

Revealing Occupancy Diversity Factors in Buildings Using Sensor Data

Pierrick Bouffaron

California Institute for Energy & Environment (CIEE)

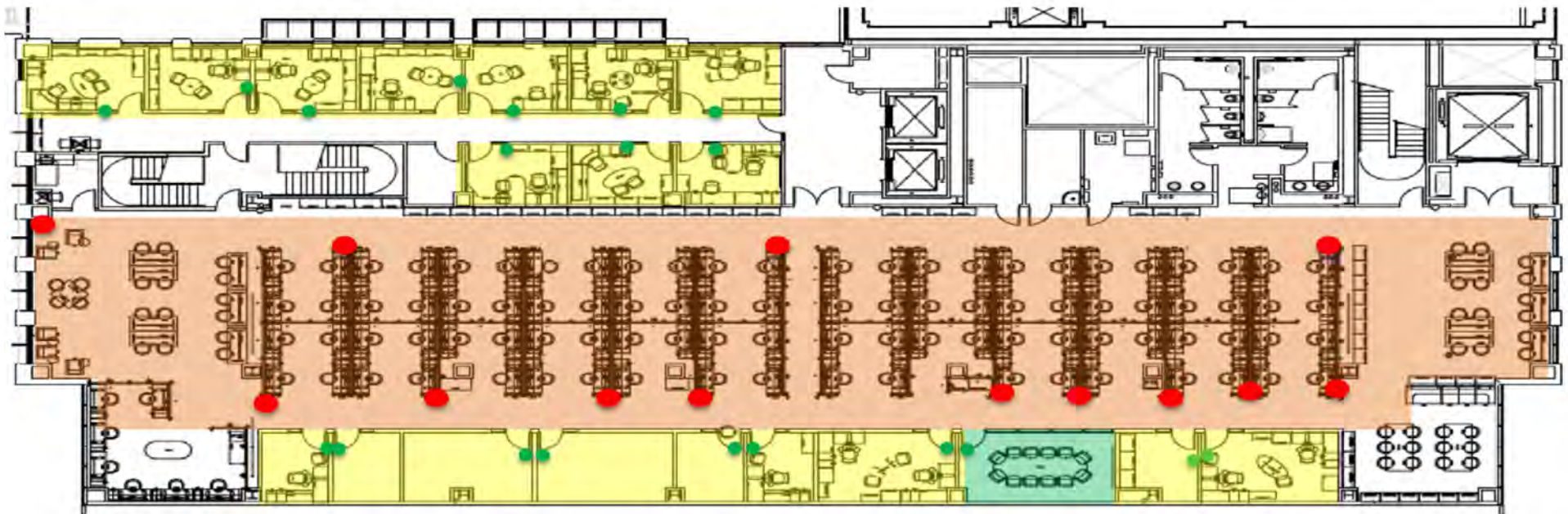
BECC 2014 - December 08, 2014



Credits: MDG UN, 2012



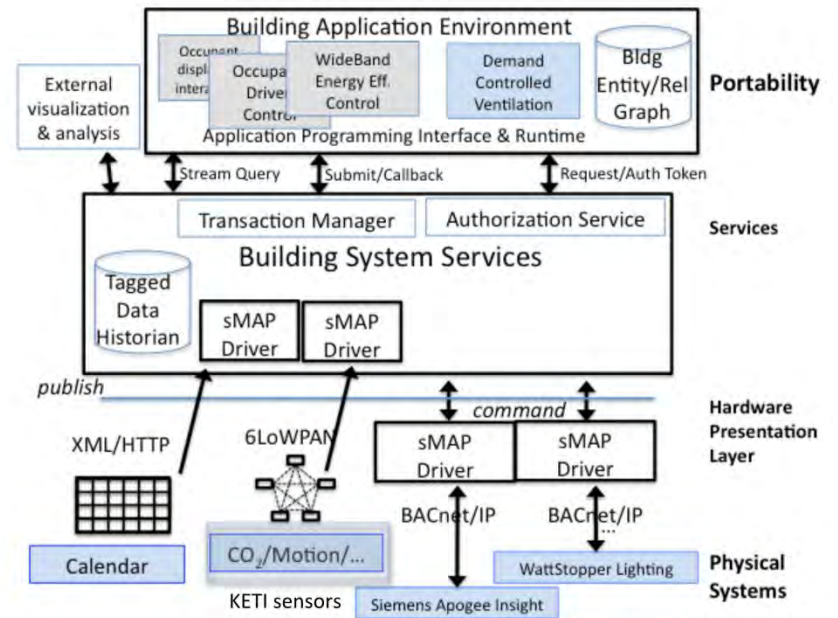
Credits: Kevin Warnock, 2011

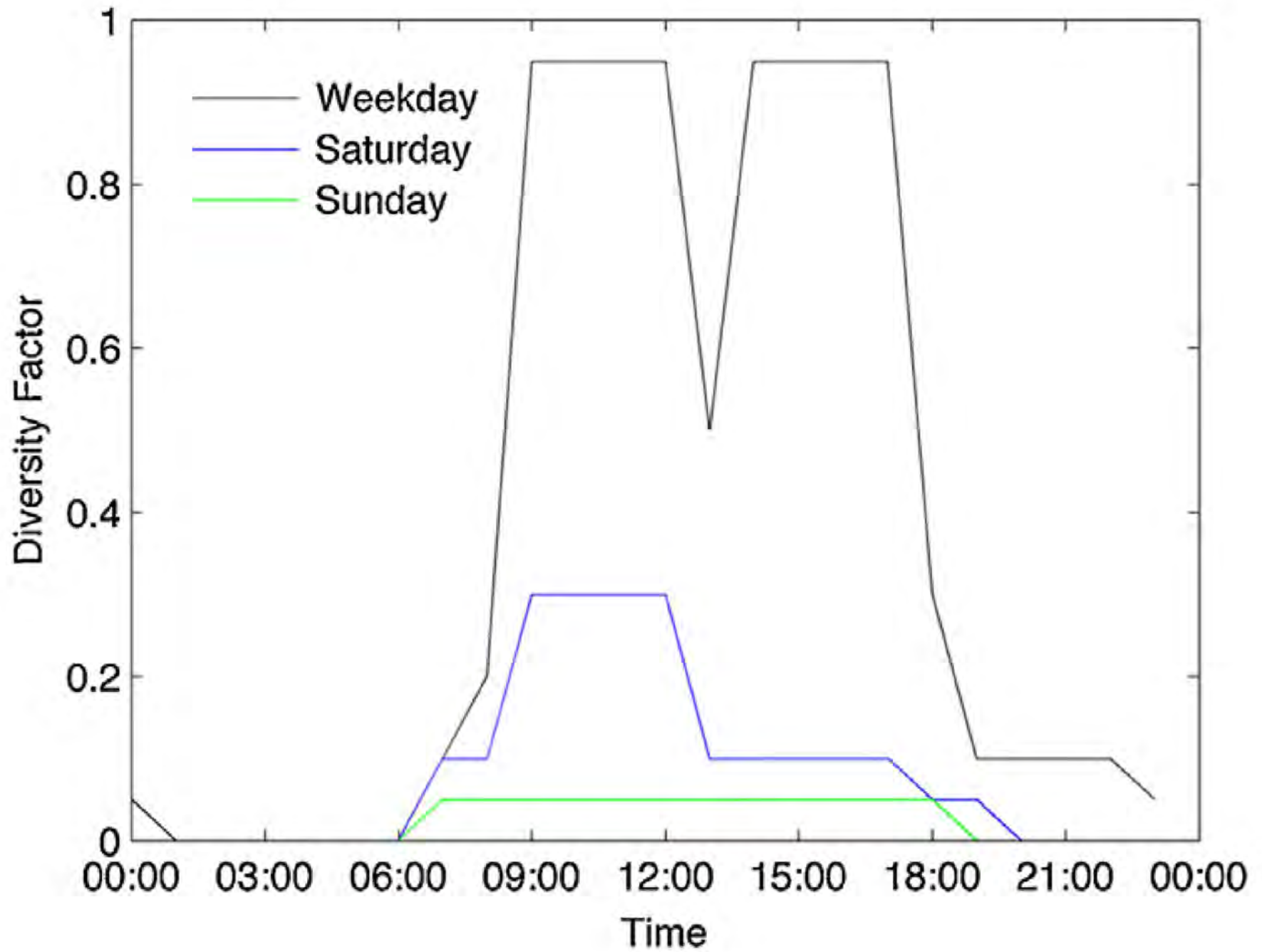


- Private office sets: 20
- Open space sets: 13

Open space area
Private office area

Conference room



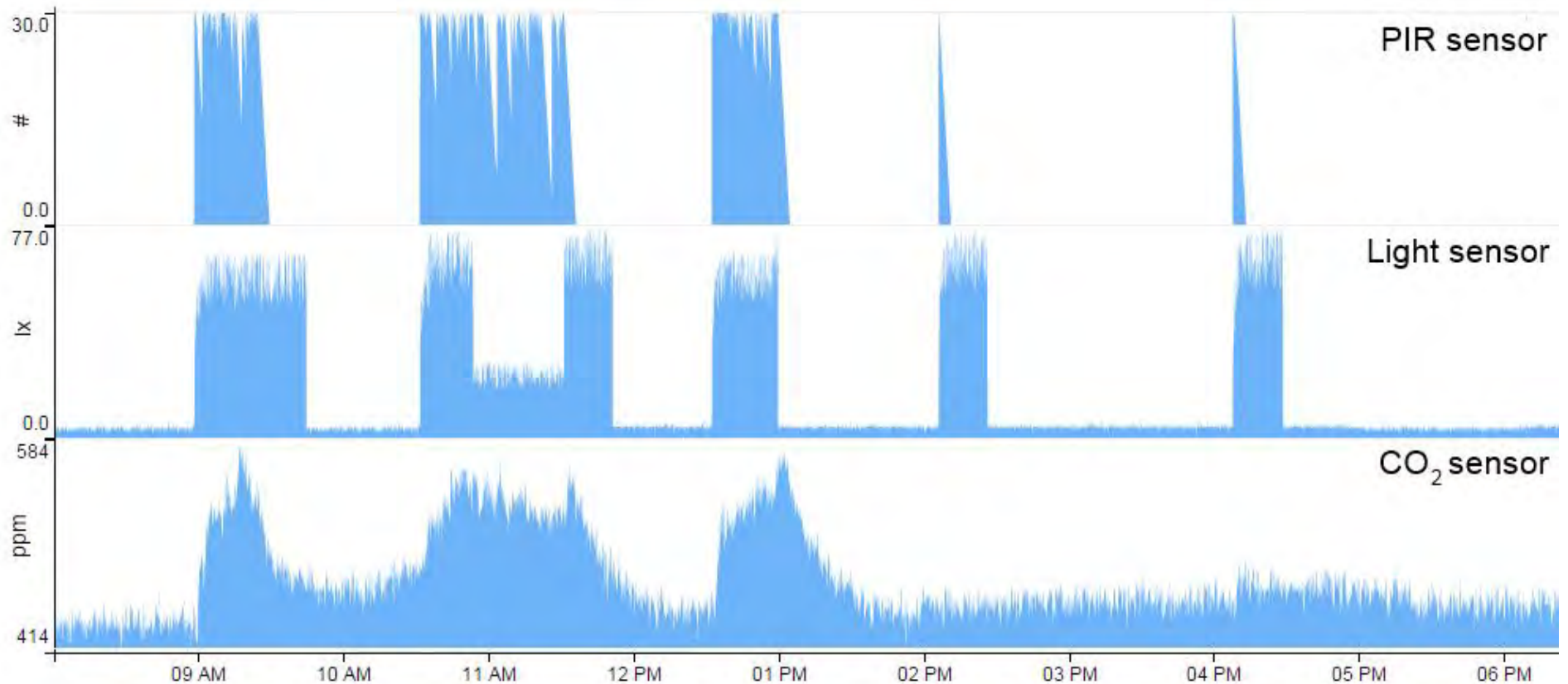


Purpose & Methodology



- 141,000 ft², 7-story research building in Berkeley, California
- Users: mostly researchers, students and UC Berkeley staff
- **69 installed Passive InfraRed (PIR) sensors** in 67 private and 2 conf. rooms
- The state of each space was aggregated to a time series with a 5-min time step
- Data collection spans **18 months (June 2013-November 2014)**
- Data were filtered to remove US federal holidays

Data Pre-Processing and Analysis (18 Months)



CO₂, light and PIR sensors' data in a private office on Monday, October 20, 2014

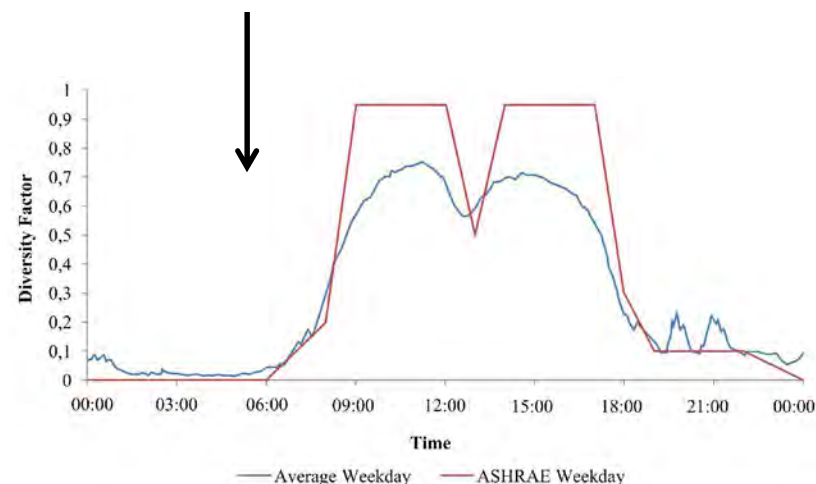
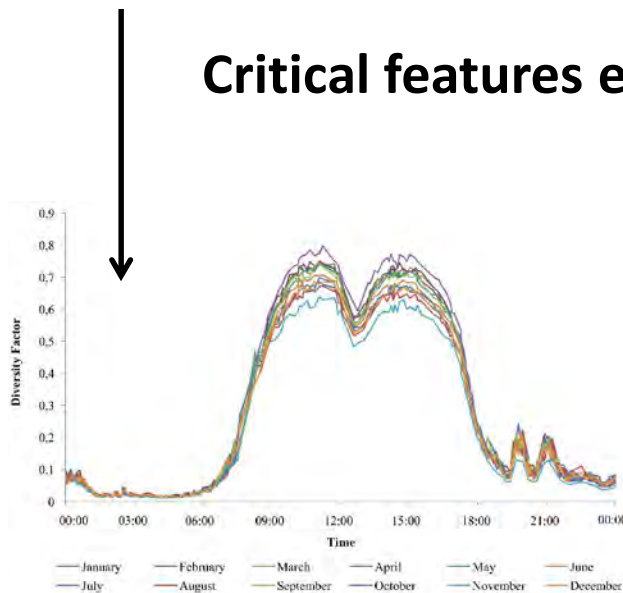
A total of 38,847 days of sensor-data: **4,150 sensor-days (10.6%)** were replaced by ASHRAE standard values

Simple and Pragmatic Method

- **Occupancy diversity factor:** percentage of sensors (out of 69) that registered an occupied state at a particular time
- Data set ***t-test* statistic methods** (95% confidence interval) to determine if there were statistically significant differences between months, days, hours

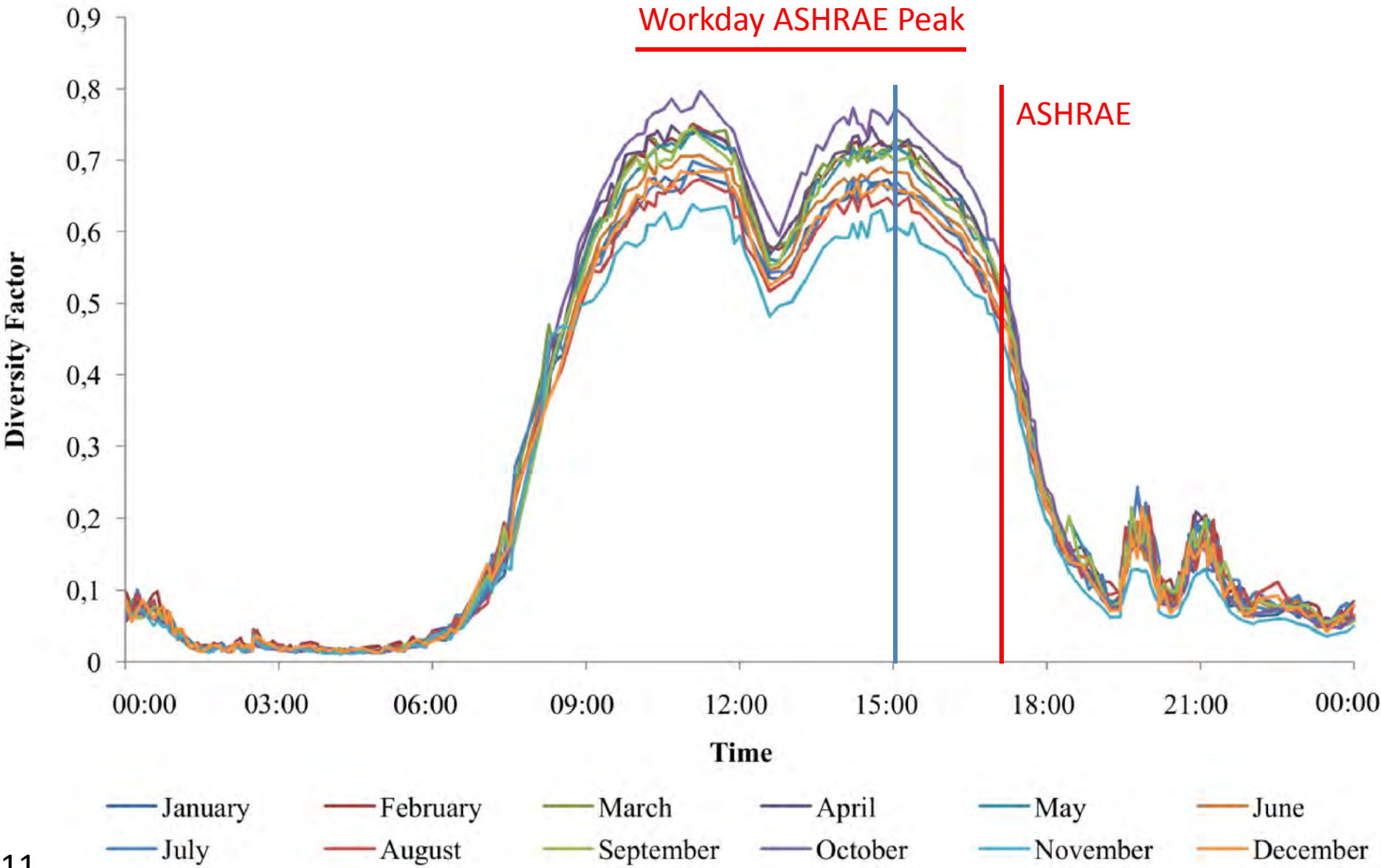
Monthly and day type profiles are reported

Critical features examined and compared with ASHRAE standards

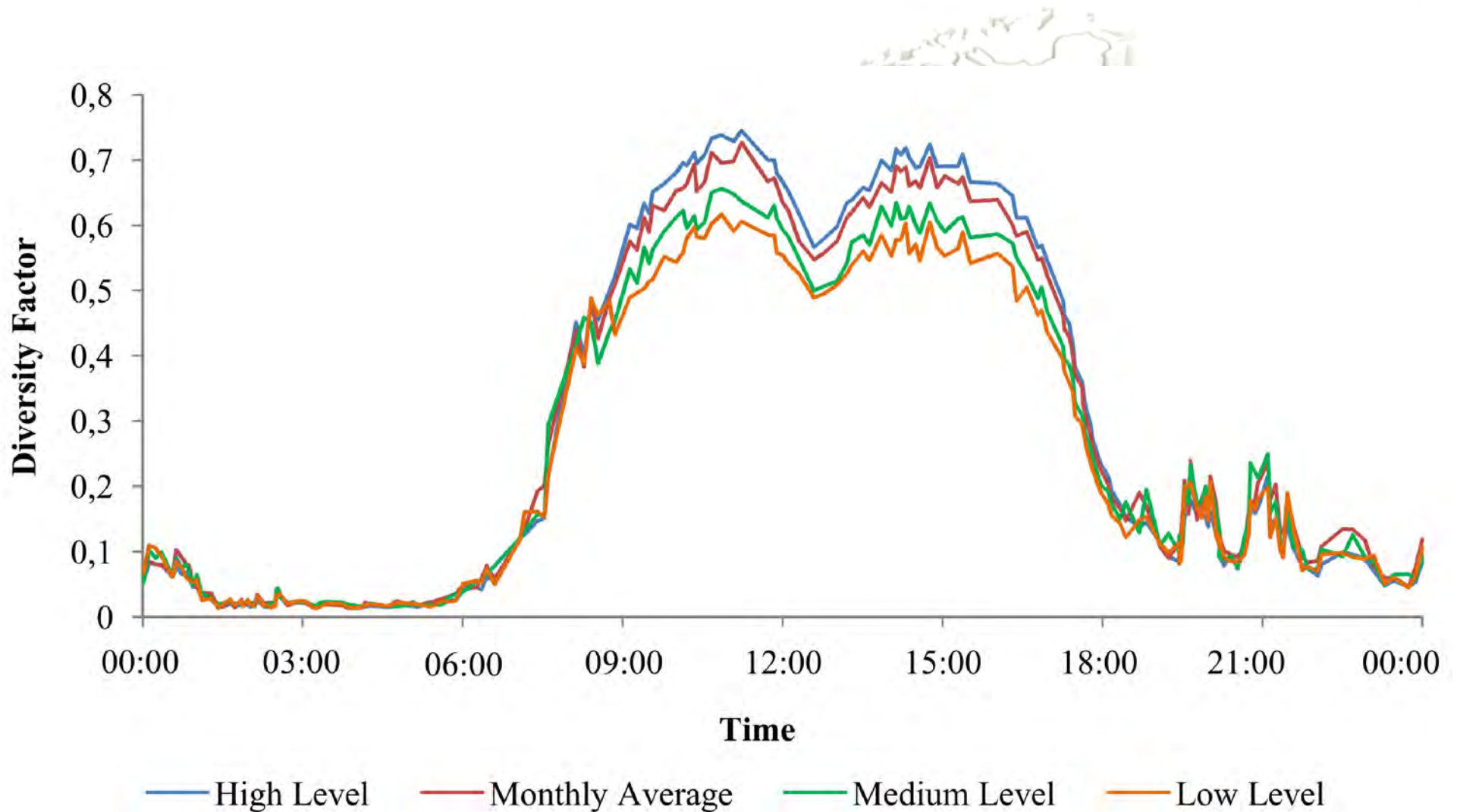


Results & Discussion

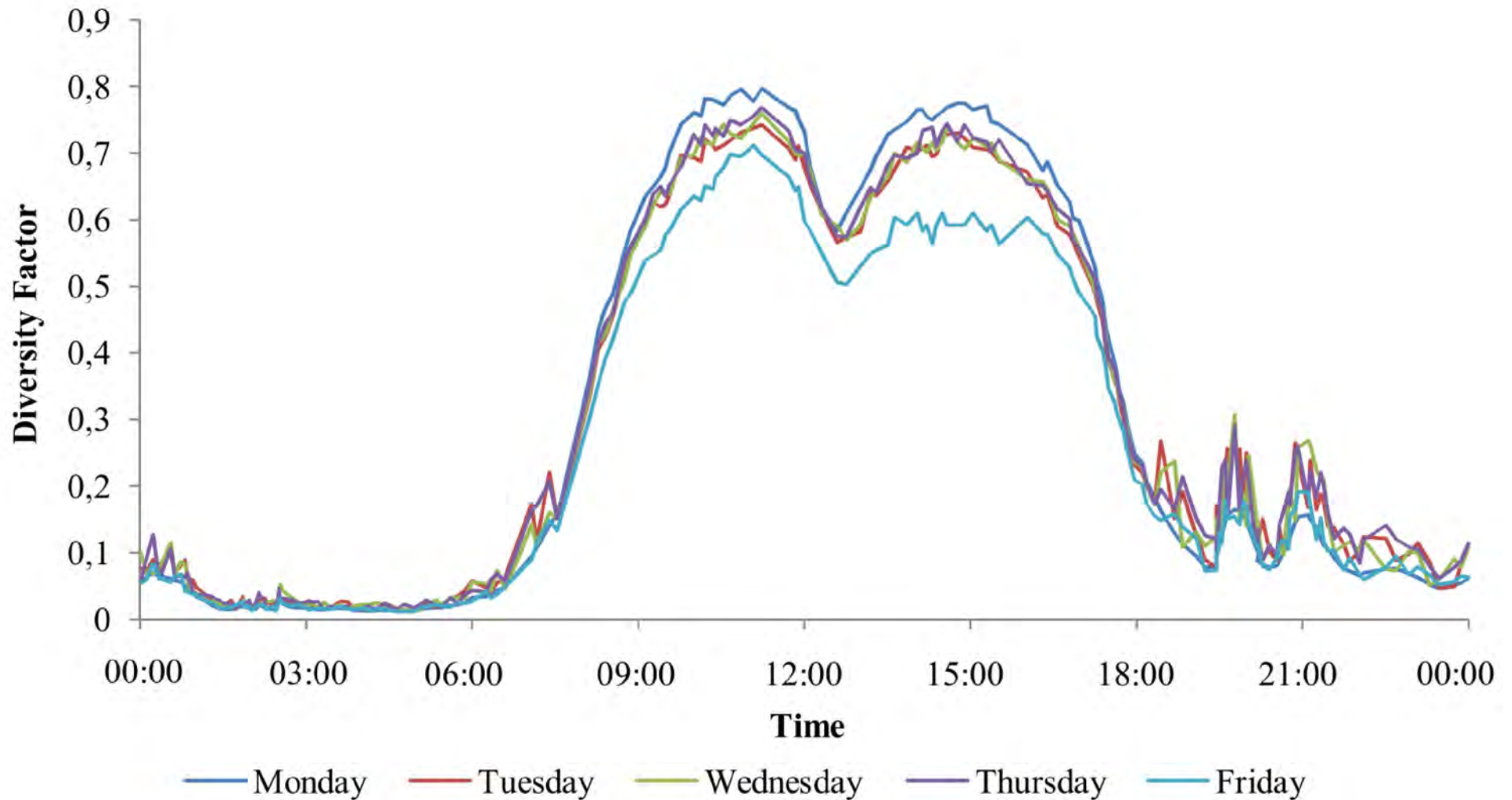
Average workday occupancy diversity factor for each month



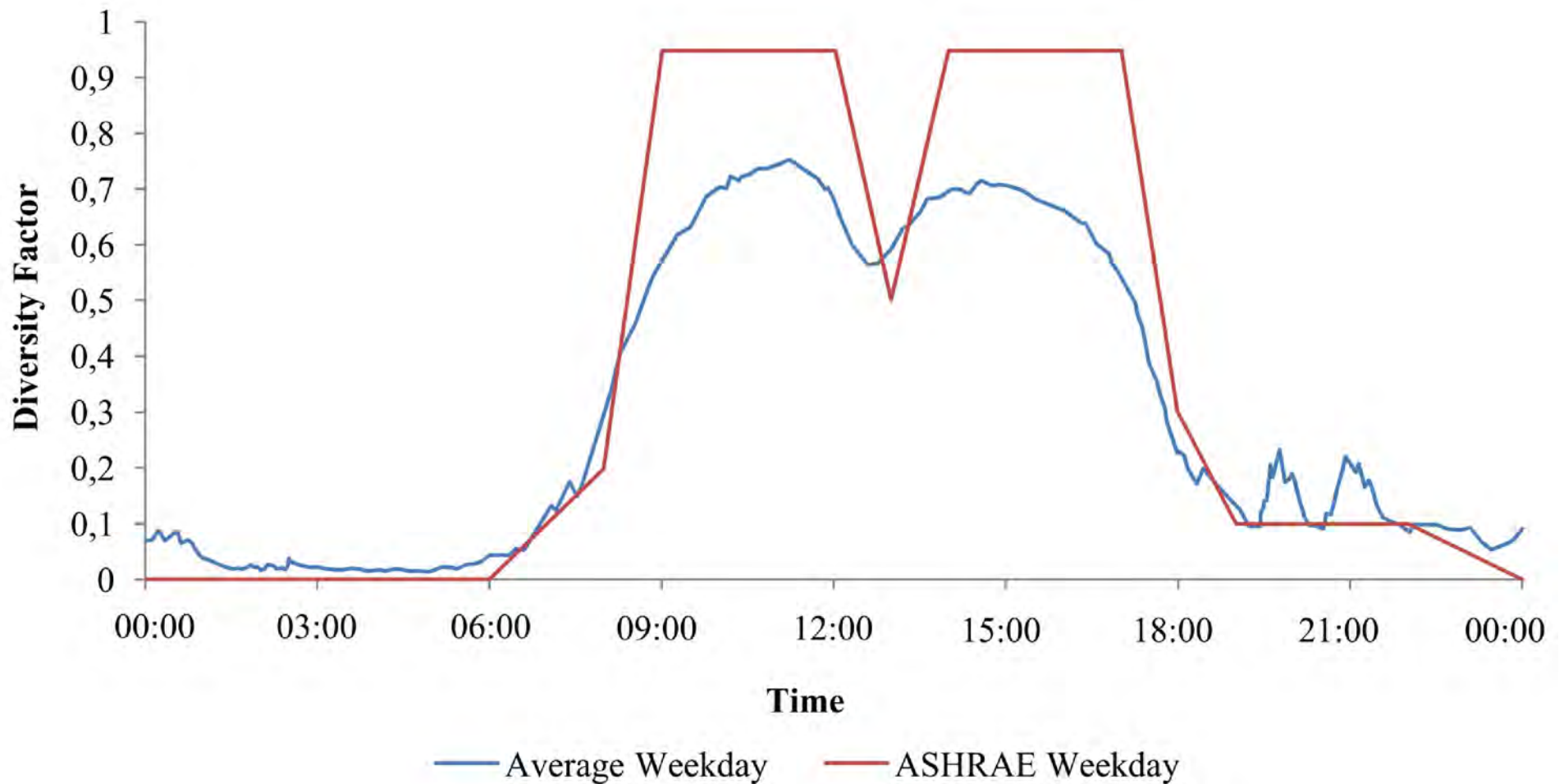
Diversity factors – Average & high-, medium-, and low-level months



Average occupancy diversity factor profile for weekdays



Comparing diversity factors (ASHRAE 90.1 2004 VS study)



Conclusion & Questions

