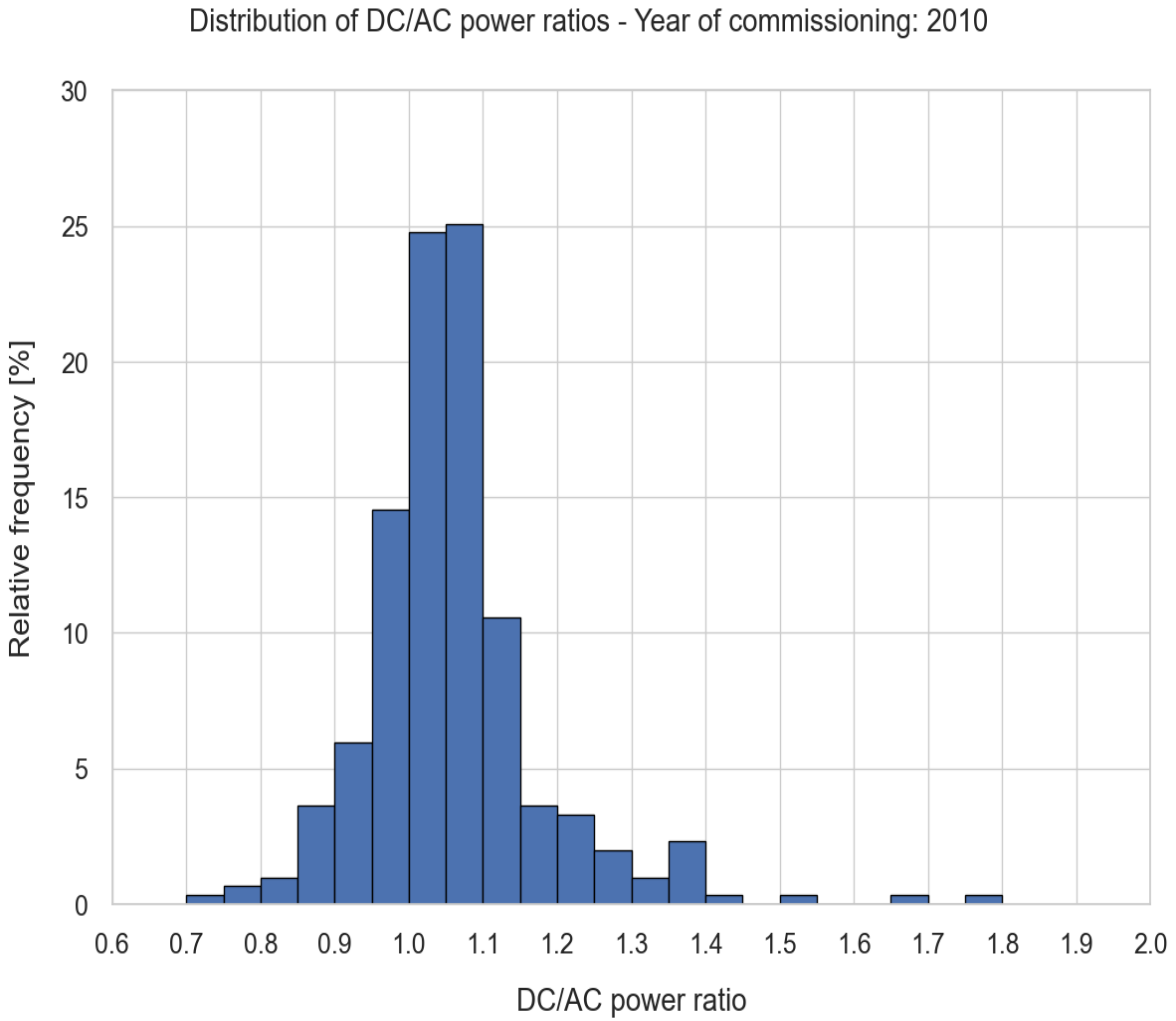


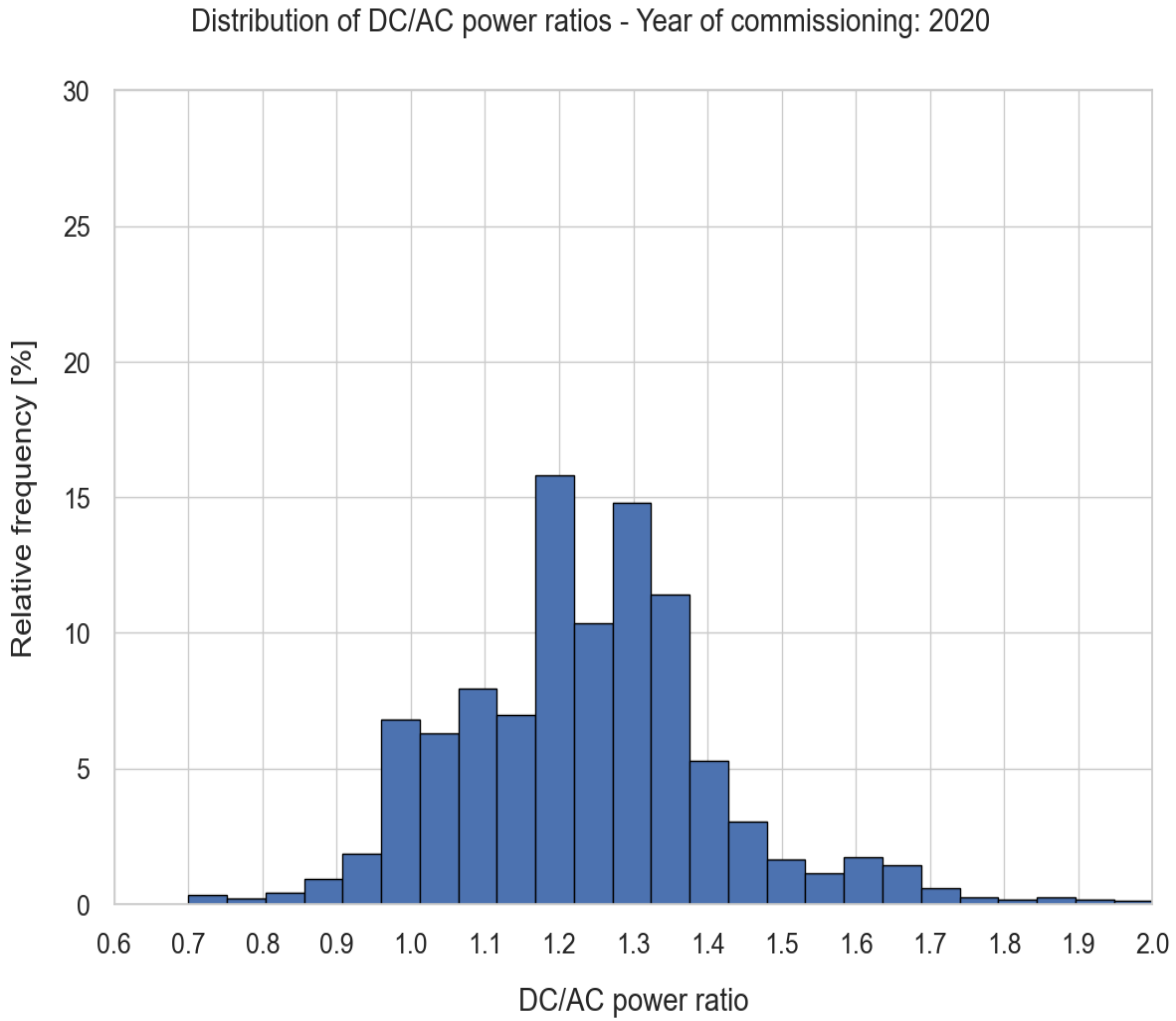
SMA dominates the solar inverter market

	Total	
SMA	55.934	
Huawei	31.181	
ABB	20.609	
SolarEdge	16.250	
Fronius	8.310	
Solis	4.206	
GoodWe	890	
KACO	811	
Growatt	723	
REFUsol	598	
Total	**147.024**	**kVA**
Others:	2.533	kVA
NDA (-):	7.511	kVA
Sample:	149.557	kVA

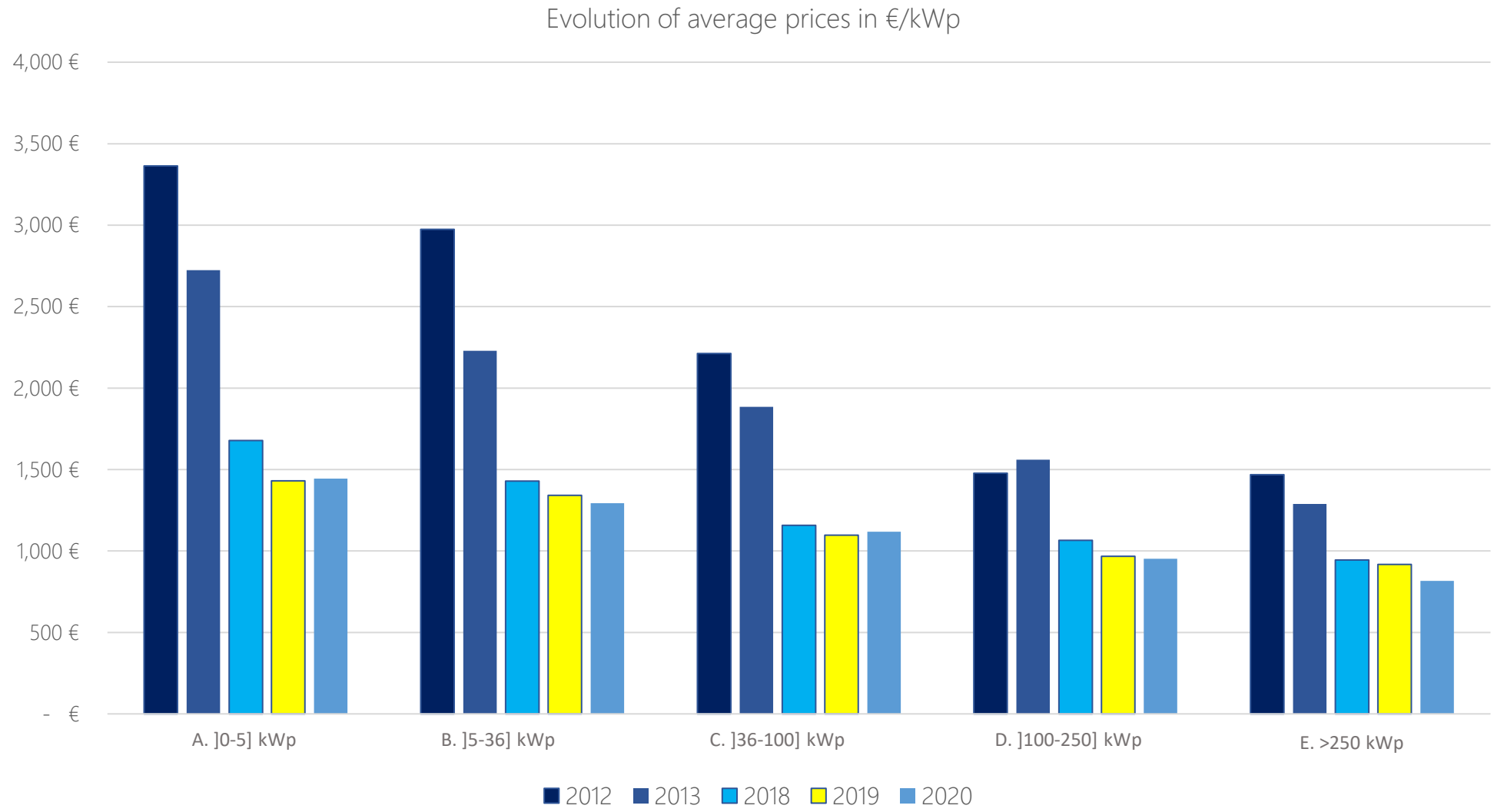


Towards very undersized inverters





Downward price trend continues



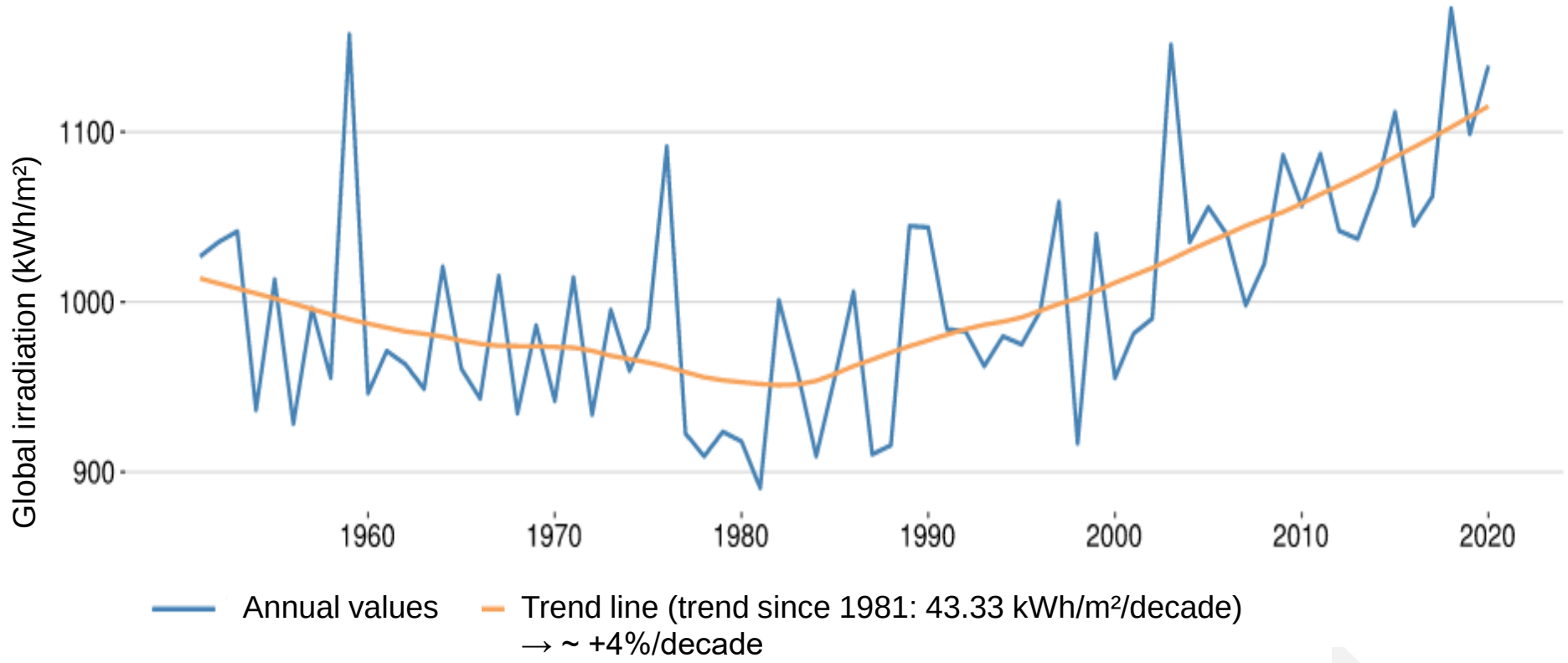
Performance assesment

Energy yield and Performance ratio:

- Production data (databases)
- Solar resource
- Azimuth angle

The solar resource has increased by 4%/decade since the 1980s

Global irradiation, annual values at Uccle from 1951 to 2020



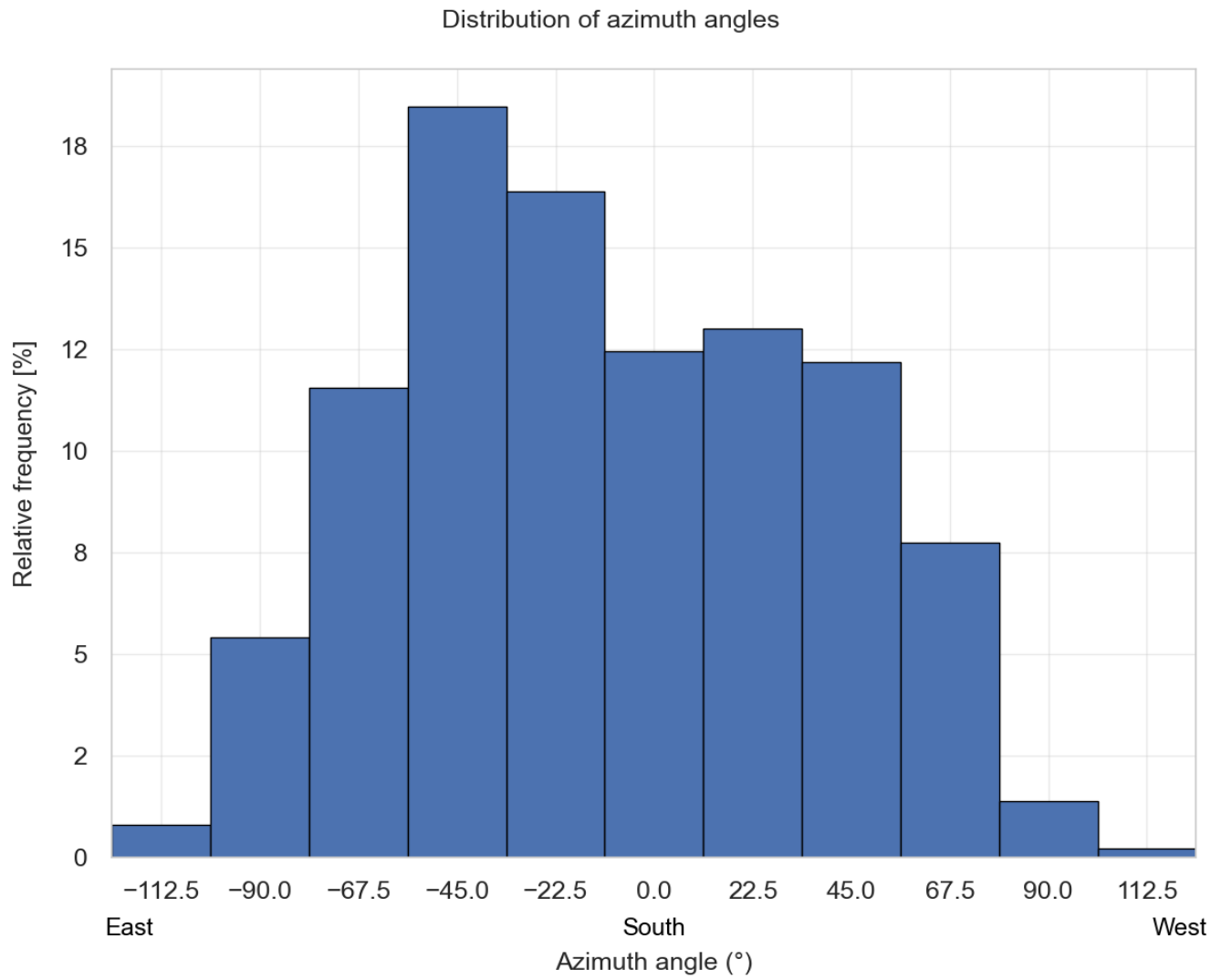
Source: IRM

Semi-manual tool developed for azimuth detection

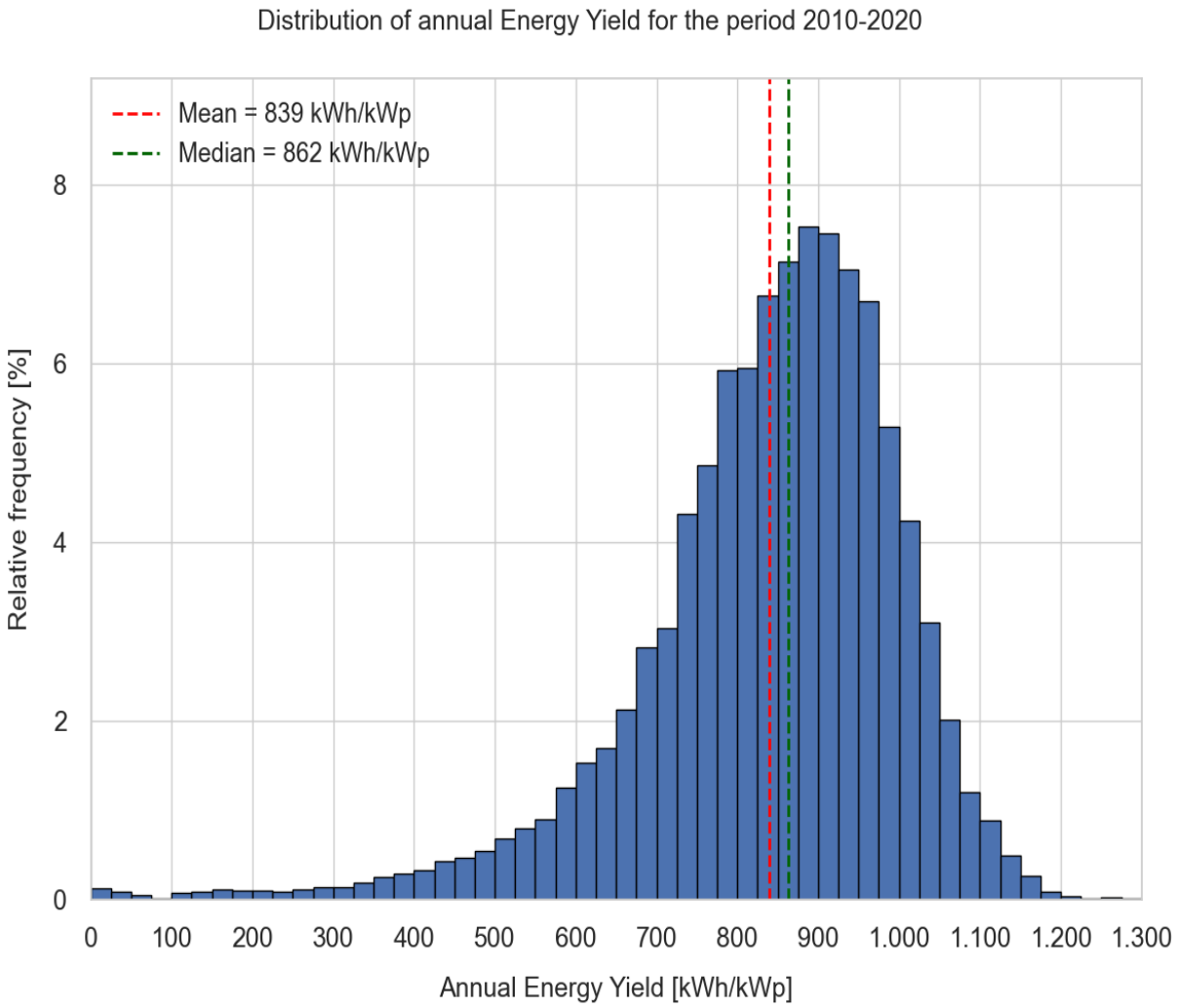
Azimuth angle of PV installation detection using its location:

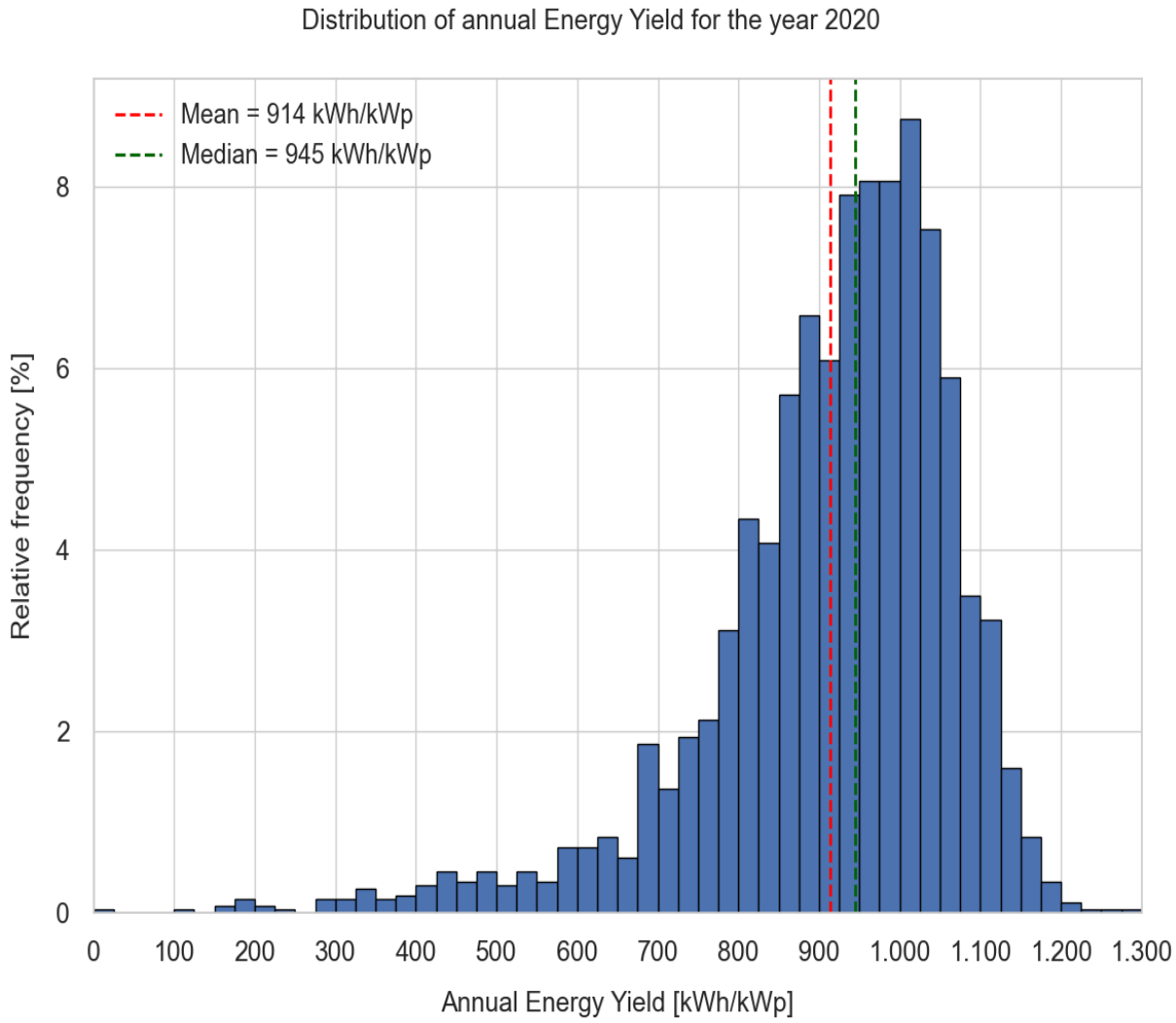
- Requires the precise latitude and longitude of the installation
- Generation of the satellite image with North on top of the figure
- Interface with two points introduction in the direction of the installation
- Azimuth estimation for more than 5,000 installations
- Accuracy error of maximum 5° in 95% of the cases

Most of the azimuth angles distributed between SE and SW

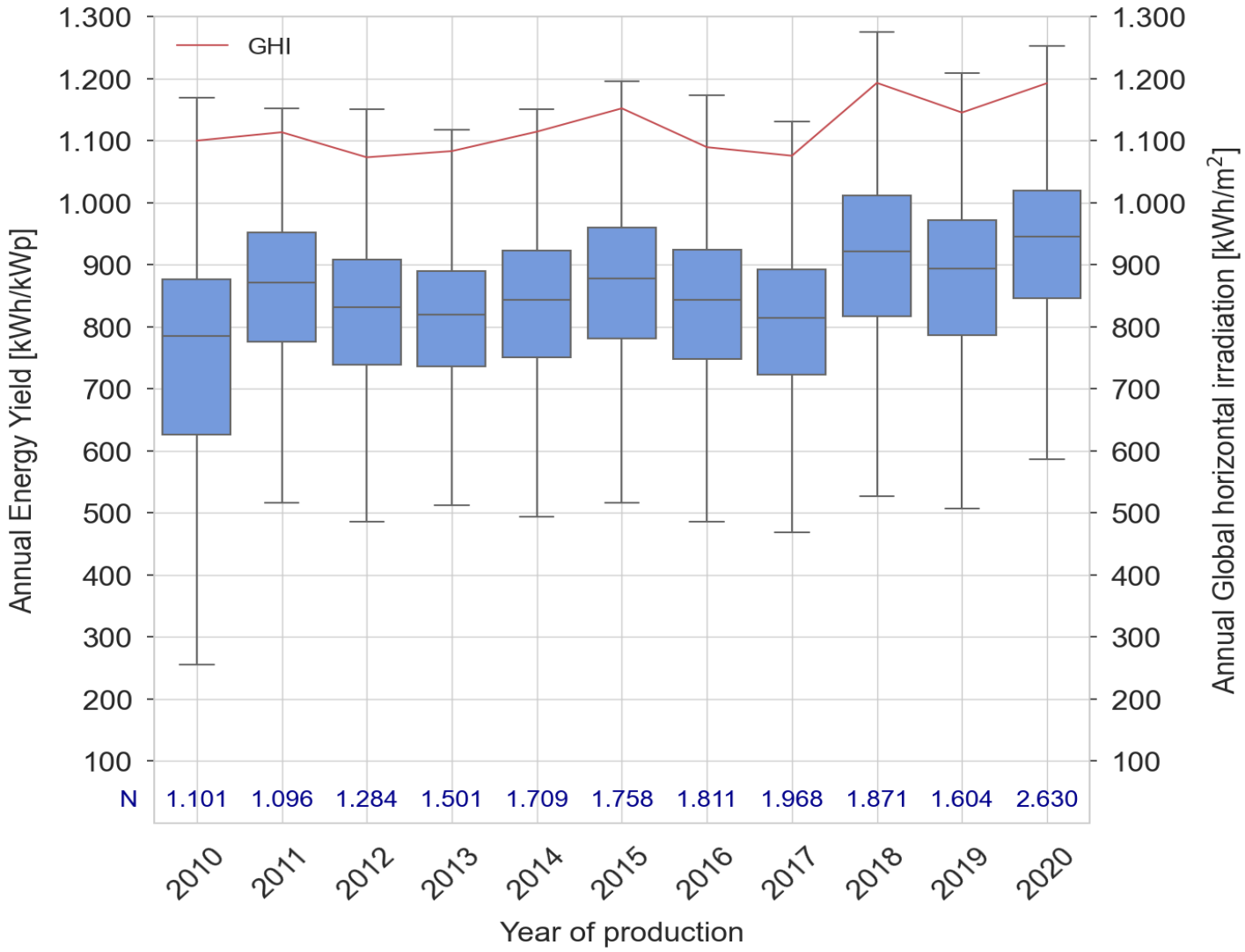


Important dispersion in energy yields

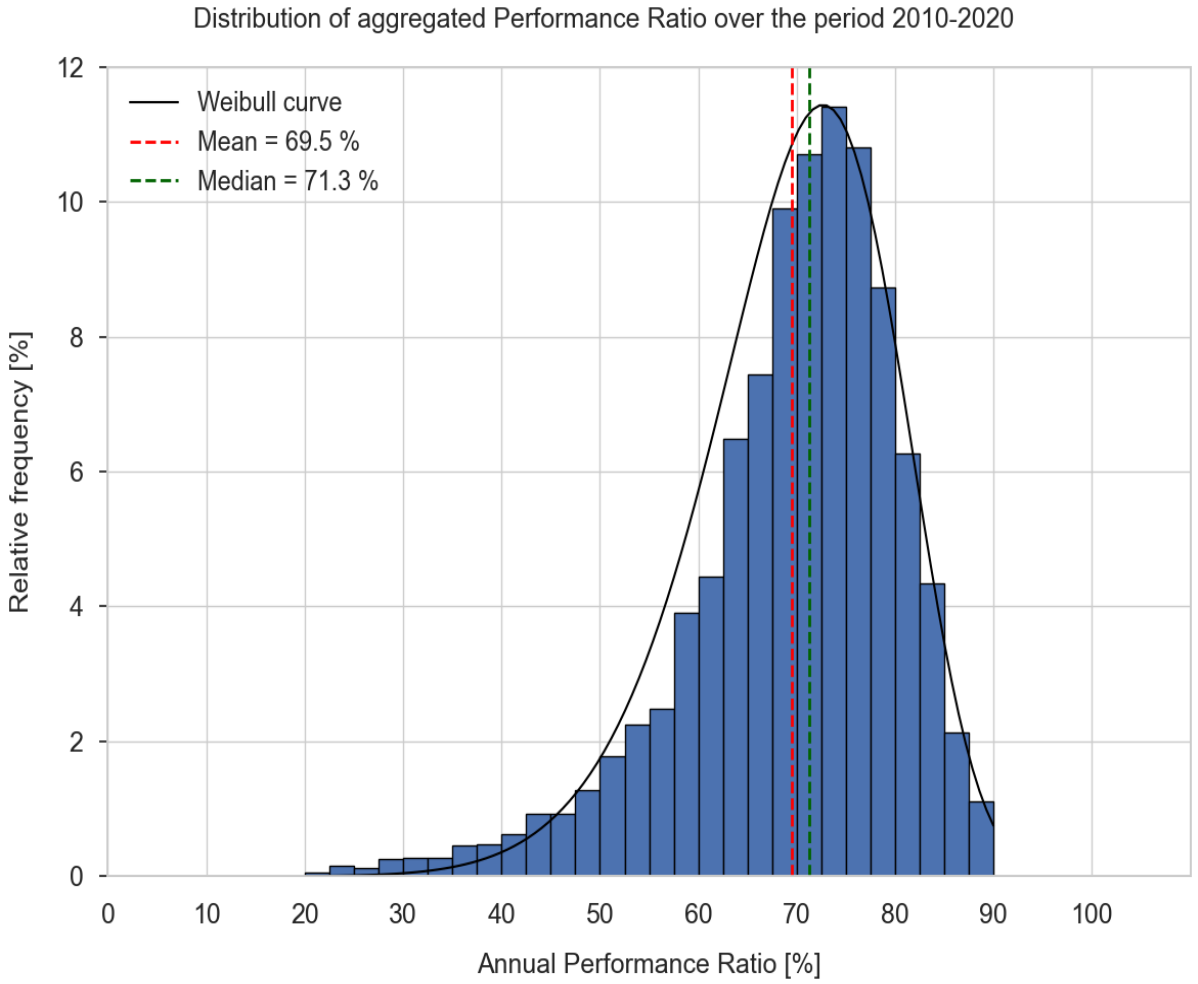


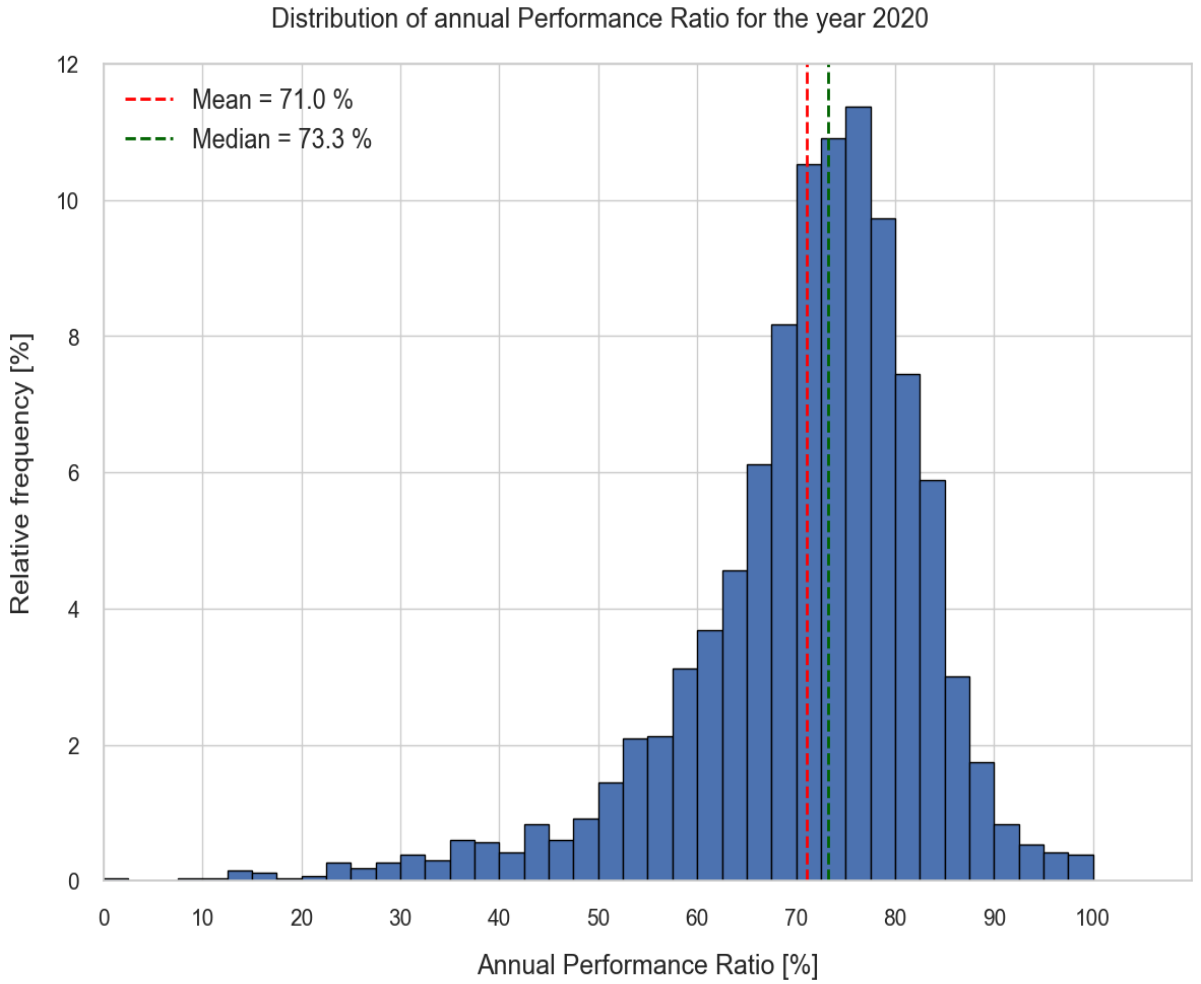


Roughly linear relationship between solar irradiation and energy yield

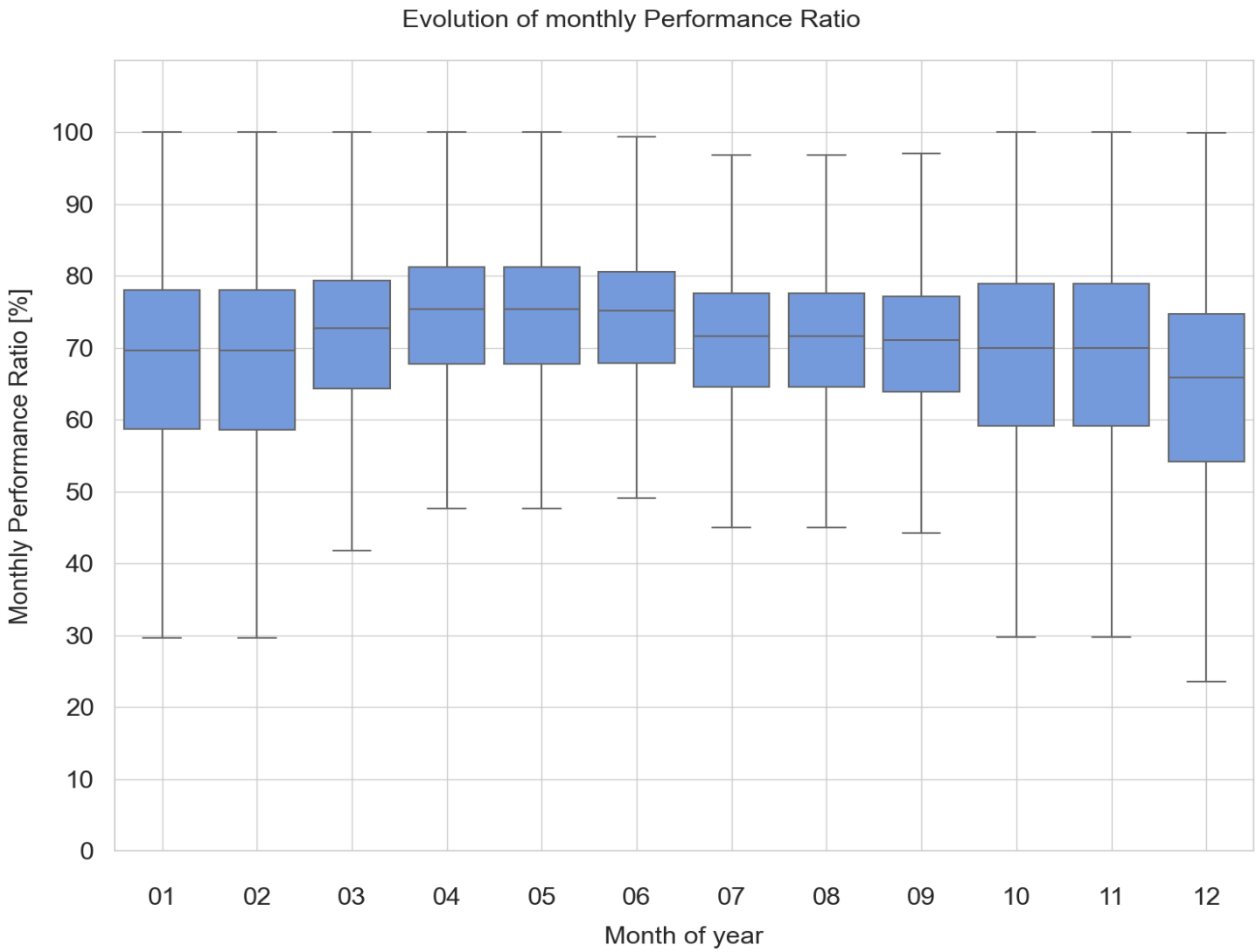


Most typical values of PR for the Brussels PV park ≈ 70%

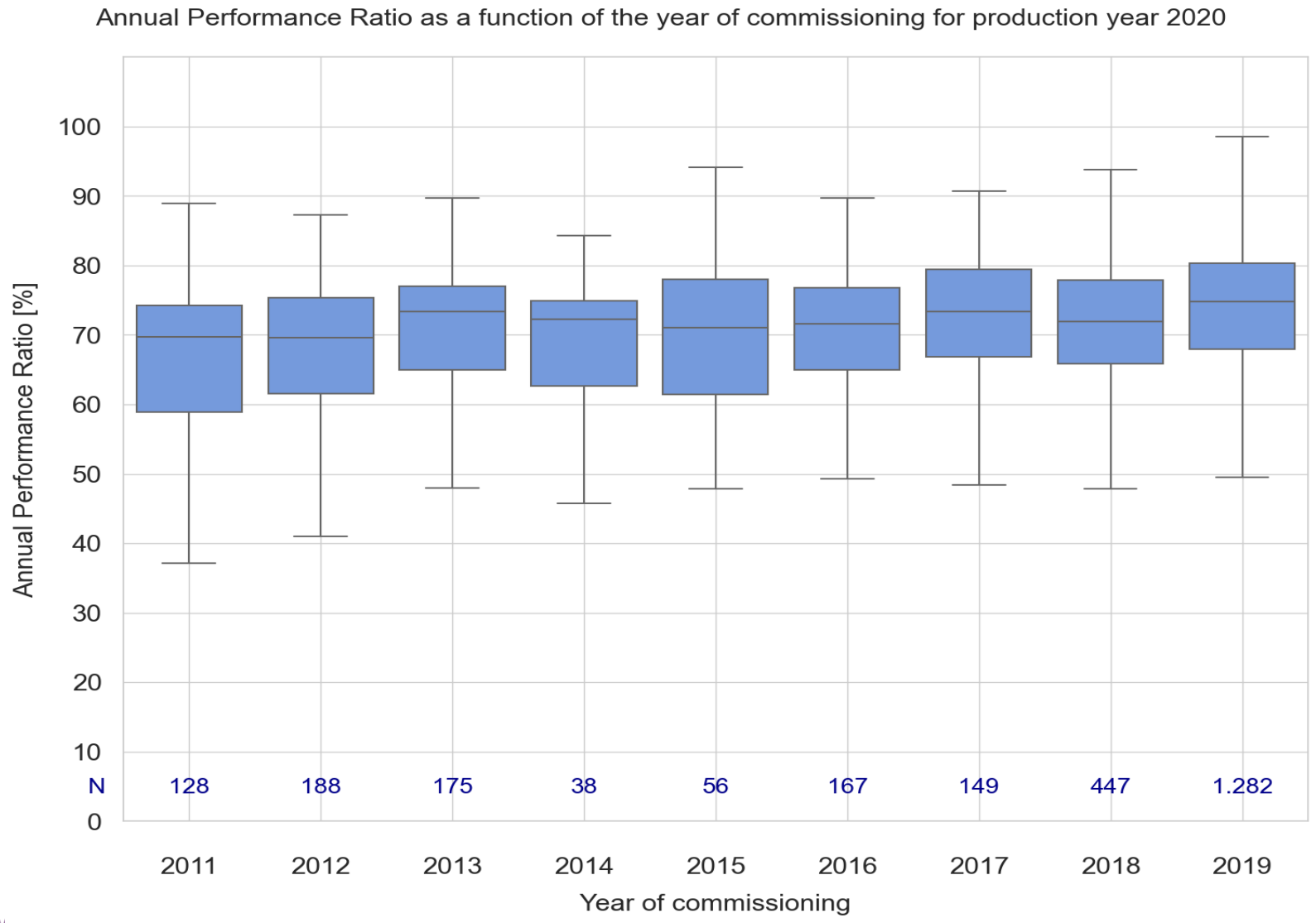




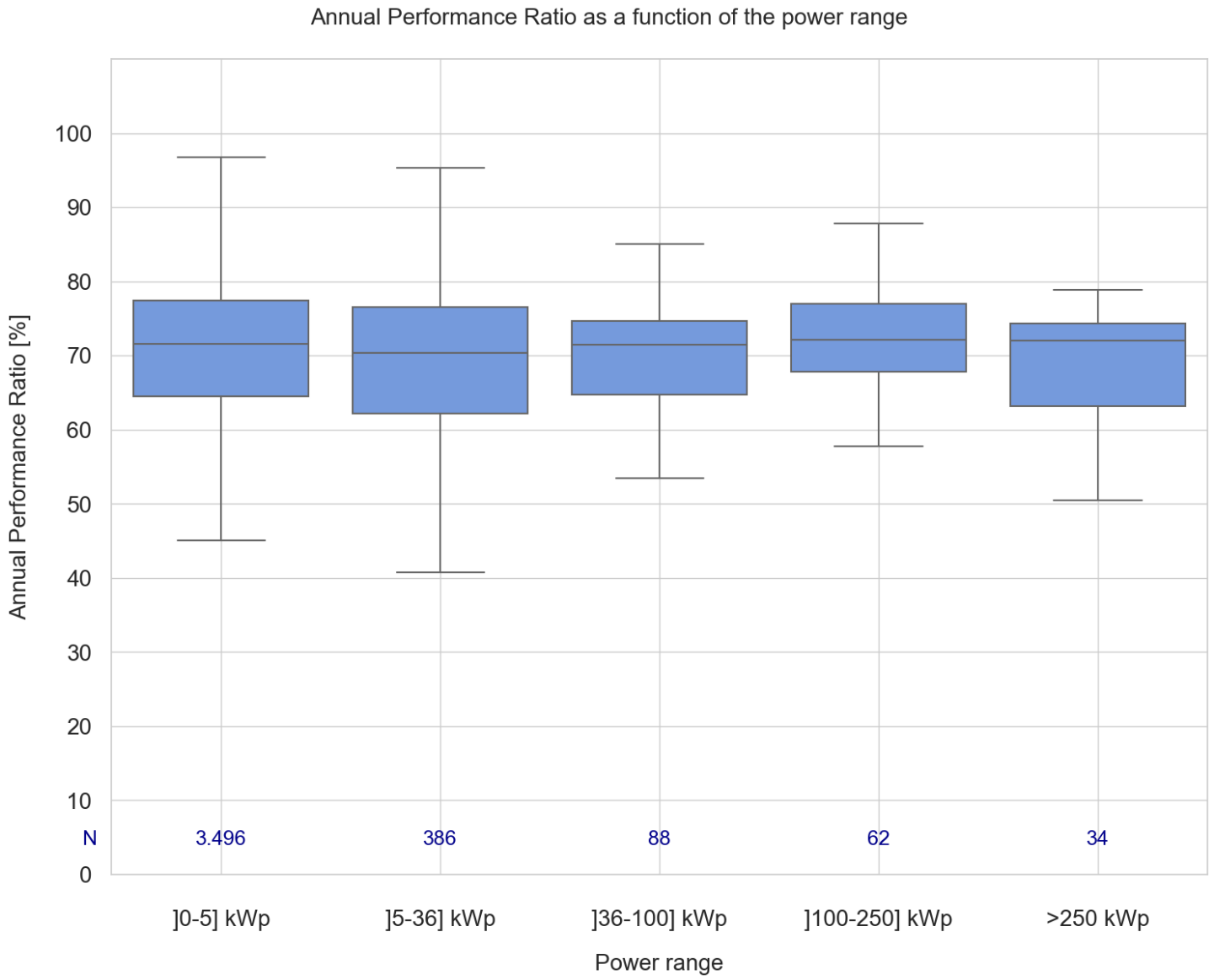
Lower dispersion and higher PR in summer and spring



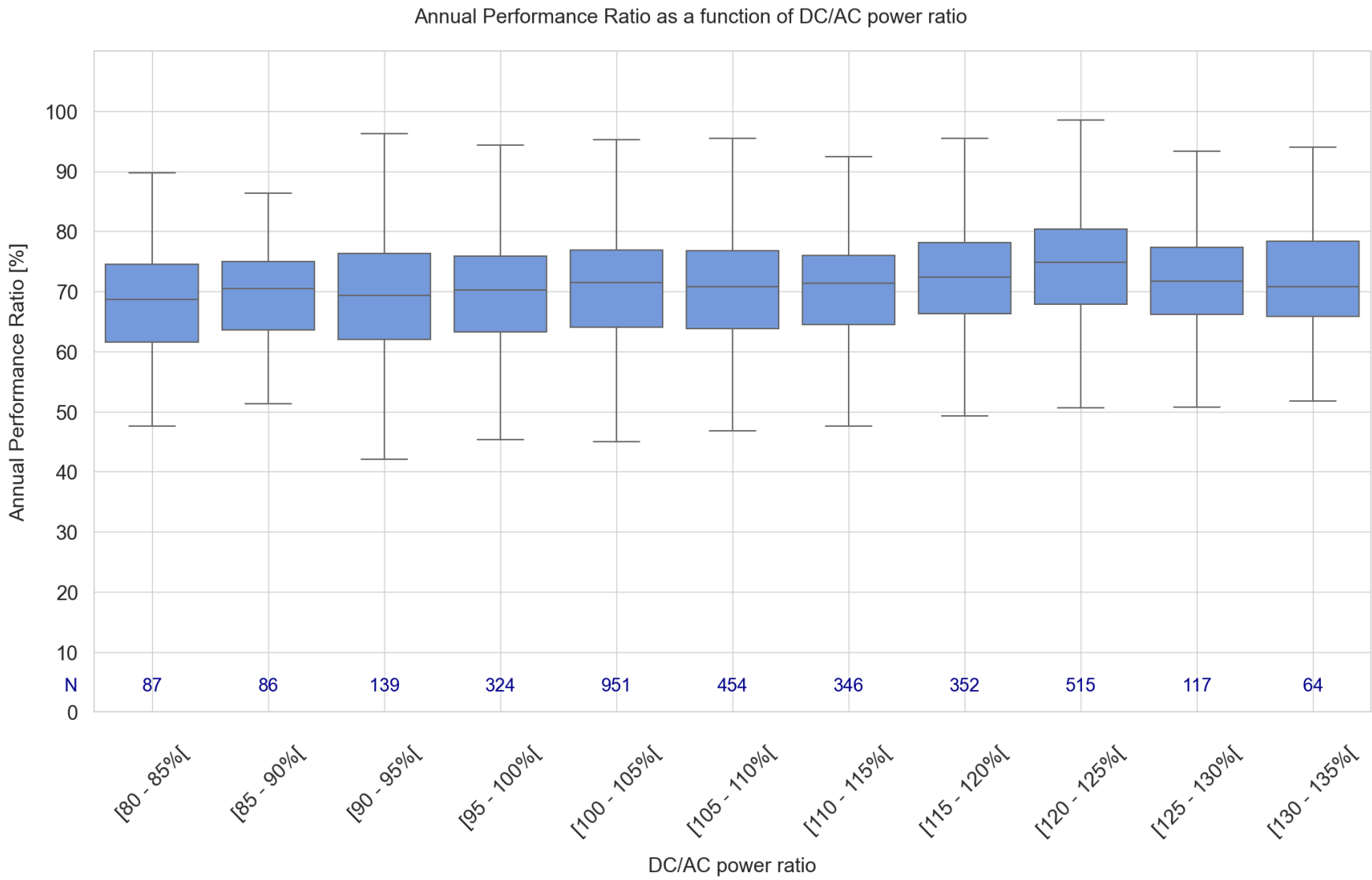
Ageing and improvement observed in PR analysis



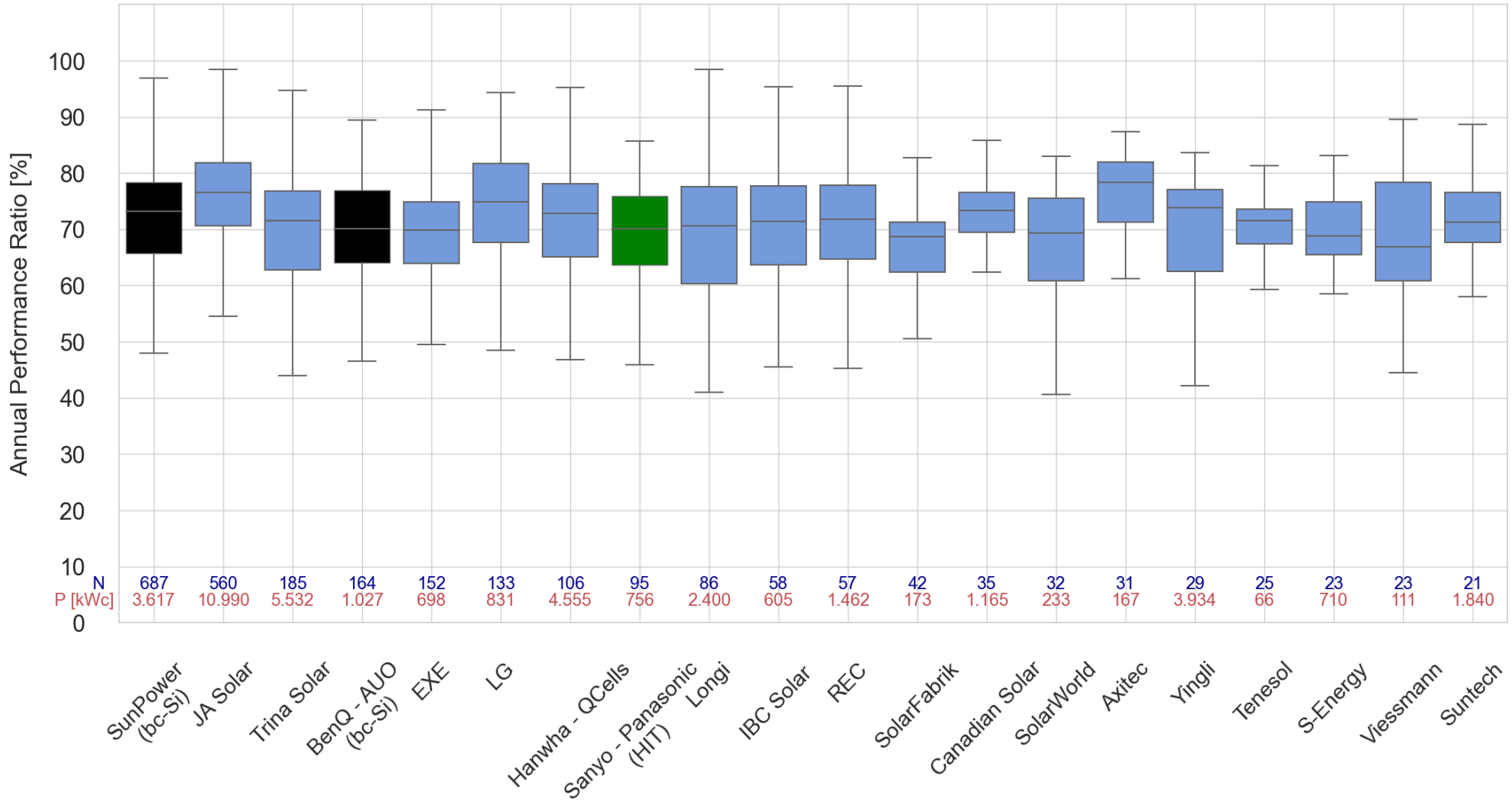
Size effect observed in PR dispersion



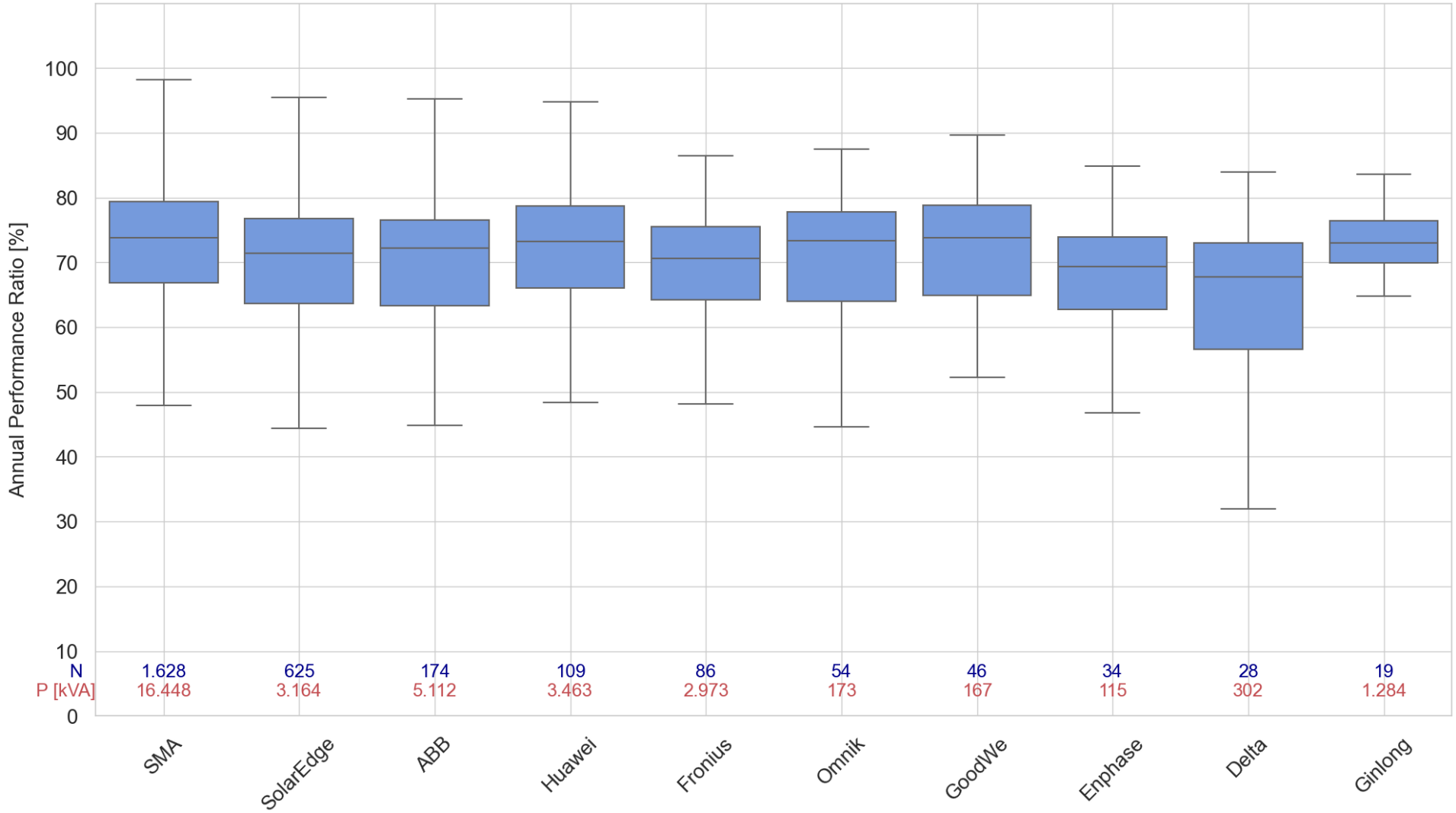
Optimum PV inverter sizing around Pdc/Pac ≈ 120%



Comparable performances between PV module brands



Comparable performances between inverter brands



Conclusion

Study of more than 10,000 installations and 195 MWp in Brussels, Belgium

PV market in Brussels dominated by:

- Chinese manufactures with *JA Solar* and Trina Solar for PV generator
- German manufacturer SMA for solar inverters

Installation prices marked by large decrease during the period 2012-2020:

- Lower than 1500Eur/Wp since 2019 for all categories
- And even lower than 1000Eur/Wp for large installation

Solar resource increasing over time, around +4%/decades

Mean annual energy yield over the period 2010-2020 = 839 kWh/kWp

Mean PR over the period 2010-202 ≈ 70%

Flexibility of the PV technology (sizing, module and inverter brands)