

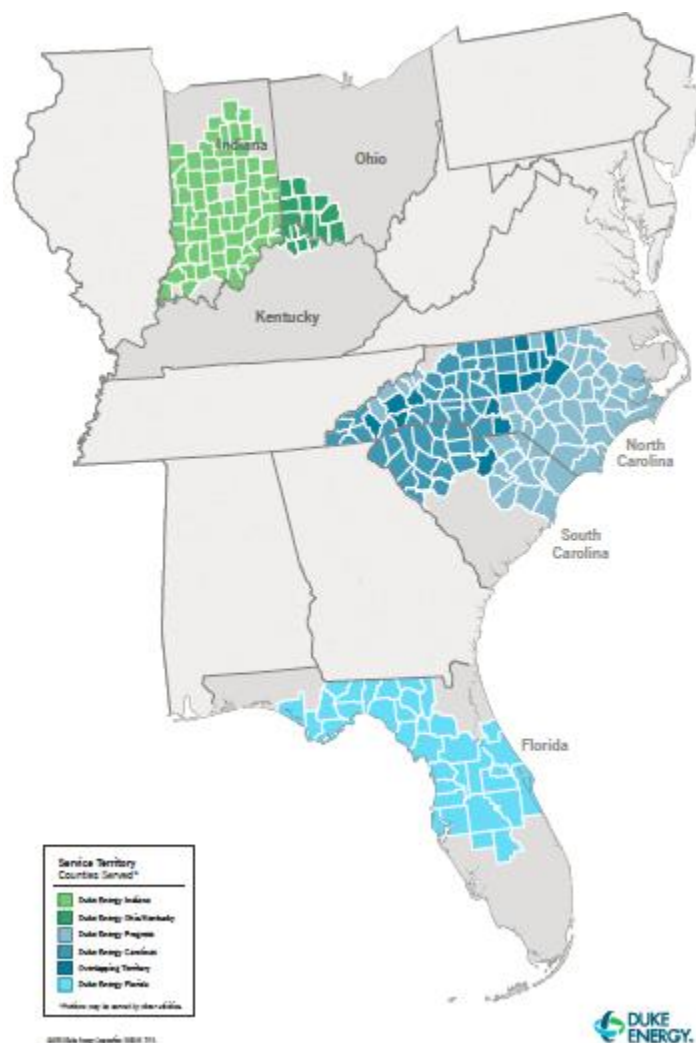


# DEP System Impacts from the Solar Eclipse

August 21<sup>st</sup>, 2017

The Lead Up

# Connected Solar Generation in Duke Energy



Region	Connected Solar (Nameplate MW)
<b>DEC</b> (Carolinas West)	<b>693</b>
<i>Transmission</i>	228
<i>Distribution</i>	465
<b>DEF</b> (Florida)	<b>64</b>
<b>DEK; DEI; DEO</b> (Kentucky, Indiana, Ohio)	<b>66</b>
<b>DEP</b> (Carolinas East)	<b>1,836</b>
<i>Transmission</i>	525
<i>Distribution</i>	1154
<i>Wholesale</i>	157
<b>Duke Energy Total</b>	<b>2,659</b>

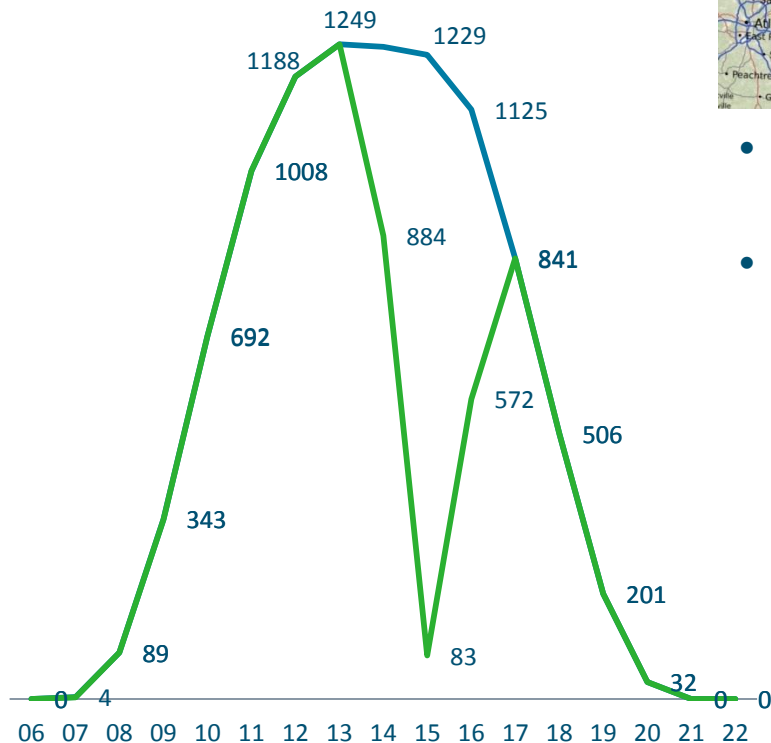
# Event Details

- Event Window:
  - Started  $\approx$  13:30 EPT
  - Maximum  $\approx$  14:46 EPT
  - Ended  $\approx$  16:00 EPT
- Eclipse path projections
  - DEP was in the 90-95% obscuration region
  - Weighted average impact around 93% obscuration
- Planned Expectations
  - Load increase
  - Temperature drop between 5°F and 7°F
- DEP Curtailed or “Turned Down” all Transmission-Connected Solar sites ahead of event

# Eclipse Full Obscuration Path and Solar Projection

## DEP BA Solar Output Forecast

— Base Solar [MW] — Eclipse Solar [MW]



- Projected a 93% drop in solar output (correlated to 93% average obscuration)
- Forecast includes only non-curtailed solar

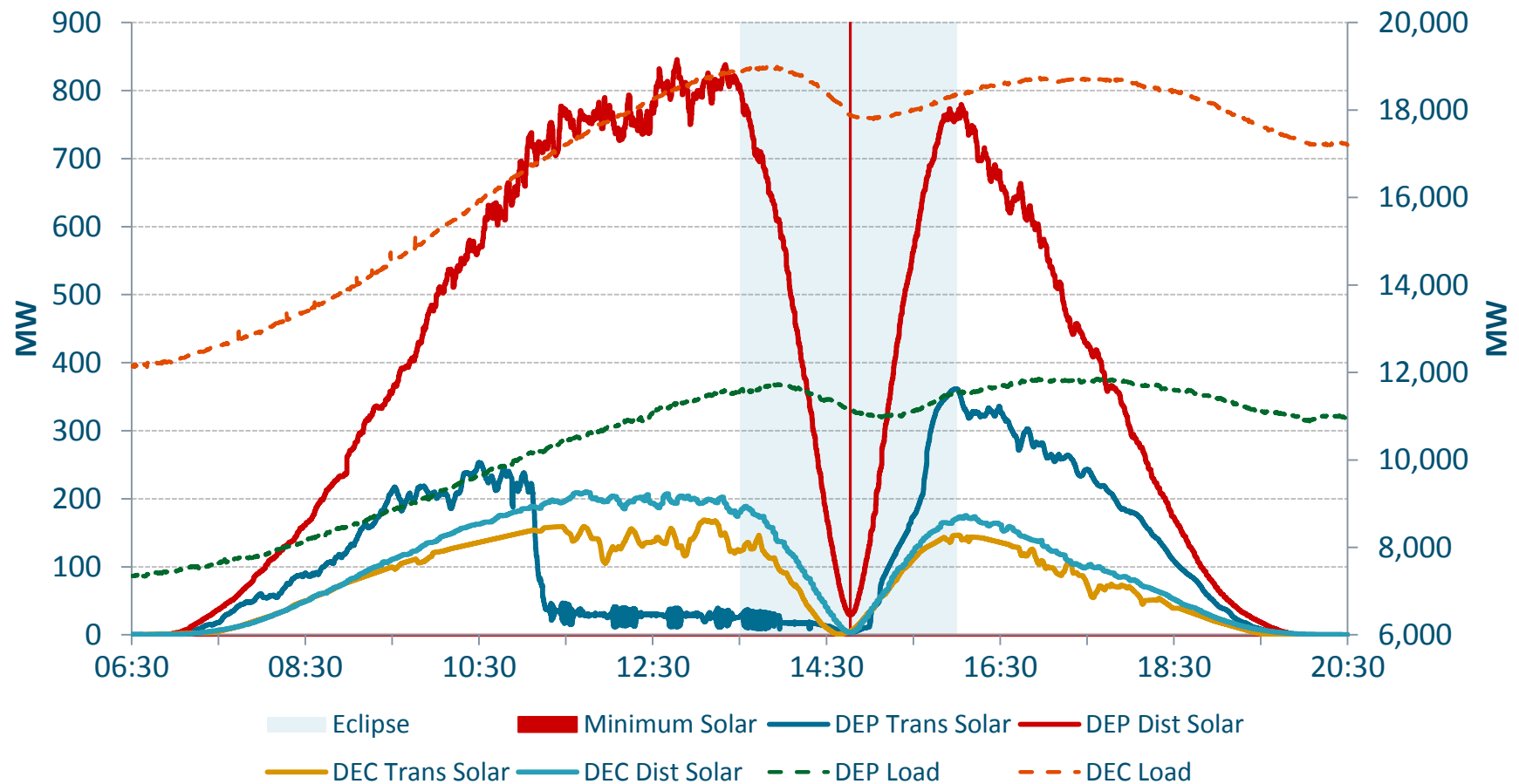
# The Results

# Results

- Reduction of solar MW output around the same percentage as the weighted obscuration
  - Projected 93%
  - Actual 97%
- Solar reductions
  - Transmission: 2 MW (turned back on at peak obscuration)
  - Distribution: 809 MW
- System Average Temperature dropped 7°F (90.3°F to 83.3°F)

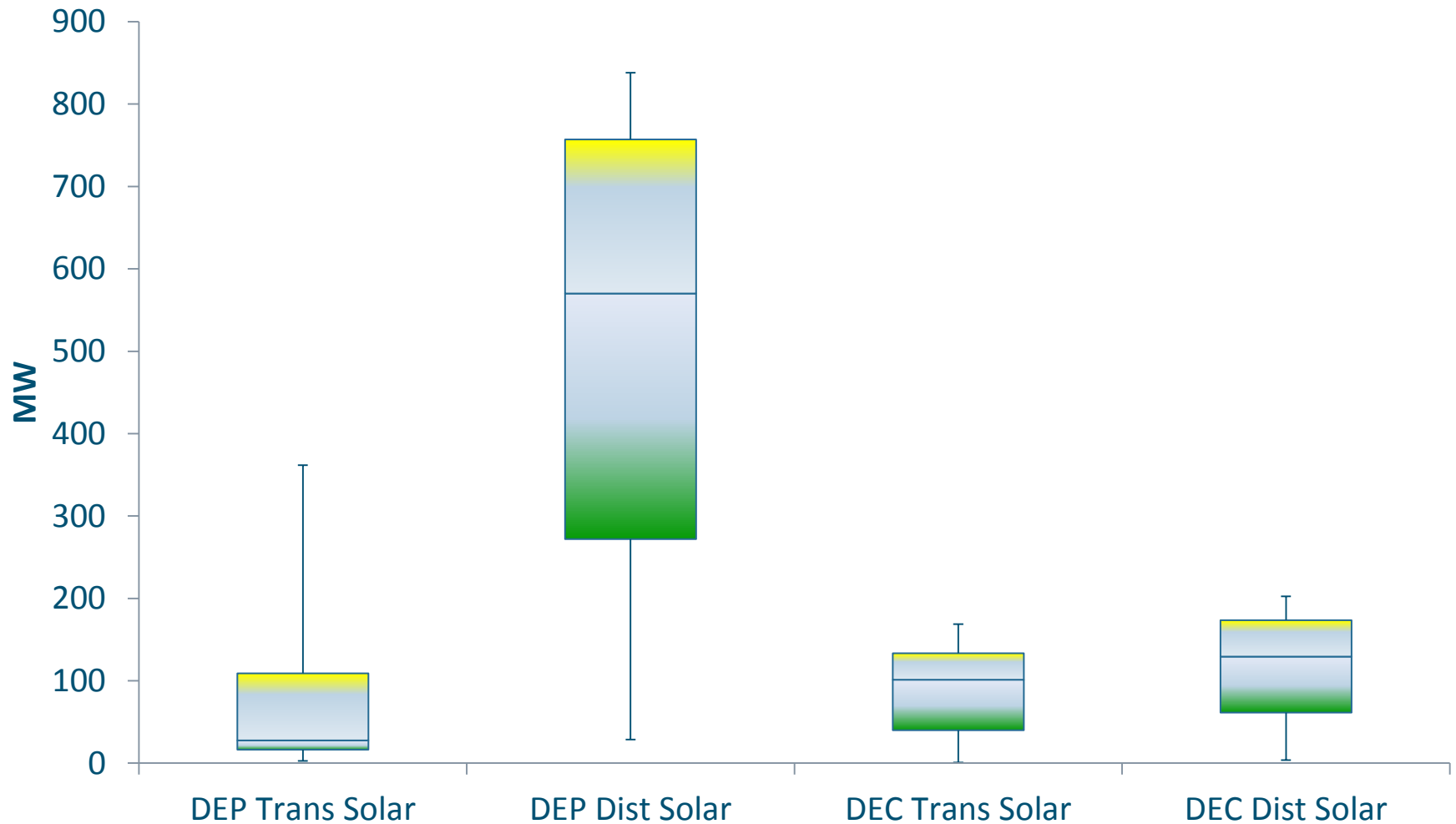
# Solar Profiles During Eclipse (DEC & DEP)

## Duke Energy Solar Profiles (DEC & DEP)



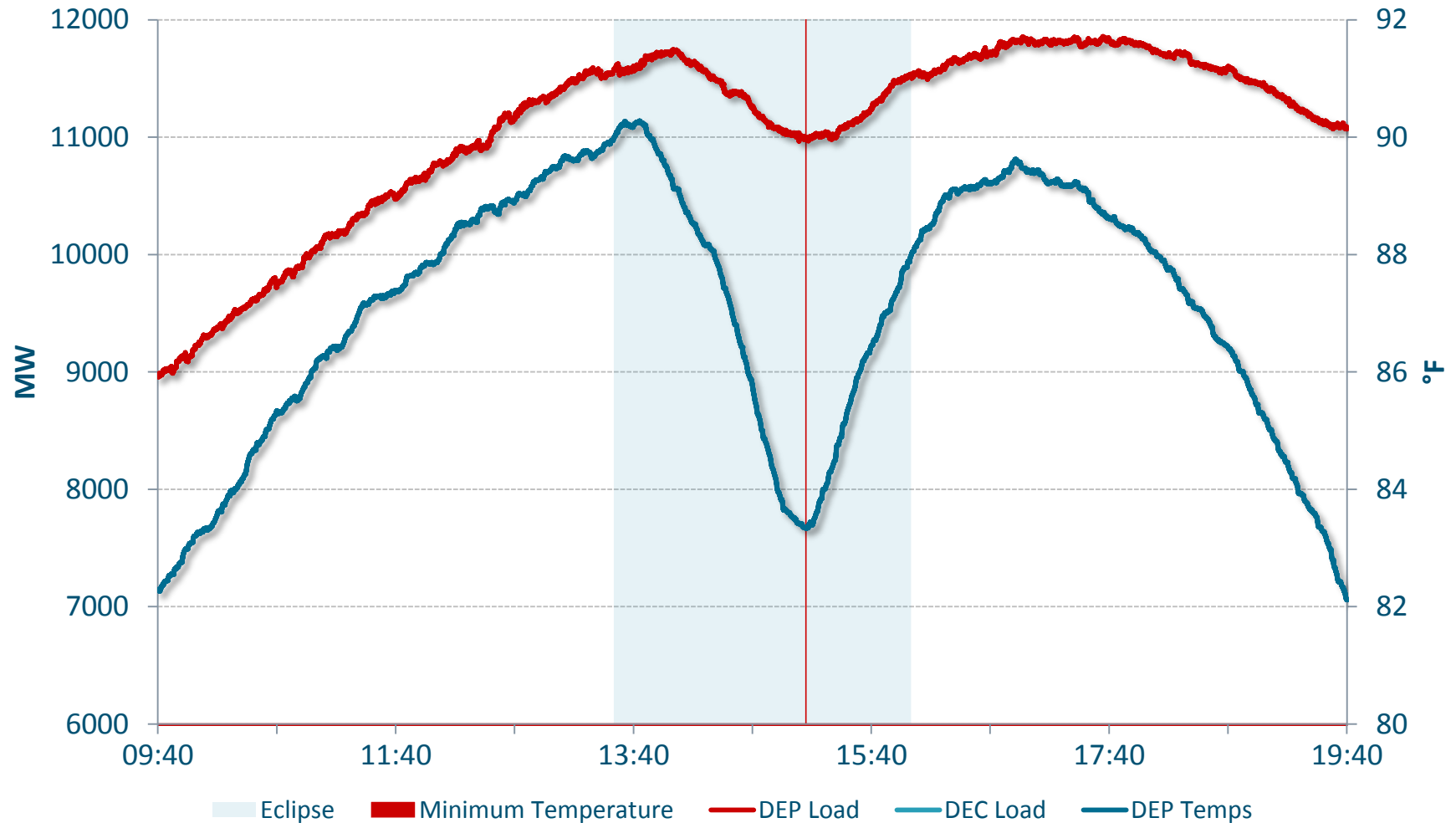


# Solar Variation During Eclipse

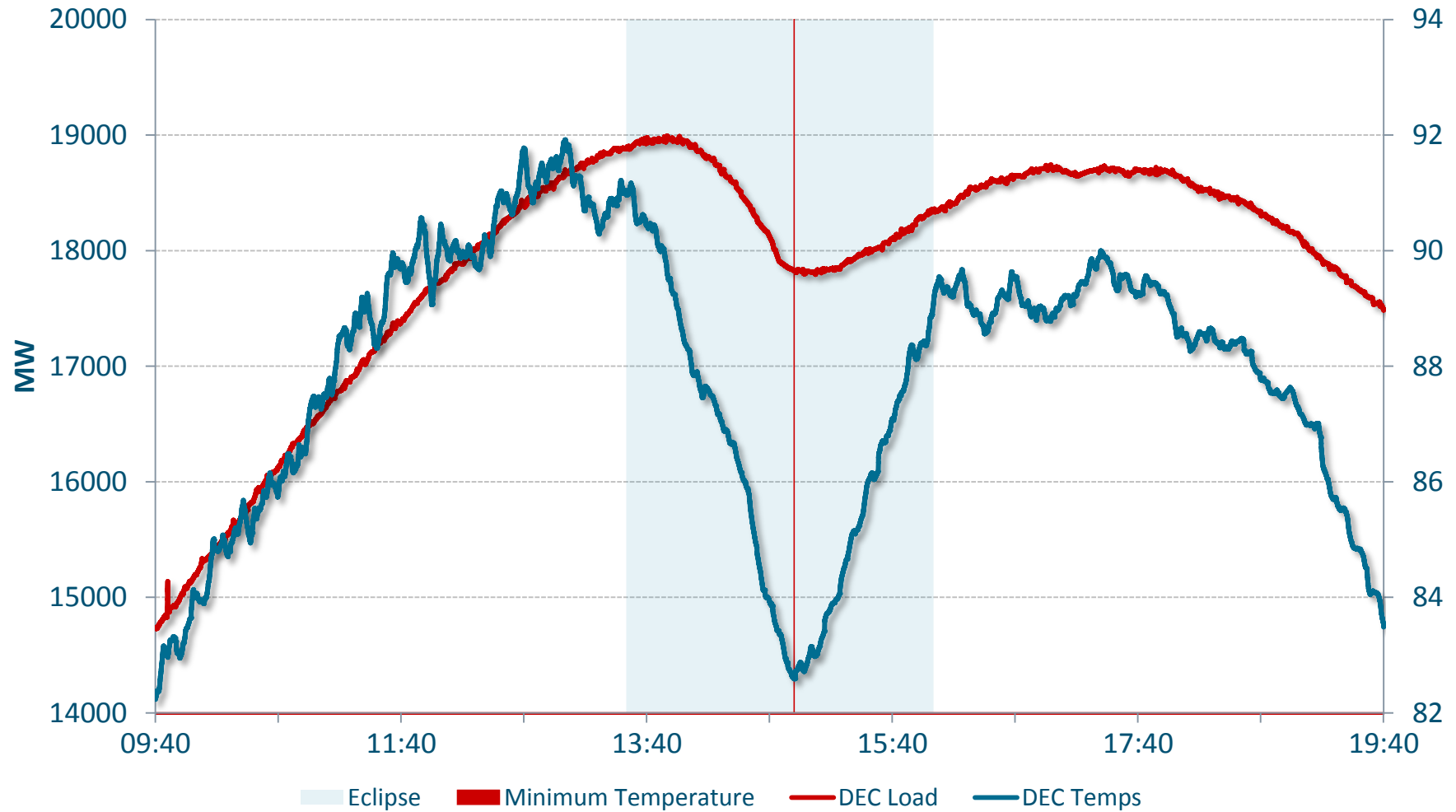


Note: DEP Transmission Solar change is due to restoring sites after eclipse.

# Load and System Average Temperatures (DEP)

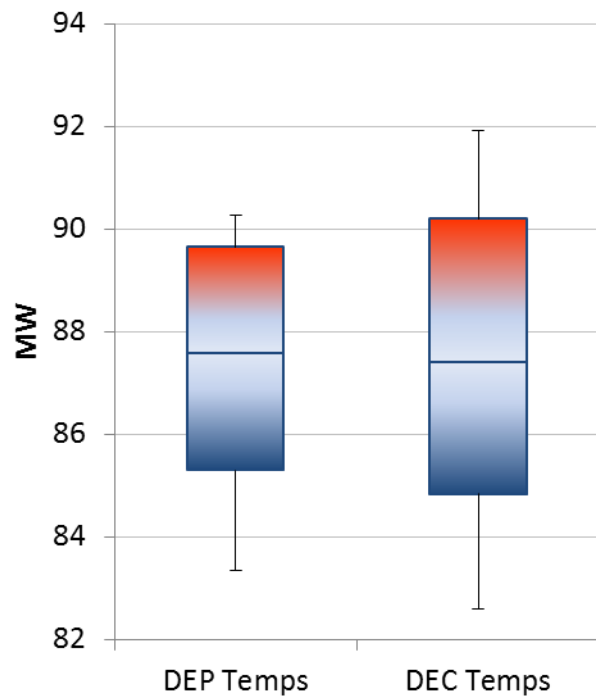


# Load and System Average Temperatures (DEC)

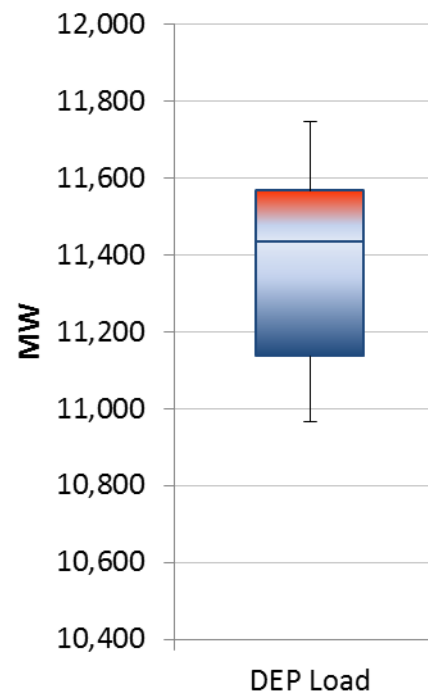


# Temperature and Load Variations

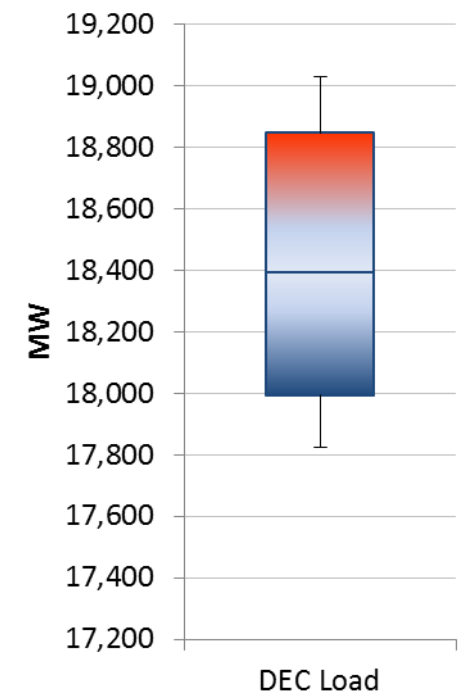
## Temperature Variations



## DEP Load Variation



## DEC Load Variation



# Lessons Learned

- Influences on Customer Demand
  - DEP Load dropped ~781 MW during the event
  - Load minimum occurred @ ~15:07 (21 minutes after solar minimum) and was coincident with ambient temperature minimum
- Solar Output Forecast was fairly accurate
- Real-Time solar generation telemetry was beneficial
- Awareness of resource curtailment capabilities (active power curtailment) and protocols was helpful
- Maintaining flexible reserve plans was important
- Prior planning and awareness of impacts important