Performance Comparison Under Significant Load Profile Variation

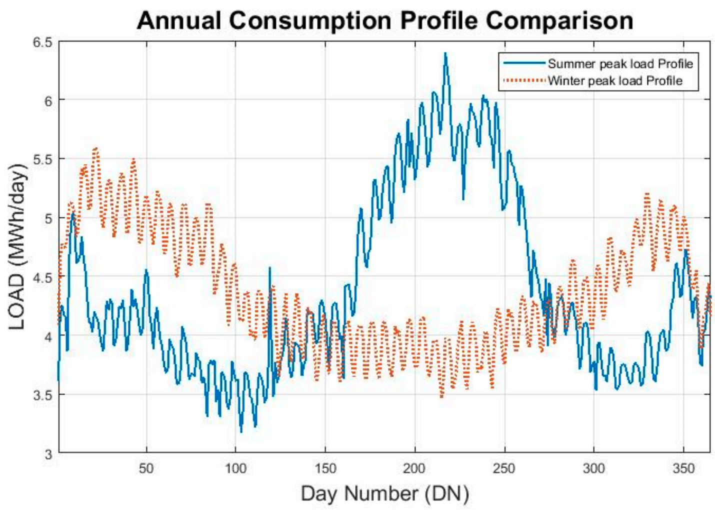

Figure S1. UK-CY load comparison.

A new load profile has been created where the load reaches a peak during the summer, in contrast to the previous assumption where the peak took place in the winter. This is based on the assumption that the large influx of visitors on the island will have an equivalent impact on electricity consumption. The analysis was re-run to evaluate the results obtained for the new "worst case" scenario profile. This profile is based on the island of Cyprus that in similitude with Sark has a high tourism arrival during summer months thus a higher energy consumption. Figure S1 shows the comparison of the two adjusted profiles, while Figure S2 below shows the temperature comparison between Sark and Cyprus.

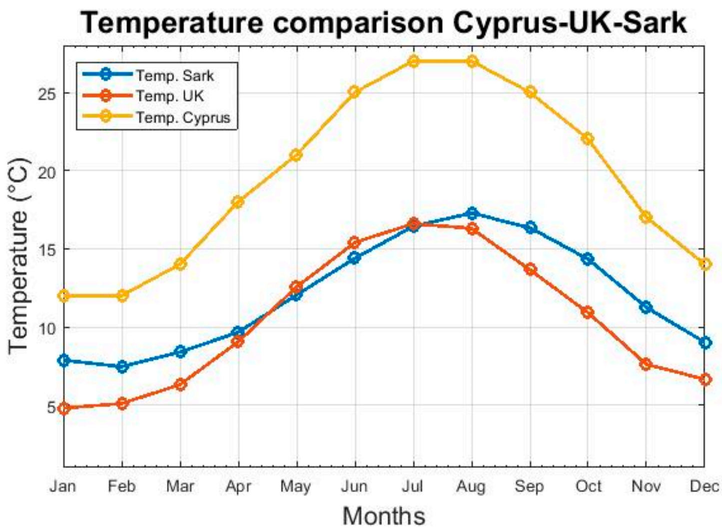

Figure S2. UK-CY temperature comparison.

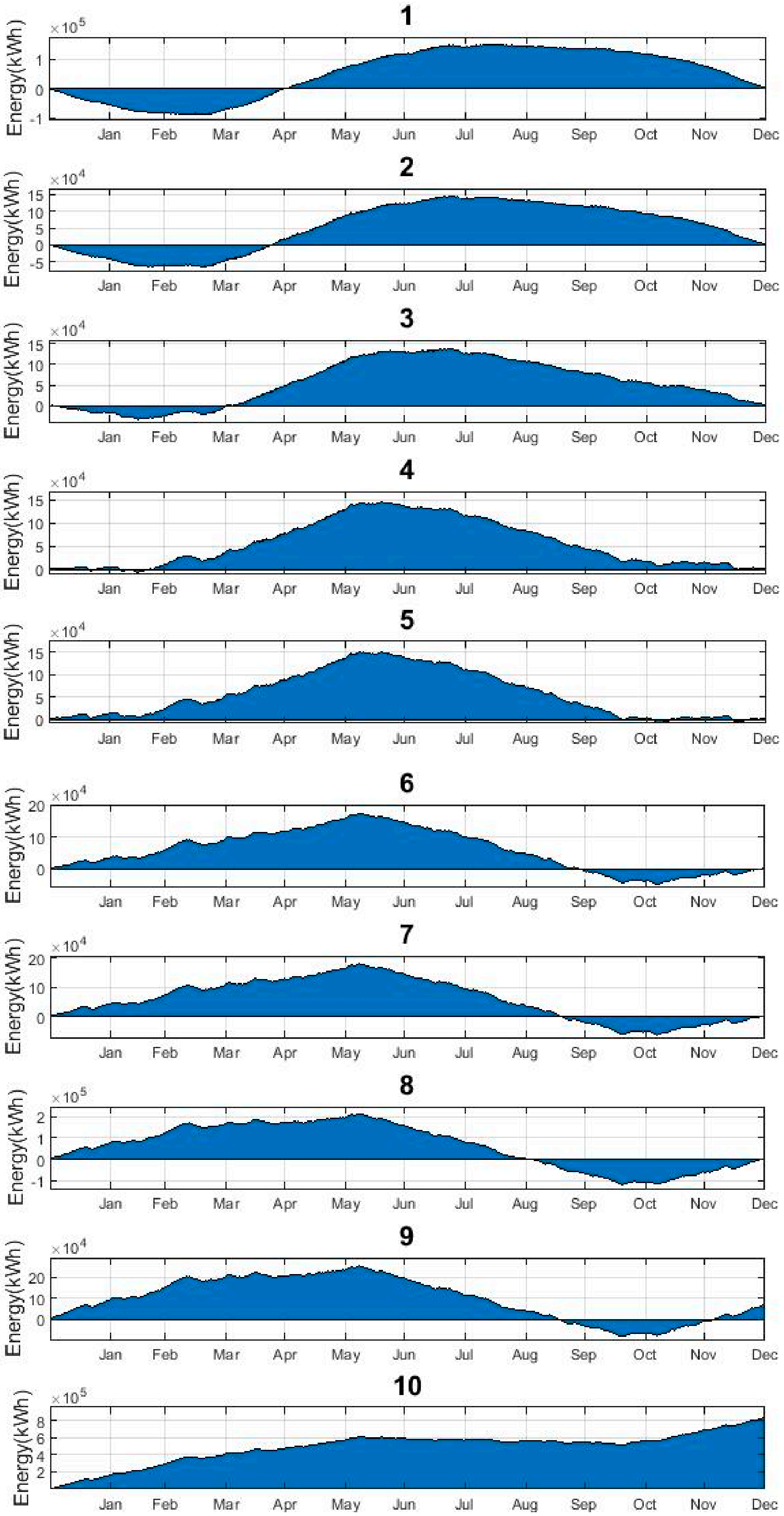

Figure S3. Annual energy balance under different levels of renewable energy production.

In Figure S3, the 10 new energy balance profiles show a variance with the previous results by shifting the fluctuation points where there is a change of energy excess to energy demand. This is expected due to the proposed energy mix, where solar has a higher impact in reducing the energy required in summer months where the new consumption peak is located.

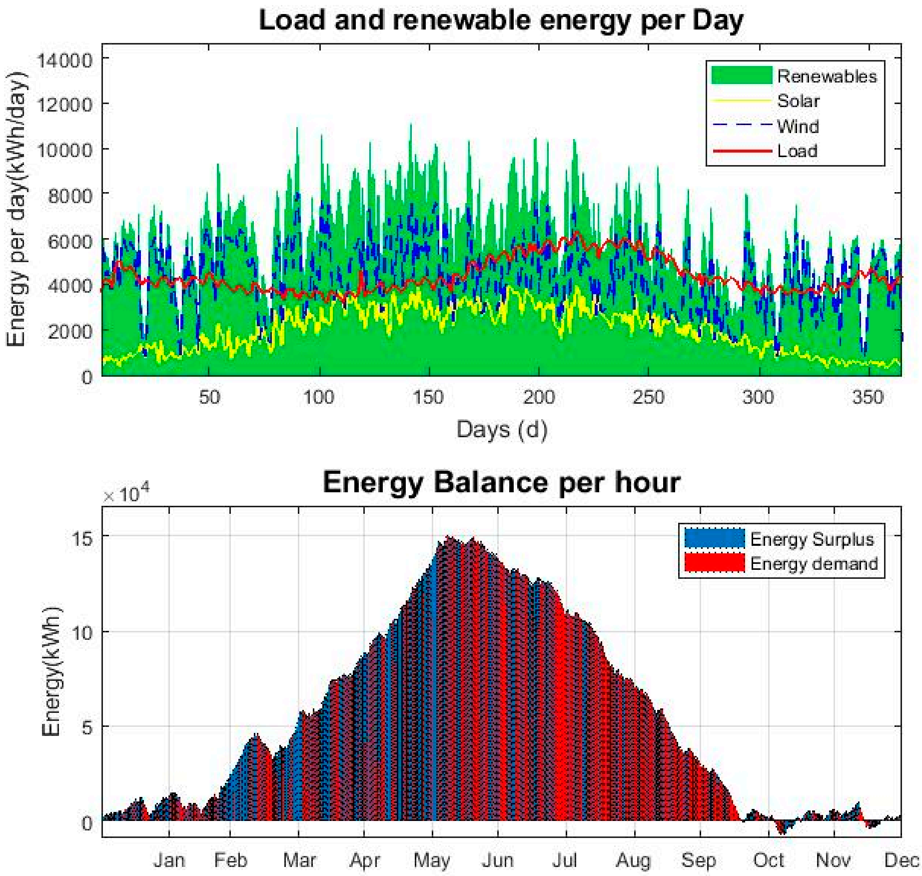

Figure S4. Case 1: Scenario 5 instantaneous generation and load variation (top) and energy balance (bottom).

The assumption is further supported in Figure S4, which showcases case 5 in further detail. It can be observed that there is a better fit of the solar energy generation with the load profile, thus helping to compensate for the lack on wind energy generation due to the reduction of wind velocity during these months. A small energy deficit can be observed at intervals between October and December.

Scenario 6, which was previously found to be the optimal scenario using the UK-based load profile, now demonstrates a consistent energy deficit between September and December, as shown in Figure S5. The impact on the system scaling is shown in Table S1, which shows the summary of the results for the different energy mix. It can be seen that the best scenarios are case 5 and case 6 with the smallest worst-case battery size requirements. A comparison of the battery size shows that there is not a great variation on the battery size between the two load profiles.

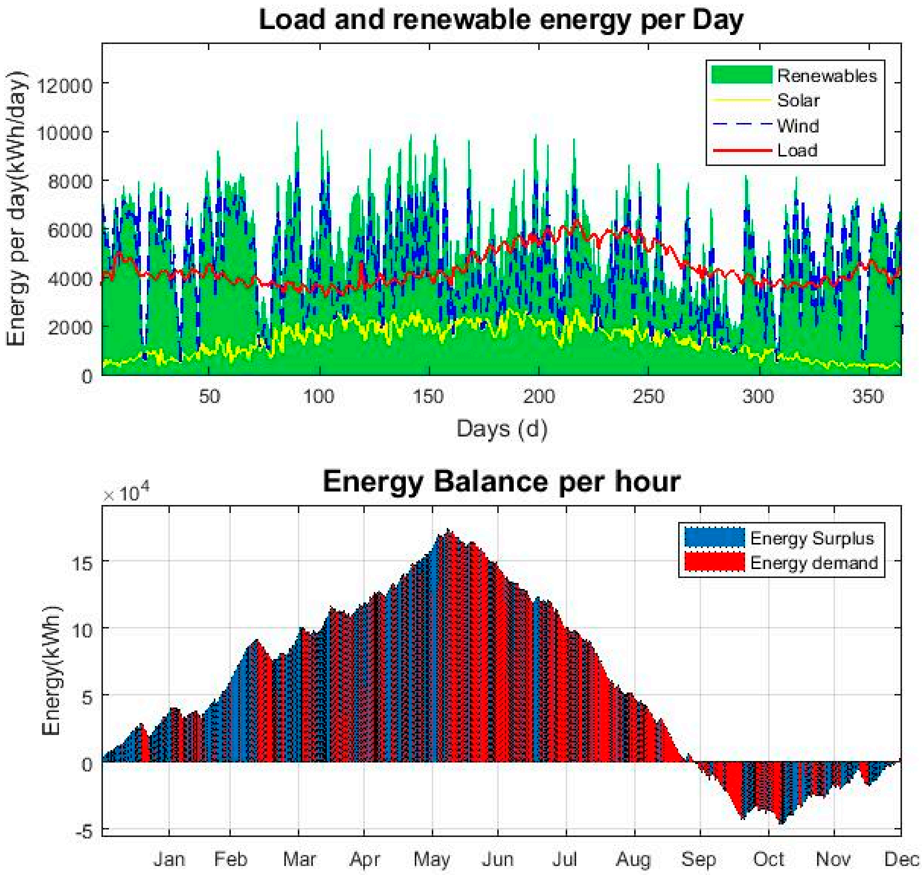

Figure S5. Case 1: Scenario 6 instantaneous generation and load variation (top) and energy balance (bottom).

Table S1. Case 1: Summary of all energy mix scenarios with estimated battery size comparison with the two different load profiles.

Case 1: Energy Balanced				
Scenario Nº.	**Wind turbine capacity (kWp)**	**Estimated solar PV capacity (kWp)**	**UK Profile-Battery Size (MWh)**	**CY Profile-Battery Size (MWh)**
1	40	1,353.9	170.98	163.59
2	115	1,238.2	149.62	142.20
3	150	1,018.8	112.00	105.87
4	225	799.9	83.66	78.53
5	245	696.9	73.81	69.33
6	300	477.5	66.49	66.53
7	320	374.4	68.15	68.93
8	435	86.6	85.66	87.47
9	450	0.0	102.84	105.16
10	500	0.0	53.89	80.33
		Battery Size Mean	84.66	83.90

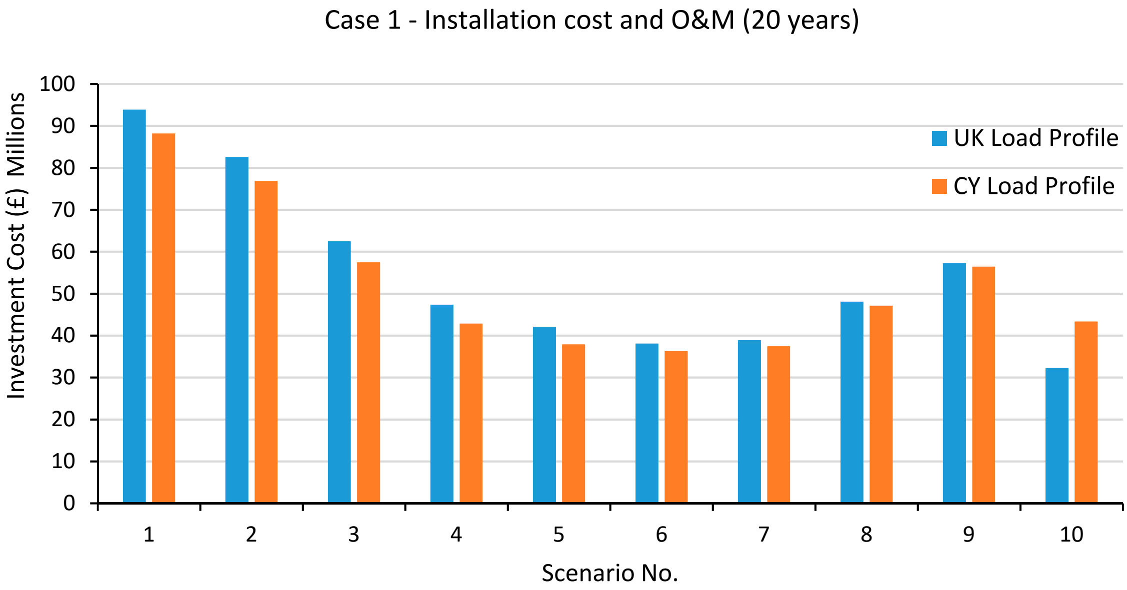

Figure S6. Case 1 installation and O&M.

Figure **S6** shows the installation cost for each scenario comparing the two profiles. Case 6 is more cost effective to install due to the smaller size of the solar system in a scale of 100 kWp smaller system.

Table S2. Case 6 performance evaluation and comparison under different load profiles.

Case 2—Scenarios Renewable Generation and Diesel Output						
Renewable system	**Scenario Nº.**	**Battery size (MWh)**	**Sark Consumption (MWh/year)**	**Renewable Generation (MWh/year)**	**Energy waste (MWh/year)**	**Genset-Diesel (MWh/year)**
UK LOAD-Case 1-Scenario 6: 557 kWp PV & 300 kW Wind	1	0.90	1,600	1,681.18	518.89	285.7
	2	1.80	1,600	1,681.21	489.85	332.2
	3	3.61	1,600	1,681.29	414.30	291.3
	4	7.22	1,600	1,681.37	331.43	229.6
CY LOAD-Case 1-Scenario 6: 557 kWp PV & 300 kW Wind	5	0.90	1,600	1,599.57	469.48	307.2
	6	1.80	1,600	1,599.60	435.82	354.7
	7	3.61	1,600	1,599.70	340.47	297.9
	8	7.22	1,600	1,599.78	252.81	227.0

Finally, Table S2 shows the small deviance on the general results from the selected ideal energy mix. It can be observed that, due to the higher consumption during the summer, more of the solar generation will be consumed, thus reducing energy waste by 17.8%. On the other hand, the use of the diesel generation is only incremented by 2%. In conclusion, these values show that even drastically changing the energy load profile implemented the best energy mix for the island using the assumed wind and solar generation.

To conclude, an extremely different load profile was chosen (peak consumption in the summer). The following further conclusions are therefore supported:

- The optimal solution is not affected greatly—only a slight difference in commissioning would be needed to adapt to the new profile.
- The new optimal energy mix would require more PV, as peak consumption matches PV production peak. The overall solution would be slightly cheaper. Our previous recommendation was therefore considered a worst-case scenario.
- The Battery size is still the same (3.61 MWh) for the optimal energy mix (a similar project cost), while the diesel generation drops. Again, this supports that our previous load profile assumption was a worst-case scenario, which was used to make an appropriate conservative recommendation.