

Model 3 Battery Range Extension Cases

A warehouse manager intended to reduce the amount of time that hundreds of Class III forklifts and their drivers were nonproductive because they had to re-fueling their vehicles at least once per shift, which took about 15 minutes each time. The solution of installing an Oorja Model 3 fuel cell on each forklift (see Figure 1) allowed refueling time to decrease to almost zero, it freed up space in the warehouse formerly devoted to fuel storage and refueling, and it also reduced greenhouse gas emissions.

Case 1, A Two-Shift Operation: A two-shift operation requires 24 kWh for 16 hours, which cannot be met by the batteries in Class III vehicles. Additional power of 12 kWh is required. Adding an Oorja Model 3 fuel cell to each Class III forklift extends its range to 29.5 kWh, which is more than the 24 kWh required for the two-shift work period. See Figure 2 for details.

Case 2, A Three-Shift Operation: A three-shift operation requires 36 kWh for 24 hours, which cannot be met by the batteries in Class III vehicles. Additional power of 24 kWh is required. Adding an Oorja Model 3 fuel cell to each Class III forklift extends its range to 38.4 kWh, which is more than the 36 kWh required for the two-shift work period. See Figure 3 for details.



Figure 1. An Oorja Model 3 on a Class III forklift

Case 1: Two-Shift Operation

During a two-shift operation the power requirement is 24 kWh for 16 hours, which cannot be met by the batteries in Class III vehicles.

In order to sustain the two-shift operation, additional power of 12 kWh is required.

- Adding an Oorja fuel cell (which supplements the existing battery output with 17.6 kWh) makes a total of 29.6 kWh during the two-shift operation. This range extension exceeds the required 24 kWh comfortably, making it a viable solution.

	 1.1 kW x 16 hrs = 17.6 kWh	 500 Ahr x 24V = 12 kWh	 1.5 kW x 16 hrs = 24 kWh load	Energy Requirement
Normal power	—	—	24 kWh	24 kWh (requirement)
Power requirement for 16 hours	—	12 kWh from battery		12 kWh (insufficient for the requirement)
Power requirement for 16 hours with Oorja power cell	17.6 kWh from Oorja fuel cell 	12 kWh from battery		29.6 kWh (exceeds the requirement)

Figure 2. Power requirements and delivery for a two-shift operation

Case 2: Three-Shift Operation

During a three-shift operation the power requirement is 36 kWh for 24 hours, which cannot be met by the batteries in Class III vehicles.

In order to sustain the three-shift operation, additional power of 24 kWh is required.

- Adding an Oorja fuel cell (which supplements the existing battery output with 26.4 kWh) makes a total of 38.4 kWh during the three shift operation. This range extension exceeds the required 24 kWh comfortably making it a viable solution.




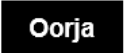
	 1.1 kW x 24 hrs = 26.4 kWh	 500 Ahr x 24V = 12 kWh	 1.5 kW x 24 hrs = 36 kWh load	Energy Requirement
Normal power	—	—	36 kWh	36 kWh (requirement)
Power requirement for 24 hours	—	12 kWh from battery		12 kWh (insufficient for the requirement)
Power requirement for 24 hours with Oorja power cells	26.4 kWh from Oorja fuel cell 	12 kWh from battery		38.4 kWh (exceeds the requirement)

Figure 3. Power requirements for a three-shift operation