Exemplary Advances

2021 April ***"Exemplary Advances"*** is the newsletter for Exemplary Energy Partners, Canberra. Feel free to forward it to friends and colleagues. Click here to subscribe or unsubscribe. Feedback is most welcome.

Past editions of ***"Exemplary Advances"*** are available on our website.

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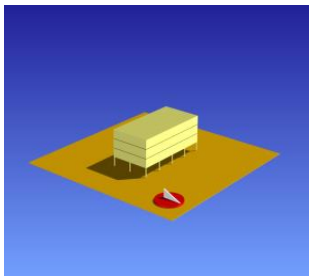
Exemplary Weather and Energy (EWE) Index[i] - March 2021

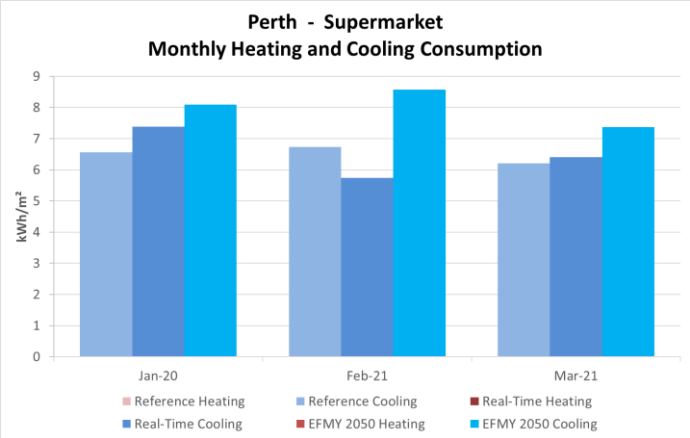
Monthly tabulation and commentary relative to the climatic norm – the Reference Meteorological Years

2021 March	Canberra		Perth		Sydney	
	Heat	Cool	Heat	Cool	Heat	Cool
10-Storey	N.A.	N.A.	-	1%	-	-20%
3-Storey	N.A.	N.A.	-	2%	-	-23%
Supermarket	N.A.	N.A.	-	3%	-	-31%
Solar PV	N.A.		6.8%		13.8%	



The Exemplary Real Time Year weather files (RTYs) the current Reference Meteorological Year files (RMYs) and the Ersatz Future Meteorological Years (EFMYs) used for these monthly simulations are available for purchase to allow clients to simulate their own designs for energy budgeting and monitoring rather than rely on analogy with the performance of these archetypical buildings and systems.

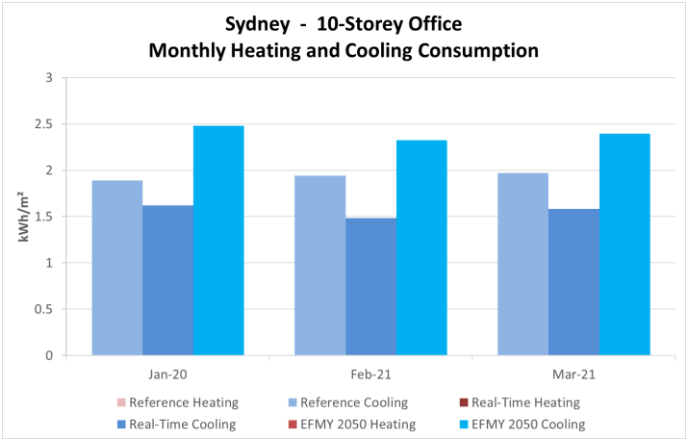
Canberra had no data for March. The problem with CSIRO's weather station is being worked on but this much appreciated source of data over more than five years will not continue for long anyway. CSIRO has advised that the project that was funding the ongoing maintenance of the solar monitoring sites is being wound up, so there's now no official support to keep things running.



Perth had a cooler but more humid March than average. The mean average and the mean maximum were lower than the long term averages by 0.6°C and 1.0°C respectively. As for the mean minimum temperature, it was higher than the average by 0.1°C. The average and maximum relative humidity (RH) in March was higher than long term average respectively by 10.1% and 1% while the maximum RH was lower by 2% (2021 Mar RH minus long term average Mar RH). Perth generally received higher than average solar irradiation in the mornings and due to the generally higher than average wind speeds during daylight hours, the solar PV simulation showed an output 6.8% higher than the average. All three commercial building models had higher than average cooling consumption in the range of 1-3%. The east facing

and north facing zones of the 10-storey office building zones showed a higher than average energy usage for cooling ranging from 2-3.5%. However, the west and south facing zones had lower than average cooling energy consumption by around 2%. This is due to the higher than average solar irradiation in the morning hours and in the afternoon hours it goes below average and also wind speeds were higher than average. Due to higher than average humidity levels through a typical day, the latent heat of cooling was 0.84% higher than average while the sensible heat of cooling was 0.03% lower than average in Perth.

When comparing the simulation results using our EFMY 2050 climate data with the current climate, it is projected that the two office building models would have around 11% higher cooling consumption and the supermarket would have 13% higher cooling consumption than this March.



Sydney also experienced a cooler March than the average. The mean average, the mean maximum and the mean minimum were lower than the averages by 1.9°C, 2.8°C and 2.5°C respectively. The average Relative Humidity (RH) in March was higher than average in March by 0.2% (2021 Mar RH minus long term average Mar RH), the minimum RH in the month was less than average by 5% and the maximum RH was same as the average. The solar irradiation received in Sydney was higher than the average value from the late mornings til the end of the day. Also due to higher than average wind speeds almost throughout the day, the simulated solar PV array output was higher than average by 13.8%. The cooling consumptions of all the commercial building models were lower than the average by a margin which ranged between 20 and 23% in case of office buildings while the supermarket was lower by 31%. All the zones in the 10 storey office building had lower than average cooling consumptions: it was 29% less than average for east facing zones and the north facing and the west facing zones were lower by around 20%. Due to the lower than average irradiance and higher than average windspeed in the mornings, the building did not have higher cooling loads leading to more deviation of the cooling energy consumption in the east facing zone from the average. Due to higher than average humidity levels especially in the morning hours, the latent cooling energy consumption for the 10 storey building was 1.3% higher than average but due to generally lower than average temperatures the sensible capacity was 0.3% lower than average.

When comparing our EFMY 2050 simulation results with the results for March, it is projected that the two office models would have around 34-38% higher cooling consumption, and the supermarket would have about 48% higher cooling consumption than for the March just gone.

Extra Exemplary data for Australian Standards

Our March edition cited the application of climate data supplied by **Exemplary** in two Australian Standards currently being updated:

- AS/NZS 4234 *Heated water systems - Calculation of energy consumption*
- AS 3634 *Solar heating systems for swimming pools*

That report ought to have also cited AS 5348 *Requirements for Pool and Spa Covers* which is under development in parallel with those two and may eventually be incorporated within the body of AS 3634 rather than becoming a stand-alone standard.

PV-CSP Hybrid Power Plant – a Techno-Economic Analysis

Our interns (Chithral, Naman, and Nihal) at Exemplary along with 3 more of their colleagues from the Australian National University (ANU) are currently working on a research project as part of their master's degree. Their project aims to conduct a techno-economic analysis of a PV-CSP hybrid power plant in the Australian context. They are working under the guidance of Dr. John Pye (pictured), a senior lecturer in the Solar Thermal Group of the Research School of Engineering at ANU.

PV (Photovoltaic) cells are composed of semiconductor material that uses sunlight to create a potential difference that enables' electricity production. On the other hand, CSP (Concentrated Solar Power) concentrates sunlight, usually via mirrors, onto a receiver, at which a special solids/fluid (AKA heat transfer medium) absorbs the heat and transports it to a "power block". Here the turbine and generator convert this heat to electricity. In comparison to CSP, the cost of electricity produced by PV is far more economical and on par with the cost of electricity produced via fossil fuels. However, due to thermal storage, CSP has a higher capacity factor in comparison to PV whose output is immediately proportional to the solar irradiation received. Thus, this study aims to find the right ratio of these technologies which when used together in a hybrid system can both improve the overall capacity factor and further decrease the long run marginal cost of electricity produced.

They have chosen to simulate their model for a region near the Olympic Dam mine in South Australia, 530 km north of Adelaide, due to the location's great solar resource, and availability if a 275 kV transmission line at a distance of about 20 km from the potential location They will be building their mathematical model on Modelica which will be used to simulate various ratios of these technologies to find the most feasible option for a hybrid plant. This model will also account for the locations' historical weather for Roxby Downs (the town built for the mine), demand, and spot-market price data which will be provided by Exemplary and AEMO respectively. They also plan to explore other storage options.

Precipitation and Cloud Cover Data in Climate Files - Update

Exemplary Energy's prospects of distributing daily precipitation into hourly precipitation data based on the hourly data of other weather elements progressed from the last update by studying dependencies (correlations) of precipitation data on other weather elements. This study undertaken by Exemplary til now considered data recorded over multiple years. Now we are working on year-long sets of data to understand if a pattern exists every year. Also the correlation studies for the yearly precipitation data was done with different weather elements even if they did not seemingly have a relation with precipitation to capture any unknown correlation between the two. Some of the variables chosen were Extraterrestrial Horizontal Radiation, Extraterrestrial Direct Normal Radiation, Global Horizontal Irradiation (GHI), Direct Normal Irradiation (DNI), Diffuse Irradiation (DIF), Relative Humidity and Wind Speeds to name a few. A total of 21 weather elements correlated also contained the hourly change in weather elements like GHI, DNI, DIF, Relative humidity, Atmospheric pressure and Wind speeds for the whole year. The correlation result for Canberra for the weather data for the year 2015 is shown here in the suite of graphs. The r values shown in each correlation plot is the linear correlation coefficient between the particular weather element in the graph and the precipitation.

In liaison with the Bureau of Meteorology (BoM) we are also experimenting with using their 1-minute Ceilometer readings from their 13 high-resolution solar monitoring stations to enhance our understanding and synthesis of **Cloud Cover** values during the hours of darkness. This work will be expanded on in the next edition of *Exemplary Advances*.

Even though the r values and the best linear fit (shown with red lines in each graph) do not show a strong linear correlation, it was observed that the distribution pattern in many of the graphs were similar for other years. This was especially so with correlation plots of relative humidity and change of solar insolation elements. Similarly, for the years under study, a monthly correlation analysis was also performed, and a similar pattern was observed for the same months in different years. Further actions will now be undertaken to understand the seasonal patterns with nonlinear correlation as linear correlation was apparently not able to do justice to these patterns.

Update of our *Star v Star* matrix for increased electricity charges

It is normal in Canberra for announcements now about electricity and gas prices to be applicable for consumers from 1 July. As soon as these are confirmed by the regulator, our **Star v Star** ready-reckoner matrix will be updated to remain a design and evaluation tool for residential construction in the ACT. Those results will be included in the next edition of **Exemplary Advances**.

[i] Exemplary publishes the EWE for three archetypical buildings and a residential solar PV system each month; applying the RTYs to EnergyPlus models developed using DesignBuilder for a 10-storey office, a 3-storey office and a single level supermarket as well as an SAM model of a typical 3 kW_{peak} solar PV system designed by GSES. All values are % increase/decrease of energy demand/output relative to climatically typical weather. Especially during the mild seasons, large % changes can occur from small absolute differences. RTYs are available for purchase for your own simulations.