

# The Food Cart of the 21st Century



A Report by  
ENERGY VISION



Energy Vision is a national 501 (c) (3) organization based in New York City whose goal is to promote — through research and action — a swift transition to pollution-free, renewable energy sources. Programmatically, Energy Vision informs and engages with policy, business, and environmental leaders, to support the shift toward a sustainable energy and transportation future.

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# The Food Cart of the 21st Century

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## Foreword

Since the days of pushcarts, mobile vendors have exemplified small business at its most entrepreneurial. Food carts can be started with little capital and improved with sweat equity. Some owners have parlayed their customer loyalty into full-fledged restaurants. However, until now, this industry has had no choice but to rely on antiquated technologies that are dirty and unsafe.

Food carts are a long-standing part of New York City street life. NYC has over 5,000 licensed food carts and trucks, and an estimated 3,000 unlicensed carts on the streets. Cart operators, representing a diverse array of ethnicities and cuisines, serve approximately 1.2 million customers everyday.

*The Food Cart of the 21<sup>st</sup> Century* describes, in detail, the innovative food cart designed and developed by NYC-based Move Systems — the MRV100. It highlights the immense environmental and public health benefits of this new food cart; a direct result of replacing gasoline/diesel generators and propane tanks with hybrid natural gas and electric systems. These systems come close to totally eliminating the carbon monoxide (CO) and other emissions that have threatened the health of New Yorkers, and especially of food cart operators. These new carts will also cut greenhouse gases by 60%. All of this is being accomplished while still offering competitive cart pricing and saving operators money on fuel costs.

In addition to immense health and environmental benefits, the MRV100 provides vendors the freedom to make many types of food and reach more customers. With refrigeration, a large grill, a spacious preparation area, a reliable energy system, and credit/debit card processing capabilities, the cart is truly a mobile kitchen.

This innovative cart also opens the door for true closed-loop operations in the mobile food industry. As New York City implements its ambitious waste reduction and recycling plans, an immense opportunity exists to collect and process food waste — generated by mobile vendors and NYC as a whole — to produce an ultra-low-carbon source of fuel/energy known as renewable natural gas (RNG). Equipped with hybrid natural gas generators, the MRV100 can run on this truly carbon-neutral or even carbon-negative fuel, further reducing the environmental footprint of the mobile food industry.

In this changing world, it is possible to have technological innovation that not only improves the environment and health of our cities, but also provides new and better economic opportunities for workers. The MRV100 exemplifies this dual possibility. Perhaps most important, this new cart brings attention to an industry critical to the cultural fabric of New York City, and one now poised to play an important role in the transition toward a sustainable urban energy future.



Joanna D. Underwood  
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## Introduction

Every day, food carts in New York City provide affordable and portable fare for hungry patrons. In fact, mobile vendors — primarily food carts — account for more than 1.2 million transactions daily in NYC<sup>1</sup>. However, their operations rely predominantly on the use of portable electric generators (and/or propane tanks) — powered by gasoline or diesel — to meet the carts' energy demands and heating and cooking needs. In general, these gasoline and diesel generators are not emissions-tested, and they produce large quantities of health-threatening nitrous oxides (NOx) and particulate matter (PM) as well as greenhouse gas emissions. Moreover, propane use for cooking and heating generates carbon monoxide (CO) emissions, which can be a major health hazard, especially in close-quarters.

These tanks and generators have experienced leaks and explosions, creating public safety concern. In addition, the high energy and maintenance costs of these generators often result in inadequate food refrigeration and cart ventilation, which can lead to food spoilage or other health concerns.

The new MRV100 food cart designed by MOVE Systems brings food cart technology into the 21<sup>st</sup> century. The cart comes equipped with a first-of-its-kind hybrid compressed natural gas (CNG) generator that supplies all energy and cooking needs, a solar panel to provide supplemental power, as well as the capability to plug in directly to the electric grid. These innovations offer considerable energy savings, emissions reductions, and luxuries — such as refrigeration — benefitting operators. In short, compared to conventional food carts, the new MRV100 cart can greatly improve the environmental and health impacts and safety of the mobile food industry in NYC and beyond.

This report provides a summary of the various immediate environmental, public health and safety benefits of this new and improved food cart, while also addressing future opportunities to further transition to fully sustainable carts, powered solely by renewable sources. Moving forward, whether powered by the biogases generated from the organic waste produced collectively by the mobile food industry (and NYC as a whole), or powered by grid electricity — from renewable energy sources provided by charging stations, the MRV100 opens the door for true closed-loop sustainability in an industry that has received little attention, but one that is poised to play a leading role in a low-carbon urban energy future.

## The Problems with Existing Food Carts

### *High Generator Emissions*

There are approximately 5,000 licensed food carts – and untold additional unlicensed carts – operating throughout New York City's five boroughs. Sixty one percent of these — or 3,100 — are equipped with gasoline or diesel generators to meet their energy demands<sup>2</sup>. Unlike the emissions standards that were first developed for automobiles in 1970, pollution controls for small portable electric generators were only established by the U.S. EPA in 2000 (including the use of catalytic converters and other equipment)<sup>3</sup>. Many generators still in use by mobile food vendors lack these basic controls<sup>4</sup>.

Compared to the standard safety and emissions testing for on-road vehicles, portable generators are not required to undergo routine inspections, and the City of New York has no requirements for the condition, age, or emissions of generators in use by mobile vendors<sup>5</sup>.

Independent emissions testing data<sup>6</sup> indicates that the most common gasoline generator in use (Honda E2000i) produces significant greenhouse gas emissions – measured in carbon dioxide equivalents (CO<sub>2e</sub>) — and high levels of carbon monoxide (CO), as well as nitrous oxides (NO<sub>x</sub>) and particulate matter (PM), which are sources of chronic health-threatening pollution. Because food carts using generators often run for 10 hours or more per day, 300 days per year<sup>7</sup>, their emissions present health and safety concerns for workers and citizens alike.

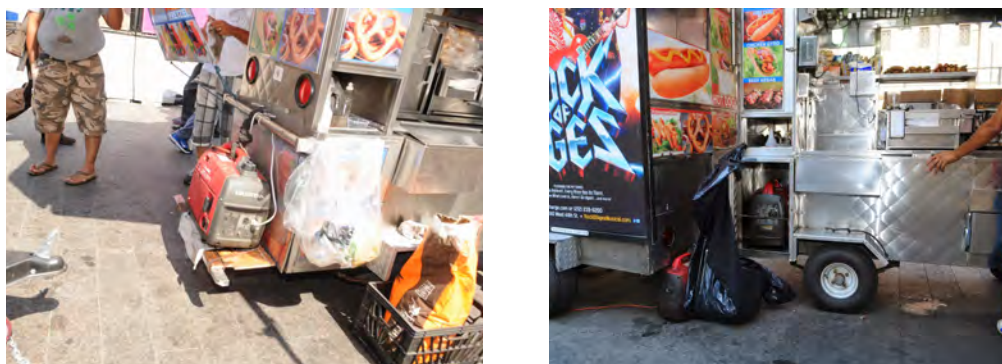
*Carbon Monoxide (CO) Pollution Risk*

An independent analysis of a sampling of the smallest but most common 2 kilowatt (kW) gasoline generator (Honda EU2000i) used by street food vendors (performed by Emissstar, LLC, an emissions consulting services firm), indicated that the average carbon monoxide (CO) exhaust per unit of energy produced was 42 times the current emissions standards for small (kW<8) generators<sup>8</sup>.

<b>CO Emissions per Kilowatt Hour (kW-hr)</b>	
EPA CO Emissions Standard (kW<8 engine)	<b>8.0 g/kW-hr</b>
Measured Emissions (Honda EU 2kW generator)	<b>337.2 g/kW-hr</b>

Generator fumes are a leading cause of carbon monoxide poisoning in the U.S.\*

- Approximately 20,000 people visit the emergency room, 500 are hospitalized<sup>9</sup> and over 400 die from CO poisoning, with up to 47% of all consumer-product related deaths coming from generator emissions<sup>10</sup>.
- The Centers for Disease Control (CDC) recommends that generators be operated no less than 20 ft away from an enclosed space with a window or vent<sup>11</sup> — an issue of particular importance in New York City (see photos below).



*Two traditional NYC food carts using portable gasoline generators in very close proximity to the cart operator, risking potentially harmful CO exposure to workers*

\* These statistics are not specific to food carts, but the number of food carts using generators across the City, and the long hours they run make them a particular concern.



While CO diffuses quickly from a tailpipe, if maintained at levels at or above 100 parts per million (ppm) for more than 90 minutes, symptoms such as nausea and headaches can start to occur, due to decreased oxygen flow to the brain. Constant exposure to merely 35 ppm of carbon monoxide can produce headaches and dizziness in six to eight hours<sup>12</sup>. In field tests conducted by Emisstar, the average CO density from the tailpipe of the small 2kw generators tested – all of which lacked catalytic converters – was measured at 19,760 ppm<sup>13</sup>.

Chronic exposure to carbon monoxide — largely dependent on time and intensity — can also have lasting effects, including:

- “Post-CO syndrome,” a condition where headaches and dizziness can be present 40 days after acute exposure to CO<sup>14</sup>.
- Increased blood clotting and decreased blood flow<sup>15</sup>; and in those with pre-existing conditions, irregular heart beat patterns may be exacerbated<sup>16</sup>.
- Cognitive decline has been shown in about 30% of patients with CO poisoning<sup>17</sup> and many also exhibit movement disorders and Parkinsons.
- The development of asthma and reduced breathing capacity, especially in children, has been linked to long-term exposure to just 1.5-1.6 ppm<sup>18</sup> and exposure to 1.6ppm or more has been significantly correlated<sup>19</sup>.

#### *Nitrous Oxides (NOx) and Particulate Matter (PM) Health Effects*

Emissions tests of generators in use by traditional food carts also show large quantities — above the threshold thought to be safe as set forth by the U.S. EPA’s National Ambient Air Quality Standards (NAAQS)<sup>20</sup> — of annual nitrous oxide (NOx) and particulate matter (PM<sub>2.5</sub>) pollution.

Numerous epidemiological studies have been conducted in NYC and other urban areas linking NOx and PM pollution to problems with respiratory and cardiovascular function<sup>21</sup>, including:

- Childhood asthma, whose correlation has been shown at a 95% confidence level for PM exposure<sup>22</sup>. (NOx also leads to asthma attacks in young and teenage children.) Asthma is the leading cause of hospitalizations for children<sup>23</sup>.
- A 30% higher risk of asthma than the national average in NYC due to urban air pollution<sup>24</sup>.
- Decreased respiratory function and blocked airflow (COPD) are strongly correlated with exposure to NOx and PM<sup>25</sup>.
- Increased daily mortality rates of 6-19% from exposure to air pollution, due to the increased incidence of heart disease and cancer in highly polluted areas<sup>26</sup>.
- Decreased blood flow to the neck and head and risks associated with stroke. Residents of NYC are at a 24% higher risk of carotid artery stenosis due to air pollution<sup>27</sup>.
- Increased cardiovascular mortality and hospitalization rates in NYC are linked to PM exposure during peak seasons<sup>28</sup>.

#### *Environmental Effects*

Nitrous Oxides (NOx) are readily converted in the air to toxic chemicals like ozone and nitrate radicals<sup>29</sup>. Additionally, nitrogen dioxide (NO<sub>2</sub>) reacts with water molecules in the air to form

nitrous and nitric acid<sup>30</sup>, leading causes of acid rain worldwide. Because nitrous oxides are so volatile, the global warming potential of one pound of NO<sub>x</sub> is equivalent to more than 300 pounds of carbon dioxide<sup>31</sup>.

The high density of particulate matter (PM) in urban areas leads to smog when it forms a mixture with sulfur dioxide and ozone, created by reactions that CO and NO<sub>x</sub> have in the air<sup>32</sup>. While visibility issues from PM have significantly decreased since the adoption of vehicle emissions regulations, conventional generators lacking catalytic converters remain smog producers. PM also carries significant acidic content, which can irritate the skin and produce acid rain<sup>33</sup>.

### *Food Safety Issues*

While the energy consumption of mobile food trucks and passenger vehicles are limited to their daily transportation time, stationary vendors often have to keep their generators running full-time to maintain the energy demands of refrigerators, cooking equipment, etc. Unable to meet their total energy demands with portable electric generation alone, many food cart owners have had to make compromises, which increase the incidence of food safety risks.

In a recent study conducted by the CDC, on a sample of 95 licensed California mobile vendors, random inspections found that a quarter of operators did not have refrigeration units turned on and 44% had insufficient refrigeration temperatures (>45°F)<sup>34</sup>. These cost-cutting, energy-saving strategies sacrifice food quality and safety and may put consumers at public health risk.

### *Fuel Safety Issues*

The use and storage of fuel for generators (primarily gasoline) and propane tanks on board food carts has led to explosions. Because vendors carry large amounts of fuel and there are minimal regulations on the condition and age of generators on food carts<sup>35</sup>, fuel leaks can create major safety hazards. In 2011, for example, a food truck exploded in Tribeca after it crashed into another vehicle. Reports show that it was carrying four propane tanks, twice the two 20 pound tanks allowed<sup>36</sup>.

Across the country, there have been reports of exploding food trucks using propane fuel, with fatalities involved<sup>37</sup>. Last year, two food truck workers in Philadelphia were killed when the propane tanks they had on-board, built in the 1940's, exploded<sup>38</sup>. Clearly, newer and safer energy solutions using less fuel and more secure on-board storage are needed to safeguard the industry.

## **The Food Cart of the 21<sup>st</sup> Century**

In order to cut air pollution, increase fuel efficiency, and reduce health and safety hazards associated with existing food carts, MOVE Systems, a New York City-based company, has developed the MRV100, an innovative new cart which incorporates the use of a hybrid compressed natural gas (CNG) system to meet all energy and cooking demands.

By using a hybrid generator, this new cart is also able to effectively power refrigeration and ventilation systems, vastly improving safety, reducing the risk of food contamination and



minimizing the risk of carbon monoxide poisoning<sup>39</sup>. Additionally, the cart is equipped with a battery that is recharged by the hybrid CNG generator. Solar panels on the roof of each cart provide additional energy. The complete system offers a hybrid controller, which will determine if the cart's energy demand can be met by the battery alone.

The new MRV100 cart significantly cuts energy costs associated with electrical generation when it is running through solar/generator power, but it is also capable of being powered solely by the electric grid. Through a partnership with Simply Grid, a business unit of MOVE Systems, vendors will have the ability to power their carts at curbside electric charging stations, an option being explored throughout New York City and beyond.



*The MRV100 food cart designed by Move Systems*



*Electric charging stations designed by Simply Grid*

### *Greater Energy Efficiency*

Portable generators running on gasoline, diesel, or propane are generally inefficient at converting energy from their respective fuel source into electrical power. One estimate reports that running at peak efficiency, the popular Honda portable generators found on many food carts in NYC convert only 13-18% of the energy in gasoline into electrical power<sup>40</sup>. Furthermore, at typical power loads, an independent report suggests that generators run 40% below their rated efficiency<sup>41</sup> and convert less than 10% of the energy in gasoline into electricity.

By using MOVE Systems' hybrid CNG generator, a food cart is able to run on battery power supplied by the hybrid generator at least 50% of the time, when it is not plugged into another electrical source. Using a hybrid central processing unit (CPU), the power controller on the MRV100 is capable of switching between generator energy and battery energy to provide the most efficient energy profile possible, cutting fuel consumption considerably over conventional generators.

Additionally, when the cart is plugged into a Simply Grid power station, the food cart will not have to run on generator energy at all and the battery is capable of being recharged. A study of the potential electrification of food carts in the New York area showed that operating food carts via grid power alone could save \$5,200/year in energy costs over a traditional 6.5 kW gasoline generator<sup>42</sup>.

### *Reduced Greenhouse Gas (GHG) Emissions*

Emissions analyses indicate that the MRV100 hybrid CNG system will reduce greenhouse gas (GHG) emissions by approximately 60% as compared to traditional gasoline/diesel generators.

### *Cleaner & Healthier Air*

In addition to GHG emission reductions, the hybrid CNG system has been shown in tests to offer considerable decreases in criteria pollutants — with particularly large declines in NOx and PM — and major reductions in CO emissions over conventional gasoline and diesel electric generators and propane tanks.

A study comparing the annual emissions of a Neapolitan Express pizza truck (the only existing operational CNG system) and a sample of conventional generators, found that replacing a gasoline generator with a CNG system would be the equivalent of taking 186 cars off the road. This estimate is based on the EPA’s current Tier 2 NOx emission standards of a passenger vehicle and using the average annual miles driven — 13,476 — according to the Federal Highway Administration<sup>43</sup>. Similarly, the implementation of each hybrid CNG system would be the equivalent of removing approximately 45 cars worth of CO pollution and 0.7 cars worth of PM<sup>44</sup>.

#### **Annual NOx, CO and PM Emissions: Standard Cart, Hybrid CNG & Avg. Passenger Car**

	NOx (grams/year)	CO (pounds/year)	PM (grams/year)
Standard Food Cart Generator	182,733	5,879	128.3
MRV100 Hybrid CNG	7,700	248.5	32.2
<b>Per Cart Emissions Reduction</b>	<b>175,033</b>	<b>5,630.5</b>	<b>96.1</b>

Average Passenger Car	943.32	124.8	134.7
<b>Equivalent Cars Removed</b>	<b>185</b>	<b>45</b>	<b>.7</b>

Overall, transitioning the fleet of 3,100 traditional food carts (operating full-time in NYC) from conventional gasoline/diesel generators to hybrid CNG systems would take the equivalent of 576,600 and 139,500 passenger cars off the road each year, in terms of NOx and CO pollution respectively<sup>45</sup>. This transition would have substantial benefits for the population of NYC and NYS as a whole, as studies suggest that recent statewide reductions in NOx, ozone, and PM concentrations by just 2-9% have resulted in declines of in-state hospitalizations from respiratory problems<sup>46</sup>.

While improved air quality city- and state-wide will reduce health risks, the greatest benefits may be for food cart/truck workers, who are exposed to emissions from generators and propane tanks for extended periods on a daily basis. By transitioning to new hybrid CNG carts, these workers (and bystanders) will no longer be susceptible to the health and safety risks associated with traditional carts and the outdated means by which food is stored, prepared, cooked and heated.

## *Moving Toward Fully Sustainable Food Carts: RNG & Grid Power*

In addition to the immediate environmental, health and safety benefits provided via widespread use of hybrid CNG food carts, their adoption also opens the door for a transition to a fully sustainable, closed-loop mobile food industry in NYC.

### *Renewable Natural Gas (RNG)*

As the City moves ahead with its plans to divert organic waste from landfills — especially food waste — via separate collection and processing, hybrid CNG food carts are uniquely positioned to set the pace for change. An immense opportunity exists to collect and process food waste generated by mobile vendors to produce an ultra-low-carbon, fully sustainable source of fuel/energy for the same carts generating this waste, effectively “closing the loop.”

Across the country, a new industry is emerging to create renewable energy and fuel from the biogases generated as organic waste decomposes, via a process known as “anaerobic digestion.” If these biogases are purified, the resulting fuel, known as renewable natural gas (RNG) or “biomethane,” can be used for all the same purposes as traditional natural gas — to heat homes, to generate electricity, or to power vehicles. What’s more, thorough analyses by the California Air Resources Board (CARB) and Argonne National Lab suggest that on a lifecycle basis (including production and use), RNG is *the* lowest-carbon vehicle fuel available today<sup>47</sup>. In fact, when produced via anaerobic digestion of food waste, RNG can even be net-carbon negative, which means that it actually captures more methane-laden biogases in the fuel’s production than it creates.

Similar to the transition from heavy-duty diesel trucks and buses to cleaner-burning, lower-carbon natural gas models, the move from conventional food carts to hybrid CNG systems opens the door and helps create the market for ultra-low-carbon RNG. Moreover, as owners and generators of food waste, cart operators may have the ability to provide the feedstock for fuel production and the market for this fuel, a unique and enviable position.

Estimates suggest that if the year-round food cart industry in New York City — 3,100 carts — were converted entirely to hybrid CNG models, these carts would collectively displace the equivalent of 4 million gallons of gasoline. To produce and use this volume of renewable natural gas via anaerobic digestion would require approximately 235,000 tons of food/green waste a year, a significant but not inconceivable amount given that NYC generates more than 2 million tons of organic waste each year. As a clean burning, net-carbon-neutral or even carbon-negative fuel<sup>48</sup>, the reductions in greenhouse gases and other pollutants from a switch to RNG would further improve the environmental footprint of New York City’s mobile food industry.

However, at present, there are no commissaries (where food carts are maintained and housed) in Manhattan, where 85% of these carts operate. Instead, the carts must be transported daily to and from sites in Brooklyn, the Bronx and Queens. Moreover, to make food carts part of the food recycling revolution in the city may require locating a new commissary for these carts and modifying a regulation that now fines cart operators who carry food-recycling bins. But these changes will surely come as food waste is increasingly recognized by City leaders, not as waste, but as a valuable source of energy and fuel.

### Grid Power

Moving forward, an immense opportunity also exists to tap into New York City's extensive existing electric grid to power food carts (and trucks) via a proposed network of charging stations. Under this scenario, all cart-related direct emissions — NO<sub>x</sub>, PM, CO and CO<sub>2</sub> — could be eliminated completely.

While additional, more detailed feasibility studies and lifecycle emissions analyses are necessary to accurately assess and compare the grid power and waste-to-fuel strategies, it is clear that the MRV100 hybrid CNG system is an important step forward from the conventional gasoline/diesel generators and propane tanks in use by traditional food carts. The MRV100 — the food cart for the 21<sup>st</sup> century — will also provide opportunities for further innovation toward a fully sustainable, zero-emissions mobile food industry in NYC and beyond.

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*"Food carts have long been a great feature of City life. However, this report describes how emissions from their heating and cooking systems pollute our air and put food vendors' health at risk. The redesigned carts assessed in Energy Vision's report and introduced today use clean fuels, which will protect cart operators and mean cleaner air for New Yorkers."*

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