

Inside The World's Most Ambitious Eco-City

Why would a petro-state erect a solar-powered eco-metropolis in the middle of the Arabian desert? To change the world.

By Dan Baum Posted 05.21.2013 at 10:04 am



Taming The Desert When completed in 2025, Masdar City will pack 40,000 inhabitants into two square miles of carbon-neutral buildings. *Courtesy Foster + Partners*

At first glance, Masdar City appears a mirage. From a distance it looks like a single multicolored building, standing lonely on the horizon. Part of the illusion is due to the city's strange setting: next to Abu Dhabi airport, just across the highway from the Arabian Gulf, in a deeply inhospitable stretch of desert. Between it and downtown Abu Dhabi lie 20 miles of the most wasteful urban development I've ever seen—a featureless plain studded with ostentatious walled houses the size of the Supreme Court and crisscrossed by empty six-lane boulevards. But the illusion is also a matter of density. Masdar City, an \$18-billion experiment, will hold 40,000 residents in only two square miles.

As the world's most ambitious eco-city, Masdar does not allow cars. Visitors must instead leave their vehicles in a giant garage at the city's northern edge. As I pulled in, a trim Westerner wearing a dark suit despite the heat stepped from the shade to introduce himself. Stephen Severance, a 45-year-old American, is the city's program manager. He came to Masdar four years ago, after working at the consulting firm Booz Allen.



Wind Catcher : The 148-foot-tall tower beside the Masdar Institute directs cool wind from above the city into a courtyard to create a perpetual breeze. *Courtesy Foster + Partners; Nigel Young*

Severance led me past ranks of parked cars to a set of smoky glass doors, which opened with a whoosh upon a marble lobby. Beyond a second glass wall, Masdar's Personal Rapid Transit pods, or PRTs, sat waiting. The little white driverless cars function as an ecological upgrade for passengers who have ditched their outmoded internal-combustion machines. Severance and I took seats facing each other, the automatic door slid closed, and the little pod began scooting through what looked like a gigantic basement at 15 miles an hour. It ran almost silently on rubber tires, following magnets buried in the floor and using proximity sensors to avoid collision.

Under the original plans, the PRTs were supposed to provide transportation across all of Masdar City, Severance explained. But to make space for them beneath the buildings, engineers would have needed to construct the entire city on 20-foot-tall pedestals. They built the existing center of Masdar City in this way—about a third of a square mile—but elevating the whole metropolis was unaffordable. The rest of Masdar will be built at ground level, and its transportation infrastructure remains undetermined: electric buses, perhaps, or solar-powered carts.

Severance gestured at the pod. "This is a little, I don't know, Jetsons," he said. "It was a nice idea, and we've proven that it works. We're running right now on solar power. These cars get where they're going and don't run into each other." But the PRT line that Severance and I boarded was the only functioning one, he told me, and the PRTs follow only one route: from the garage to Masdar Institute, about half a mile.

As the pod slid into its parking space, an electronic voice reminded us to take our belongings. We stepped into the lobby of the PRT terminal underneath the institute and followed a sweeping spiral staircase to an open-air courtyard at street level. A half-dozen mid-rise buildings rose in a cluster, separated by a tight maze of connected courtyards. One building, a terra-cotta-colored apartment house, is home to the 119 students of the Masdar Institute—the city's only residents so far. Another, wrapped in a steel facade, houses the institute itself. Severance led me on a tour of the small and strange collection of businesses that make up the commercial district, among them a sushi restaurant, a coffee shop, a mini supermarket, a travel agency, and a cellphone-company office.

This small, artificial pocket of urbanity didn't feel like the seed of a true metropolis, but that's the plan. Over the next 12 years, this little cluster of buildings will grow into two square miles of dense mixed-use real estate. A recycling plant is already under construction. There will be a functioning smart grid and improved power generation and distribution. The city will draw residents on the promise of quiet walkable streets and a sustainable lifestyle. By 2025, Severance told me, Masdar, Arabic for "source," will have transformed itself from university campus and commercial mishmash to a working city of the future.



Green Campus : Most development in Masdar is centered around the Masdar Institute (steel facade) and its dormitories (clay facade). *Courtesy Foster + Partners; Roland Halbe*

THE EXPERIMENT BEGINS

In 2006, the government of Abu Dhabi, the largest and most oil rich of the United Arab Emirates, announced that it intended to spend \$22 billion to become a leader in renewable energy. Abu Dhabi is the very definition of a petro-state. About the size of South Carolina, it holds the world's sixth-largest oil reserves—20 percent more than Russia. The U.A.E., a nation that contains fewer people than the Los Angeles metropolitan area, has the third-highest ecological footprint per capita in the world.

Unlikely as it seemed, the government of this tiny state on the southern shore of the Persian Gulf proposed to do something no other nation had seriously attempted. It would build a carbon-neutral, zero-waste city from the ground up on an empty piece of desert. The entire city would be an experiment, a clean-technology incubator on a grand scale, powered by renewable energy projects. A graduate-level, sustainable-technology research university in partnership with MIT would serve as the idea factory, and a fleet of driverless electric cars would shuttle the inhabitants from place to place. Over every building, engineers would mount huge photovoltaic roofs. The initial drawings looked like fantasy.

For such a pillar of the oil economy to express such an interest in renewable energy reeks of either penitence—like the munitions tycoon Alfred Nobel sponsoring a peace prize—or outright fraud. But as the years passed, the project became real. High-efficiency apartment houses, offices, and businesses began to rise. The driverless electric cars materialized—and they worked. The fledgling city consumed less electricity than its solar arrays generated, and the Masdar Institute of Science and Technology assembled a faculty of 76 PhDs, 13 of them from MIT. Even at the height of the financial crisis, as renewable energy projects stalled around the world, Masdar City moved forward. In 2009, the International Renewable Energy Agency made the unlikely selection of Abu Dhabi as its world headquarters. Then, in 2011, the Masdar Institute graduated its first class of 70 master's students. But it wasn't until 2012, when the German technology giant Siemens was putting the finishing touches on its new Middle East headquarters in Masdar City, that the experiment morphed from grand gesture to something much more significant: a new and viable model for renewable energy development on a massive scale.

The Entire City Would Be An Experiment, A Clean-Tech Incubator On A Grand Scale.

But even a city of the future, muscled into existence by oil money and sheer will, was not immune to the troubles of the present. The financial crisis of 2008 forced planners to scale back their ambitions. After the crash, Masdar shaved about \$4 billion from its budget, and engineers had to abandon the most futuristic features. The elaborate solar-collecting roofs disappeared from the drawing board; instead, they'll situate photovoltaic arrays at the edge of town. The PRTs devolved from a citywide system to a parking-garage shuttle. Complicating matters, Masdar had originally intended to desalinate its own water using the sun, but the local well water turns out to be three times as salty as the Gulf's. Desalinating it would require significantly more energy than planned and, perhaps worse, would create a gigantic brine-disposal problem. Instead, Severance told me, Masdar will aggressively monitor the use of water. Compared with the bold vision Masdar once was, the adjusted plans can't help but disappoint.



Oil-Free: Cars are not allowed in Masdar. The Personal Rapid Transport (PRT) pods travel underground from the city's edge to the Masdar Institute. *Courtesy Foster + Partners; Nigel Young*

THE NEW ENERGY MODEL

Oil made settled life possible in Abu Dhabi. The Trucial Coast Oil Development Company discovered the first commercial oil field here in 1960. At the time, the settlement was little more than a collection of camels and bedouin tents, a port where men in loincloths waded through the surf to unload dhows by hand. Then, in less than half a century, oil brought the Emirates from abject poverty to the world's sixth-highest GDP per capita. Abu Dhabi is now a roaring metropolis filled with flamboyant skyscrapers—a tower shaped like a giant coin standing on edge, another like a 40-story videogame joystick. Commuters drive Ferraris and Jaguars. Malls stock Piaget and Versace.

Yet Emiratis are planning for a post-oil world. In 2002, the Emirates' crown prince, Sheikh Mohamed bin Zayed al-Nahyan, ordered the creation of Mubadala Development Corp., an investment firm owned by the government and dedicated to diversifying the nation's economy beyond oil and gas. In 2005, Mubadala's 31-year-old energy chief, Sultan al-Jaber, set off on a seven-month tour of renewable energy projects in such places as South Korea, Germany, and Silicon Valley and reached a very futuristic conclusion. Renewable technology, he determined, was far more mature and practical than the investment world at the time seemed to believe. But the various interests necessary to develop it were not coordinated. Scientists were discovering new materials and technology that stalled before reaching market. Companies tried to market clean-energy products at a steep cost disadvantage to fossil fuels, and government regulators hadn't a clue how to support them. "There wasn't a true champion across the world for renewable energy," Jaber told me.

Masdar is intended to unify those elements by addressing everything there is to know about renewable energy—from the technology of generation and consumption to the economics of financing projects to the politics of getting them approved. "We're trying to capture the whole thing," said Bader al-Lamki, the 38-year-old director of Masdar Clean Energy, which builds and owns solar projects in Abu Dhabi and elsewhere and has a big stake in a gigantic offshore wind farm near Great Britain. Lamki and I were sitting in a temporary building at the edge of the Masdar City construction site; he adjusted the red-and-white ghutra draped around his head and neck and nodded to a South Asian gentleman in a blue smock serving us tea. "In other places, people are focusing on only one part," he said. "Here, we integrate the whole value chain."

"In Oil And Gas, The Question Is 'Why Innovate?' Here It Is 'Why Not Innovate? Why Do It In The Normal Way If You Don't Have To?'"

Lamki's division is one of four components of Masdar, the others being the Institute of Science and Technology; Masdar Capital, which bundles investors' money into projects; and the centerpiece city itself. Already, the organization has led renewable energy projects in Spain, Tonga, Mauritania, and elsewhere in the Emirates. One of Lamki's most surprising prospects is in Saudi Arabia, which expects to have to triple its electricity production in the next 20 years. The Saudis already consume within their borders almost a third of the oil they produce, which is in large part due to air conditioning. They're talking with Lamki's group about trying to meet some of their future demand with power from the sun, the one resource the country has in greater abundance than oil.

MAKING SOLAR WORK

If it's to prove anything, Masdar must get solar power right. Abu Dhabi, where the temperature reaches 120°F and every drop of water must be desalinated, now burns so much natural gas to generate power that it has become a net importer. With Masdar, the country is trying to show that it can create huge quantities of electricity without fossil fuels.

Masdar has spawned a handful of solar projects so far, but the largest is a concentrated solar power plant about a hundred miles from the city; on my second day, I drove out to see it. This part of the Arabian Peninsula looks less like the billowing-dune set of Lawrence of Arabia than like a vast plain of kitty litter. Crossing it in a rented marshmallow of a Kia was a 90-minute experiment in sensory deprivation. Airborne dust so obscured the horizon that the beige desert blended seamlessly with a beige sky.

Humans have generated heat by concentrating the sun's rays at least since Archimedes reportedly used mirrors to torch a Roman fleet attacking Syracuse in the third century B.C. Masdar's plant contains 192 parabolic-mirrored troughs, each a little longer than a football field and nearly 20-feet wide. A glass-clad steel pipe full of oil runs above each trough, at the focal point of the parabola. In the five minutes it takes electric pumps to push a gallon of oil up one trough and down another, the gathered rays of the sun heat that oil to a blistering 740°F. After leaving the troughs, the hot pipes pass through a chamber of water. The heat from the oil converts the water to steam, which turns a turbine. The cooled oil then flows back to the mirrored troughs for reheating. Computer-operated hydraulic pistons constantly rotate the mirrors to trace the sun's arc across the sky.

After a safety briefing in a trailer, I donned a hard hat, joined a group of engineers, and was shuttled by truck into the reflector field. One of the troughs was pointed sideways for maintenance, so we walked along it to get a good look. By the time we reached the end, the heat was so intense that it had all but set the backs of our pants on fire.

Concentrated solar technology has been around for decades, but the Masdar plant was, when I visited last December, the biggest such project in the world. (This year, it will be surpassed by one near Phoenix and one in northern Nevada; several more, as much as four times the size of Masdar's, are under construction worldwide.) It is growing fast, with almost two gigawatts—enough to power up to two million homes—expected online worldwide by the end of 2013 and four times that under contract. That's small compared with other renewables, such as photovoltaic power, which generated 20 times as much electricity worldwide at the end of 2010, and wind, which generated 100 times as much that same year.

But concentrated solar has advantages that wind and PV lack. Of the three, it alone generates heat, which, in addition to providing power, can be used to do things like desalinate water. And unlike photovoltaic, concentrated solar power plants can also contribute power much more cheaply at night because they store energy as heat instead of in expensive batteries. A Masdar-affiliated company built three concentrated solar power plants in Spain that use molten salt as its medium, improving heat capture and storage even further.

"Masdar wanted to make this simple and big, the first of its kind in the Middle East," said Laurent Longuet, the plant's project manager. Longuet came from the French oil-and-gas company Total and found the transition to the renewables world a pleasant shock. "Oil guys are very conservative," he said. "In oil and gas, the question is 'Why innovate?' Here, it's 'Why not innovate? Why do it in the normal way if we don't have to?'"

As we spoke, Longuet surprised me by conceding that his plant, though brand-new, is essentially obsolete. One of the concentrated solar power plants that Masdar built in Spain uses clustered mirrors around a central tower instead of parabolic troughs, which generates much higher temperatures. Also, between the time Longuet started building the Masdar plant in July 2010 and the day he switched it on in December, Chinese companies so flooded the market with inexpensive photovoltaic panels that concentrated solar lost a lot of its cost advantage. "If this turns out to be a transitional technology, that's okay," said Abdulaziz al-Obaidli, a wiry young Emirati engineer on Longuet's staff. "We're learning about optics. We're learning about metallurgy, astronomy, fluid dynamics, thermodynamics, manufacturing processes. It's not just about power generation." Obaidli also pointed out that the plant, obsolete or not, works. It can continue generating electricity for decades with, essentially, zero fuel costs.



Masdar City : Courtesy Foster + Partners

INSIDE THE ENERGY LABS

The more time I spent at Masdar, the more I realized that every aspect of the city is a research project. Cloaked in a brushed steel facade, the Masdar Institute is a warren of electronics-cluttered benches, humming machinery, and glass dividers covered with algorithms scrawled in grease pencil. Each lab focuses on a different kind of technology. In the Bio-Energy and Environmental Lab, students are developing microbial fuel cells that could generate power while remediating waste. In the Smart Technology for Electric Vehicles and Automotive Systems lab, they are designing integrated networks that could connect drivers and vehicles to road and traffic conditions. There are labs that focus on artificial intelligence, nano-materials, nano-scale energy storage, solar cells, and more.

In the microsystems lab, I met Jerald Yoo, a professor of engineering from South Korea. Sitting at a bench littered with bits of wire and tools, he held up a black T-shirt with a silvery pattern silk-screened on it. "Printed circuits," he said. Someday, he said, circuitry embedded into our clothes will constantly monitor our health, perhaps sending regular updates to our phones. That could have big implications for those with health conditions; for example, Yoo told me, bandages with his circuits could detect seizures 10 seconds before they happen. With that much warning, he said, a current can be applied to suppress the seizure. I asked how his project related to Masdar's goal of an energy-sustainable future. "The circuits have to consume extremely little energy," he said. "Masdar's mission is not only how to produce energy sustainably but also how to consume the least energy to do the work."

The institute's marquee project is a gigantic tower of mirrors on the edge of town called the Beam Down Solar Thermal Concentrator. The device not only concentrates solar rays to generate heat but will one day also split light into various wavelengths for scientific experiments, thermal energy production, and even more efficient energy generation. Its mastermind is Matteo Chiesa, a young Norwegian professor of nano-science who doused me with a fire hose of technical jargon in the apparent belief that I, too, held a PhD in applied mechanics. I nodded politely as he paced his office in a T-shirt and sandals, pulling on his long, wild hair. He struck me as a little stir-crazy. Chiesa has been in Masdar for five years—he claims to have been the institute's 37th employee—and in that time, he and his colleagues have published more than 60 scientific papers. I asked him whether he liked being here. "Happiness means death," he said. Until other residents beyond the students and faculty at the institute begin to call Masdar home, the place and its inhabitants will remain pretty isolated.

THE IMPOSSIBLE CITY

One particularly blazing afternoon, I joined Stephen Severance on a stone bench in the center of Masdar City. I wanted an impression of life in the city of the future. What struck me first was the almost shocking quiet of the place, devoid, as it was, of horns, idling trucks, and sirens. Then, I noticed the temperature. It was much cooler here than in downtown Abu Dhabi. For one thing, we were out of reach of the sun. Severance pointed out that the designers had angled the densely packed buildings to maximally shade one another and the courtyards in between. Pedestrians like us could sit in comfort and the buildings themselves require less air conditioning. Also keeping us cool was a stiff breeze. Severance stood and

motioned me across the courtyard to a hollow tower on steel legs—a vertical tube 20 feet across and five stories high. The tower acts as a wind catcher, drawing in cool breezes from above the city and directing them down to the courtyard. The street-level breezes it generates are constant and virtually free. It's not a modern invention—wind towers are likely Persian in origin and were used centuries before oil brought wealth to this part of the world. Engineers at Masdar improved upon the tradition by mounting computer-operated louvers at the top of the structure to maximize efficiency; the panels open and close according to prevailing winds. They also added misting units to cool the air even further.

On my way back to the hotel in Abu Dhabi, I made a wrong turn and ended up at the Al Wathba camel-race track, an eight-kilometer oval etched onto the hard, brown floor of the desert. From where I stood, in a grandstand built for thousands, the track disappeared into the distant haze.

I wandered down to the bedlam of the starting gate, expecting to be shooed away; instead, a beaming youth bearing a silver urn offered me tea in a china cup. As the camels lined up for the day's third race, I noticed that they had on their backs not human riders but a metal contraption with a three-foot stick poking out the back. I struck up a conversation with a nearby cameraman, who turned out to be covering the race for Egyptian television. He explained that camel owners had pressed generations of children into service as jockeys, but after enough of them fell off and were trampled to death, the federation that regulates the sport ordered them replaced with robots.

The camels were lean and long-legged—genetically engineered at tremendous expense for speed and endurance. As they took off with their weird slow-motion gait, a phalanx of SUVs roared after them on a track, weaving for position and blaring their horns in a jumbled, parallel race. Each vehicle contained a trainer, shouting at his camel through a loudspeaker attached to the beast's robot and stabbing at a button to remotely rap the beast with the three-foot stick. The trainers were in turn taking orders from the camels' owners, who were watching at home on television and barking instructions via cellphone. The strategy, the cameraman explained, is to use the stick only when the camera is not on one's own camel, because a camel seen on television as needing the stick is a less valuable camel than one that is not.

In the explosion of wealth and unchecked development that is Abu Dhabi, where ancient technology anchors a futuristic city and where robots ride camels, Masdar attempts to corral it all into a plan. Critics can complain that Masdar's goals have been tempered, but that doesn't make them irrelevant. If designers had not scaled back during the financial crisis, it would have signaled that the project was little more than a pricy plaything for an oil-rich emir. Instead, Masdar is bound to real-world economics, which means that it can teach real-world lessons. "You can talk about environmental sustainability all you want," Lamki had told me, "but there has to be economic sustainability too."

No one I spoke to during my visit to Masdar was under the illusion that the city was perfect. The world is not about to tear down its infrastructure and start over with walkable, solar-powered, smart-grid cities. In that regard, Masdar will never be a model for development. It is instead a model for innovation, a place dedicated more to the generation of sustainable ideas than sustainable technology. In creating an irreproducible city—isolated, expensive, and nearly empty—the architects of Masdar may be building a better place for us all.

Writer Dan Baum lives in Boulder, Colorado, and is the author of Gun Guys: A Road Trip.

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9 COMMENTS

[silversona](#)

05/21/13 at 3:00 pm

I am one of the few privileged to live in Masdar City. It's legit, but still has a long way to go to make a real difference in this world. Kudos and many thanks to the UAE for making this dream a reality.

[Link to this comment](#)



[Mr_Grant](#)

05/22/13 at 7:05 pm

Future phases of Masdar could still have PRT, pods just need to be routed onto elevated guideway, like the pods at Heathrow.

[Link to this comment](#)

[mrd2005](#)

05/23/13 at 11:54 am

Well that's beautiful. Things like that are an inspiration. Its possible to move towards a cleaner world. Solar Energy, I believe is the best resource we have and its very abundant. Unless the sun burns out in our lifetime we have an endless supply of energy. That city is proof that the transition is possible. We need to explore all of our option and make wise decisions.

www.solarsystemsus.net/idevaffiliate/idevaffiliate.php?id=223

[Link to this comment](#)

CraigMO

05/23/13 at 2:45 pm

Just as Biosphere2 was an experiment, so is Masdar. We have to put theories aside and eventually build something to see how it really works out. We will always learn from these projects along the way, imperfect as they are. At least they are applying some of their oil wealth in a constructive manner. But an educated populace will also be necessary to appreciate, utilize and maintain such an operation, and that means social change as well.

[Link to this comment](#)

dmbeast

05/23/13 at 3:10 pm

I have got to go there...

[Link to this comment](#)

Hey You

05/26/13 at 5:15 pm

While it is great that there are some "eco" friendly communities being developed, we need to remember that a lot of "dirty" work has been done to allow us to get to this place. Just one example is that of steel production; without steel, there would be a lot less "eco" friendly activities.

[Link to this comment](#)



dorispotr

05/27/13 at 6:02 am

The plan seems to be working for Masdar city and things are going extremely well I have heard. It is going to be future city in all the senses.

[Link to this comment](#)

jareshiah

05/28/13 at 8:18 am

Though Masdar is working at being an "eco-city", does that mean that moral corruption will be non-existent, that sickness will be no more, that hate will cease to exist, that no one will die anymore, that genuine love will abound ?

Our Creator, Jehovah God, has purposed for the entire earth to be "eco-friendly", transforming it into a paradise (Luke 23:43), for not just 40,000 inhabitants, but for all who change their personality into being "meek", teachable by God.(Matt 5:5)

These will live on the earth "in the abundance of peace...forever" (Ps 37:11, 29), whereby even the animals will be at total peace with them. Isaiah 11 says that "the wolf will actually reside for a while with the male lamb, and with the kid the leopard itself will lie down".(Isa 11:6) And why will there be genuine peace on the earth at that time ?

Isaiah 11:9 says: "They (the animals as well as humans) will not do any harm or cause any ruin in all my holy mountain; because the earth will certainly be filled with the knowledge of Jehovah as the waters are covering the very sea."

Hence, the "real life" that God purposed for "meek" ones of mankind will become a reality, so that anywhere a "meek" person goes on the earth, there will be peace, and in which all the nationalistic boundaries will be gone (Dan 2:35) so that all the "meek" ones are God's people as one group.(Rev 21:3-5)

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