Daily & Hourly Load Duration Curve Review – 2002 to 2018

Arthur Maniaci

Supervisor, Load Forecasting & Analysis

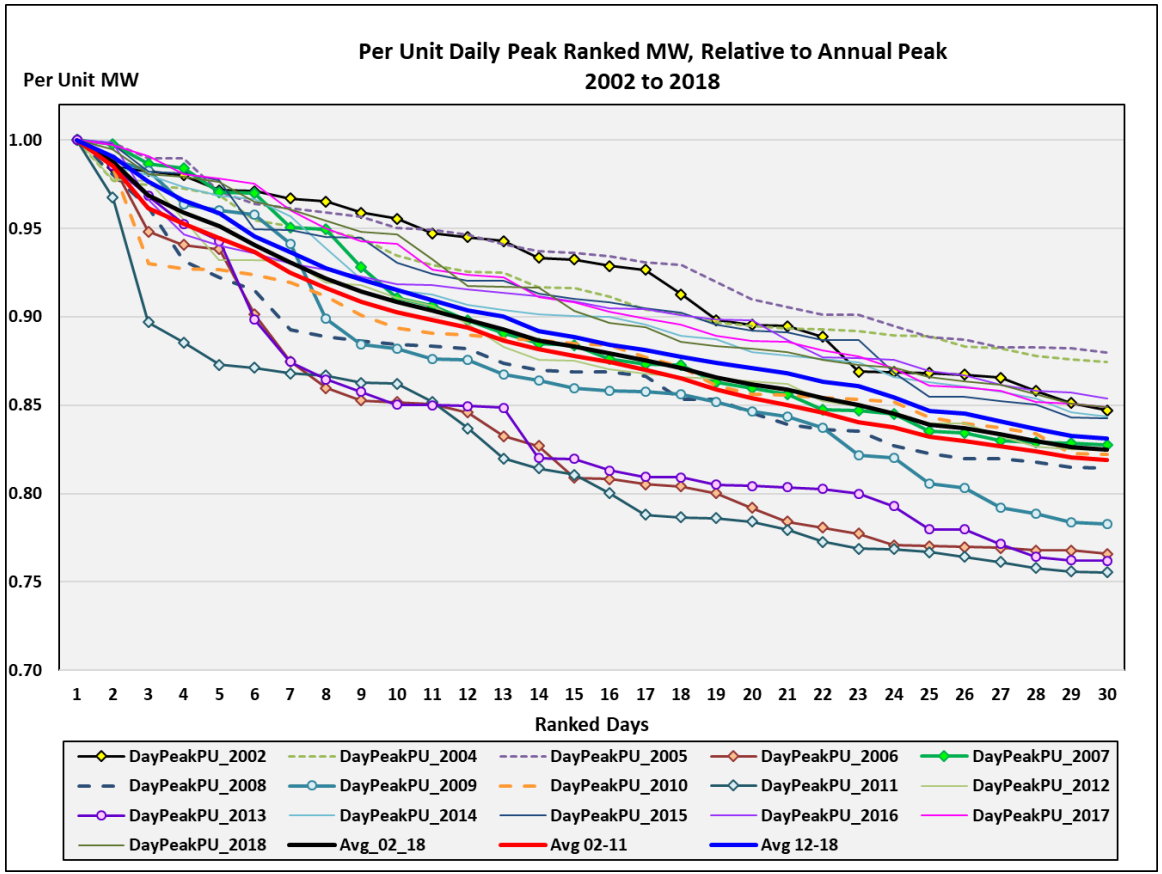
NYSRC – Installed Capacity Subcommittee
Meeting #219

May 1, 2019
NYISO, Rensselaer, NY

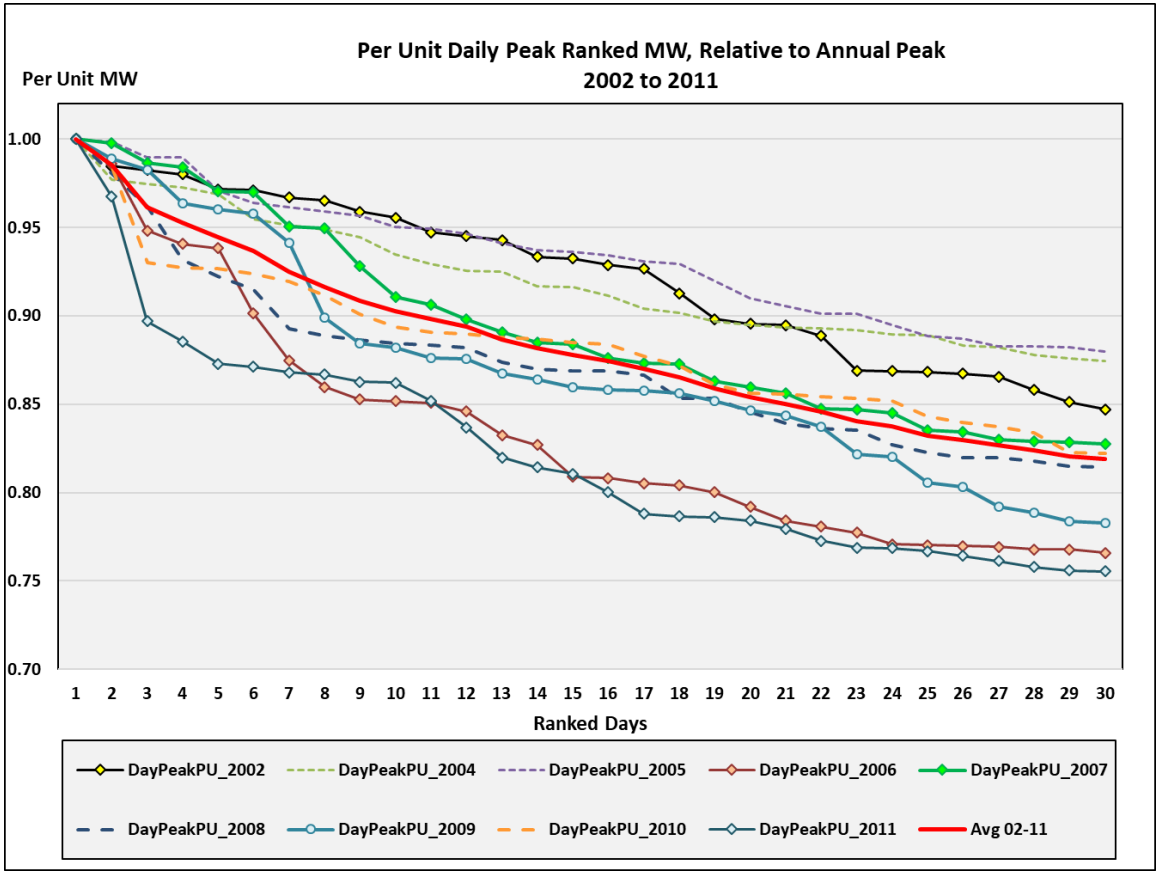
Overview

- This presentation updates the presentation to the ICS on April 3 with the addition of hourly load duration curves.
- Selection of multiple year load shapes was last reviewed with NYSRC in 2012. Using both quantitative metrics and informed judgement, three years were chosen for use in MARS for IRM studies, based on the years 2002 to 2011
  - 2007 – most representative of typical years
  - 2006 – most representative of a year with very hot weather, albeit a small number of high load days
  - 2002 – most representative of a year with many more high load days, though not the year with the highest peak
- Similar analysis has now been updated to include the years 2012 to 2018
- Though the purpose of this presentation is not to recommend new years for use in MARS, a case can be made that:
  - 2012 is similar to 2007
  - 2013 is similar to 2006
  - 2018 is similar to 2002
- NPCC CP-8 Committee just reviewed 2018 & 2002 shapes and selected 2002
  - Report (2018 Load Shape Analysis for NPCC Reliability Assessments) will be posted pending approval, https://www.npcc.org/Library/default.aspx
- Note: All load duration curves have been adjusted to add back the impacts of any NYISO Demand Response Programs

Review of Daily Load Duration Curves

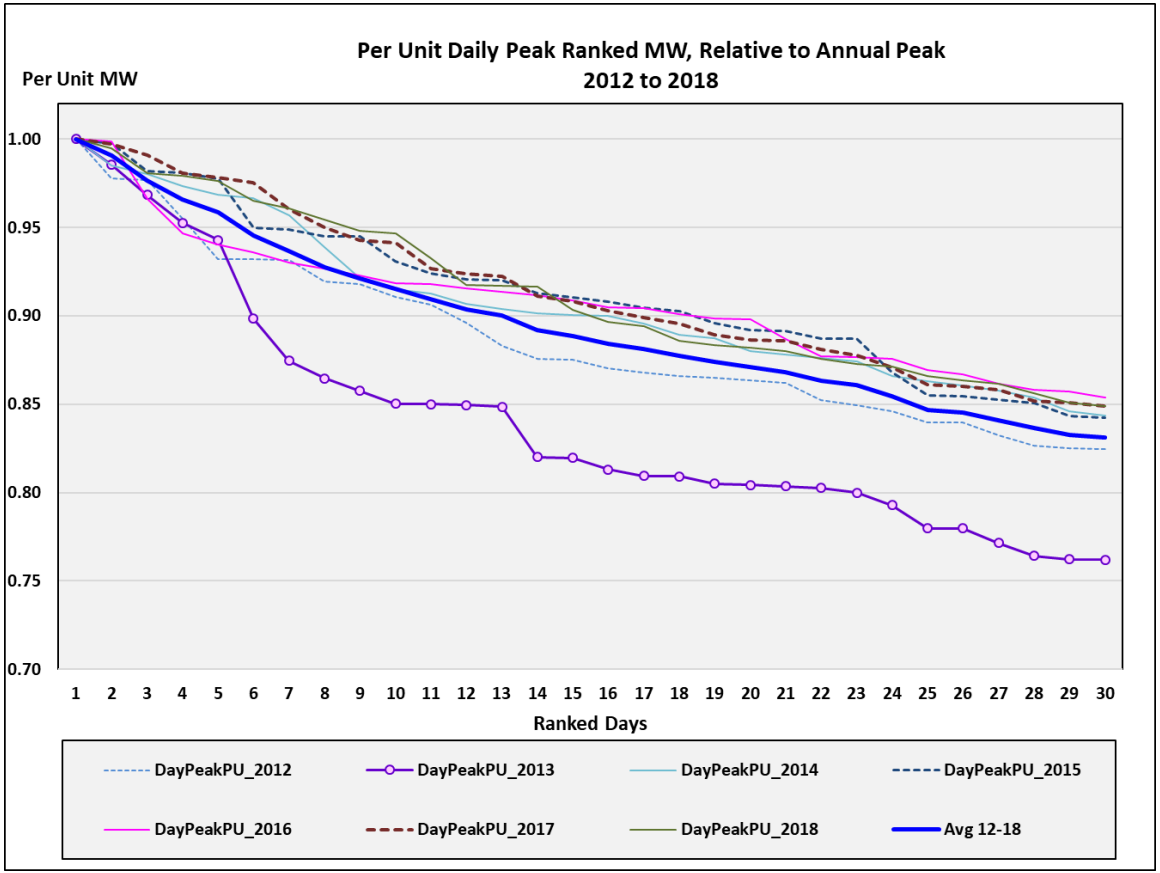


- Per Unit loads (relative to annual peak) of top 30 days
- 2003 omitted (black out year)
- Three averages were calculated: 2002-2011, 2012-2018 and 2002-2018 average. All are very similar.



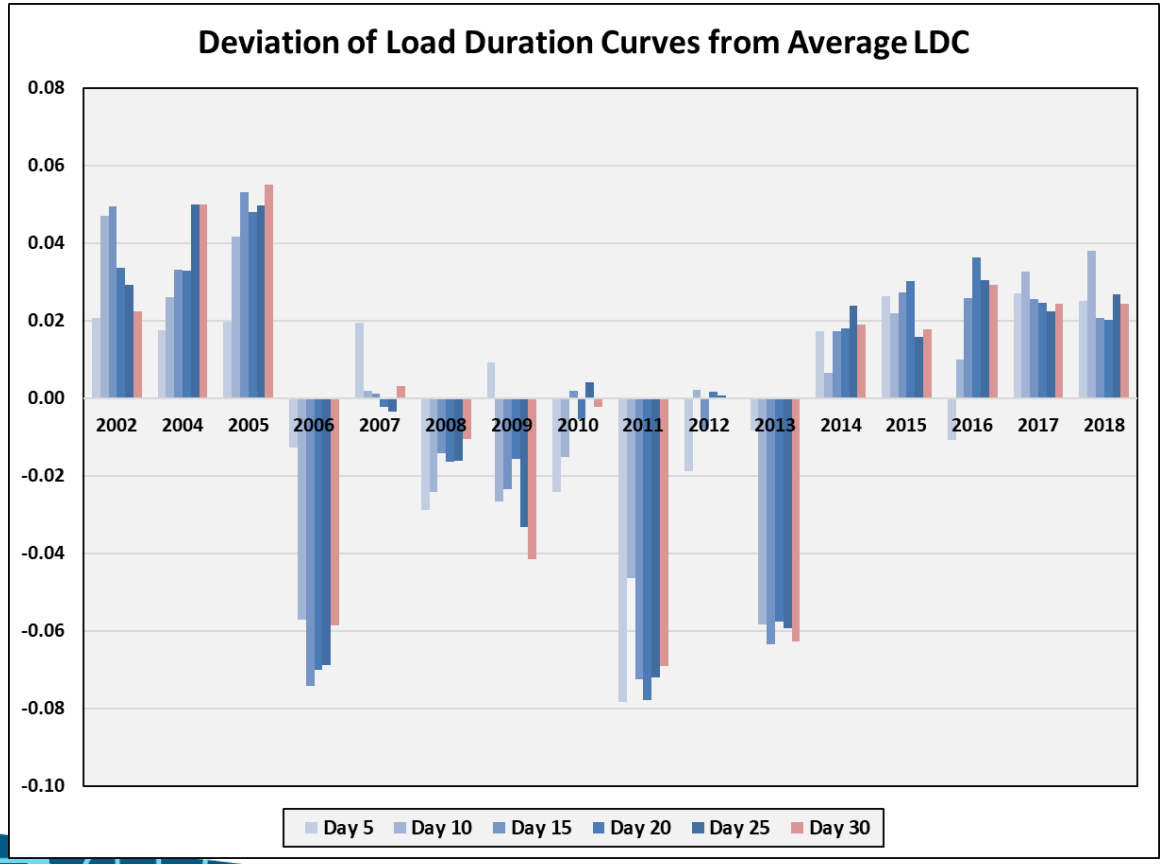
- 2002, 2005- higher number of near peak load days (very gradual decrease in LDC)
- 2006, 2011- extreme peaks observed (sharp decrease in just a few days)
- 2007, 2010, 2014 - close to the average

NEW YORK INDEPENDENT SYSTEM OPERATOR



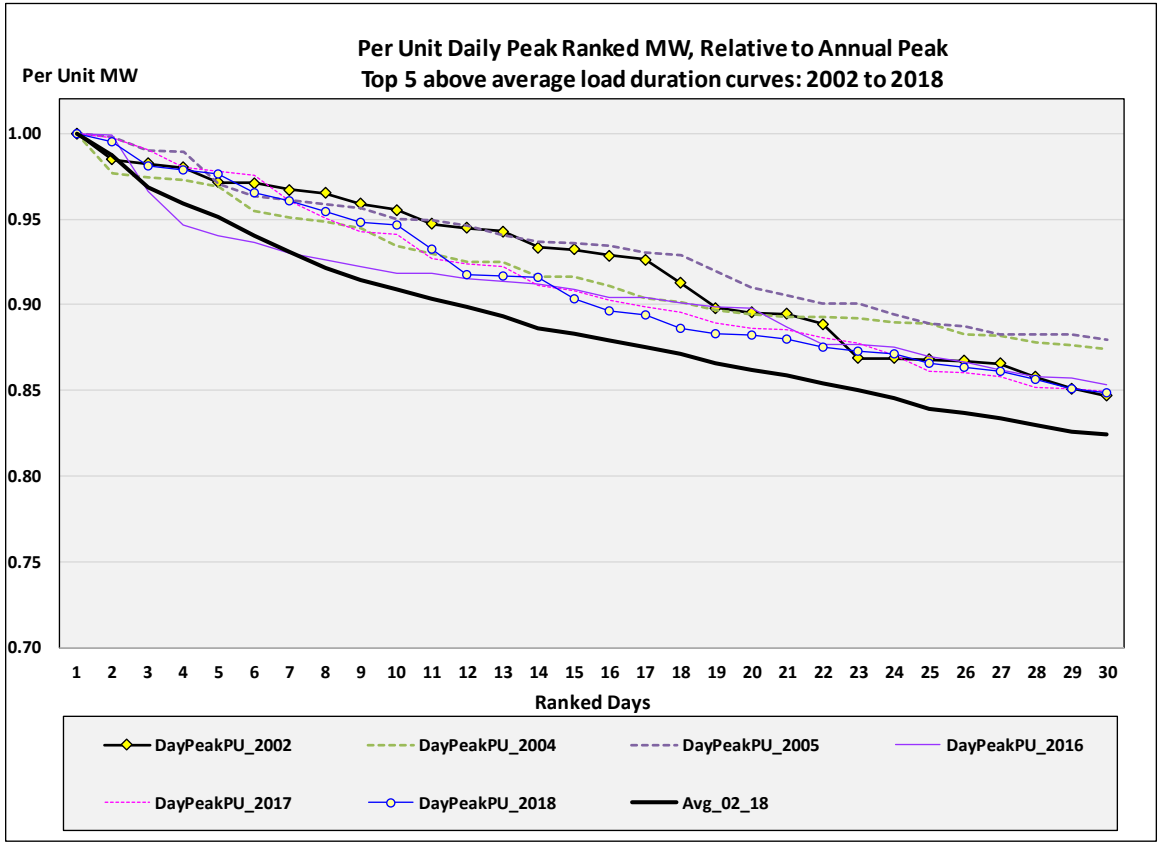
- 2013- extreme peak observed
- 2012- close to the average
- Most years are above average; only one year with a very sharp decrease in per-unit loads.

Deviation of each year's LDC from the average



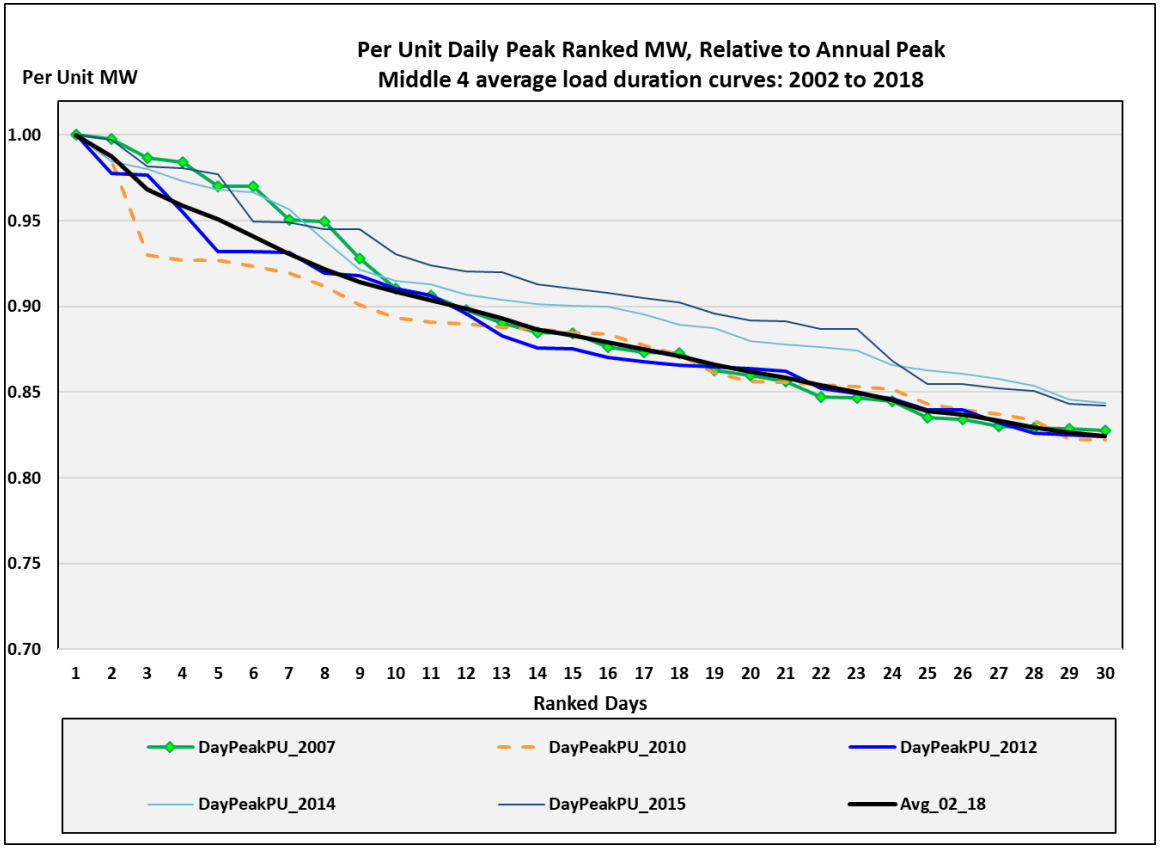
- Allows a closer look at the behavior of each year.
- Good way to classify years
- 2007, 2010, 2012- average load
- 2006, 2011, 2013- extreme peaks observed
- No extreme weather since 2013, hence most years after 2012 have more days above the typical year.
- Therefore, though not as extremely high as 2002 to 2005, they do provide greater stress on the system than 2012, all else equal.

NEW YORK INDEPENDENT SYSTEM OPERATOR



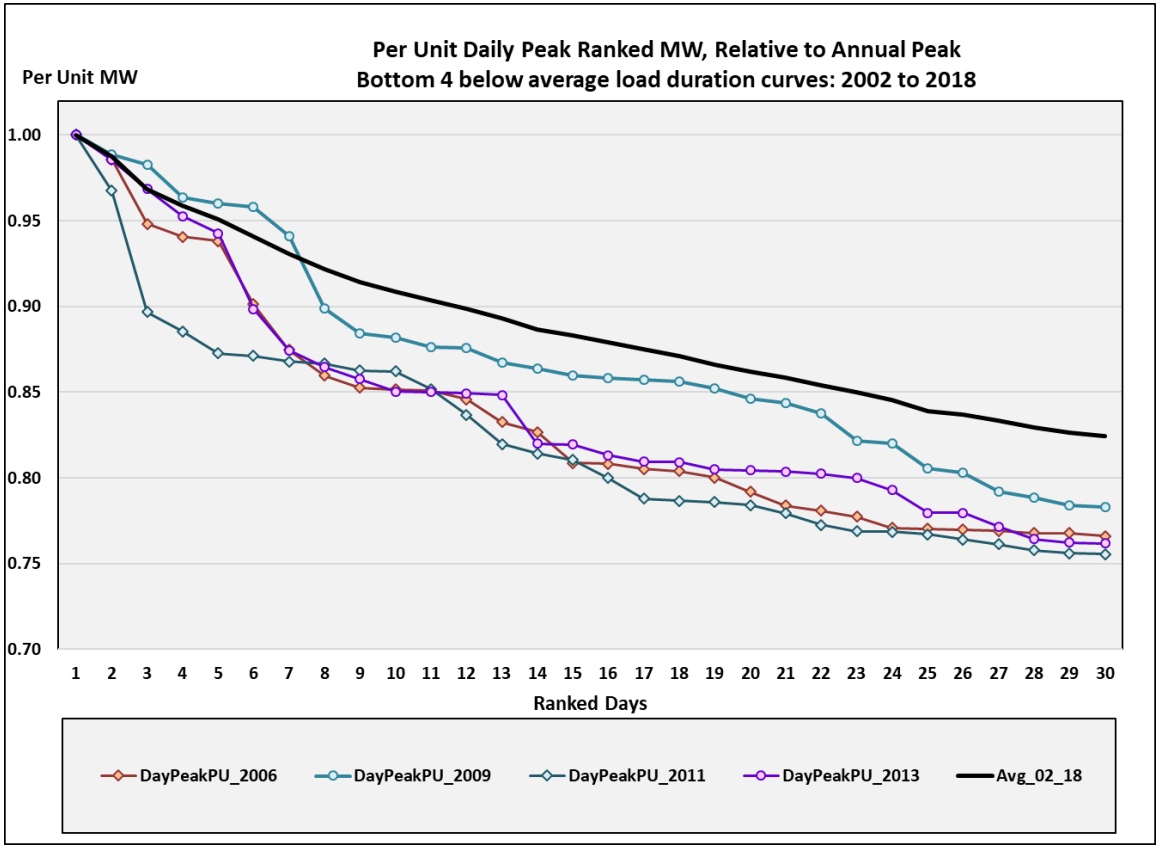
- Three recent above-average years, compared to 2002, 2004 & 2005
- Ranked by taking difference of each LDC with the with PU value of the average of 02-18 on day 30[1]
- 2002, 2005 - more number of near peak load days
- 2018 is very close to 2002 up to day 10, and is virtually the same from day 22 onward

[1] *Ranking with 30-day average produces almost similar results*



- Three recent years near the average, compared to 2007 & 2010
- Ranked with day 30 PU
- 2007, 2010 2012, 2014- very close to the average LDC
- 2012 is very close to average for the largest number of days

NEW YORK INDEPENDENT SYSTEM OPERATOR



- Three below-average years, compared to 2006
- Ranked with day 30 PU
- 2006, 2011, 2013- extreme days observed
- 2011 has the steepest behavior

NEW YORK INDEPENDENT SYSTEM OPERATOR

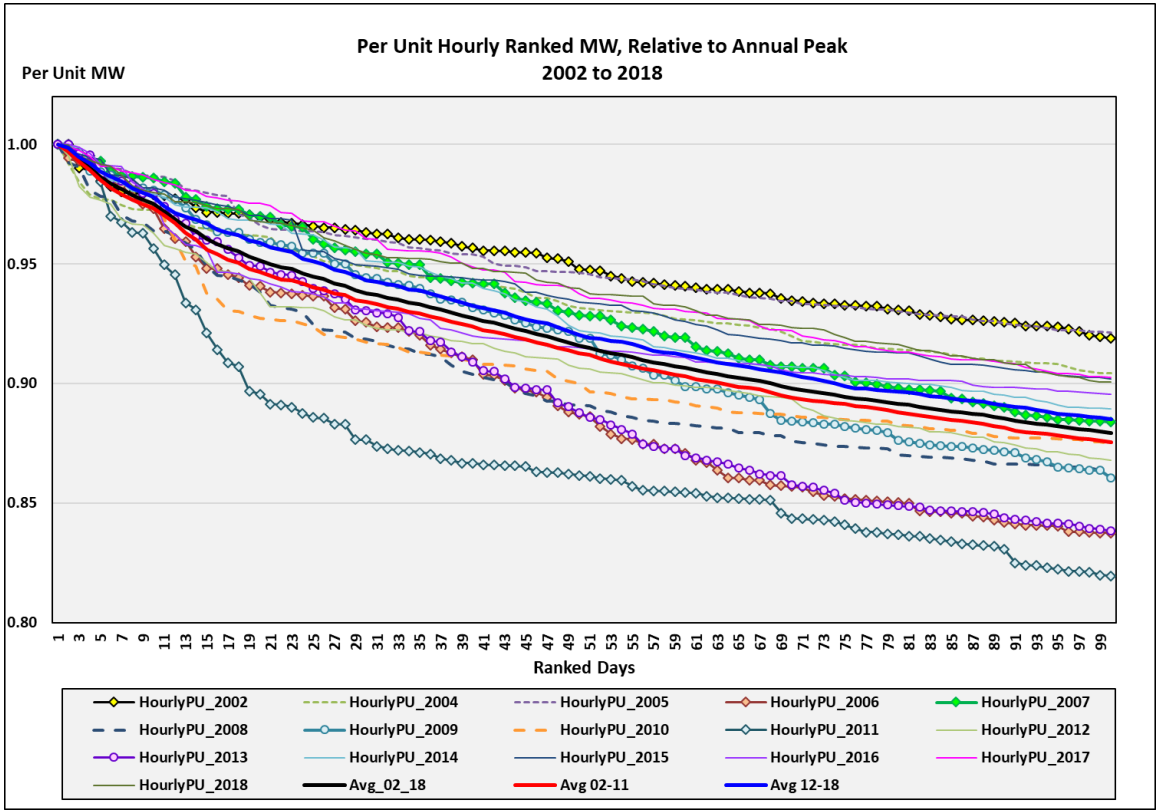
Annual Load Duration Curve & Peak Weather Metrics with Rankings

Year	10-day Load Factor	Peak CTHI	Rank LF	Rank CTHI
2002	0.974	83.28	15	10
2004	0.963	81.18	10	14
2005	0.974	83.38	16	9
2006	0.915	88.02	2	1
2007	0.965	82.68	11	12
2008	0.926	84.55	4	6
2009	0.946	82.44	7	13
2010	0.932	86.43	5	4
2011	0.895	87.54	1	2
2012	0.945	83.96	6	7
2013	0.919	86.71	3	3
2014	0.961	80.5	9	16
2015	0.966	82.82	12	11
2016	0.949	83.84	8	8
2017	0.972	80.79	14	15
2018	0.971	85.12	13	5

- Comparison of the load duration curve to the peak-day weather for that year.
- The highest 3 years for peak loads and weather all had the load duration curves which had the steepest descent.
- This type of load duration curve is most characteristic of load behavior during extreme weather conditions.

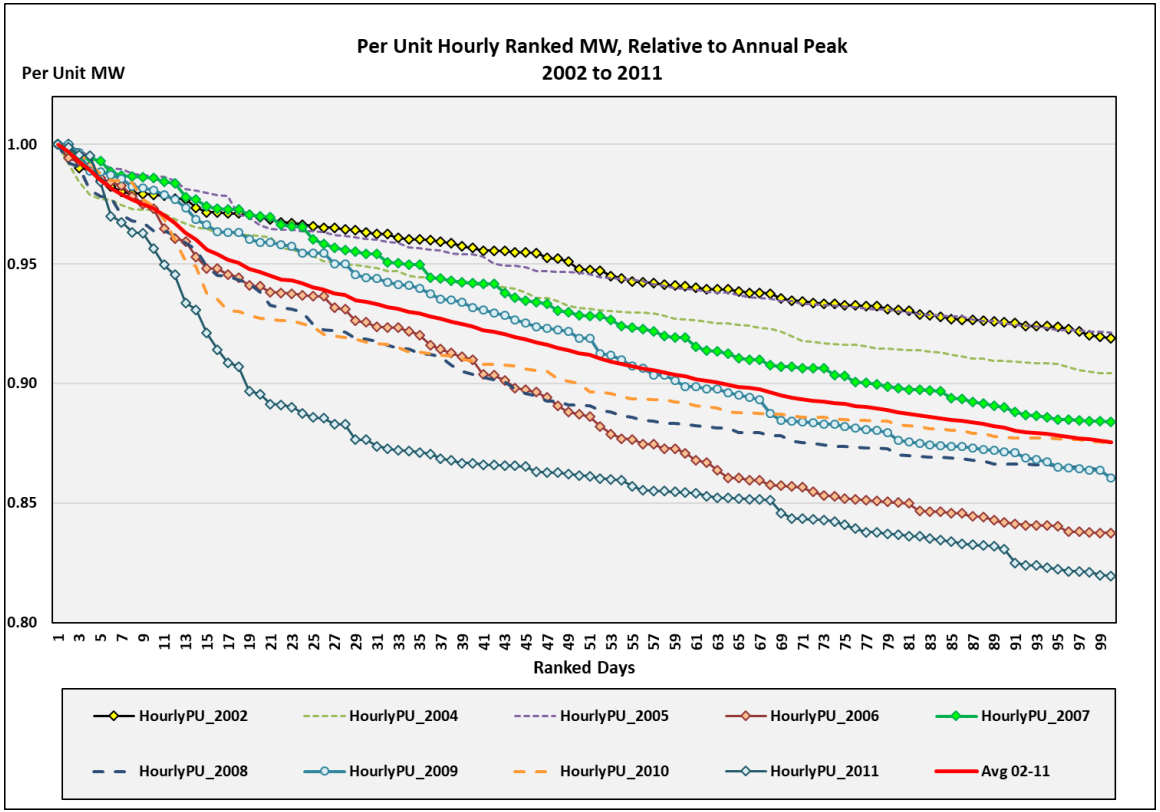
NEW YORK INDEPENDENT SYSTEM OPERATOR

Review of Hourly Load Duration Curves



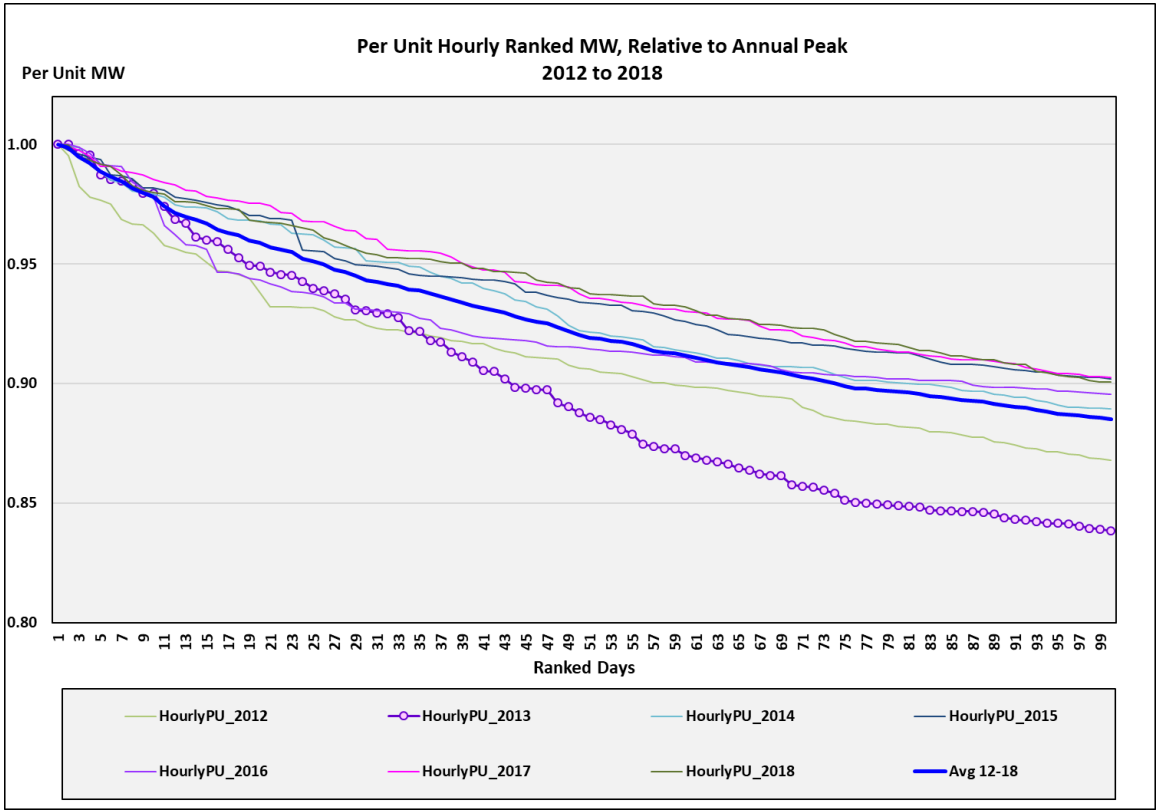
- Per Unit loads (relative to annual peak) of top 100 hours
- 2003 omitted (black out year)
- Three averages were calculated: 2002-2011, 2012-2018 and 2002-2018 average. All are very similar.

NEW YORK INDEPENDENT SYSTEM OPERATOR



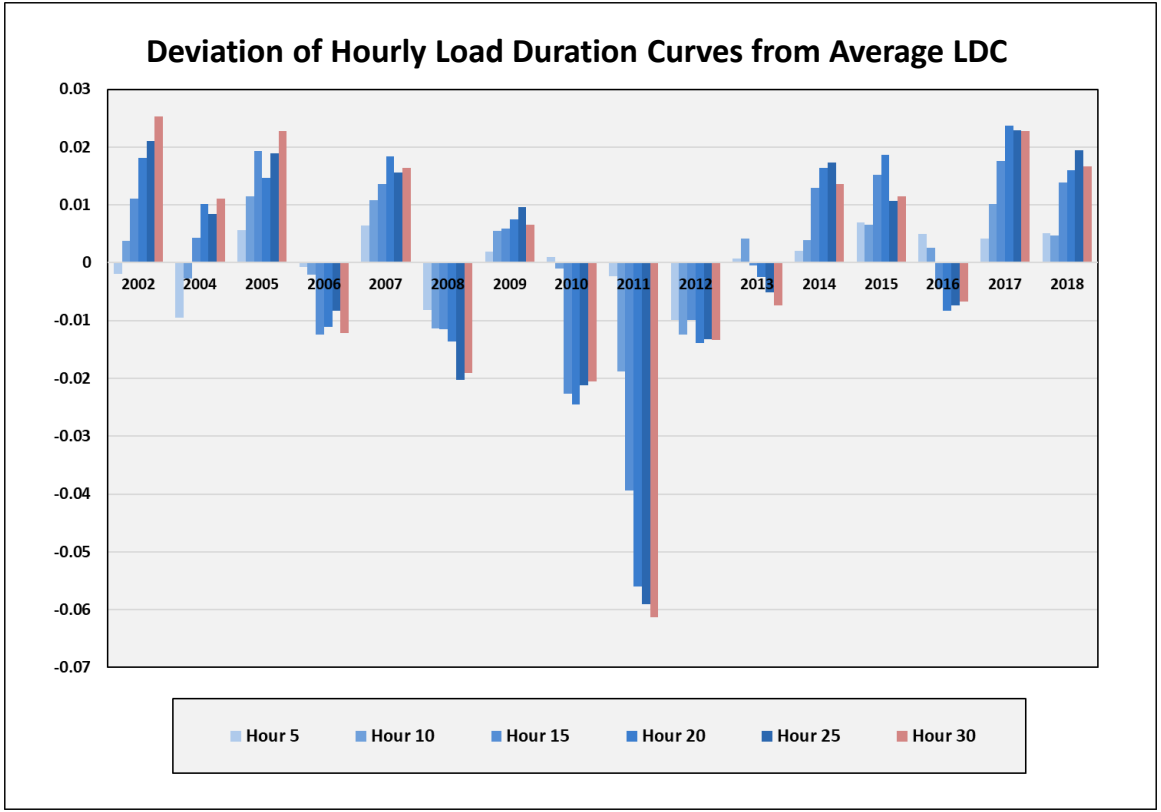
- 2002, 2005 - higher number of near peak load days (very gradual decrease in LDC)
- 2011- extreme peaks observed (sharp decrease in first 20 hours)
- 2006 - close to average up-to about 25 hours followed by gradual decrease, implies more number of extreme hours.
- 2009 - close to the average

NEW YORK INDEPENDENT SYSTEM OPERATOR



- 2013 – first 16 hours were very high in MW values, since 2013 set the all-time highest peak. All higher hours were therefore much below average.
- Most years are above average; only one year with a very sharp decrease in per-unit loads.

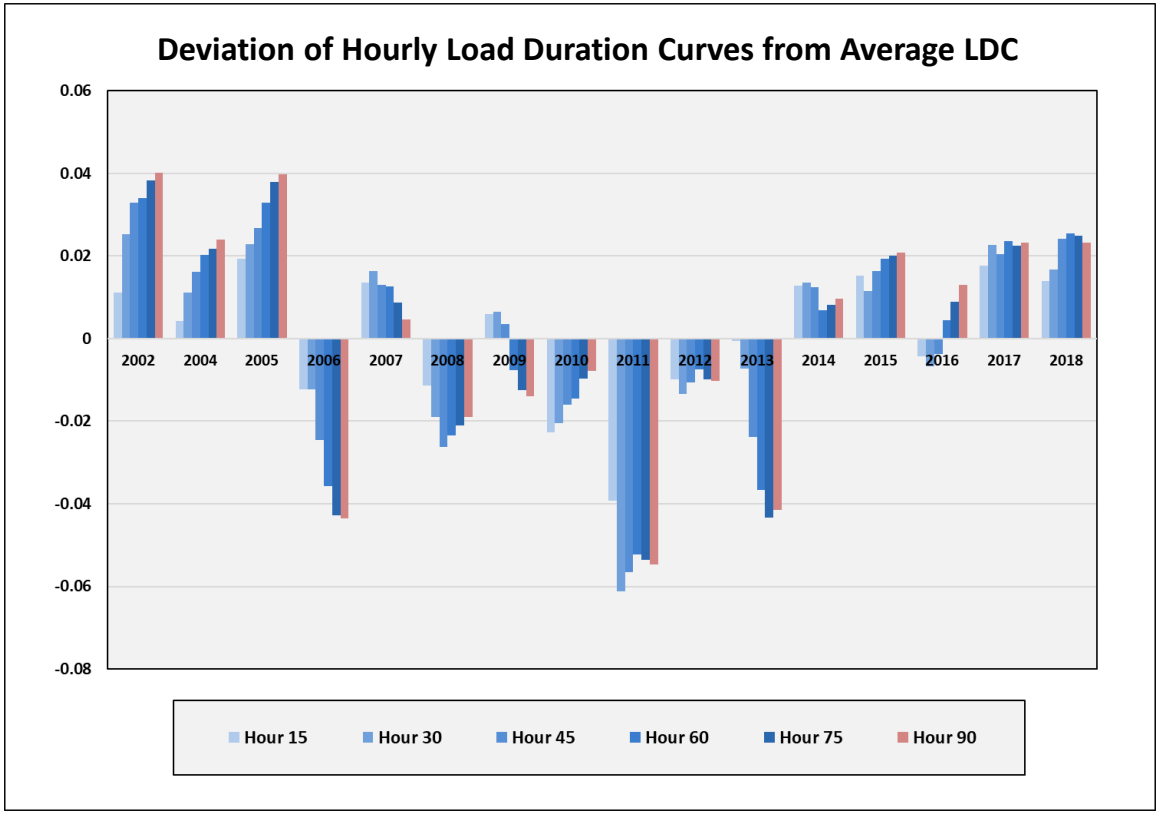
Deviation of each year's LDC from the average: 0 to 30 hours



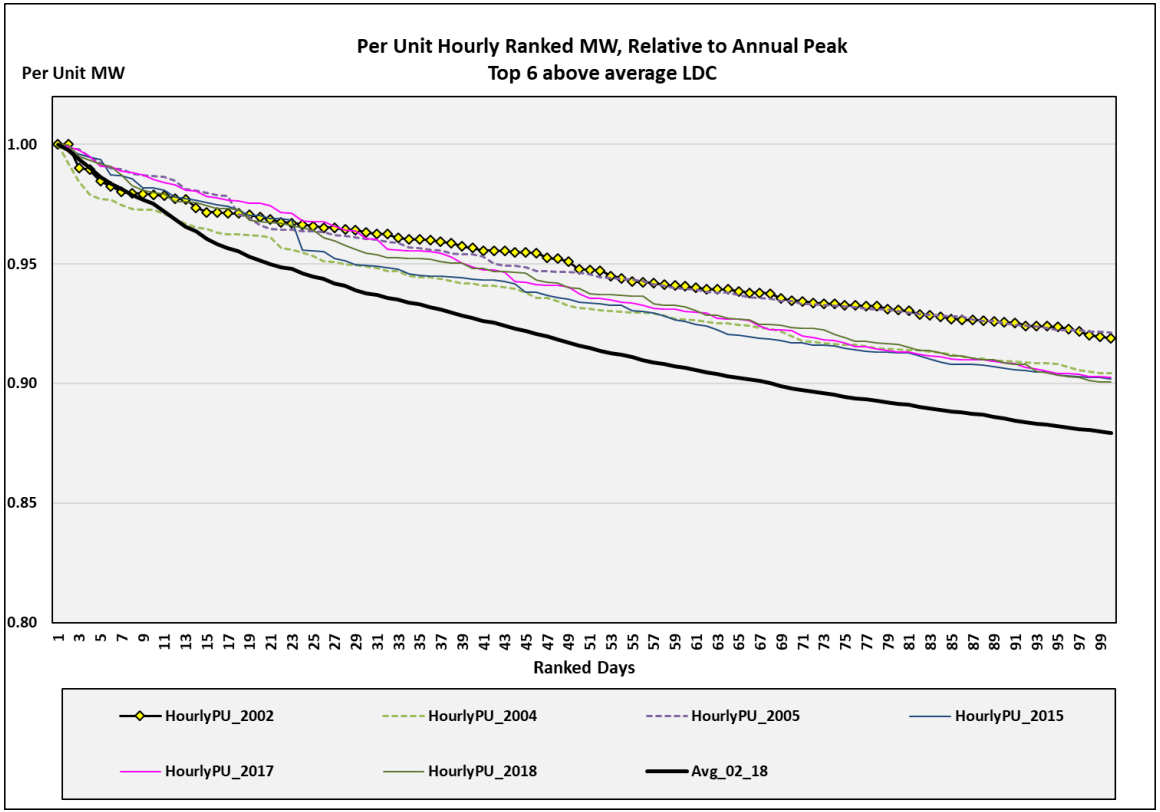
- Allows a closer look at the behavior of each year.
- Good way to classify years
- Top 30 hours are too few to classify entire year.
- 2007, 2010, 2012- average load
- 2006, 2011, 2013- extreme peaks observed
- No extreme weather since 2013, hence most years after 2012 have more days above the typical year.
- Therefore, though not as extremely high as 2002 to 2005, they do provide greater stress on the system than 2012, all else equal.

NEW YORK INDEPENDENT SYSTEM OPERATOR

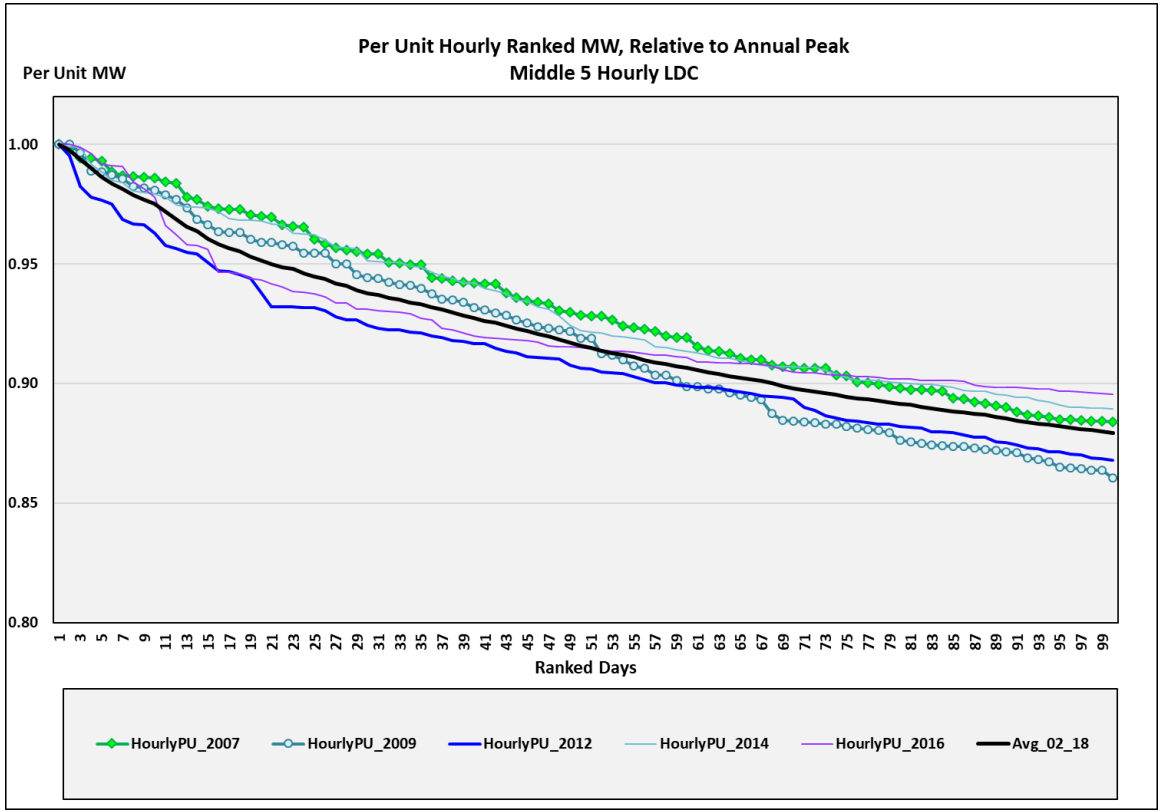
Deviation of each year's LDC from the average: 0 to 90 hours



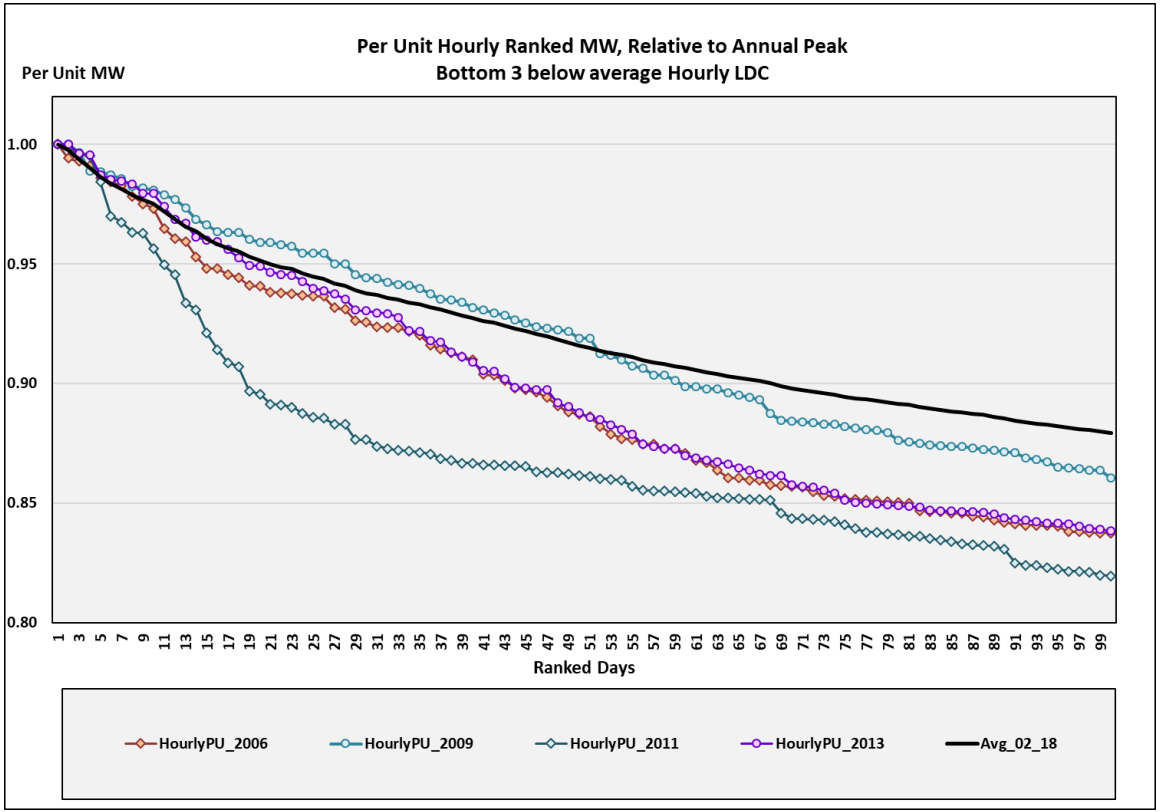
- Allows a closer look at the behavior of each year.
- Top 90 hours only.
- Good way to classify years
- 2007, 2009- average load
- 2006, 2011, 2013- extreme peaks observed
- No extreme weather since 2013, hence most years after 2012 have more days above the typical year.
- Therefore, though not as extremely high as 2002 to 2005, they do provide greater stress on the system than 2012, all else equal.
- Daily loads up to 30 days seem to provide a better way to classify than top 90 hours



- Top 6 recent years
- Ranked with top 100 hours average
- 2002 & 2005 - higher number of near peak load days
- 2015, 2017, 2018- virtually the same after hour 35



- Middle five recent years
- Ranked based on average of 100 hours
- 2009 is very close to average for the first 50 hours
- 2007 is closer to the average in hour 50-100



- **Bottom three recent years**
  - 2009 for comparison with daily LDC
- **2006, 2011, 2013- extreme days observed**
- **2011 has the steepest behavior**

NEW YORK INDEPENDENT SYSTEM OPERATOR

Hourly LDC & Peak Weather Metrics with Rankings

Year	Avg PU top 100 Hours	Peak CTHI	Rank Avg PU top 100 Hours	Rank CTHI
2002	0.95	83.28	16	10
2004	0.94	81.18	11	14
2005	0.95	83.38	15	9
2006	0.90	88.02	2	1
2007	0.93	82.68	10	12
2008	0.90	84.55	4	6
2009	0.92	82.44	7	13
2010	0.91	86.43	5	4
2011	0.87	87.54	1	2
2012	0.91	83.96	6	7
2013	0.90	86.71	3	3
2014	0.93	80.5	9	16
2015	0.94	82.82	12	11
2016	0.92	83.84	8	8
2017	0.94	80.79	14	15
2018	0.94	85.12	13	5

- Comparison of the load duration curve to the peak-day weather for that year.
- The highest 3 years for peak loads and weather all had the load duration curves which had the steepest descent.
- This type of load duration curve is most characteristic of load behavior during extreme weather conditions.
- Similar to rankings using 30-day LDCs.

NEW YORK INDEPENDENT SYSTEM OPERATOR

Questions?

NEW YORK INDEPENDENT SYSTEM OPERATOR

The Mission of the New York Independent System Operator, in collaboration with its stakeholders, is to serve the public interest and provide benefits to consumers by:

- Maintaining and enhancing regional reliability
- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policy makers, stakeholders and investors in the power system

www.nyiso.com

NEW YORK INDEPENDENT SYSTEM OPERATOR