Temporal and spatial variability of distributed PV impacts on Australian distribution network load profiles

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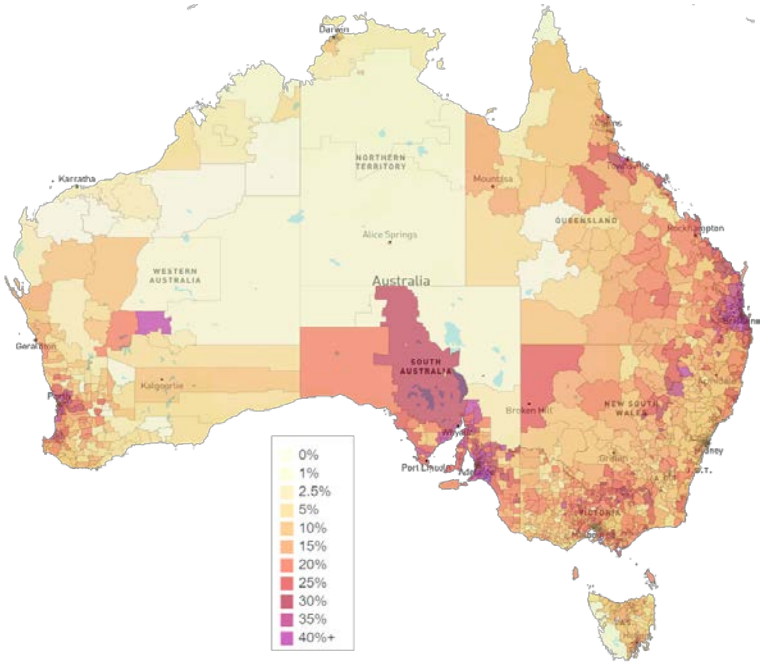
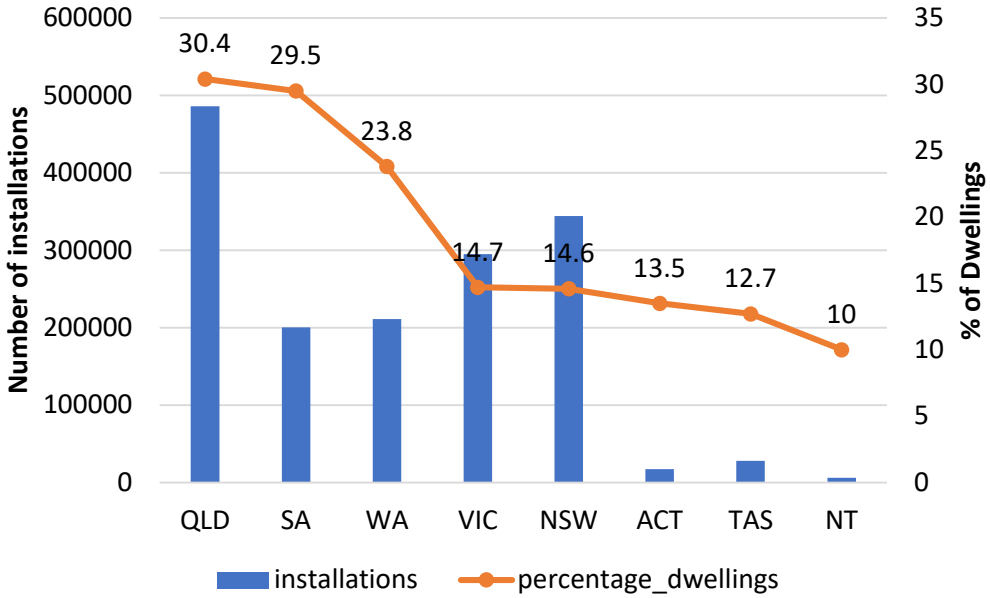
Context

- More than **80%** of the **6GW** of PV installed in Australia is comprised of distributed PV systems installed on residential, commercial, and industrial rooftops.





© Australian PV Institute (APVI) Solar Map (as of April 2016)

Context

- Unlike conventional utility-scale generation, small-scale PV systems are rarely systematically **monitored**
- Thus, difficult to investigate the **performance** and hence **impact** of them on the network
- The impact also depends on the underlying network load profile, which varies across different climates and according to the spatial characteristics of both PV and energy consumers across the network

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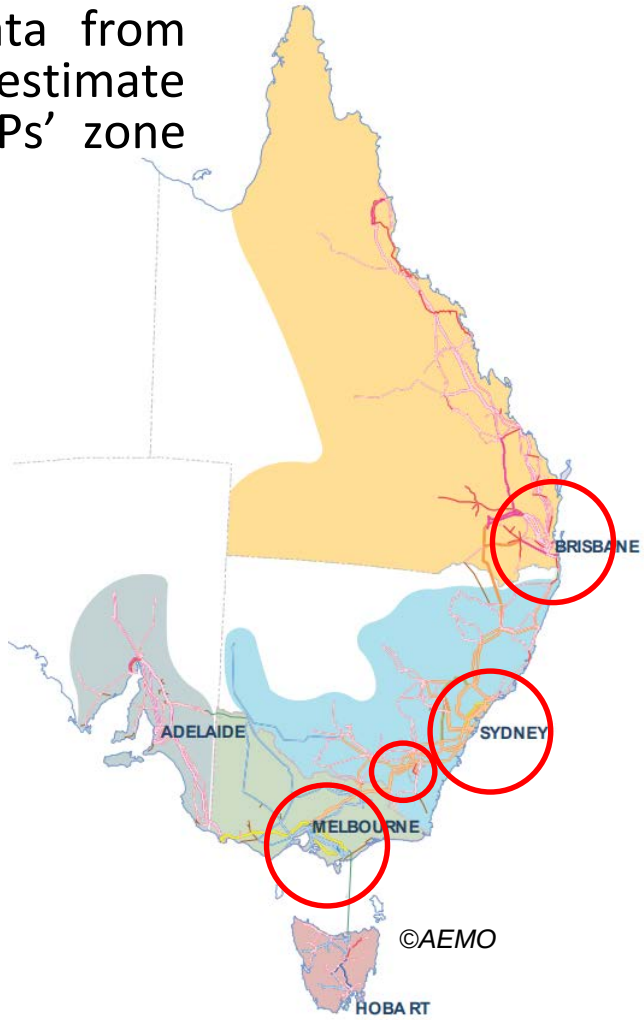
PV performance in DNSPs

Therefore, we have used historical generation data from thousands of distributed PV systems in Australia to estimate the average performance of distributed PV in DNSPs' zone substations (ZS).

- The DNSPs include (total 518 ZS):
  - ✓*Ausgrid* in NSW (~170)
  - ✓*ActewAGL* in ACT (10)
  - ✓*Energex* in QLD (237)
  - ✓*Powercor* (2), *Ausnet* (52), *Citpower* (2), and *United Energy* (45) in VIC



Method

Average PV performance is estimated in each 2-digit postcode area for each half hour from 2013-2016 [1]

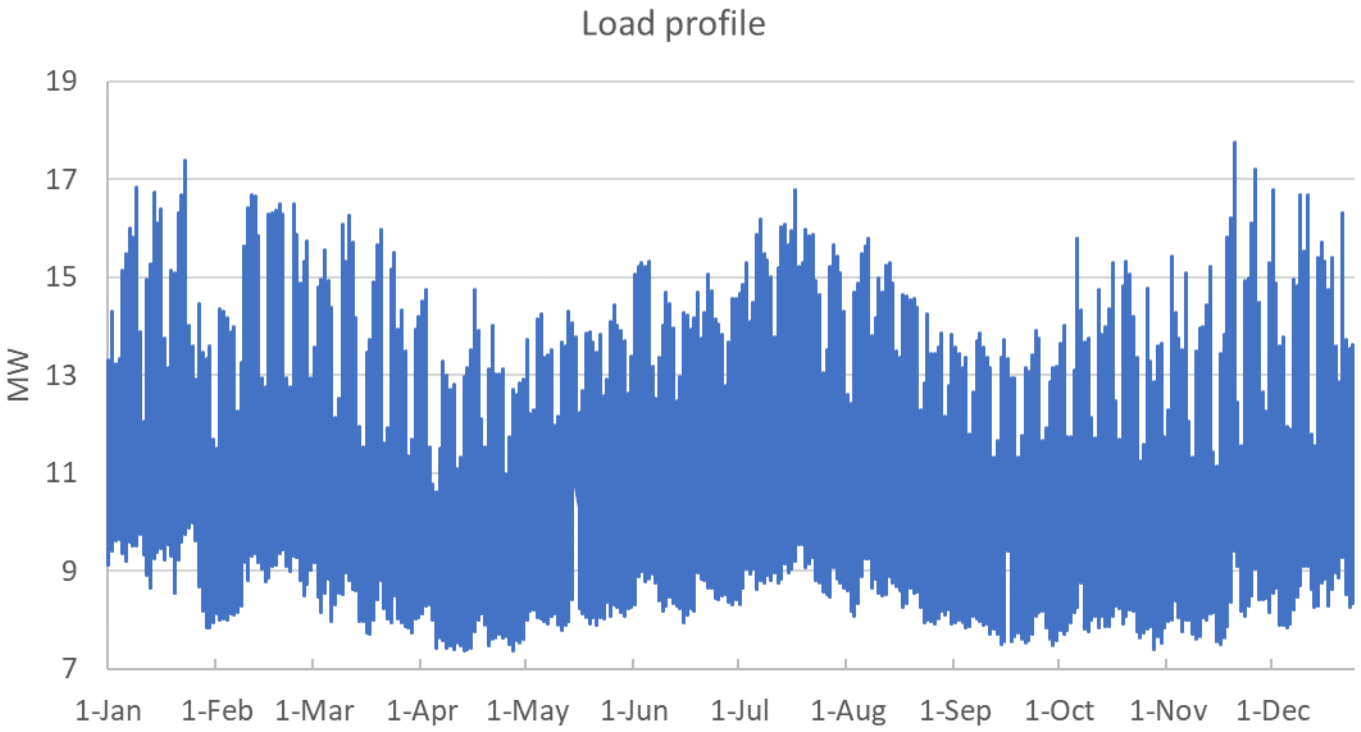
PV performance is found for the location of each ZS

Peak load PV performance for each ZS is extracted for analysis

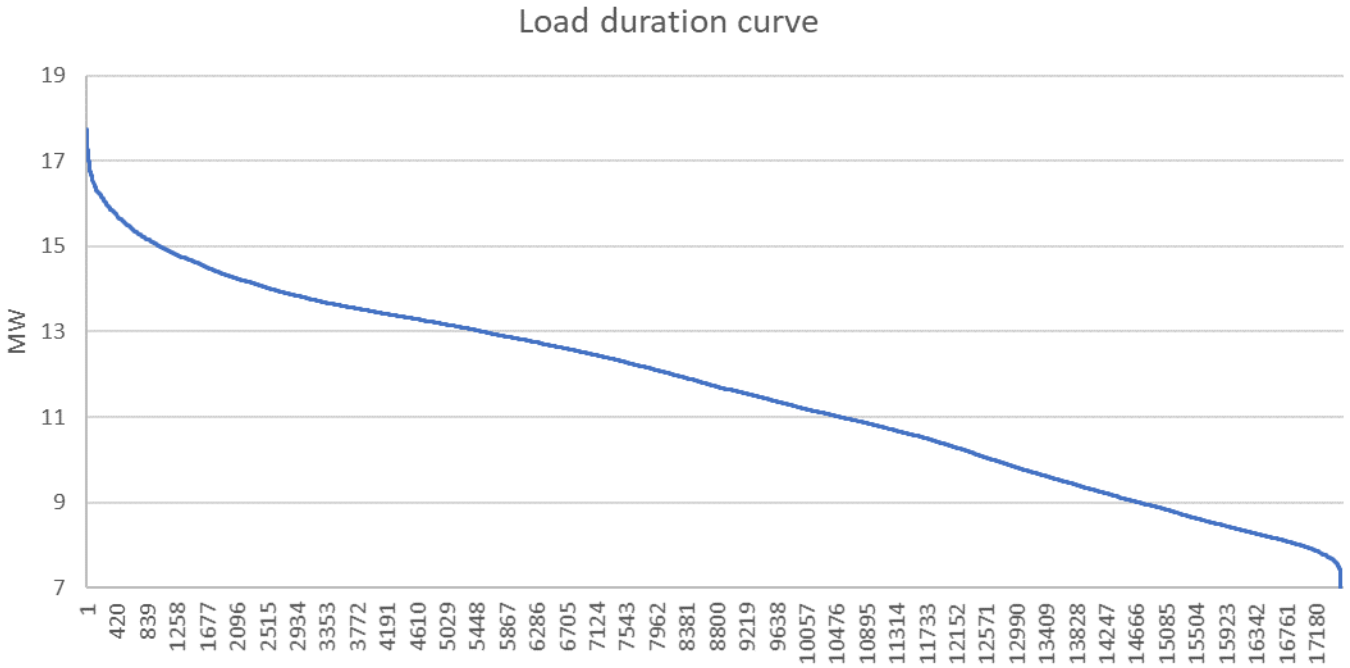
Note that the result would have been more accurate if we could have the actual capacity of the installed PV and hence underlying load in each ZS.

[1] The method is used in **APVI live map** and described in: Haghdadi et al. “Assessing the representativeness of “Live” distributed PV data for upscaled PV generation estimates”. Power and Energy Engineering Conference (APPEEC), IEEE PES Asia-Pacific, November 2015, Brisbane, Australia

Method


Load profile
19
17
15
13
11
9
7
MW
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec

Method


Load duration curve
MW
19
17
15
13
11
9
7
1
420
839
1258
1677
2096
2515
2934
3353
3772
4191
4610
5029
5448
5867
6286
6705
7124
7543
7962
8381
8800
9219
9638
10057
10476
10895
11314
11733
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14247
14666
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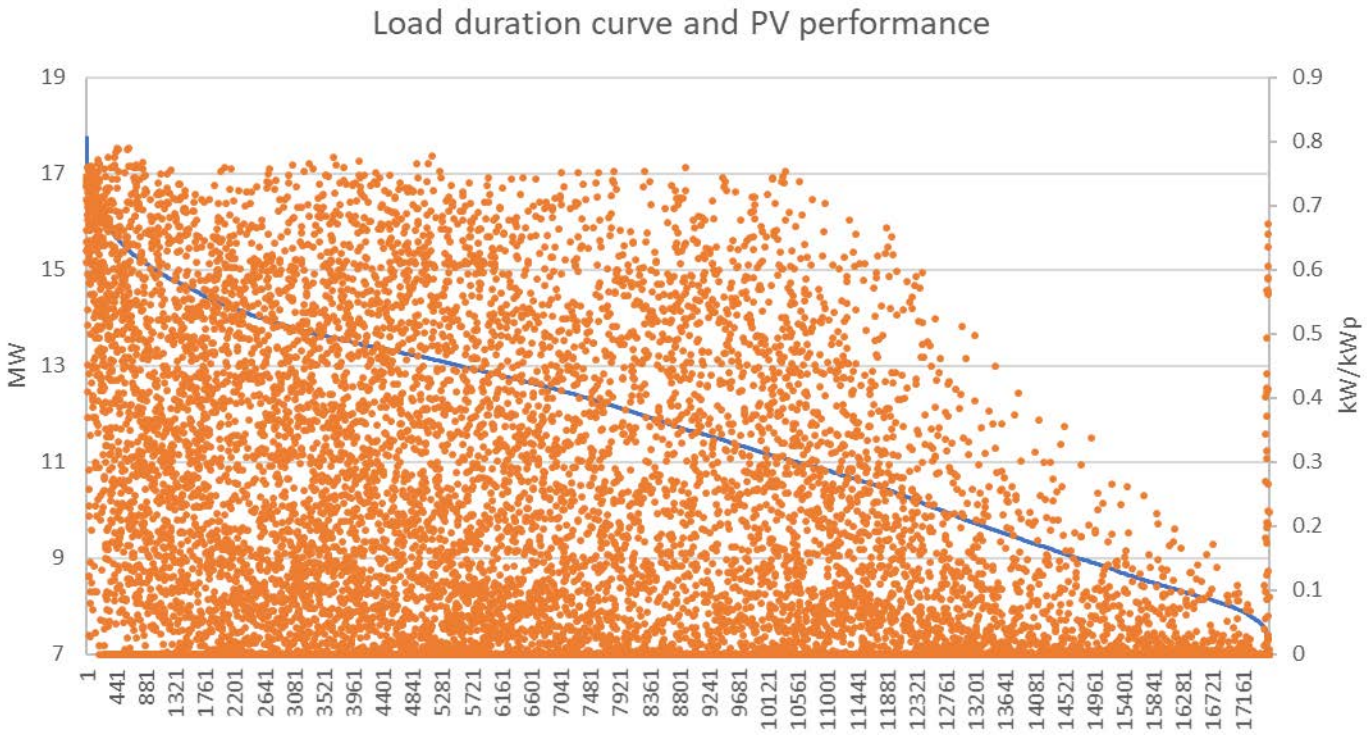
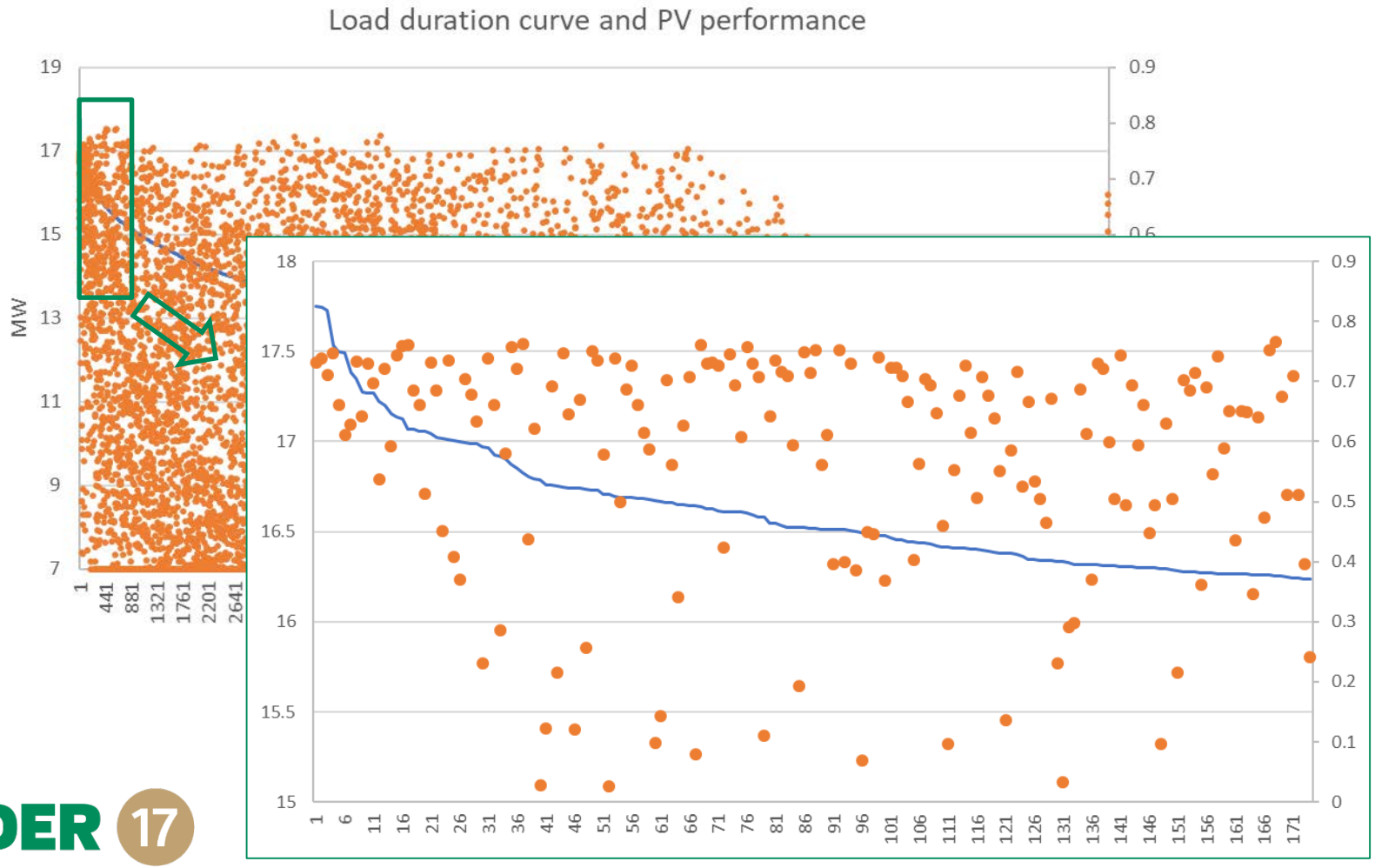
15923
16342
16761
17180

Method


Load duration curve and PV performance
MW
kW/kWp
19
17
15
13
11
9
7
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
441
881
1321
1761
2201
2641
3081
3521
3961
4401
4841
5281
5721
6161
6601
7041
7481
7921
8361
8801
9241
9681
10121
10561
11001
11441
11881
12321
12761
13201
13641
14081
14521
14961
15401
15841
16281
16721
17161

Method


Load duration curve and PV performance
MW
19
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13
11
9
7
1
441
881
1321
1761
2201
2641
0.9
0.8
0.7
18
17.5
17
16.5
16
15.5
15
0.6
0.5
0.4
0.3
0.2
0.1
0
1
6
11
16
21
26
31
36
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46
51
56
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66
71
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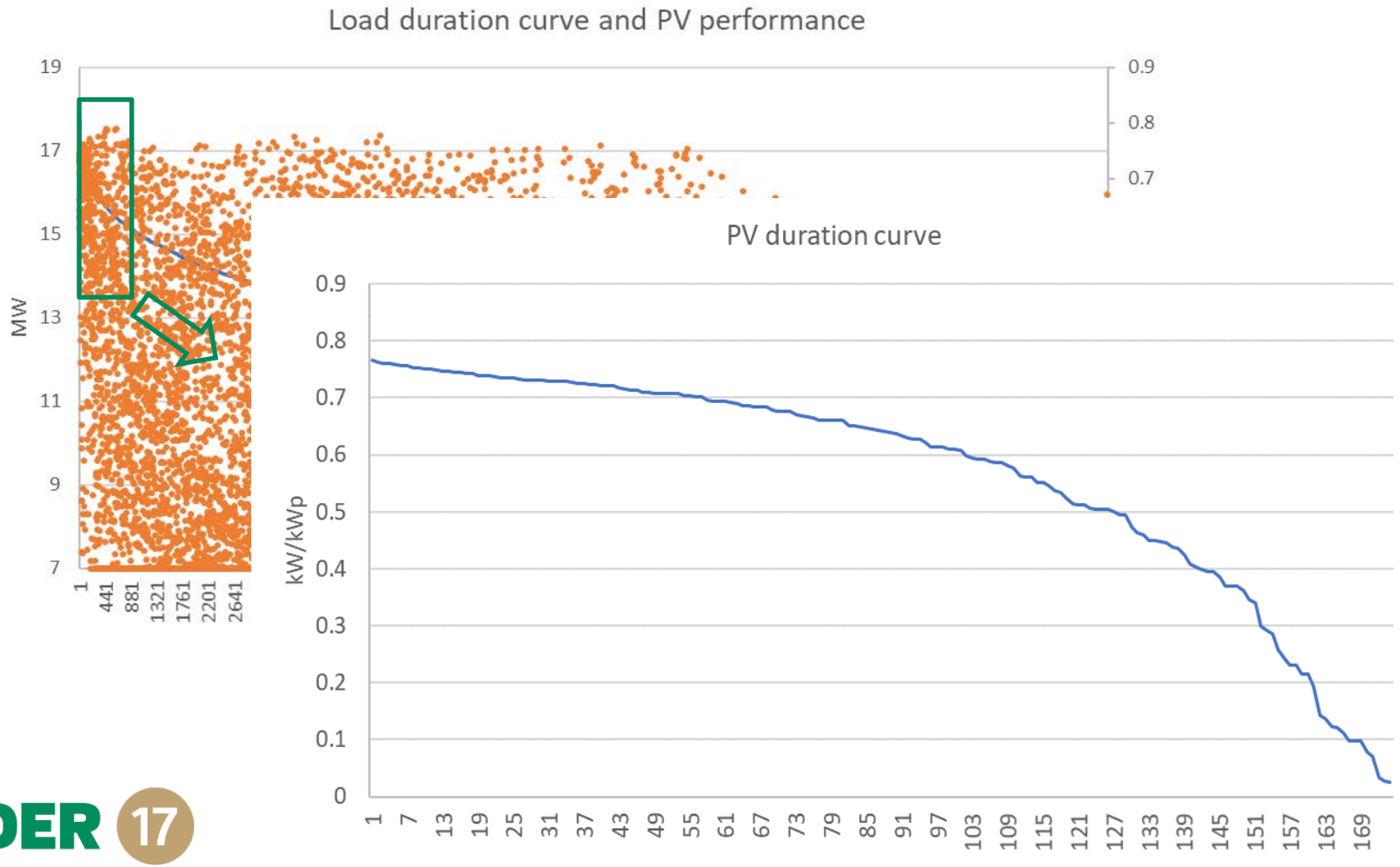
171

Method


Load duration curve and PV performance
MW
19
17
15
13
11
9
7
1
441
881
1321
1761
2201
2641
0.9
0.8
0.7
PV duration curve
kW/kWp
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
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13
19
25
31
37
43
49
55
61
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85
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121
127
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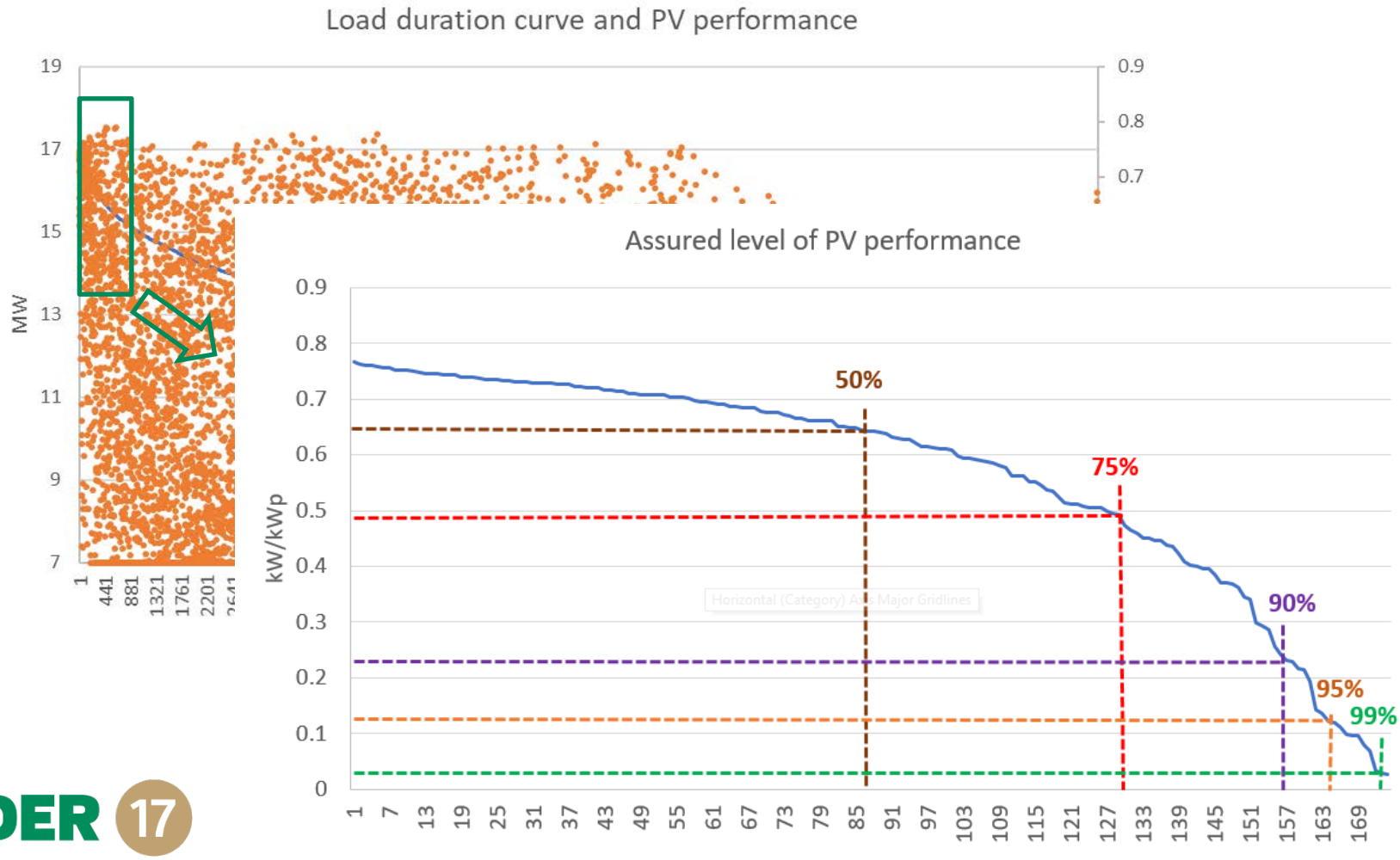
145
151
157
163
169

Method


Load duration curve and PV performance
MW
19
17
15
13
11
9
7
1
441
881
1321
1761
2201
0.9
0.8
0.7
Assured level of PV performance
kW/kWp
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
50%
75%
90%
95%
99%
1
7
13
19
25
31
37
43
49
55
61
67
73
79
85
91
97
103
109
115
121
127
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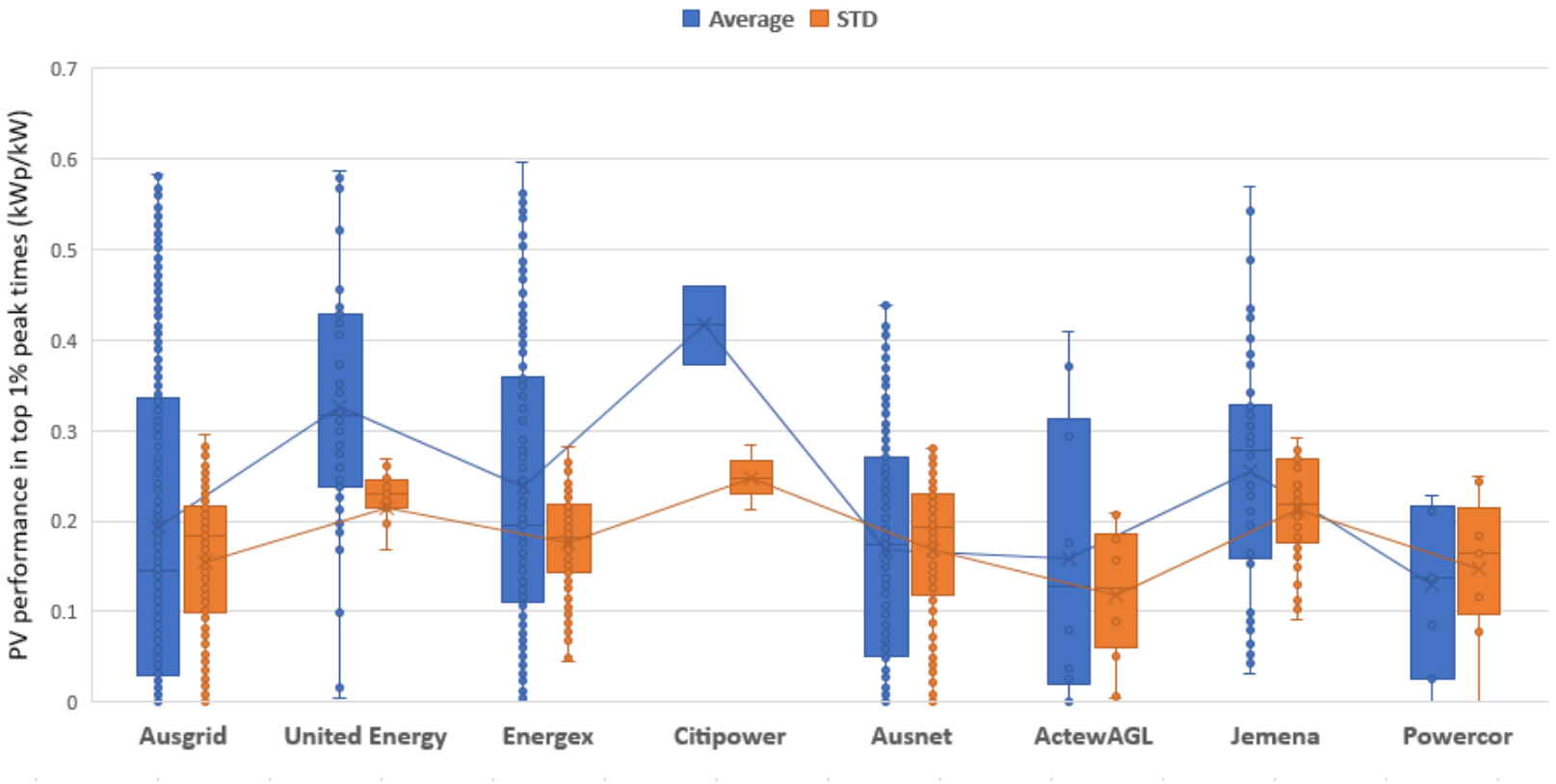
139
145
151
157
163
169

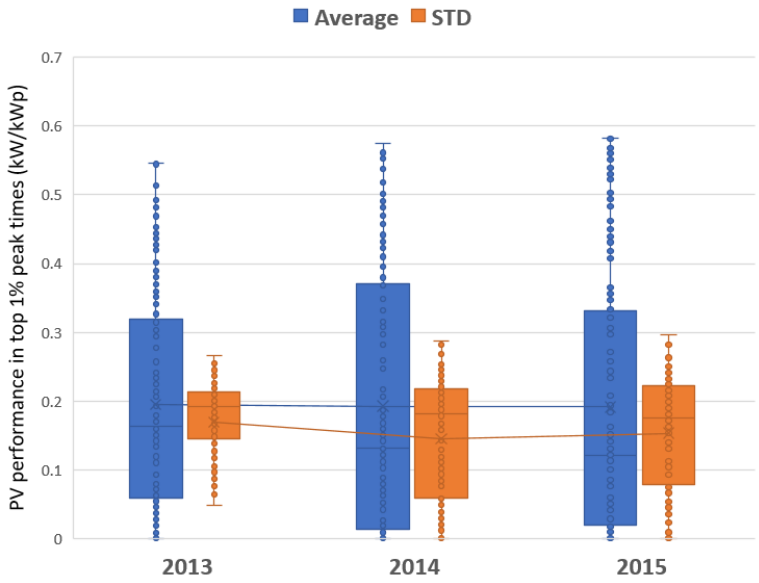
Results

Average PV performance in top 1% of peak times in each zone substation

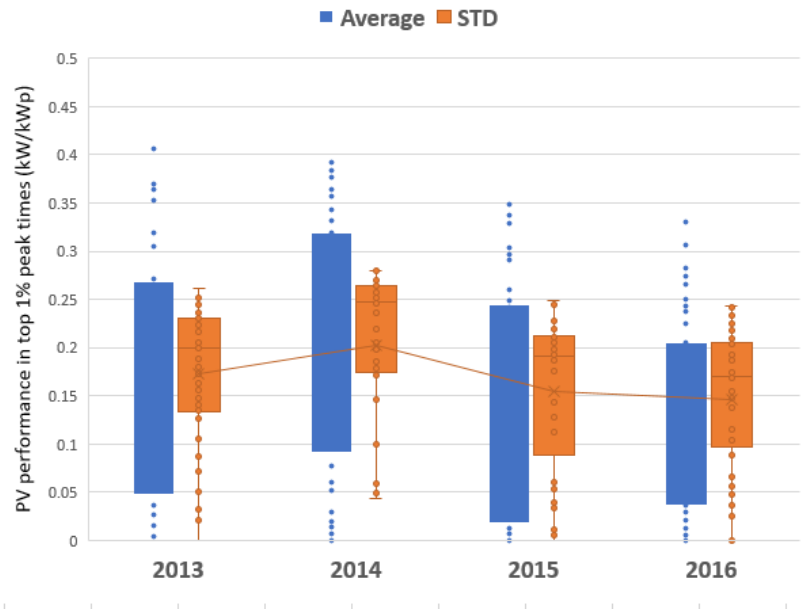


Result

Average PV performance in top 1% of peak times in each year



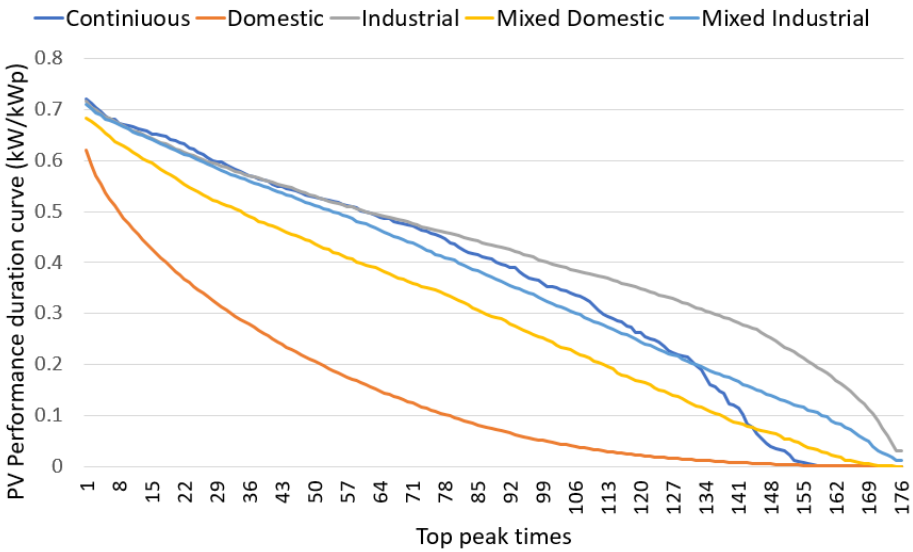
Ausgrid



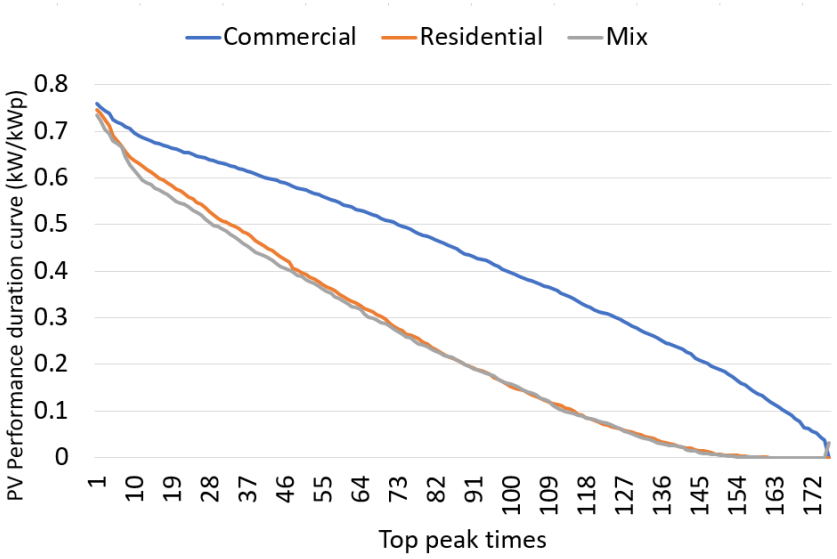
Ausnet

Result

Impact of load type



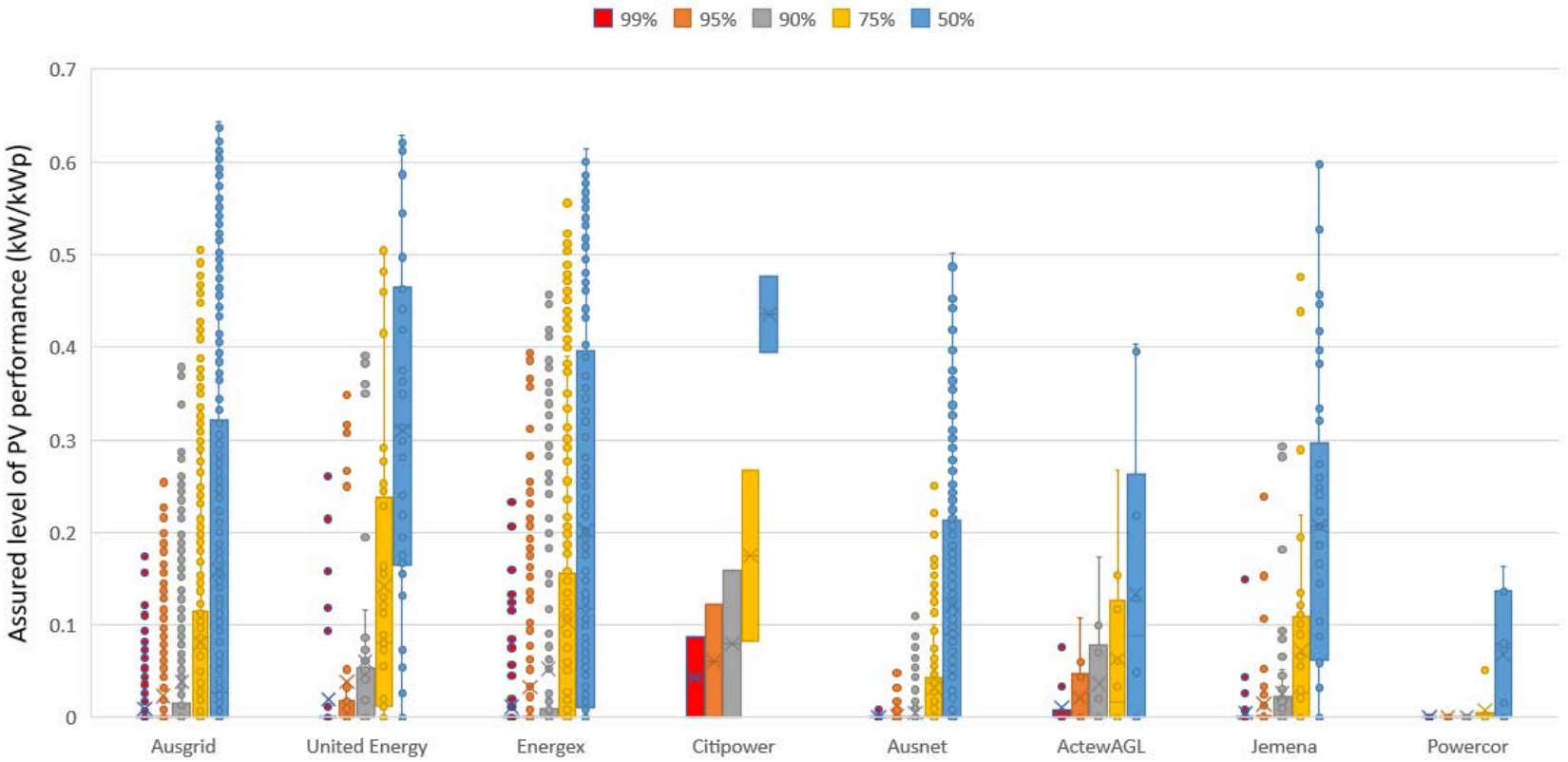
Energex



United Energy

Result

Assured level of PV generation in peak times



Conclusions

- The correlation of PV performance and peak load has been assessed in different zone substations in Australia
- The performance of distributed PV and hence its potential for peak reduction is found to be variable in different locations (most probably due to variable climate and hence load profile)
- The impact can vary between different years (most probably due to the inter-annual variability of load and solar potential)
- The minimum assured level of PV varies between different load types

Thank you!