

Developing a Smart and Sustainable City: Is Masdar City the Answer?

Smart Cities Brown Bag Series
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Masdar City, UAE

A. Background

1. History and Location

2. Goals

B. Characteristics

1. Layout and Design

2. Energy

3. Transportation

C. Criticisms

D. Discussion/Questions



Acknowledgement to Megan Tornoe

A. Background

1. History and Location

- **United Arab Emirates (UAE)** is an oil rich nation (petroleum and natural gas)
- UAE Facts (CIA Factbook, 2018):
 - * 6,072,475 people (UN estimate at 9.4 million people)
 - * Ethnic Groups: **Emirati** (11.6%), **South Asian** (59.4%), and **Egyptian** (10.2%)
 - * Independence from the British in 1971



A. Background

1. History and Location

- **UAE** is an innovator in urban development and design:
 - * Palm Islands
 - * The World Islands
- Famous Cities: **Abu Dhabi** and **Dubai**
- Tallest building in the world:
 - Burj Khalifa** in Dubai is
2,722 feet tall
- Rapid urbanization [video](#)



A. Background

1. History and Location

- The Masdar City concept was developed in 2006
 - Masdar is Arabic for “spring” or “source”**
- Public/Private Partnership:
 - Seed capital from the **Government of Abu Dhabi**
 - Subsidiary of **Mubadala Development Company**
 - Designed by **Foster and Partners** (British firm)
- Estimated cost: **\$22 billion** for a site of 2.3 mi²
- Construction began in 2008

- Located in the **United Arab Emirates**

A. Background

1. History and Location



A. Background

1. History and Location

- UAE realized that their natural resources were finite

“My grandfather rode a camel, my father rode a camel, I drive a Mercedes, my son drives a Land Rover, his son will drive a Land Rover, but his son will ride a camel.”

--Sheikh Rashid bin Saeed Al Maktoum, UAE VP (1990)

- UAE used money made from oil to develop a sustainable city
- Idea: create an environmentally sustainable and smart city
- **“Greenprint”**: city planning that incorporates ways to reduce energy use, water use, and waste

A. Background

2. Goals

- **Masdar City's main goal: Zero Carbon Emissions**
- Create an **'Ecotopia'**
- Objectives:
 - * **Walkable and car-free**
 - * **Reliance on renewable energy**
 - * **Incorporate technology to form a smart city**

A. Background

2. Goals

- **Specific Goals** (McArdle, 2018; Herzog, 2016):
 - * **Total population of 50,000 by 2025**
 - * **Develop **Personal Rapid Transit (PRT)**:
Driverless vehicles**
 - * **Desalination and Water Recycling Systems (done by 2020)**
 - * **Buildings insulated with argon (to keep out outside heat)**
 - * **Waste-free city**



- Home to the **International Renewable Energy Agency (IRENA)**

B. Characteristics

1. Layout and Design

- **High-density layout**
- **No cars or skyscrapers**
- **Difficult surface to build upon:**
 - * **Sandy soil with underground salt water pockets**
 - * **Concrete pillars placed 65 feet underground**



B. Characteristics

1. Layout and Design

- Architecture: **Traditional Arabic techniques**
 - * **Buildings near each other**—funnel in wind and create more shade for cooler temperatures
 - * Terracotta Walls
 - * Roads aligned with predominant winds
- Design influenced by Aleppo, Syria and Shibam, Yemen
- Mixed-use developments (similar to New Urbanism)





Fosters and Partners, 2018



Herzog, 2016

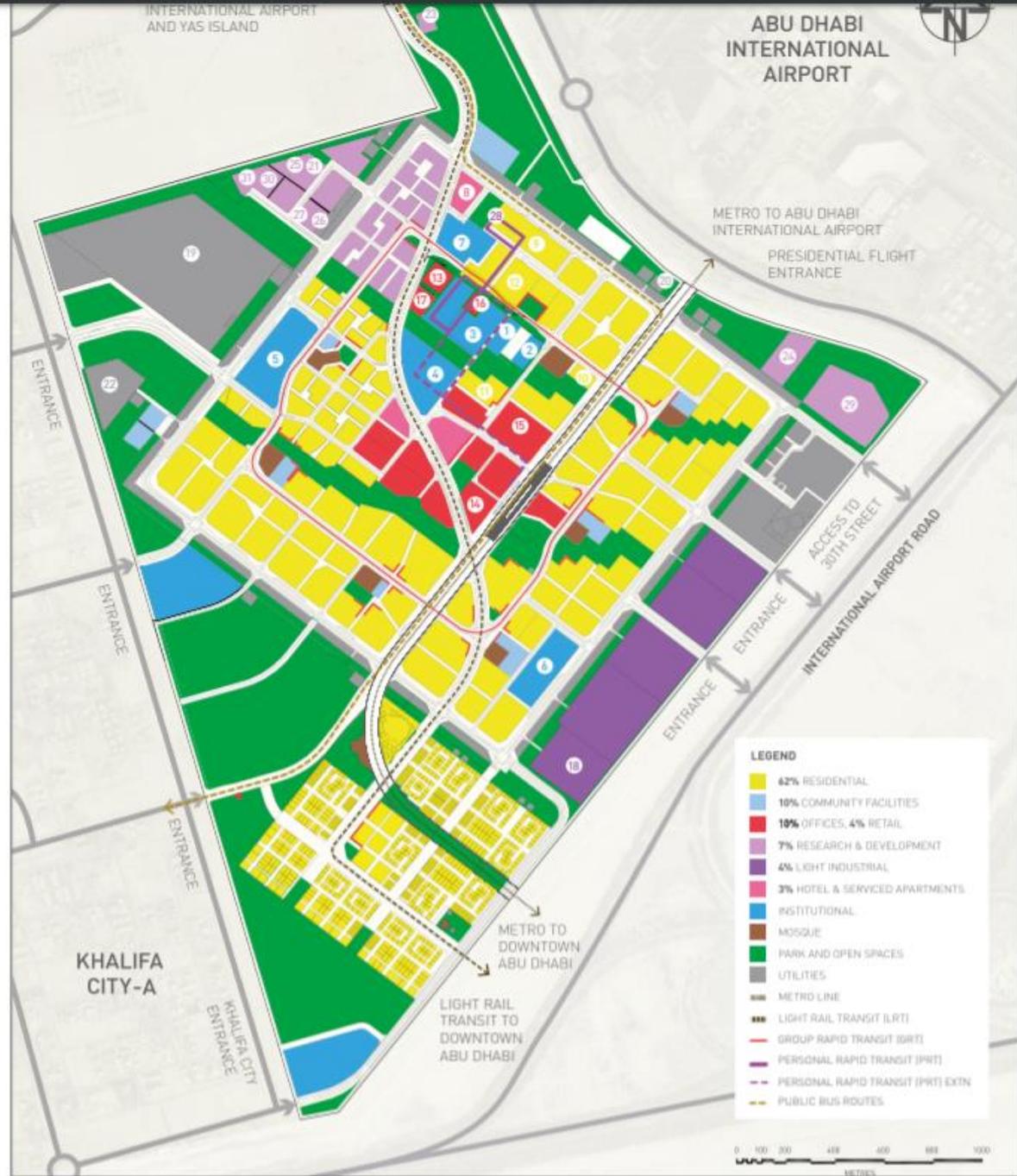


MASTERPLAN KEY:

- 1 ABU DHABI SCIENCE CENTRE
- 2 MASDAR VISITOR CENTRE
- 3 MASDAR INSTITUTE OF SCIENCE AND TECHNOLOGY (PHASE 1)
- 4 MASDAR INSTITUTE OF SCIENCE AND TECHNOLOGY (PHASE 2)
- 5 GEMS EDUCATION
- 6 RYAN INTERNATIONAL SCHOOL
- 7 EMIRATES COLLEGE OF TECHNOLOGY
- 8 CHIC RESIDENCE
- 9 RESIDENTIAL COMPLEX (500 UNITS)
- 10 LEONARDO RESIDENCES
- 11 TRISTAR RESIDENTIAL BUILDING
- 12 RESIDENTIAL COMPLEX (NH1)
- 13 SIEMENS MIDDLE EAST HQ
- 14 INTERNATIONAL RENEWABLE ENERGY AGENCY (IRENA) HQ
- 15 COMMUNITY MALL
- 16 INCUBATOR BUILDING
- 17 TRISTAR OFFICE BUILDING
- 18 KHAZNA DATA CENTRES
- 19 MASDAR 10MW SOLAR PHOTOVOLTAIC PLANT
- 20 DISTRICT COOLING PLANT

RESEARCH, DEVELOPMENT AND PILOT FACILITIES:

- 21 Masdar Solar Hub: Photovoltaic Test Centre
- 22 Masdar Solar Hub: CPV Testing Facility
- 23 Masdar Solar Hub: Masdar Institute Solar Platform
- 24 Seawater Energy and Agriculture System (SEAS)
- 25 Electric Energy Storage Solutions Hub
- 26 Masdar City Eco-Villa Prototype
- 27 Smart Home Energy Management System (SHEMS) for Masdar City Eco-Villa
- 28 Personal Rapid Transit (PRT) System
- 29 Masdar City Construction Waste Management
- 30 Masdar Institute for Science and Technology Field Station
- 31 Feasibility of District Cooling powered by Geothermal Energy for Masdar City



LEGEND

- 62% RESIDENTIAL
- 10% COMMUNITY FACILITIES
- 10% OFFICES, 4% RETAIL
- 7% RESEARCH & DEVELOPMENT
- 4% LIGHT INDUSTRIAL
- 3% HOTEL & SERVICED APARTMENTS
- INSTITUTIONAL
- MOSQUE
- PARK AND OPEN SPACES
- UTILITIES
- METRO LINE
- LIGHT RAIL TRANSIT (LRT)
- GROUP RAPID TRANSIT (GRT)
- PERSONAL RAPID TRANSIT (PRT)
- PERSONAL RAPID TRANSIT (PRT) EXTN
- PUBLIC BUS ROUTES





Masdar City Master Plan, 2013

A Sustainable City in the Desert

Promoters of Masdar, a city under construction near Abu Dhabi, say that it will be the world's first carbon-neutral city. It will be home to a research institute focused on renewable energy and sustainability, and eventually, if all goes as planned, to various clean-technology companies, and to a projected 45,000 residents and another 45,000 commuters.

Complete this fall
 Under construction

The surrounding trees will help mitigate windblown dust and sand.

APPROX. 1 MILE

Computer rendering of the planned city

Phase 1 MASDAR INSTITUTE

The area being completed this fall has some design features common to the entire project.

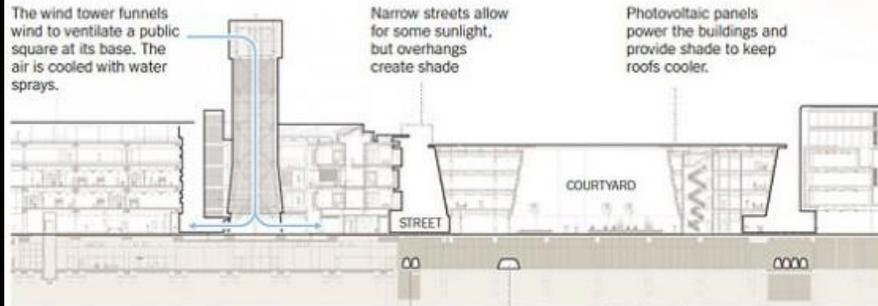
The wind tower funnels wind to ventilate a public square at its base. The air is cooled with water sprays.

Narrow streets allow for some sunlight, but overhangs create shade

Photovoltaic panels power the buildings and provide shade to keep roofs cooler.

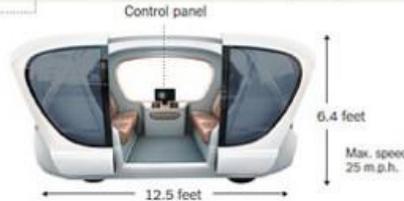
The city is surrounded by recreation areas, power generation facilities, parking garages and food production areas.

A light rail line will pass through the center of Masdar, linking it to downtown Abu Dhabi and providing transport within the new city.



Automated cars with room for four adults.

Automated transportation
Masdar will be using an automated system of electric vehicles, including passenger cars and freight trucks. The city's ground level was elevated 23 feet, and the vehicles will operate underneath.



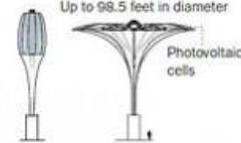
Masdar Headquarters

Photovoltaic panels on Masdar Headquarters, the city's biggest office building, are expected to produce more energy than the building consumes. It is scheduled to be finished in 2013.

Wind cones will provide natural ventilation and soft daylight to the building's interior.



Neighborhoods will have distinct buildings and design elements. Masdar Plaza, for example, will have 54 sunshades that open and close automatically at dawn and dusk.



MASDAR HEADQUARTERS

MASDAR PLAZA

Streets are laid out at angles that optimize shading. Long, narrow parks catch and cool the prevailing winds, and assist in ventilating the city.



MASDAR INSTITUTE

B. Characteristics

2. Energy

- Solar Energy (Masdar Master Plan, 2013):

- * Largest Photovoltaic Plant in SW Asia
- * **Produces 17,500 megawatt-hours of clean electricity** (offsets 15,000 tonnes of carbon emissions per year)
- * Covers 210,000 m²

Solar Energy [Video](#)



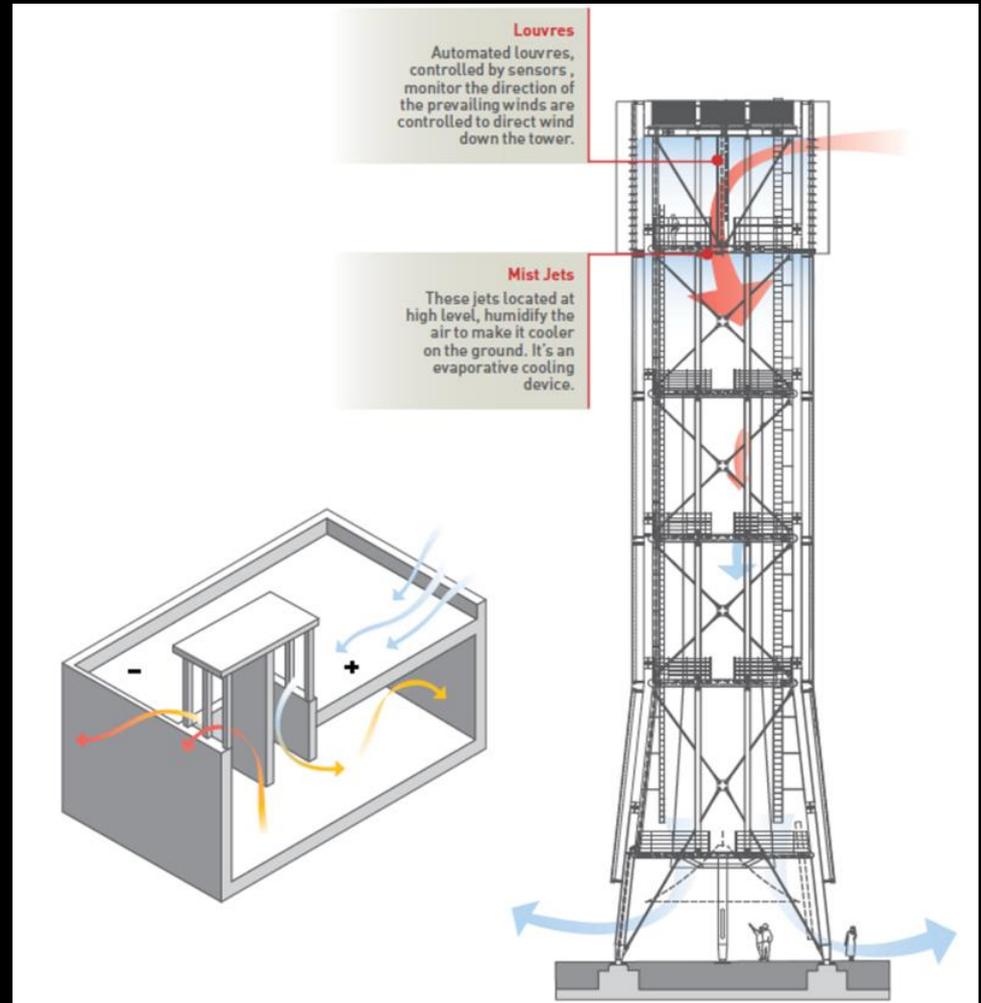
B. Characteristics

2. Energy

- Wind for cooling (Masdar Master Plan, 2013):

- * **Wind Tower**

Wind Tower [Video](#)



B. Characteristics

3. Transportation

- Personal Rapid Transit (PRT): **only two underground stations opened** (planned for 100 stations)
- **Podcar developed by Mitsubishi** (test fleet of 10 podcars)

PRT [Video](#)

- Future Transportation:
 - * Public Transportation
 - * Electric and Clean Energy Vehicles
 - * Parking lots will be built at the edge of the city

Masdar City promotional [video](#)

C. Criticisms

- **Original goals were not met**
- **Development slowed due to an economic downturn around 2010**
- **Switched goal from a carbon-free city to a carbon-neutral city**
- **Current energy tied to fossil fuels (not all from on-site solar energy)**

“As of today, it’s [Masdar City] not a net zero future, it’s about 50%.”

–Chris Wan, Masdar City Design Manager (Guardian, 2016)

- **PRT costs are high—PRT will not expand outside the pilot program**
- **Less than 5% of the original plan has been built (Guardian, 2016)**
- **Only 300 people live on-site (Guardian, 2016)**

C. Criticisms

- **Federico Cugurullo (2016) argues that Masdar City is a business success, but not an environmental success**

“By developing, integrating and commercialising clean technologies, the Emirati eco-city project capitalises on environmental concerns to generate profit.” (Cugurullo, 2016:2430)

- **Elizabeth Rapoport (2014) urges caution in hyping eco-cities—can experiments be replicable?**

“However, it is difficult to predict whether experiments conducted in small, controlled environments can be scaled up to a level at which they may generate widespread change.” (Rapoport, 2014)

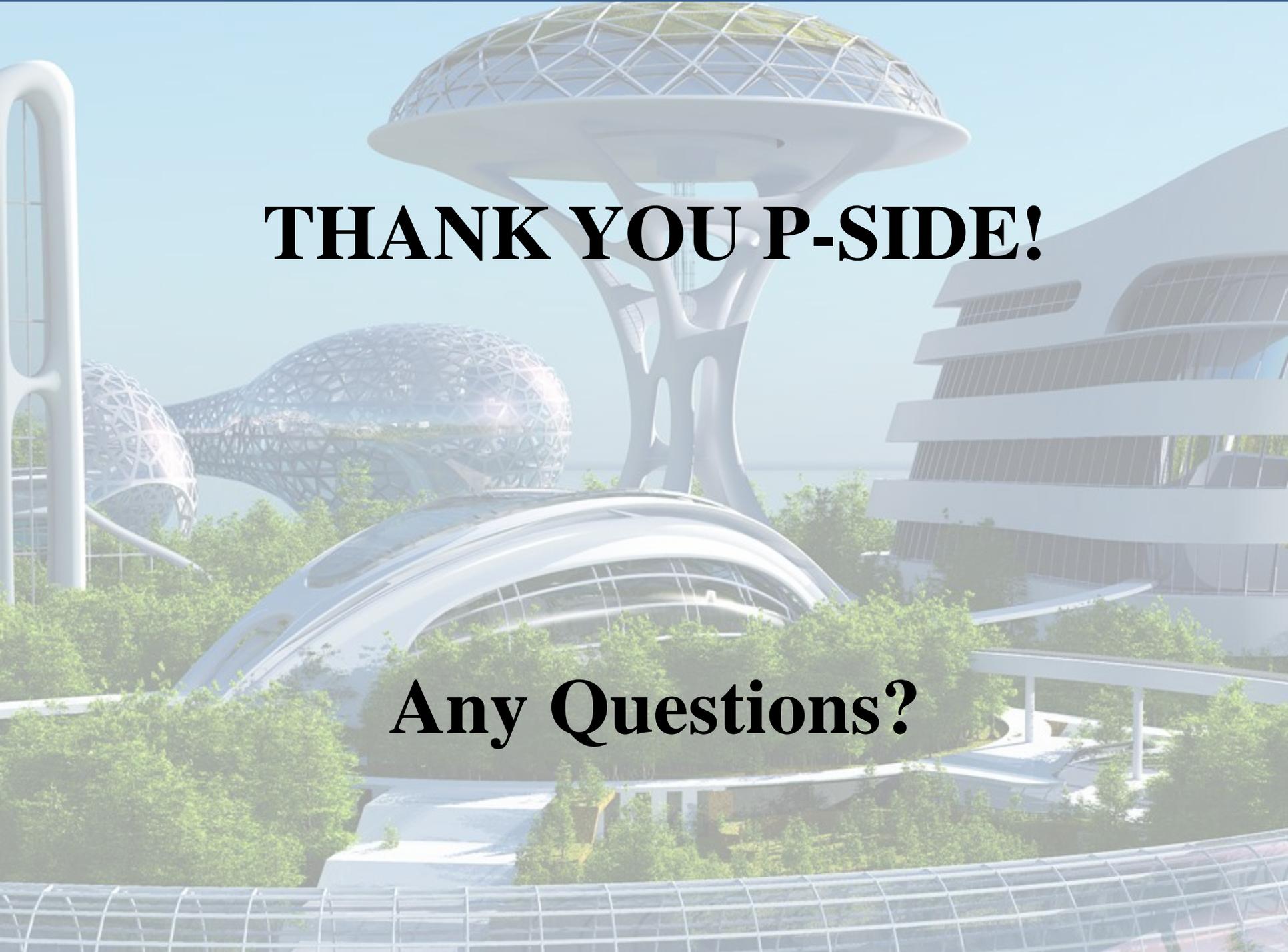
D. Summary/Discussion

- **Masdar City in the UAE is the most expensively built city in the world**
- It relies on traditional Arabic architecture, solar energy and wind towers for cooling
- Mixed results
- **The main goal was to achieve zero carbon emissions**

(Morgan Freeman narrator voice: **“they did not.”**)



- Criticism: Masdar City is more of a company, than a city
- Will it become a **Green Ghost Town?**

A futuristic architectural rendering of a modern building complex. The scene features several large, white, organic structures resembling trees or mushrooms with intricate, lattice-like canopies. In the foreground, there's a curved, glass-enclosed walkway. To the right, a multi-story building with horizontal bands of windows is visible. The background shows a clear blue sky and a body of water. The overall aesthetic is clean, modern, and eco-friendly.

THANK YOU P-SIDE!

Any Questions?