Date: 15-Jun-06	**Type**: Monthly Report 8270 Appendix	**Author**: Ib I. Olsen
Subject: DCEC Residential Installation – April/May 2006		

Installation Summary:

This report covers two months of operation.
The PowerTower was online for most of the period, until it was bypassed at the end of May because some severe voltage dips. The fuel cell ran most of the time, but was down for seven days at the end of April and six days in the beginning of May.
The PowerTower was bypassed at the end of May after the house owner overloaded the system, which resulted in significant voltage drop.
We had speculated that the ongoing flicker problem was caused by the inverters in the PowerTower cycling between charge and discharge mode. Furthermore, we had observed that we hardly used the energy storage. We therefore decided to keep the fuel cell at it lowest power setting unless the battery voltage dropped significantly. Unfortunately, that appears to force the fuel cell to operate outside its comfort zone, and it went down after operating some days.
Interesting enough, when the fuel cell went down and acted as a pass-through for grid power, the short-term flicker went down, but it still stayed higher than if running on grid power alone. We will have to investigate this in more details in the next phase of the project.

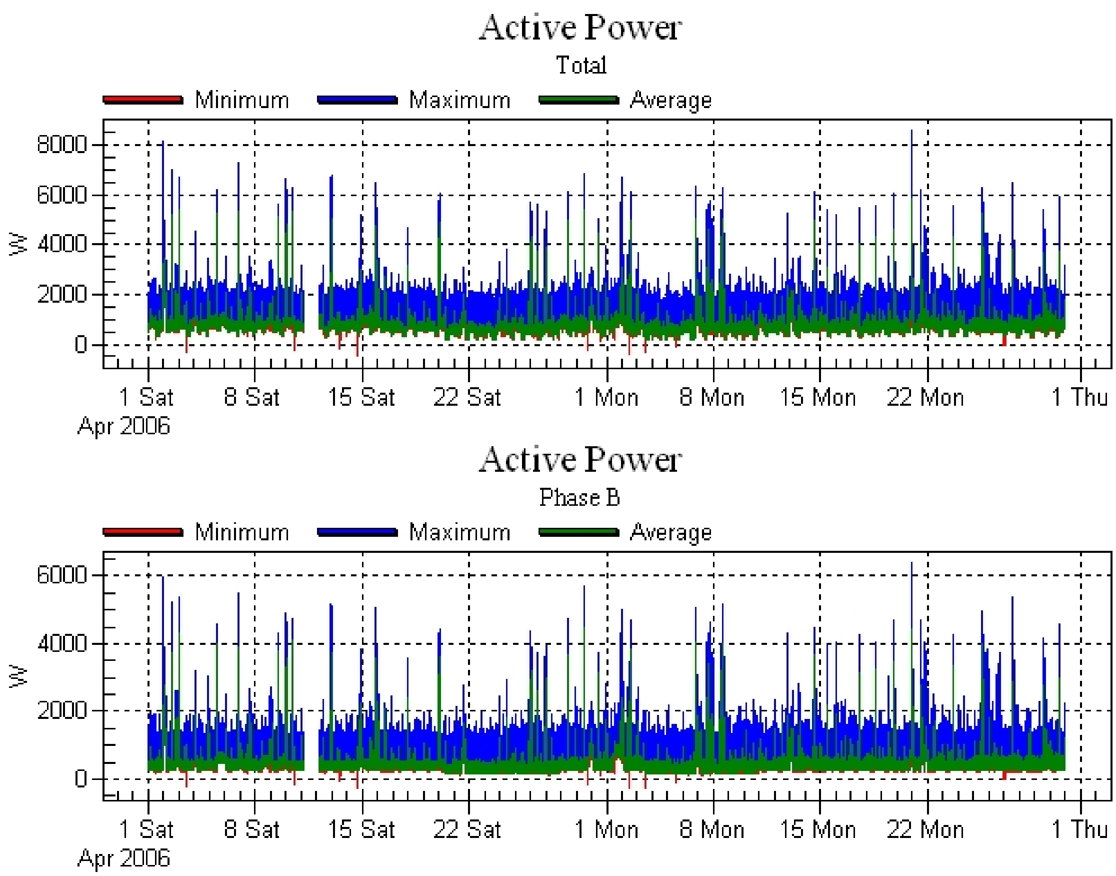

Figure 1: Total system load (Service Entrance). Even without the hot tub the load reached more than 8kW at times, and phase B would reach more than 5.5 kW, which is the rated limit of the inverter.

The data collection in May ran into some short term problems. First the virtual network was down for a couple of days and then Gaia introduced a slight change in the data header from the PowerTower, which caused temporary problems for reporting of historical data – real time reporting was unaffected. After we identified the problem, Enernex was luckily able to apply a patch to the data conversion program.

Results / Discussion

Short-term flicker problem continues to be an issue. In April we changed the algorithm for changing the set-point of the fuel cell to force deeper discharge of the batteries, and it did improve on the flicker, but it did not bring it down to 'utility grade'

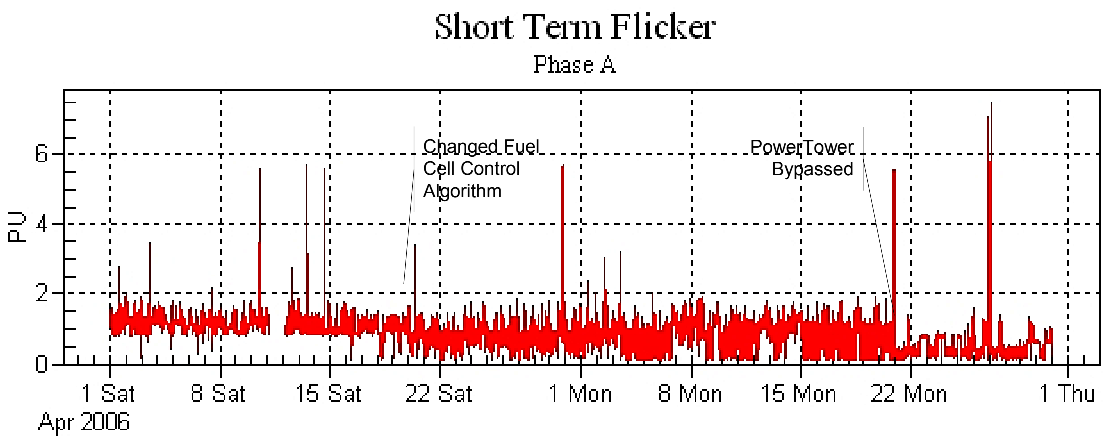

Figure 2: Short term flicker. A PU value above 1 corresponds to more than 50% of the population will notice flicker in an incandescent light bulb.

As it can be seen from Figure 2 the flicker went down after the fuel cell control algorithm was changed, but it still is not as good as the utility alone. We had a phone conference with Enernex, and they claim that the behavior is not atypical of a source-limited installation.

As seen in Figure 3 the change in fuel cell algorithm did increase the battery usage and reduced the charge frequency, but clearly not enough to prevent the flicker. Unfortunately, without turning of the fuel cell it is not possible to increase the battery usage more. However, this can be demonstrated in the grid / storage scenario.

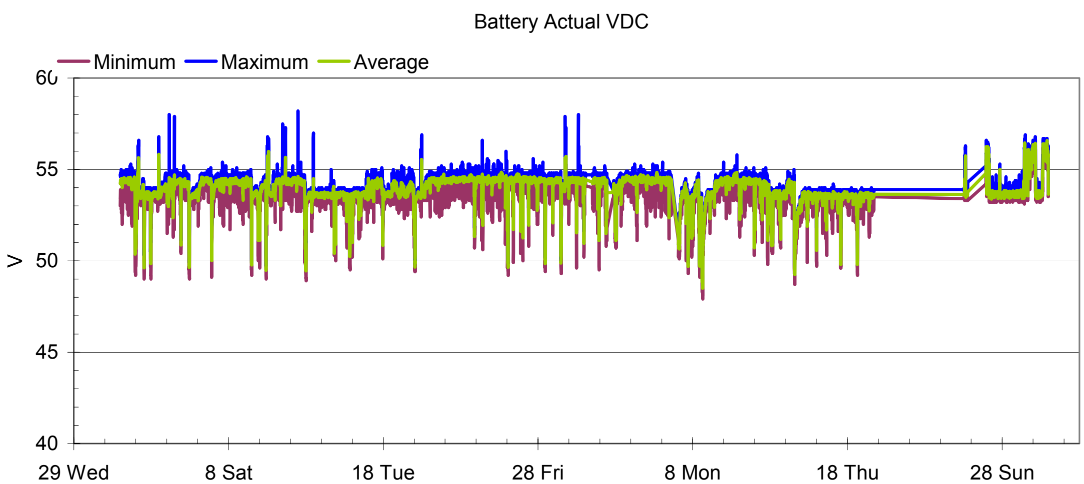

Figure 3: PowerTower battery voltage (GP PowerTower Battery)

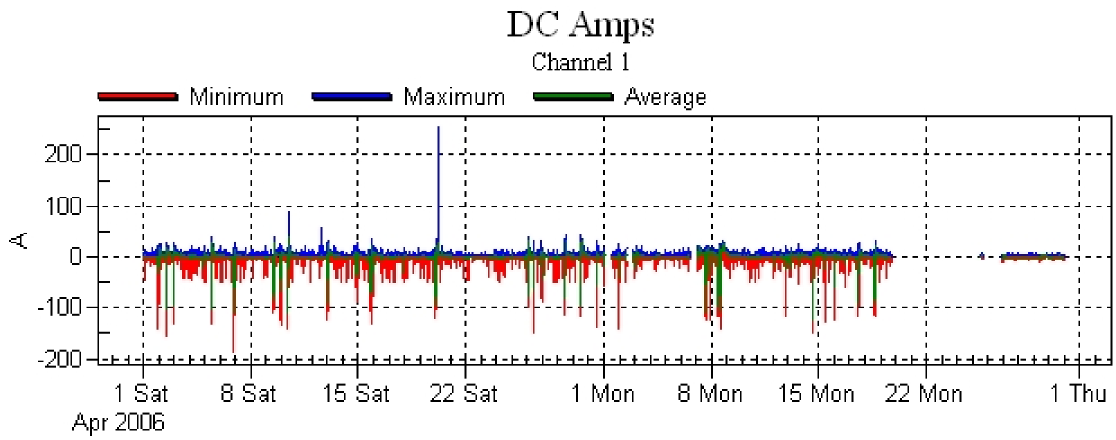

Figure 4: PowerTower battery current (Battery Monitor). Negative current equals discharge and positive equals charge.

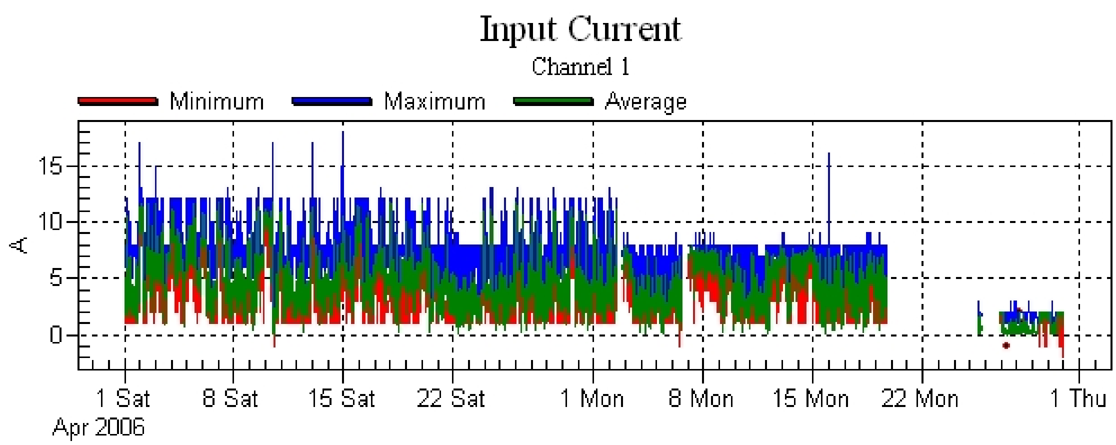

Figure 5: Inverter 1 input current (GP PowerTower Inverter A)

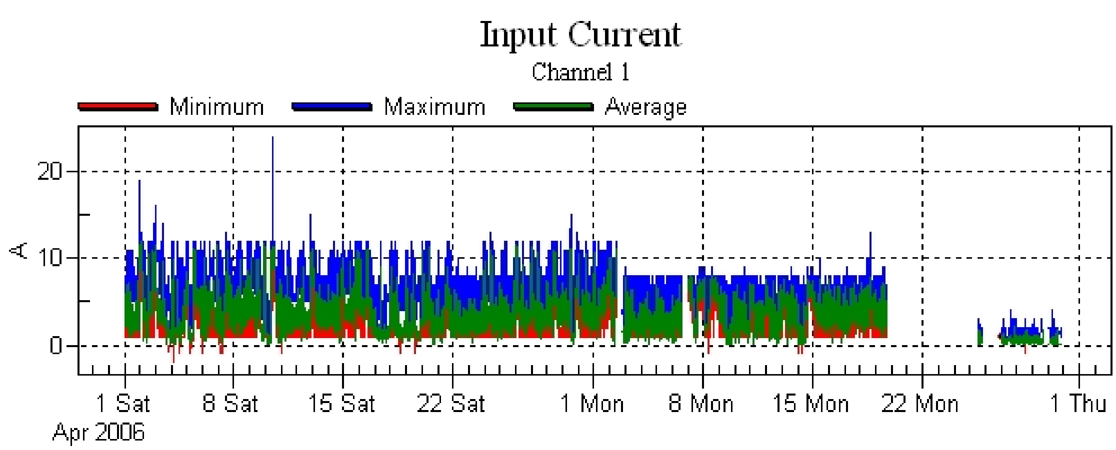

Figure 6: Inverter 2 input current (GP PowerTower Inverter B)

Compared to March the input current was kept at a much lower level in this period, which might have been detrimental for the fuel cell performance, as it stopped working two times in the period.

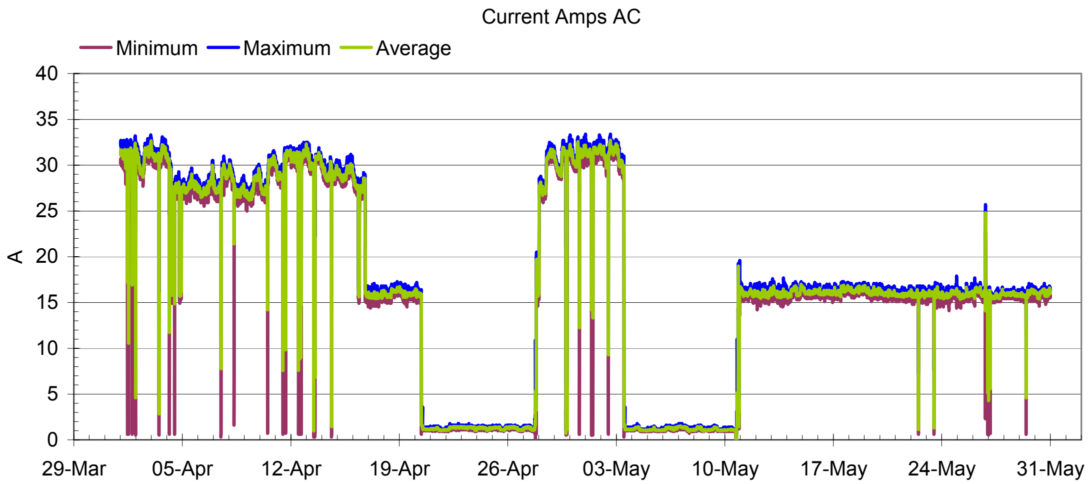

Figure 7: Fuel cell output (PP Fuel Cell Output). Fuel cell went off-line twice in this period.

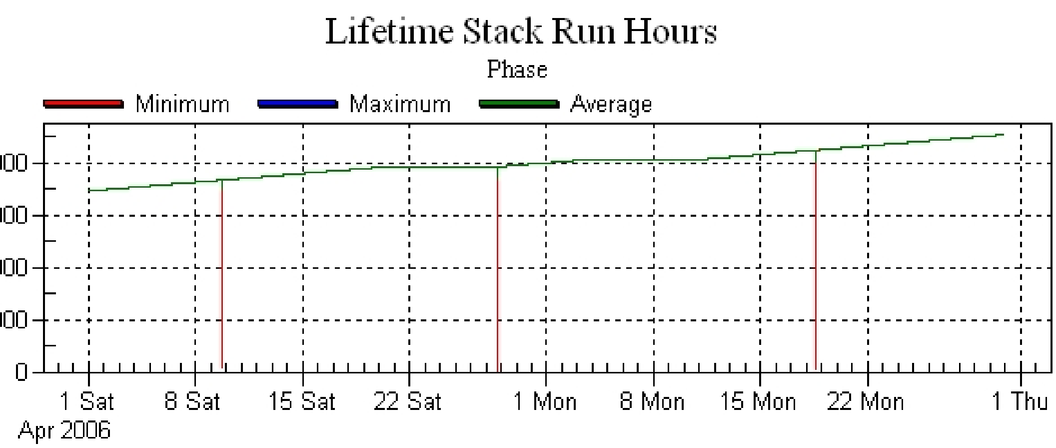

Figure 8: Accumulated run time of fuel cell stack (PP Fuel Cell Internal).

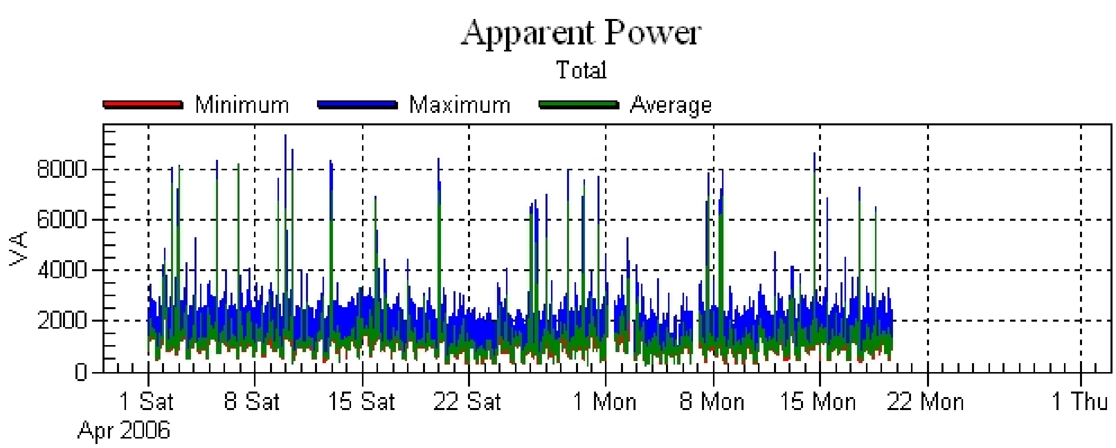

Figure 9: Battery storage power output for the month (GP PowerTower Output).

Figure 9 shows that the battery storage delivered over 8 kW during its operation in April and May. A further analysis of the system during the time the battery storage was online, shows that it performed as expected.

At the end of May the house owner experienced significant voltage drop / light flicker and he pulled the by-pass switch. A closer look at the power demand in and out of the PowerTower in Figure 10 shows that the voltage dip was caused by sudden increase in current demand on both phases. In fact the increase corresponded to 10kW and the inverters were maxed out at 5.6 kW each, which is slightly above the rating. At this point we do not know what the house owner tried to power, but it was not disconnected when he tried to reinsert the PowerTower again 45 minutes later.

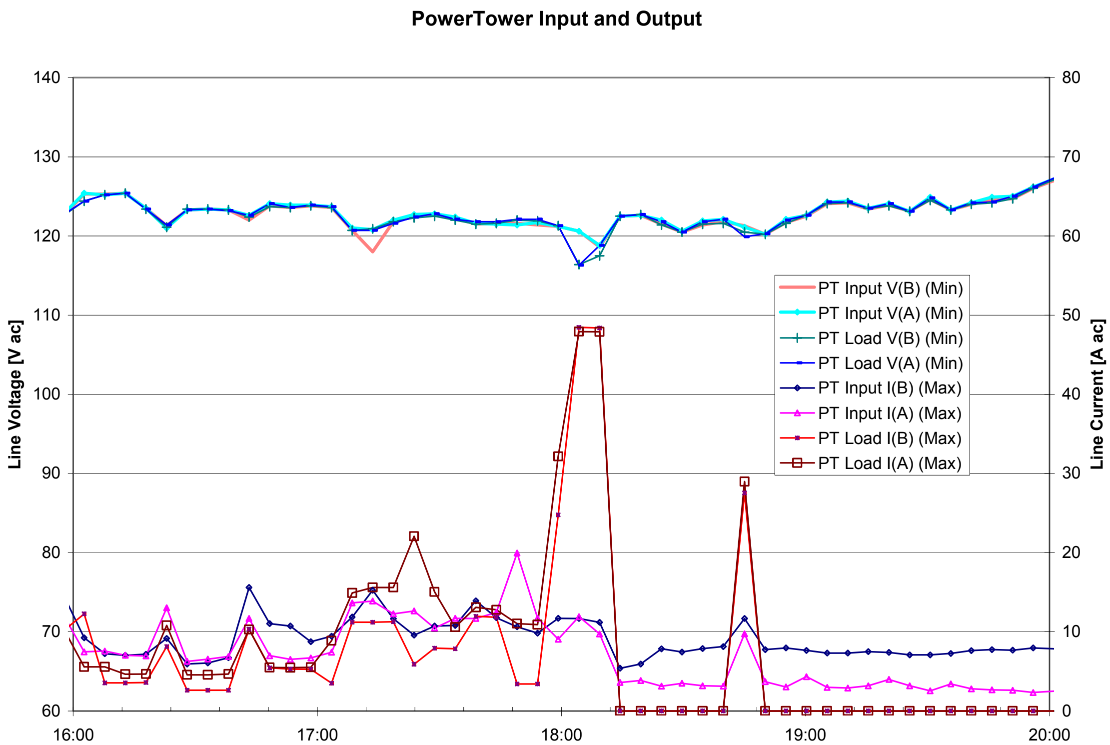

Figure 10: PowerTower input and load just before and after voltage dip and subsequent by-pass.