ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

PEER REVIEWED
ASIA-PACIFIC
SOLAR RESEARCH CONFERENCE

Extending Real-Time Year Weather Data Services with Bureau of Meteorology Data

Naman Jain, Nihal Abdul Hameed, Trevor Lee, and David Ferrari

Exemplary Energy, 32 Fihelly Street, Fadden, Canberra, Australia

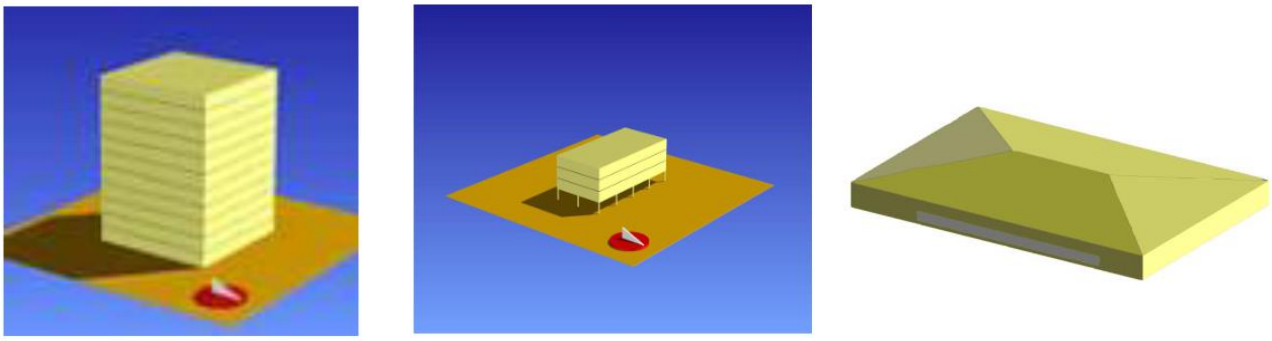
A Real-Time Year (RTY) data set is a collection of historical real-time weather data acquired from the Bureau of Meteorology (BOM) which can be provided to clients for their various needs. This data set includes elements like Global Horizontal Irradiation (GHI), Direct Normal Irradiation (DNI), Diffuse Horizontal Irradiation (DIF), Humidity, Wind Speed, and Direction, Cloud Cover, Temperature, and Pressure. We provide these data sets in Typical Metrological Year (TMY), Energy Plus Weather (EPW), and Australian Climate Data Bank (ACDB) formats. RTYs for over 200 Australian locations since 1990 have been available for over a decade but with a substantial delay caused by BOM's QA processes and, recently, their suspension of dissemination of satellite solar data after July 2019 following the death of their key staff member, Dr. Ian Grant in November that year. His last publication on that subject (Grant, 2019) informs this work on an ongoing basis.

Timely RTY data was, however, available for Brisbane, Canberra, Perth, and Sydney by courtesy of arrangements with QUT, CSIRO, Murdoch University, and the Department of Planning, Industry and Environment (initially Macquarie University) respectively.

The Exemplary Weather and Energy (EWE) Index is a monthly free public service provided in order to understand how the RTY weather compares with the long-term average and with the medium-term future climates. It is published through the "Exemplary Advances" e-newsletter since November 2014 (Exemplary Energy, 2014 and ongoing). The long-term average climate condition for a particular month is obtained from the RMY (Reference Meteorological Year) data which Exemplary's in-house software, ClimateCypher, is able to produce. RMYs (A, B, or C according to the weighting given to the weather elements, with A having the greatest weighting given to solar irradiation) represent the entire time duration of the weather data in a single synthesized year and provides a convenient way to model building and energy systems (Lee, 2011). This service compares the building and solar PV system performance under these RTY weather conditions with the RMY weather condition in a particular location. Exemplary offers this service for the cities of Brisbane, Canberra, Perth, and Sydney. The weather elements that are compared include the dry-bulb temperature, solar insolation, wind speeds, and humidity. The building performance is compared for 3 storey office building, 10 storey office building, and ground-level supermarket. The building services (primarily cooling and heating) energy consumptions are compared as part of this building performance comparison by simulating the building models in, EnergyPlus™, a software developed by the US Department of Energy (DOE) and the National Renewable Energy Laboratories (NREL). The graphical model of these archetypical buildings used for simulation is shown in Figure 1. The EWE index service also provides a comparison of a 3 kW PV system under the RTY weather conditions and long-term average and future climate conditions. While not included in the Index, comments are routinely offered on interesting results for any of the four permiter zones of the archetypical buildings. An example of the EWE Index can be found in the appendix.

Both the RTYs and the EWE Indexes have many applications (Lee, 2009; Lee and Edwards, 2015) and can be used for:

- Simulation Model Calibration
- Building or energy system monitoring which helps to identify underperformance and take early restorative actions.
- Renewable energy generator monitoring.
- Measuring actual output or consumption in the previous 12 months or month relative to RMYs.



a b c

Figure 1. Graphical models of the Archetypical buildings used in EWE simulation. a: 10 storey office building, b: 3 storey office building, c: Supermarket

The RTY surface weather data used for our EWE Index service for Canberra is sourced via an Automated Weather Station (AWS) located in CSIRO's Black Mountain campus and Sydney's data was originally sourced from an AWS at Macquarie University (Exemplary Energy, 2013a; Exemplary Energy, 2013b). The data received from the AWS at CSIRO naturally contain site-specific factors in the temperature and wind speed readings which we normalize based on correlations we have found with respect to readings from BOM's official site at Canberra Airport via empirically derived formulas (Exemplary Energy, 2013a). Similarly, we have also found site-specific factors in temperature and wind speed readings from the AWS at Macquarie University which we normalize based on empirically derived formulas we have found with respect to readings from BOM's official CBD site at Sydney RO (Regional Office) (Exemplary Energy, 2013b).

In August 2021, the BOM inaugurated a new source of real-time weather data which will allow us to geographically expand our RTY data set and enable us to provide the latest weather data. This will also allow the expansion of the EWE Index. We will use the bureau's recently launched real-time solar irradiation product (Bureau Of Meteorology, n.d.) to acquire hourly solar insolation data. This data is derived via the Heliosat-4 radiation model which uses imager observations from the Himawari-8 satellite which is expected to be active till 2022 and then thereafter from the Himawari-9 satellite which is expected to be operational from 2022-2029. As for the surface weather data like temperature, wind speed and direction, humidity, etc we are planning to subscribe to one of the many real-time products (Bureau Of Meteorology, 2021) provided by BOM to complement accessing its monthly subscription service for ground-based measurements.

Acknowledgment

The authors acknowledge the Australian Bureau of Meteorology as the intended source of all the raw data products and other members of the Exemplary team who have made this work possible: Zhongran Deng, Yoke Fung, Miao (Chris) Wang, and Chun Yin Wu. For support in our early work with real-time data, we thank the hard-working and helpful sources: QUT Brisbane (especially Dr Aaron Liu), CSIRO Canberra (especially Mark Kitchen and Chris Russell), Murdoch University Perth (especially Philip Good), and Macquarie University Sydney (especially the late Dr Grant Edwards).

References

Bureau Of Meteorology, 2021, 'Real-time Data Service'
http://reg.bom.gov.au/reguser/reguser.shtml

Bureau Of Meteorology, n.d., 'Satellite derived, bias-corrected Solar Radiation and Exposure User Guide '
http://reg.bom.gov.au/catalogue/satellite_solar_data.pdf

Exemplary Energy, 'Exemplary Advances', monthly since November 2014, Canberra
http://www.exemplary.com.au/information/exemplary-advances.php

Exemplary Energy, 2013a, 'QA and Normalisation of CSIRO Canberra Data to the BOM Canberra Standard'
http://www.exemplary.com.au/download/ExE%20RTY%20QA%20Report%20-%20Canberra%202013-07-01.pdf

Exemplary Energy, 2013b, 'QA and Normalisation of Macquarie University Data to the BOM Sydney RO (Regional Office) Standard'
http://www.exemplary.com.au/download/ExE%20RTY%20QA%20Report%20-%20Sydney%202013-07-01.pdf

Grant, I, 2019, A Comprehensive Quality Assessment of the Bureau of Meteorology's Satellite Gridded Solar Data, Proceedings APSRC, Canberra

Lee, T, 2009, 'Climate data for building optimisation in design and operation in Australia'
http://www.exemplary.com.au/download/Lee%20-%20Paper%201298%20-%20Climate%20Data%20For%20Building%20Optimisation%20for%20IBPSA%202011.pdf

Lee, T, 2011, 'Climate data for building optimisation in design and operation in Australia', *Proceedings of Building Simulation 2011: 12th Conference of International Building Performance Simulation Association*, 14-16 November, Sydney

Lee, T and Edwards, G, 2015, 'Weather Affects Building and PV Performance Simulation v Monitoring'*, Asia-Pacific Solar Research Conference 2015*, 8 – 10 December, Brisbane
http://www.exemplary.com.au/download/Lee%20-%20AVPV30%20Weather%20Affects%20Building%20and%20PV%20Performance%20-%20Simulation%20v%20Monitoring%20V3%20POSTER.pdf

Appendix

The following shows the summary of results of the EWE simulations performed for the month of June 2021 and reported in the July edition of Exemplary Advances (http://www.exemplary.com.au/download/services/newsletters/Exemplary%20Advances%202021%20Jul.pdf)

Table I. Summary of EWE simulation results

2021 June	Weather Index (monthly means)						Weather and Energy Index (%)						
	Temperature (°C)			Rel. Humidity (%)			10-Storey		3-Storey		Supermarket		Solar PV
	Min	Avg	Max	Min	Avg	Max	Heat	Cool	Heat	Cool	Heat	Cool	
Brisbane	-4.3	-4.4	-3.6	+52.0	+15.8	-3.0	+60.1	-24.8	+71.5	-30.6	+22.5	-100	-8.3
Canberra	+2.2	+0.2	-1.2	+5.0	-6.0	-7.0	+14.1	-21.2	+11.6	-20.8	-16.6	-	-5.3
Perth	-1.0	-0.3	+0.3	+3.0	+4.0	-3.0	+11.8	-3.5	+7.1	-1.7	+4.6	-100	+8.9
Sydney	+1.6	+1.1	+0.4	+3.0	-12.9	-15.0	-37.1	+8.8	-35.4	+10.0	-43.2	-	+8.2

As can be seen from Table 1, EWE reports the deviation of the monthly means of minimum, average and maximum recorded data for RTY weather elements with the long-term average data. Also, the difference in heating and cooling energy consumptions in buildings and the energy outputs from the solar PV system simulated with the RTY data and the RMY data is shown.

The EWE index, in addition to comparing the building performance under the RTY condition with the long-term average and the futuristic (EFMY) energy performance, informs about the trends seen in the building services energy consumption over the last three months for the cities analysed. The results for June 2021 are shown in Figure 2.

If any interesting correlation could be established between these findings and the observed weather, then this would also be reported with the index.

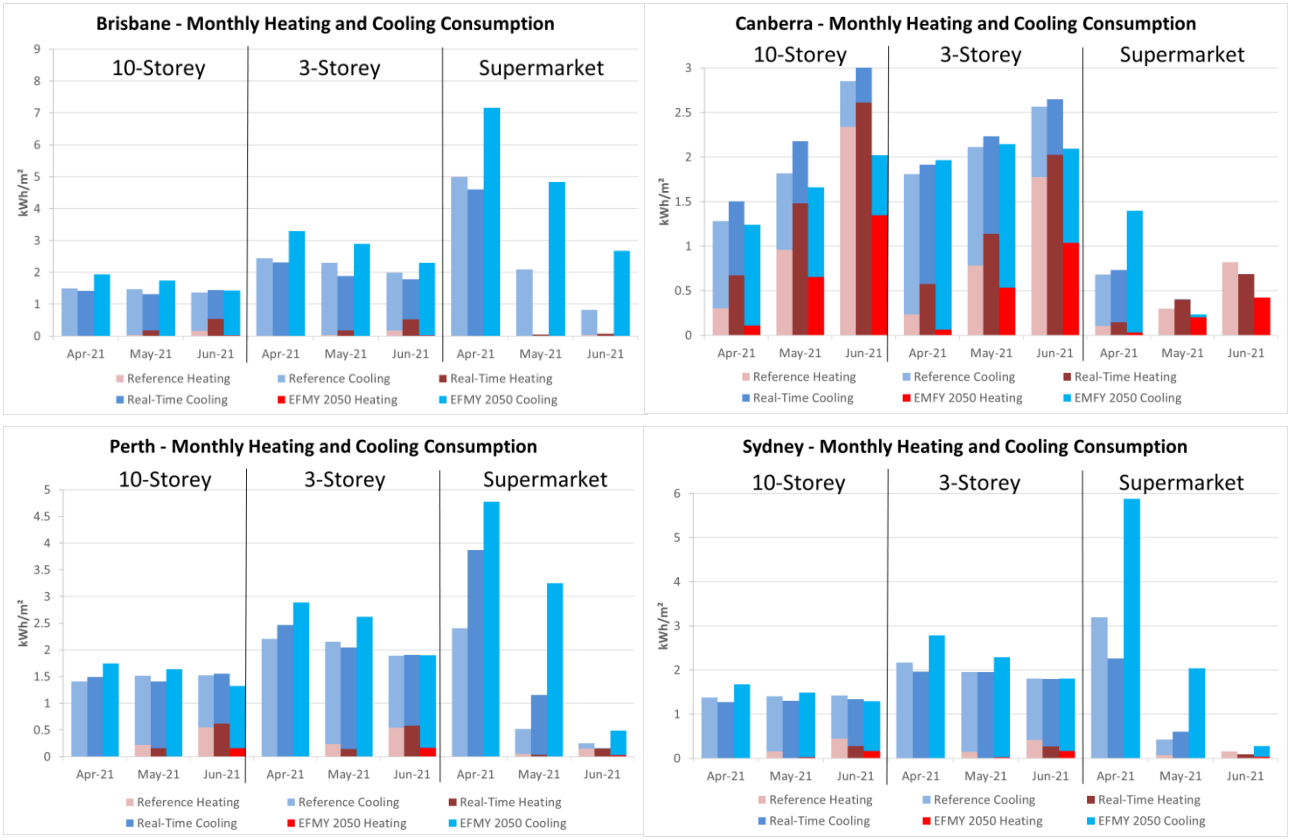


Figure 2. Energy consumption comparison and trends for the three archtypical buildings in different locations

A similar analysis is done for a 3 kW solar PV system, where the energy outputs simulated with the RTY weather data are compared with the simulations with RMY and EFMY data and the trend over the last three months are reported. The results of June 2021 are shown in Figure 3.

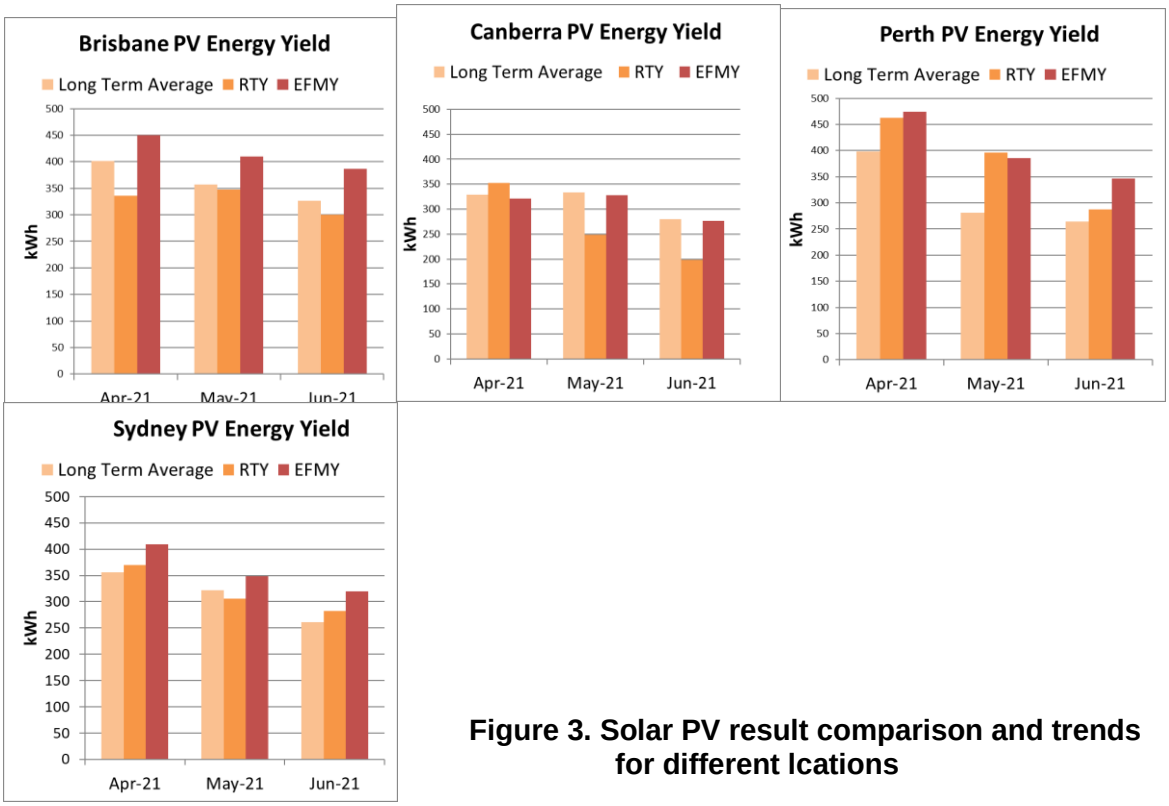


Figure 3. Solar PV result comparison and trends for different lcations