

## SII – Sustainability Innovation Inventory

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### Solar-Powered Personal Rapid Transit (Masdar City, Abu Dhabi)



(Image from: <http://www.inhabitat.com>)

#### Executive Summary

In Abu Dhabi, construction is currently underway on a six square kilometer zero-waste, zero-emissions, and zero-car concept city called Masdar. Masdar, which means “the source” in Arabic, will have three levels of non-car transportation pathways: an elevated light rail connecting Masdar City to the rest of Abu Dhabi, a network of narrow, shaded streets at ground level for pedestrians and bikers, and an underground modular public transit system designed to replace the need for personal cars. The Masdar Personal Rapid Transit (PRT) system will consist of a fleet of small, solar-powered electric vehicles capable of carrying up to six passengers directly between any of the city’s approximately 1500 planned transit stops on a flexible, ad-hoc basis. The PRT network is designed to be trackless and automatic – a kind of futuristic coordinated system of driverless taxis frequently described in science fiction terminology by Masdar designers and reporters alike (Chino, 2008; Palca, 2008).

Masdar’s PRT system, which will be the first of its kind in the world, will connect the six square kilometers of Masdar City comprehensively, with a maximum distance of 200 meters from any point in the city to a transit station. It will eventually serve a population of 100,000 residents and 20,000-30,000 additional workers commuting in daily “as freely as if they had their own vehicles, but without producing any hydrocarbons” (Awad, 2008; CH2M HILL, 2008).

## Sustainability

Masdar's design explicitly follows the principals of "One Planet Living" – ten sustainability principals proposed by the WWF and Bioregional Development to ensure that no individual consumes more than his or her "fair share of the Earth's resources" (WSP, 2007). Masdar City is designed to be completed in 2015, initially supporting 1500 businesses and 50,000 residents (The Masdar Initiative).

The Masdar project's celebrated sustainable design choice to ban all cars from the city has a two-fold effect:

1. The city's street-level roads will be narrow (at most 3 meters wide) and pedestrian friendly, which allows walking paths to be shaded from the hot desert sun and encourages community.
2. The city will maintain cleaner air at street level, with zero transportation-related air pollutants.

In order for a no-car city to be feasible, however, the Masdar project realized a need for public transportation that is modular, responsive, and efficient. The Masdar PRT's fleet of many low-occupancy transport pods will provide city residents many of the conveniences of personal vehicle travel, including quick access to transit and direct trips available on an individual's schedule. Centralized monitoring and control of the PRT pods will allow for efficient routing and dynamic response to fluctuating demand, thereby reducing traffic congestion. Additionally, the modularity of the Masdar PRT system means that PRT vehicles will be in operation only when needed, thus eliminating the inefficiencies of low ridership common to public buses and trains during off-peak periods and saving energy (Chino, 2008).

Another guiding principle behind Masdar's construction is to use recyclable materials wherever possible, including in the city's transportation system. The zero-waste, zero-emissions mentality is taken so seriously that Masdar designers are even keeping track of unavoidable emissions produced during the construction phase of the city's infrastructure and offsetting these emissions by planting trees and providing surplus renewable energy to Abu Dhabi's national power grid (Palca, 2008). As of January 2008, the Masdar photovoltaic testing site – a 70-by-70 meter testing site for experimenting with different solar panels and solar panel suppliers – was already delivering 250 kW of power to the Abu Dhabi grid daily (Awad, 2008). The Masdar PRT design and construction naturally are governed by Masdar's sustainability guidelines for recyclable materials and carbon offsets, making it truly a zero-waste, carbon-neutral public transportation network.

One final note on sustainability: architect and urban designer Christopher Choa argues that, ultimately, the most sustainable characteristics of Masdar's design are "well known and straightforward: mixed-use, high-density development [dependent on] mass-transit" (Fox, 2008). The potential of the Masdar PRT system to make high-density urban life simply more efficient, convenient, and user-friendly will contribute as much to future sustainability initiatives as will its more trendy carbon-neutrality and waste reduction programs.



**Figure 1: Masdar City Aerial View.** A high-density, mixed-use ecocity planned for an eventual population of 100,000 residents, Masdar City will mix traditional Arabic desert-city design features with modern advances in renewable energy and transportation to create a zero-waste, zero-emissions, and zero-car urban environment (Vidal, 2008). (Photo from <http://www.inhabitat.com>)

## Current Technology

The Masdar PRT will be a modular underground transportation system covering an area of six square kilometers. The system will be comprised of a fleet of battery-powered pods that can seat up to six people at a time and will be programmable to take the riders directly to any one of 1500 stations (see Figure 2). PRT stations will be located such that no point in the city is more than 200 meters from access to public transportation. The CH2M HILL Transportation Business Group, which is managing the PRT project's implementation phase, estimates that approximately 2,000 PRT pods will be in operation during peak travel times (CH2M HILL, 2008).



**Figure 2: Masdar PRT System.** An underground modular public transportation system with a central control system will give Masdar residents the convenience of a personal vehicle as well as the health and community benefits of car-free streets. The battery-powered PRT pods, shown above, hold up to six passengers. (Photo from <http://www.inhabitat.com>)

Eighty percent of roof space in Masdar City will be dedicated for photovoltaic (solar) cells, a portion of which will be used to power the PRT system (Vidal, 2008). Additionally, digital information kiosks will be available throughout the city to help residents find a nearby PRT station, check PRT availability, and “summon” a pod to the closest station (The Masdar Initiative; CH2M HILL, 2008).

Each PRT pod will be managed remotely by “a complex, supervisory control system with multiple redundancies” designed to coordinate user demand and dynamically plan routes for occupied pods (CH2M HILL, 2008). Upon entering a PRT pod, riders will be able to program their desired destination into the vehicle’s computer interface. The PRT control system will then analyze the most efficient way to get there and take the riders directly to their destination (Palca, 2008; CH2M HILL, 2008).

CH2M HILL is currently testing and evaluating nine different system designs for the Masdar PRT. All systems under consideration are “barrier-free” to make travel convenient for residents with disabilities (CH2M HILL, 2008).

In addition to providing public transportation, the PRT system will be used for deliveries and waste removal in Masdar City. The same supervisory control system will coordinate the movement of delivery pallets and dumpsters along with pedestrian pods (CH2M HILL, 2008).

This modular public transportation system will support Masdar’s goal of being car-free. However, parking lots with easy access to the PRT will be available on the outskirts of the city for commuters and visitors. Masdar City will also be connected to the outside world by a light rail transit system that runs to Abu Dhabi’s city center, the Abu Dhabi International Airport, and the popular Raha Beach resort (WSP, 2007).

## Technology and Experience Roadmap

An ambitious and unprecedented project, the Masdar PRT system has been subject to praise and skepticism from the press and planning community. Khaled Awad, the Director of Property Development for Masdar City, invites skeptics to comment freely - he views critical reviews as a tool that will help Masdar become a better city (Palca, 2008). Here are a few prominent concerns:

### Coordinating the PRT Pods

The Masdar project claims that the finished city will be a place where “traffic belongs to the past.” However, modular vehicle-sharing programs in other cities, such as Paris’ experiments with [Vélib’](#) and [Autolib’](#) have found that it is extremely difficult to maintain an even distribution of vehicles around the city, even in a publicly managed and centrally monitored program. According to Masdar construction manager Scott McGuigan, the PRT pod – though electric and automated – is “really [just] a car,” which makes the PRT system theoretically little more than a municipal car-sharing program (Palca, 2008).

Unlike Autolib’, however, the Masdar PRT system is intended for municipal and commercial operational support as well as public transportation – it is literally the only non-fixed route option for transporting anything in the city. The fact that the vehicles are also autonomous makes them much more than just cars. These characteristics set the Masdar PRT service apart from traditional vehicle-sharing programs in several important ways:

1. Routine operations like trash removal and deliveries can be slated to occur only at off-peak hours, except in emergencies.
2. Major events and large construction projects can be scheduled in the PRT system well in advance, so the system is not surprised by sudden added demand.
3. Empty PRT pods can be remotely commanded to move to another PRT station or a central holding area in case of congestion or to even out supply and demand.

Nonetheless, CH2M HILL’s Transportation Business Group notes that “a PRT system of this scale has never been done” and that the PRT system design is one of the most significant challenges of the Masdar project (CH2M HILL, 2008). Moreover, because it is intended to replace cars completely, the success of the entire city is in many ways dependent on the success of the PRT network (Fox, 2008).

### Can the PRT actually replace cars?

While parallels between the Masdar PRT and personal automobile ownership helps evoke the particular kind of modular, individualized mobility Masdar is attempting to create for its residents, because the PRT is a public, shared service, it will have to carefully address the ways in which it is *not* like owning a car. Ecocity visionary and author Richard Register muses, for example:

*Personal rapid transit seems like a car-addicts claim to socially responsible transit without giving up the idea of the car... I can’t figure how the impersonal privacy of the proto-car you are in [in Masdar] would be fun or safe-feeling. How would one handle a weird or dangerous looking fellow passenger, for example? What about graffiti and weird smells in an environment that confined?*

Register’s comments bring up important considerations about, essentially, fitting any innovative ideal system into an imperfect urban reality. Like all vehicle-sharing programs around the world, the Masdar PRT will have to plan for social phenomena as well as technical. Some other pertinent social questions could include:

- How will the PRT handle queues during rush hour? Will there be different options for people willing to share a PRT pod (and therefore get to their destination less efficiently) and people who want the privacy or efficiency of their own pod? For people willing to share, how can the system efficiently manage crowds to group people going to similar locations?
- How will the system handle a pod that is out-of-order, needs cleaning, or is unsatisfactory to riders in some other way?

- What special accommodations will be built into the PRT system to transport distinguished city guests, both in terms of security and vehicle luxuries?

For the Masdar PRT to truly negate the need for a personal car, it will have to be flexible and adaptive enough to offer the same range of services currently met by the vast variety of urban vehicles in other cities.

### **Building from Scratch versus Retrofitting**

Finally, the real test of the innovativeness of the PRT will be seen outside of Masdar City. One of the stated purposes of the Masdar Initiative is to serve as a model of carbon-neutral living for the rest of the world; however, the cities that could benefit most from Masdar's experiments are not other new concept cities, but rather existing cities looking to retrofit their current infrastructures. As the Masdar PRT is built and implemented, important side work could be done to analyze how existing subway systems could be retrofitted to adopt PRT technology – a possibility that has the potential to dramatically change urban living for billions of people worldwide.

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