

OorjaPac

Fuel Cells for Forklifts

Green Paper

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TABLE OF CONTENTS

Introduction	Page 3
OorjaPac and Fuel Cell Education	Page 4
Benefits to the OorjaPac System	Page 7
OorjaPac Return on Investment	Page 8
Carbon Footprint Reduction	Page 9
Frequently Asked Questions	Page 10
About Pacific Material Handling Solutions, Inc.	Page 12
About Oorja the Company	Page 13
OorjaPac Brochure.....	Page 14

INTRODUCTION

What is OorjaPac

Oorja has pioneered the development and commercialization of an Ultra-Powerful Alcohol Fuel Cell solution for the material handling industry.

OorjaPac is an on-board battery charger for material handling vehicles.

The OorjaPac solution completely eliminates the need for battery-swapping or rapid charging, allowing customers to economize their fleets.

The powerful direct methanol fuel cell, trickle-charges the batteries and periodically equalizes the batteries.

Value Proposition

The target market for OorjaPac™ is the materials handling industry, for use in electric forklifts, pallet trucks, and automated guided vehicles. The OorjaPac addresses the following key challenges faced by material handling fleet managers:

- Low runtime of vehicles on a single battery charge
- Multiple batteries swapping to meet vehicle runtime needs
- Significant operational costs associated with electricity, battery room, and lost productivity

Deploying the OorjaPac can create real savings and resolve the above mentioned challenges.

Fuel

OorjaPac operates on liquid methanol. Methanol is a widely available and easy to handle energy source. It is produced from natural gas and from land fill gases and bio-waste. The process of fueling the OorjaPac is as simple as refueling a car.

Operating Conditions

OorjaPac operates in the temperature range from -20 F and +110 F and fits within the vehicles battery compartment. OorjaPac is designed to operate in a variety of taxing industrial environments and can tolerate dust and airborne particulates. It can operate in either indoor or outdoor conditions.

Off The Grid

With the OorjaPac installed, forklifts and other vehicles can be completely independent of the grid.

Reduction in Carbon Footprint

The deployment of OorjaPac fuel cells on your forklifts will reduce your carbon footprint.

OORJAPAC AND FUEL CELL EDUCATION

1) What is a fuel Cell?

A fuel cell is an electrochemical device that generates electricity by converting the chemical energy stored in a fuel to electrical and thermal energy. Instead of burning the fuel as in the case of an internal combustion engine, it generates power using an electrochemical reaction. The byproducts of the electrochemical reaction are pure water and heat.

2) Are all fuel cells the same?

No, there are many different types of fuel cells. Some of the key differences are in the type fuel they use, the way they are built and the operating conditions such as temperature and environment. Uses range from powering small consumer devices to generating electricity for power plants. The application dictates the type of fuel cell required.

3) What fuels are used in fuel cells?

A variety of fuels can be used including hydrogen, methanol, ethanol, butane, natural gas, ammonia and liquefied petroleum gas. Energy from landfills, biomass, coal, wood and agricultural waste can also be used to create the fuel. Because they function on such diverse input, fuel cells are a logical choice to transition from current combustion based technologies to renewable energy sources.

4) What are the benefits of fuel cell technology?

Pollution Reduction: Fuel cells lower greenhouse gas emissions and reduce other environmental pollutants. CO₂, CO, NO_x, SO_x, particulates, hydrocarbons and other emissions are reduced with all fuel cell technologies.

Lower Costs: In many cases fuel cells produce power at lower cost than traditional fossil fuel competition. This is increasingly true as the cost of fossil fuels escalates.

Reliability: Fuel cells provide a reliable source of power for applications that had previously be subject to power interruptions.

Efficiency: Fuel cells operate at 40-80% efficiency depending on the type of technology deployed. This often represents a substantial increase in efficiency as compared to burning fossil fuel to generate power.

Fuel Availability: Fossil fuels are a non renewable resource and will one day be depleted. Many fuels used to power fuel cells are renewable or represent untapped resources that augment our fossil fuel reserves.

Quiet, Clean, Modular, Durable: Many fuel cells operate at minimal noise. They can be modular, compact and durable. This makes them ideal candidates for many applications that are removed from the grid or where traditional power delivery expensive.

5) What is the difference between a fuel cell and a battery?

A battery chemically stores and releases electricity, while a fuel cell produces energy through the electrochemical reaction of a fuel and air. A battery will run out of power and require recharging, then disposal. A fuel cell, however, will continue to function and produce power as long as fuel and oxygen are supplied.

6) Are fuel cells a renewable energy source?

Fuel cells themselves are not a power source: rather they use a fuel to produce power. If the fuel is obtained from renewable sources, then fuel cells can be an important part of the renewable energy chain.

7) What type of fuel cell does Oorja provide?

Oorja designs, develops, and manufactures liquid methanol based fuel cells.

8) Where are fuel cells used?

The following applications are a sample of the areas where fuel cells are being used commercially today.

Off-Grid Applications: Remote home sites, field science stations, telecommunication repeaters, backup power for schools, hospitals and government facilities

On-Board Charging: Forklifts, Automated Guided Vehicles, golf carts, tuggers, riders, cars, motorcycles, submarines

Portable & Mobile Power Applications: Consumer electronic devices, cell phones, MP3 players

Auxiliary Power Applications: Recreational Vehicles, military vehicles, boats, homes

9) What advantages does OorjaPac offer in comparison to batteries or internal combustion powered options for forklifts?

Lower Costs

OorjaPac reduces costs (labor, electrical, battery) and increases productivity (labor, space, battery) for material handling operations.

Reduced Pollution

OorjaPac reduces green house gas, eliminates NOx, and eliminates SOx. OorjaPac increases battery life and reduces battery requirements. This reduces the overall use of toxic chemicals inside the batteries.

10) What is the impact of the life of the battery and how would the OorjaPac Solution impact the maintenance requirements of the battery?

OorjaPac continuously trickle charges the battery in the material handling vehicle. This ensures the battery never reaches a state of deep discharge. Battery charge and power are maintained and the battery is not subject to heat damage caused during recharging. Therefore, battery life is increased and battery maintenance needs are reduced.

11) How do you refuel the OorjaPac?

Methanol is delivered to the fuel cell similar to refueling a car. A compact methanol refueling cabinet with a hose and nozzle is used to transfer methanol to the fuel tank in the OorjaPac. Anyone can refuel the OorjaPac with minimal training.

Methanol delivery for our customers is ensured by Oorja. We have set up partnerships with several large national methanol suppliers so that the fuel can be regularly supplied to any location within 24hrs.

12) Are other options for refueling available?

There are other options for refueling such as using a hand pumps or swapping of tanks. However, these options are not standard and are customized based on the unique needs of our customers.

13) What is your policy on system repair and maintenance?

The OorjaPac has few moving parts and requires little maintenance. However, when it is required, we have a large dealer network available with labor and parts for on-site service. Pacific Material Handling Solutions, Inc., offers a number of maintenance plans to cover all operating environments.

14) What model batteries does the OorjaPac Support?

The Oorja unit works with all batteries that operate on 24, 36 and 48 Volts.

BENEFITS OF THE OORJAPAC SYSTEM

Benefits of On-board Charging

Leveraging its patented break-through technology, Oorja provides the next generation of fuel cell technology to the material handling industry. The OorjaPac product line allows material handling managers to significantly increase productivity, reduce operational costs, and reduce their carbon footprint in the following ways:

Reduced Labor Costs

Lift truck operators spend part of their day swapping batteries to ensure sufficient battery charge. Estimates of time lost for charging and swapping range from 30 to 80 minutes over a 2 shift period. OorjaPac eliminates battery swapping.

Increased Productivity

OorjaPac increases productivity in two ways, (1) it eliminates time and resources spent swapping and charging batteries and (2) it maintains a constant state of charge.

Reduced Battery Replacements

With OorjaPac powered forklifts, fleet managers require fewer batteries to run their fleet. Using the OorjaPac liquid methanol fuel cell, the need for additional batteries and their replacement is eliminated. The OorjaPac acts as an on-board charger and ensures that the batteries are not deep discharged, thereby reducing the need for battery replacement.

Eliminate the Need for Battery Rooms

With the OorjaPac there is no need to charge batteries outside the forklift. This frees valuable cubic footage on the warehouse floor.

Leverage Existing Investments with On-Board Charging

Methanol storage and handling requires minimal infrastructure change. This affords seamless transition to deploying OorjaPac as an on-board charger.

Environmental and Safety Improvements

OorjaPac improves safety by eliminating the heavy lifting required with lead-acid batteries. Safety is also improved because trips to and from the battery charging area are also eliminated. Fewer batteries mean fewer acid spills and less pollution when the batteries and their contents are finally retired.

Pollution Reduction

OorjaPac reduces the carbon footprint of forklift operations. OorjaPac releases no SOX or NOX. reduction helps meet corporate goals of a cleaner workplace and community.

OORJAPAC RETURN ON INVESTMENT

Pacific Material Handling Solutions conducts ROI studies in conjunction with customers in the material handling industry. We quantify cost and productivity variables that determine payback for the OorjaPac solution. Some of the variables we use include:

1. **Productivity Savings**

- Eliminates time to swap batteries
- Eliminates time driving to and from battery swap area
- Eliminates labor cost for battery swapping
- Eliminates downtime of vehicle for swapping and charging

2. **Equipment Savings**

- Reduces the number of batteries required
- Eliminates charging equipment
- Right-size vehicle fleet

3. **Infrastructure Savings**

- Eliminates battery charging infrastructure
- Eliminates space used for battery charging room
- Reduces electricity cost

4. **Maintenance Savings**

- Reduces battery maintenance
- Reduces forklift maintenance
- Eliminates maintenance of charging equipment

5. **Environmental Savings**

- Receive Federal, State, and County credits
- Reduces green house gas emissions

6. **Safety Savings**

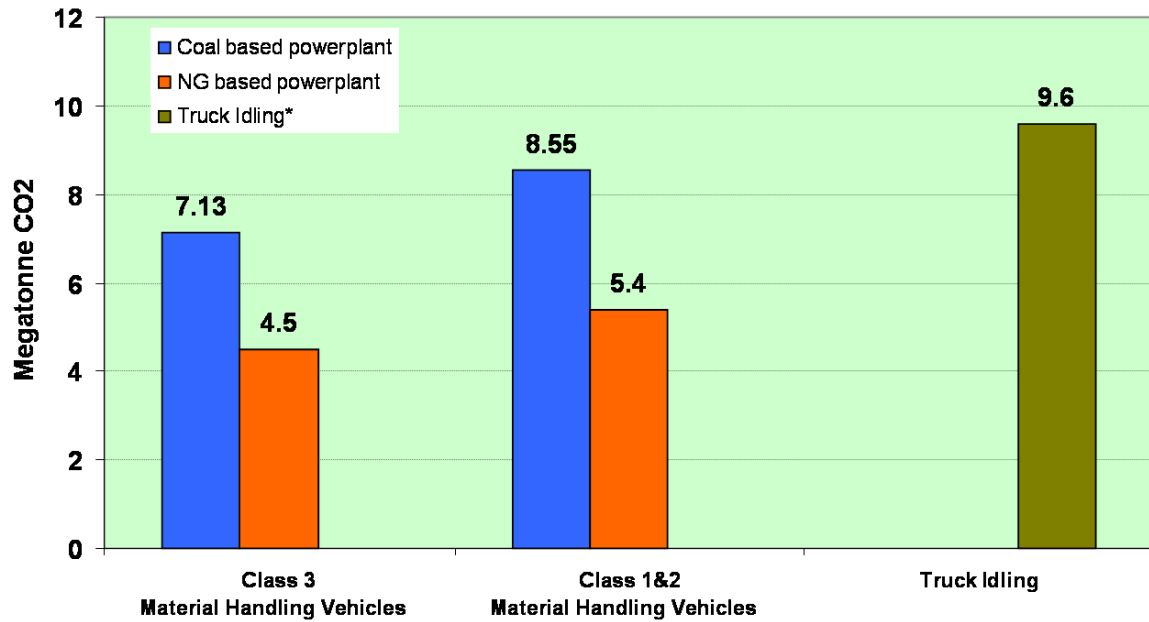
- Eliminates battery swapping accidents.
- Reduces battery acid spills

In all cases we find that the OorjaPac reduces greenhouse gas emissions and provides a rapid payback. We can assist with your goal of protecting the environment while improving your bottom line. Contact us for an analysis of how OorjaPac can improve your operations.

OORJAPAC REDUCES YOUR CARBON FOOTPRINT

Potential Annual Carbon Footprint Reduction by Deploying 1000 OorjaPacs

Carbon Footprint Reduction



* Data from Argonne National Lab, Transportation Technology R&D center

FREQUENTLY ASKED QUESTIONS

Question	Answer
How many OorjaPac units can be supported by one fueling station?	A single OorjaPac Fueling Station holds two 55 gallon drums of methanol. A 55 gallon drum can supply fuel to 15 OorjaPac units that are completely out of fuel before the drum is emptied. Therefore, the OorjaPac Fueling Rig can support many OorjaPac units.
Are there any environmental or Eco concerns in regards to the refueling station?	No, the refueling station is an NFPA 30 rated cabinet with compression fittings at all connection points. Additionally, all the couplings on the refueling station are self sealing couplers with an in-line “dry-break” coupler - in case a driver forgets to disconnect before driving away.
Does a trickle charge do any harm to the battery? Are there any drawbacks to trickle charging?	No, a trickle charge is the best type of charge for the batteries as it does not heat the battery. The only drawback to trickle charging is time; however since the OorjaPac is mounted on and connected to the battery at all times, the time factor is not applicable.
How many hours does the once-a-week equalization take?	It depends on multiple factors. However, if a “healthy” battery is assumed, a 510Ahr battery that has been depleted 40% SOC will take <6 hrs to complete equalization.
What is the basis of our claim that a battery will last 50% longer with Oorja?	<p>With the OorjaPac mounted, the battery State of Charge (SOC) remains at the optimum levels of 40%-80%; it does not experience any deep discharges which cause the lead sulfate (PbSO₄) formation or crystallization thus preventing loss of active surface area; in general, more surface area, equals more capacity. The OorjaPac is an onboard trickle charger; therefore, the battery never experiences the high currents/temperatures associated with regular or rapid chargers. Additionally, the OorjaPac is programmed to automatically take the battery to 100% SOC daily and automatically equalize once a week.</p> <p>Therefore, if a battery typically lasts 5 years, we can increase the life of the battery by 2.5 years.</p>
How do OorjaPac emissions compare to our state's emissions?	(This varies from state to state) On a national level, the OorjaPac produces 66% less emissions than the power generated by major power plants.
What environmental subsidies does the OorjaPac qualify for?	There are incentives at Federal, State, County and City levels. On a federal level, there is a \$4500 per system (\$3000 per kW) tax incentive from the Federal government according to the 2005 energy bill which is valid until Dec 31st 2016. At the State, County and city levels, additional tax incentives may or may not be available depending on location.
Can the OorjaPac operate in freezers?	Yes, the OorjaPac can operate in freezers without any negative impact on OorjaPac performance or life. The OorjaPac has been operationally tested to below -30°F conditions.
Will the OorjaPac impact a vehicle's stability?	No, the vehicle remains well within its manufacturer's specifications. The OorjaPac is only about 10% of the battery weight; with the OorjaPac installed the driver will not experience any difference in vehicle stability.

<p>How safe is the methanol tank in the OorjaPac?</p>	<p>Safety is our biggest priority; as such the system is very safe. The methanol tank is the only place that contains 100% methanol. It is double-contained with a thick outer steel box and an inner polyethylene container where the fuel is actually stored. As a third layer of protection, the systems cover acts as a barrier. A fourth safety measure -- a liquid spill sensor -- is located in the fuel tank; if it detects even the slightest amount of liquid, it will shut the OorjaPac down.</p>
<p>Will battery watering still be required at the same frequency?</p>	<p>No, our in-house testing as well as data from our customers shows that the watering frequency can be extended 4-5 times. For example, if the “normal” watering frequency is once a week; installing the OorjaPac will shift the watering cycle to once every 4-5 weeks.</p>
<p>How is battery watering accomplished with the OorjaPac installed?</p>	<p>We recommend installing “single-point” water kits to the batteries to optimize the watering process. However, even without the watering kit, the OorjaPac very easily “slides” out of the way for clear access to all the cells by removing just 4 hold-down screws.</p>
<p>Will we go completely grid free with the OorjaPac?</p>	<p>Yes, with the OorjaPac installed, the vehicles can be completely independent of the grid.</p>

ABOUT PACIFIC MATERIAL HANDLING SOLUTIONS, INC.

About Pacific Material Handling Solutions, Inc.

Pacific Material Handling Solutions, Inc. (PMHSI) was founded in 1993 and is a privately owned fleet management and material handling dealership headquartered in Hayward, CA. We have branch operations throughout Northern California, Northern Nevada, Oregon, and Washington.

We are a company which values education because we believe education stimulates imagination. It is this imaginative atmosphere that stimulates the development of new ideas, skills, products and processes to provide real solutions to our customers. Execution of real solutions improves performance and sustainability for our customers.

We operate within a structured environment with well thought out policies and processes to ensure consistent results. We are committed to growing our business, providing quality benefits and opportunities for our associates.

We promote social responsibility and give back to our local communities. At Pacific Material Handling Solutions, Inc. we provide the highest level of excellence in customer satisfaction.

Our Value Proposition

We focus on really listening to our customers and we are committed to integrity, high customer satisfaction, and long-term relationships with companies that need cost effective solutions. We look to reduce your operational costs through our Technology, Fleet Management, Human Resources, and Environmental Sustainability solutions.

We offer products with the highest quality and productivity available, supported with unmatched parts and technical service support.

OorjaPac Solutions Partner

Pacific Material Handling Solutions is the OorjaPac dealer and service center throughout Northern California, Northern Nevada, Washington, and Oregon.

ABOUT THE OORJA COMPANY

Oorja designs, develops, and manufactures the most powerful and advanced methanol fuel cells in the world. In development for 3 years and on its 5th generation of technology, Oorja's products are customer and OEM proven, reliable, and available today. Its customers include OEMs, retailers, automotive manufacturers, logistics providers, and food processing companies. The company is privately held and funded by leading venture capital companies including Sequoia Capital and DAG Ventures.