Masdar Clean Energy

Masdar Clean Energy division is a leading developer and operator of utility-scale, grid-tied projects; small-scale applications providing energy access to communities away from the electricity grid; and carbon abatement projects. Since 2006, Masdar has invested in renewable energy projects with a combined value of US$8.5 billion; Masdar's share of this investment is US$2.7 billion.

Masdar's renewable energy projects span the UAE, Jordan, Mauritania, Egypt, Morocco, the UK, Serbia and Spain. The electricity generating capacity of these projects, which are either fully developed or under development, is 2.7 gigawatts (GW) gross.

I) KEY UAE PROJECTS:

Completed:

1. Shams 1, Abu Dhabi (100 MW CSP plant):

In March 2013, Masdar inaugurated Shams 1, one of the world's largest Concentrated Solar Power (CSP) plants and the first of its kind in the Middle East & North Africa (MENA) region. Masdar partnered with Total and Abengoa to deliver the 100-megawatt (MW) solar thermal project. In January 2016, Masdar purchased Abengoa's 20% stake in the asset, increasing its share to 80%.

2. Masdar City, Abu Dhabi (10 MW PV Plant and the Masdar Institute Building Roof-Top Installation):

Masdar City uses clean energy generated on site from both the 10MW solar power plant and 1MW rooftop solar panels installed on the Masdar Institute buildings, predominantly supplying the national grid. Combined, they produce approximately 19,100MWh's of electricity annually, displacing 11,450 tonnes of carbon emissions per year. This is enough to power 500 homes in the UAE for a year.

3. CCUS, Abu Dhabi:

The Carbon Capture, Usage & Storage (CCUS) project is the first project under Al Reyadah, a joint venture between Masdar and Abu Dhabi National Oil Company (ADNOC). The project captures up to 800,000 tonnes of Carbon Dioxide (CO_2) per annum from current emissions from Emirates Steel plants, and transports it via a pipeline network for use in Abu Dhabi's oil fields. The CO_2 is injected into the reservoirs for enhanced oil recovery, replacing other gas traditionally utilised to pressurise and maintain oil wells. The injected CO_2 will remain geologically stored in the reservoirs.

Under development:

Mohammed bin Rashid Al Maktoum Solar Park, Phase 3:

In June 2016, a Masdar-led consortium was selected to develop the 800MW third phase of the Mohammed Bin Rashid Al Maktoum Solar Park in Dubai. At the time, the consortium's winning tariff of 2.99 US cents per kilowatt hour was the lowest price quoted for solar power generation in the world. The project power purchase agreement (PPA) was signed in November 2016. Phase 3 of the Dubai Solar Park is due for completion by 2020

II) KEY INTERNATIONAL PROJECTS:

Completed:

1. London Array, UK (630MW offshore wind farm):

A joint venture joint venture between E.ON (30%), DONG Energy (25%), Caisse de dépôt et placement du Québec (CDPQ) (25%) and Masdar (20%), London Array is the world's largest offshore wind farm currently in operation. Inaugurated on July 2013, the plant powers over half a million homes and displaces about 925,000 tonnes of carbon dioxide emissions per year.

2. Gemasolar, Spain (20MW):

The world's first utility-scale solar power plant to combine a central tower receiver system and molten salt storage technology enabling electricity supply 24 hours a day, Gemasolar can generate electricity for up to 15 hours without solar irradiation.

3. Valle 1 and 2, Spain (100MW):

Adjacent solar plants in Cadiz, Spain that feature parabolic trough solar technology combined with molten salt storage facilities. The plants have a combined power capacity of 100MW and produce approximately 320 GWh/year, which is equivalent to the average consumption of 80,000 households, or the entire city of Cadiz.

4. Tafila Wind Farm, Jordan (117MW):

The first commercial utility-scale wind power project in the Middle East, the Tafila Wind Farm has increased the country's total power capacity by 3% and generates enough electricity to power 83,000 homes.

Under development:

1. Dudgeon, UK (402MW offshore wind):

The Dudgeon Offshore Wind Farm, located 32 kilometres off the coast of North Norfolk, in East Anglia, is a partnership with Statoil, the Norwegian multinational oil & gas company, and Statkraft, Norway's state-owned electricity company. Masdar has a 35% stake in the project, which is expected to reach commercial operations by the end of 2017.

2. Hywind 30MW floating offshore wind farm, Scotland, UK:

Hywind is Masdar's latest investment in the UK's renewable energy sector and the world's first commercial scale floating offshore windfarm, located 30 kilometres off the coast of Peterhead, Scotland. It is being jointly developed with Statoil (75%) and is expected to reach commercial operations by the end of 2017.

3. Baynouna Solar Energy Project in Jordan (200 MW):

Located east of Amman, Baynouna is the largest single solar energy project currently under development in Jordan. The project constitutes 4% of the installed capacity in Jordan. The plant will supply the annual energy needs of 110,000 homes and displace 360,000 tonnes of CO2 emissions each year.

4. 158MW Tesla wind farm in Serbia:

Masdar signed a power purchase agreement for the Tesla wind farm in October 2016. The project is a utility scale onshore wind farm under development in Dolovo province, Serbia. Due for completion in early 2019, the project will provide clean, reliable and economically viable electricity to approximately 113,000 Serbian homes, mitigating approximately 750,000 tonnes of carbon dioxide emissions each year.

III) Special projects

Masdar's Special Projects division deploys renewable energy and clean-technology solutions to remote, rural communities around the world – often in the most challenging and complex conditions.

Some of the projects in the Special Projects portfolio include:

Completed:

1. Afghanistan:
Masdar has installed 600 solar home systems in 27 villages in Helmand Province in southern Afghanistan. Completed in September 2013, the project is improving the lives of more than 3,000 people without access to electricity.

2. Sheikh Zayed Solar Power Plant, Mauritania (15 MW PV plant):
Masdar's 15MW photovoltaic power plant in Nouakchott was the largest solar power installation in Africa at the time of its completion. The project is the first utility-scale solar power installation in the Islamic Republic of Mauritania, accounting for 10% of Mauritania's grid capacity.

3. Eight additional PV projects in Mauritania (16.6 MW):
Eight new rural solar energy projects, with a capacity of 16.6 MW, were completed in November 2016, nearly doubling the UAE's total contribution to Mauritania's clean energy capacity. The projects will supply clean power to remote communities, meeting 30% of their demand on an average.

4. Port Victoria Wind Power Project, the Republic of Seychelles (6 MW):
The Port Victoria Wind Power Project, a 6 MW onshore wind farm in the Republic of Seychelles, is the country's first large-scale renewable energy project. It accounts for more than 8% of the grid capacity on the archipelago's main island of Mahe, where 90% of the country's residents live.

5. Masdar Special projects in Egypt:
Masdar has delivered 30MW of utility-scale clean energy projects and 7,000 solar home systems in remote and strategically important areas across Egypt. The projects are part of a UAE-funded grant programme for rural electrification in Egypt, carried out in partnership with Egypt's New and Renewable Energy Authority.

a) Siwa Solar PV Plant, Egypt (10 MW)
Masdar's 10-megawatt (MW) solar photovoltaic (PV) power plant in Siwa was the largest solar power installation in Egypt at the time of its completion in March 2015. The project is the first utility-scale solar power installation in the country and accounts for 30% of the grid capacity of Siwa City and its neighbouring areas.

b) Red Sea Solar Power Plants (14 MW)
Built in the Red Sea cities of Marsa Alam (6 MW), Shalateen (5 MW), Abu Ramad (2 MW), and Halayeb (1 MW), the four PV plants in Egypt's Red Sea Governorate have a total capacity of 14MW and provide reliable energy supply to support the area's vital tourism sector.

c) Al Wadi Al Jadeed Solar PV Plants (6 MW)
Masdar built three solar power plants in the Governorate of Al Wadi Al Jadeed, the largest and most sparsely inhabited region in Egypt. The plants have been developed in the cities of Al Farafra (5 MW), Abu Minqar (0.5 MW) and Darb Al Arbaeen (0.5 MW). They provide electricity for over 4,800 homes and displace over 8,700 tons of CO2 emissions, and reduce the diesel consumption of existing power plants by over 40%.

d) 7000 Solar Home Systems
Masdar has provided 7,000 standalone solar home systems (SHS) to homes and public/community buildings in remote areas in six Egyptian governorates without access to the national electricity grid. Each SHS consists of two solar panels, two batteries, charge controllers, energy saving light bulbs, cables, switches, and a mounting structure.

6. UAE-Pacific Partnership Fund projects:
The UAE-Pacific Partnership Fund (UAE-PPF) is a US$50 million initiative led by the Masdar Special Projects Unit. The fund delivers grant-funded renewable energy projects across 11 Pacific island nations. All projects are delivered by Masdar in cooperation with each nation's government, with grant funding provided by the Abu Dhabi Fund for Development (ADFD).

Cycle 1:

a) Kiribati: 500kW Solar PV & Water Protection
The UAE-PPF project is helping to meet the needs of 17% of Kiribati's population who live off-grid. The 500kW solar PV plant is also protecting an endangered freshwater aquifer by restricting access and limiting contamination. The project also features a state-of-the-art control system.

b) Fiji: LaKaRo 525kW Solar PV
Inhabitants on three of Fiji's outer islands (Kadevu, Lakeba, and Rotuma) now have access to energy around the clock having previously had power for only 12-18 hours a day.

c) Samoa: 550kW Cyclone-Proof Wind Farm
Samoa depends on imported diesel to meet 70% of its energy demand. The first wind power project in the country is designed as a cyclone-proof facility with two 55 metre-tall turbines that pivot at the base, enabling them to be lowered and locked in place in less than one hour.

d) Tonga: Vava'u 512 kW Solar PV
Masdar has helped reduce fuel consumption on the Tongan island of Vava'u by installing a 512kW solar PV plant along with advanced control systems. These systems ensure a maximum of 70% of the solar energy is efficiently fed into the grid at peak hours; any surplus is stored in a battery bank for later use.

e) Tuvalu: 500kW Rooftop Solar PV
Built on a 4-metre high structure, the UAE-PPF project in Tuvalu creates shaded public space while feeding clean energy into the grid. 500kW of energy capacity is distributed across three roofs and three structures.

f) Vanuatu: Port Vila 767kW Solar PV
Port Vila, the capital city of the island state of Vanuatu, has a population of 44,000, of which only 27% have access to electricity. While the island already has some local renewable generation capacity – including PV, wind, and hydro – the majority of energy demand is still met by diesel generators. Three new solar PV plants help increase the share of renewable energy in the energy mix in addition to providing shading for 112 parking spaces at the country's key civic areas

Cycle 2:

g) Solomon Islands – Solar PV Plant in Honiara
The Republic of the Solomon Islands consists of over 1,000 islands inhabited by a total population of 609,883. Approximately 90% of the electricity produced is diesel generated. The one megawatt plant, which was expanded from 600 kW following a grant from the New Zealand Ministry of Foreign Affairs and Trade, will bolster energy resilience and reduce costs associated with diesel imports.

h) Marshall Islands – Solar Water Collection in Majuro
The Republic of the Marshall Islands is made up of 29 low-lying atolls and five elevated islands inhabited by 71,000 citizens. The nation is dependent on diesel for more than 90% of its electricity. A new 600 kW PV Plant in Majuro is being built on an existing water reservoir. The new plant will provide power to the existing grid and will increase the rain water yield of the reservoir through increased run-off.

i) The Republic of Nauru – Nauru Solar
The Republic of Nauru is an island of just 21 square kilometres with more than 9,500 citizens that is highly dependent on imported fossil fuels for transport and power generation. The new 500 kW solar PV plant bolsters energy resilience by contributing electricity to the national grid.

j) Palau – Solar Penetration and Water Access
The Republic of Palau consists of over 250 islands inhabited by a total population of 21,186 citizens, the majority located on four main islands including Peleliu and Anguar. The three projects in Palau consist of a 100 kW PV / 150kW low-load diesel hybrid generation plant on Peleliu, a 100 kW PV / 100 kW diesel hybrid plant on Angaur which powers a water treatment facility capable of supplying 50 m3 of clean water per day, and 100 of 1.7 kW solar home systems on the island of Koror provided through a subsidy loan program by the National Development Bank of Palau.

k) FSM – Solar in Pohnpei
The Pohnpei Island State is one of the four main groups of islands in FSM. The 600 kW solar plant, the largest PV project in FSM, will supply up to 10% of the peak demand of Pohnpei's 34,000 residents

Under-development:

7. Solar Home Systems in Morocco:

As part of an innovative project to electrify rural Morocco, Masdar is installing Solar Home Systems across 940 villages as part of a partnership agreement with Morocco's Office National de l'Electricité et de l'Eau Potable (ONEE). All of the 290-watt solar home systems are designed, supplied and installed under a project that is being executed by the Masdar Special Projects team.

8. Ongoing Rural Projects:

- Bab Al Shams: 1.2 MW: The project is a 1.2 MWp PV plant that will be grid connected to the DEWA grid. It is located on a farm in the Bab Al Shams area of Dubai.

- Toshka 10MW: The Toshka Solar Power Plant located in Egypt is being built to provide power for the large-scale operations of an agriculture company. The electricity generated by the solar plant will reduce the company's reliance on the local utility company.

IV) Renewable energy water desalination programme

Located in Ghantoot, 90 kilometres from downtown Abu Dhabi, Masdar is implementing a renewable energy desalination pilot programme. The aim is to research and develop energy-efficient, cost-competitive seawater desalination technologies that could be powered by renewable energy.

Operated with the support of four commercial partners – Abengoa, Suez, Veolia and Trevi Systems – the project is evaluating reverse osmosis and forward osmosis technologies to create usable water from the sea. In total, the programme has a combined capacity of 1,500 cubic metres and uses 40 per cent less energy than conventional thermal seawater desalination facilities.

In October 2016, a fifth pilot plant was installed by Mascara NT, the French engineering firm. A unique off-grid, solar-powered solution without batteries, this project is ideally suited for remote locations.

Reverse osmosis is a more energy efficient alternative to the multi-stage flash thermal technology currently used for large-scale seawater desalination across the Arabian Gulf. Forward osmosis is still an emerging technology but could be a viable long-term solution for hard-to-treat water sources such as highly saline water (including certain groundwater sources in the UAE or the brine stream ejected by desalination plants) or water containing significant amounts of organic matter.

Masdar's Domestic and International Projects

- **Nearly 2.7GW of renewable power projects in operation and under development globally**
- **Masdar has made gross investments of US2.7$ billion in renewable energy projects over the last 10 years**

INTERNATIONAL

1. **London, UK** — London Array and Dudgeon Wind Farms
2. **Scotland, UK** — Hywind, Floating Wind Farm
3. **Spain** — Torresol Energy
4. **Serbia** — Tesla Wind Farm
5. **Morocco** — Solar Home Systems
6. **Mauritania** — Sheikh Zayed Solar Plant and Rural Electrification Programme
7. **Afghanistan** — Solar Home System, Rooftop PV
8. **Egypt** — PV Plants and Solar Homes
9. **Seychelles** — Port Victoria Wind Farm
10. **Jordan** — Tafila Wind Farm and Baynouna Solar Plant
11. **Palau** — Palau Solar and Desalination
12. **Nauru** — Nauru Solar Plant
13. **Phonpei** — Federated States of Micronesia
14. **Tuvalu** — Tuvalu Solar Plant
15. **Kirbati** — Kiribati Solar Plant
16. **Honiara** — Solomon Islands Solar Plant
17. **Vanuatu** — Vanuatu Solar Plant
18. **Samoa** — Samoa Wind Turbines
19. **Majuro** — Marshall Islands Solar Plant
20. **Fiji** — Fiji Solar Plant
21. **Tonga** — Tonga Solar Plant
22. **Germany** — Gotha, PV Solar Power Plant

ABU DHABI, UAE

1. Shams 1
2. Al Reyadah - CCUS Project
3. Masdar City
4. Solar Roof Programme
5. Um al Zumool Farm Project
6. Murwah Island Project
7. Al Wathba Stables Project
8. Sea Palace
9. UAE Island – PV & Desalination
10. Desalination Pilot Plant
11. Al Ain Dewan
12. Masdar City, PV Plant
13. Al Jarnain Island, PV Plant

RAS AL KHAIMAH

1. Rashid Abdullah Omran Hospital

DUBAI

1. Mohammed bin Rashid Al Maktoum Solar Park