As mentioned above, we make operational forecasts of PV power. An example 10 minute ahead power forecast is shown in Fig. 8. The MAE for the 10 minute ahead network forecast on the day shown is 0.0908 MW or 2.7% of capacity, and the RMSE is 0.140 MW or 4.1% of capacity. We do not present more detailed error statistics of our power forecasts as we did for irradiance above because the data we currently have for the UASTP is so coarse, often with 5 minutes between measurements. For the purposes of forecast comparison, it is also more useful to compare irradiance forecasts to remove the extra step of converting irradiance to power.

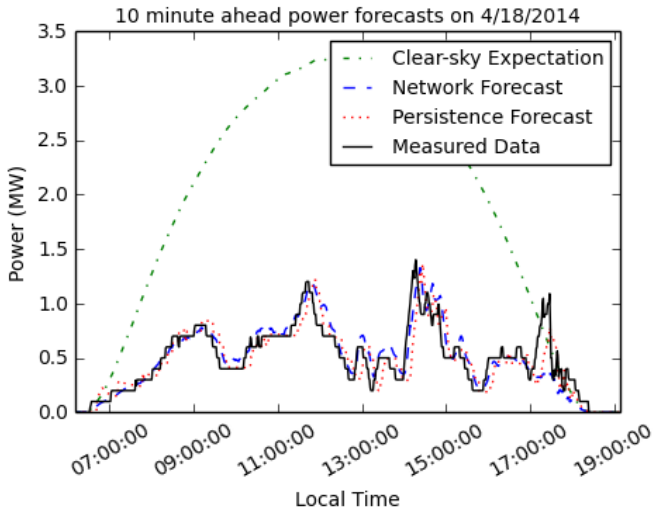

Fig. 8. Example 10 minute ahead power forecasts made on 4/18/2014. The network forecast, clearness persistence forecast, clear-sky expectation, and measured data are shown.

V. Conclusions

We designed and built low-cost irradiance sensors in order to make irradiance network forecasts. Using this network, we have been making operational forecasts since the beginning of 2014. A retrospective analysis for 26 days in April shows that our forecasts often perform better than a persistence model. When comparing forecasts, one must remember that our error statistics were calculated for irradiance and not clearness. This essentially weights our MAE and RMSE by the time of day. In the near future, we will re-evaluate our forecasts to make a more direct comparison with other work. We will also calculate numerous metrics that are described in [11] and [12] for further comparison with other techniques.

While our results of intra-hour forecasts with a network of irradiance sensors are encouraging, there are still many improvements to be made. We are satisfied with the operation of our custom INNs, but we need to deploy more throughout the Tucson region for higher quality forecasts that perform better at forecast horizons approaching one hour. There are also numerous improvements that we can explore for our forecasting algorithm including:

1) More accurate cloud motion vectors from ground sensor correlations, upper-air soundings, WRF forecasts, artificial neural networks, or some combination
2) Improved clearness map boundaries that incorporate satellite derived irradiance
3) Clearness map interpolation techniques that use previous measurements more wisely to fill in gaps.

We expect that these improvements will noticeably reduce our errors and extend the time horizons at which we can outperform persistence models.

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