

Buffering PV Output during Cloud Transients with Energy Storage

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THE PROBLEM

- Photovoltaic output power can be affected by many factors including clouds passing overhead.
- Utilities in generally prefer a guaranteed power delivery level over some specified power delivery period.
- Power delivered during peak demand hours is generally more valued by utilities. For the Desert Southwest this is in the summertime afternoons. For the local area this will be defined as 1-5 pm for the three summer months.
- While battery power can be adapted to this problem, large batteries to be expensive.

A POSSIBLE SOLUTION

- A high concentration PV unit manufactured by Amonix (model CPV 7700) will be the basis for this study, using actual 15-minute output data for one summer.
- The unit puts out 38 kW of power maximum.
- In the beginning a generic type of battery is assumed, and then costs will be compared for three different types of batteries.
- An attempt will be made to determine the constant power level that could be put out over the period by a system of this sort using an electrical storage battery.
- Perhaps used electric vehicle batteries might be used for this application because they will have several years of life left at a lower power level when they need to be replaced in the car. This could be a less expensive solution for this application.

THE STRATEGY

- Set the size of the battery, both in power and energy.
- During a full summer season assume that power generated off-peak is used to charge the battery unless the battery is fully charged.
- Power generated on-peak is sent to the grid and battery power supplements this when the power is not constant.
- Numerical experiments are performed holding the output power constant during peak times at a given value.
- If the system does not have enough energy to supply to the constant load during the summer peak, the desired constant load is lowered.
- The numerical calculation/iteration is continued until the desired constant load is met.
- Another rating for the battery is set and the calculation sequence is performed again.

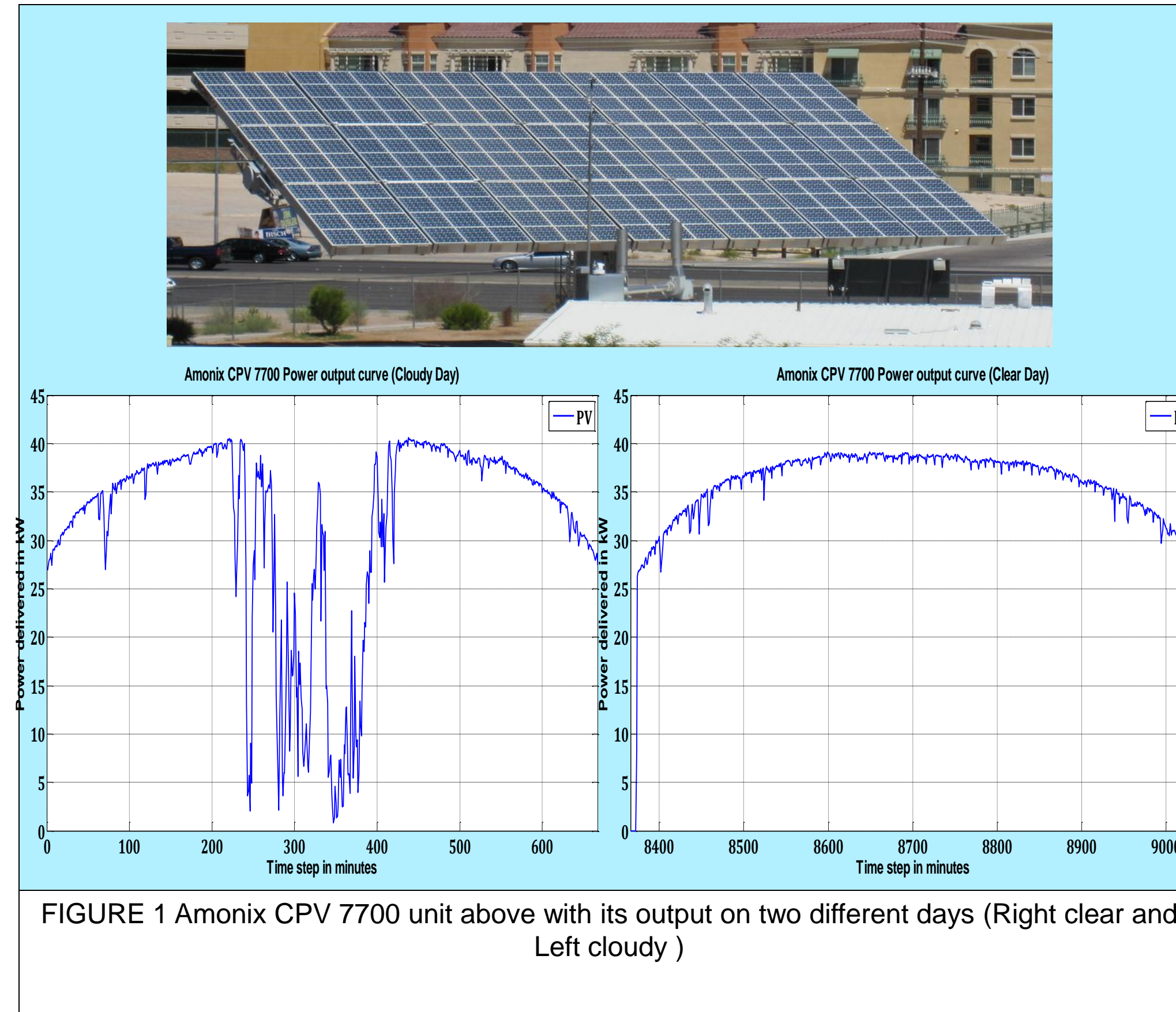


FIGURE 1 Amonix CPV 7700 unit above with its output on two different days (Right clear and Left cloudy)

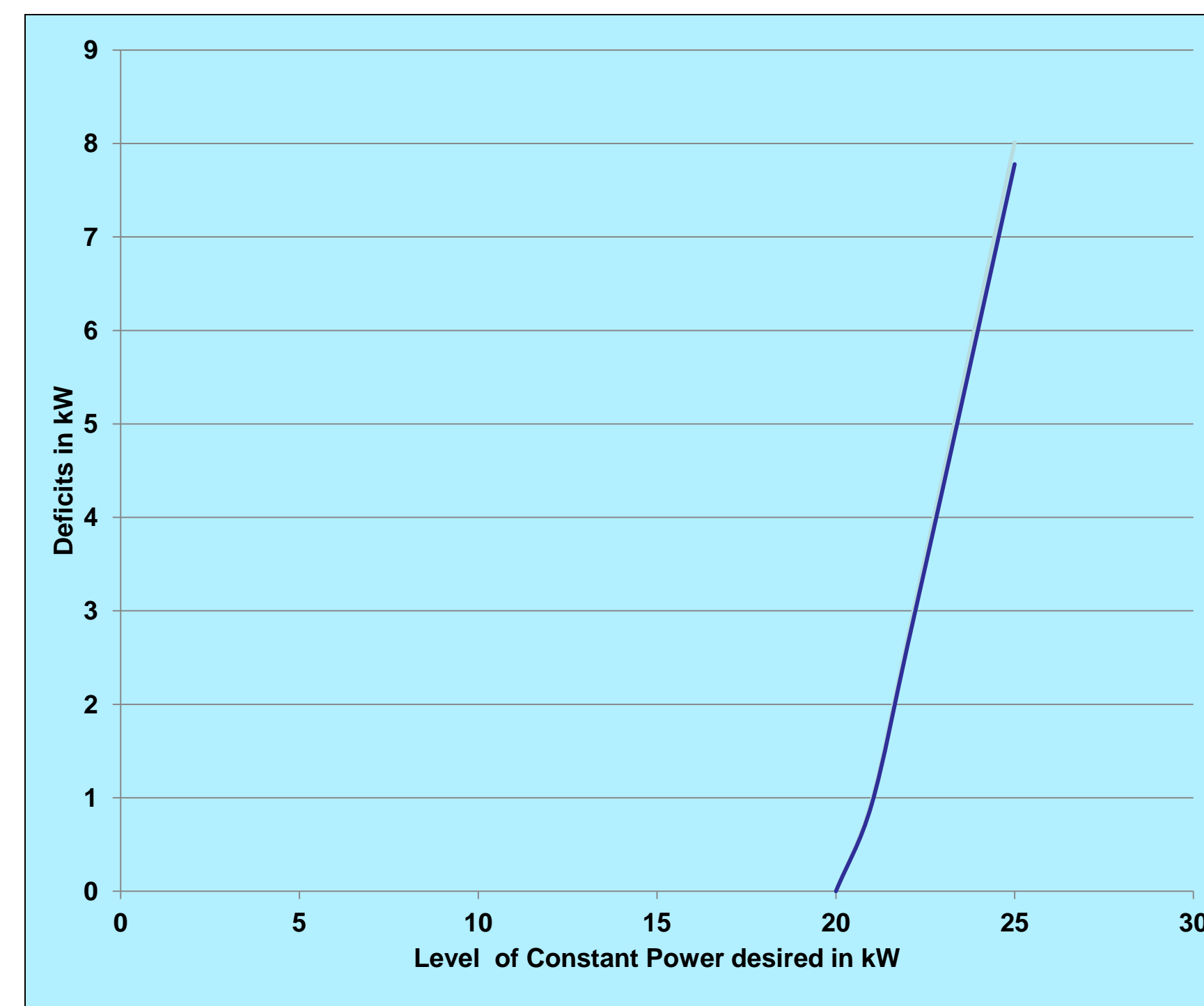


FIGURE 3 Graph showing deficit equals zero at desired power of 20kW
Constant battery (54kW) vs Variable power supply (20,21,22,23,24,25kW)

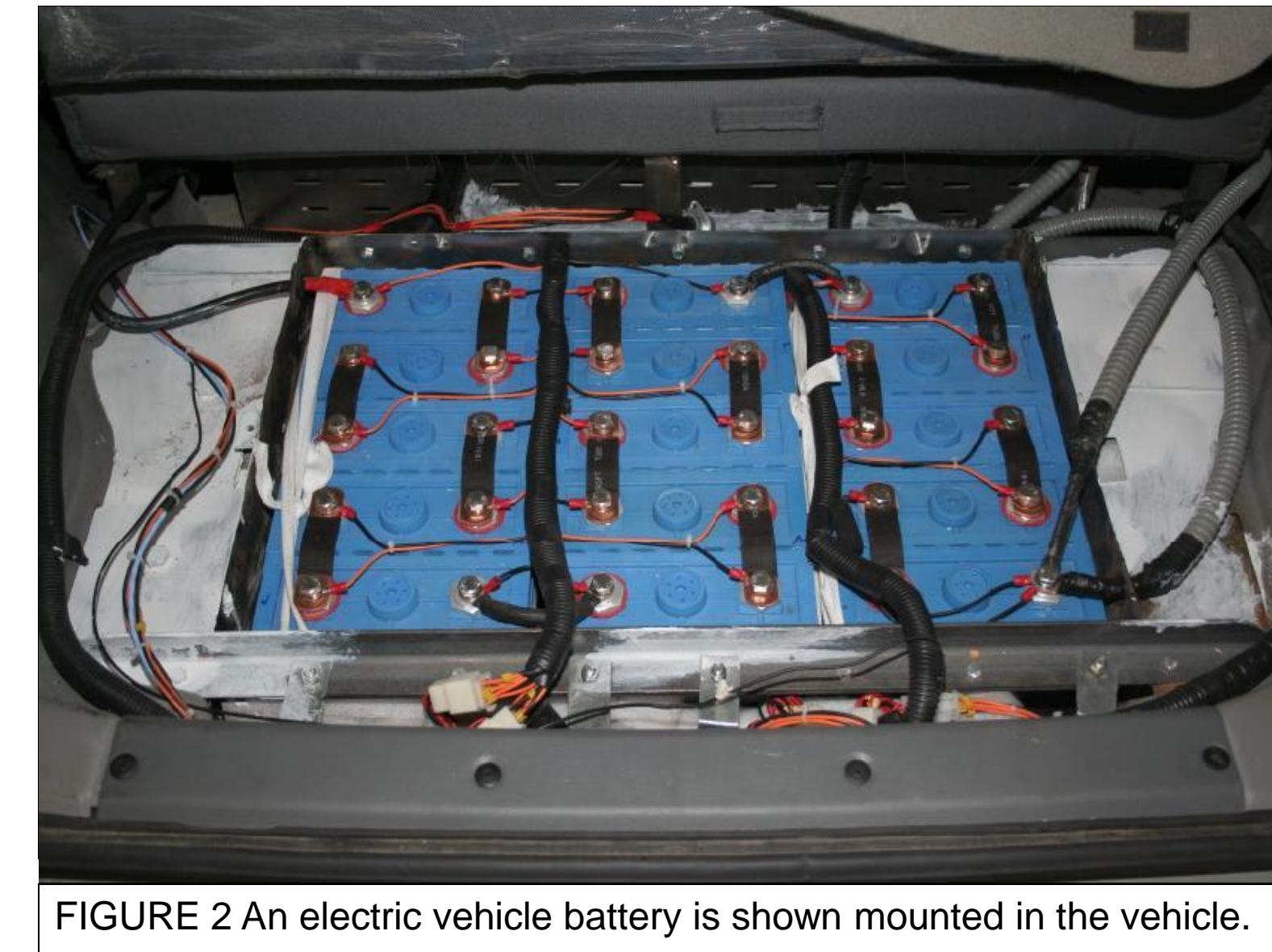


FIGURE 2 An electric vehicle battery is shown mounted in the vehicle.

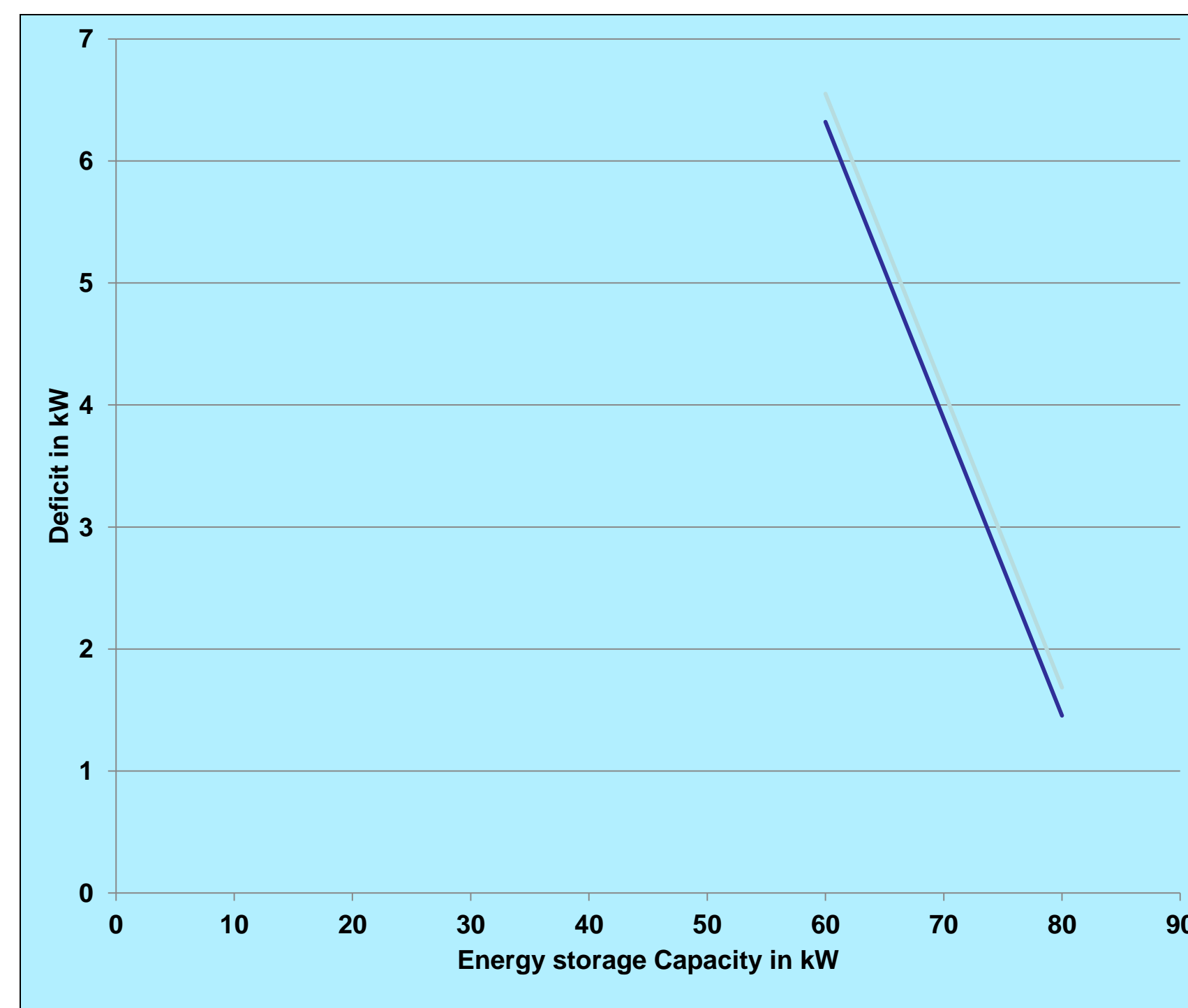


FIGURE 4 Graph showing decreasing deficit as ESS is increased
Constant power supply (25kW) vs Variable ESS capacity (60,65,70,75,80 kW)

ECONOMIC ANALYSIS

- Average Electric Vehicle (EV) price/kWh = \$775
- Total Energy capacity of the CPV 7700 = 18.36kWh
- Total price = 18.36kWhx\$775/kWh = \$14,229
- For 2nd EV battery life; price is halved to \$7,114.5
- This is what Amonix would pay for each unit if they were to put an ESS on to smooth out any transients.

CONCLUSIONS

- Simulations started with power of constant 15kW with an ESS of 30kW for the period of 1pm to 5pm (summer)
- Simulation findings matched the calculated values
- Constant power of 20kW throughout peak times periods of the summer is achieved !
- Estimates of the cost-effectiveness with current prices were not positive
- Could be if battery pack prices drop to \$375/kWh or below
- Performing an experiment on an actual system is desirable to see if the estimates made here would be reasonable.

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