



Abu Dhabi goes green?

Emma Rawlings Smith

Urban sustainability, renewable energy and the pressures on global resources are all important AS topics. Here Emma Rawlings Smith looks at attempts in Abu Dhabi to make the city more sustainable. It includes a case study of Masdar, a large-scale initiative in developing clean energy technology

The United Arab Emirates (UAE) is alleged to have the largest ecological footprint on the planet at 9.5 global hectares per person (a global hectare is a measure of bio-capacity).

- Water usage has reached 590 litres per capita per day, 24% of which is obtained by the energy-hungry process of desalination.

- Carbon emissions in the country are the fourth highest in the world at 25.1 tonnes per capita per year.

- Abu Dhabi, the capital city of the UAE, sits on 98 billion barrels or 8% of proven global crude oil reserves, worth some \$12 trillion at current market value (*The Report: Abu Dhabi 2010*).

So what is Abu Dhabi doing right for the environment?

Urban growth

The UN reports that global population growth is expected to peak at 9.1 billion in 2050, with

5 billion people likely to be living in cities. The passage from a mostly rural to a largely urban society is known as the **urban transition**. In China alone 1.4 billion m² of land is developed every year for housing. In Africa and Asia the urban population is likely to double between 2000 and 2030; by which time 80% of the population will live in towns and cities. How can sustainable city design become a reality? Abu Dhabi illustrates many of the challenges faced by rapidly expanding modern cities.

City planning in Abu Dhabi

Abu Dhabi is located across a low-lying T-shaped island between the desert of the Arabian Peninsula and the Persian Gulf to the northwest (see Figure 1). Recent urban development in the city has been rapid. Its population has grown from 20,000 in 1971, when the country was founded, to 930,000 today.

In the 1980s plans for the growth of the city were devised, but it was never expected to have more than 600,000 residents. The Urban Planning Council created in 2007 is the agency responsible for the visionary *Plan Abu Dhabi 2030*, a complete development of the city's islands, coastline and 'off-island' mainland. A key strand of the plan is to develop the city sustainably to accommodate

Glossary

Carbon capture and storage/sequestration (CCS) The process of capturing carbon dioxide emitted by industry and storing it in such a way that it will not enter back into the atmosphere, usually underground.

Concentrated solar power A system that uses lenses or mirrors to concentrate sunlight onto oil pipes which produce steam to drive a traditional turbine creating electricity.

3 million inhabitants within the next two decades.

Sustainability

Since April 2010, all construction in Abu Dhabi must reach the 2 Pearl Standard following the regional Estidama Pearl Rating System for sustainable built environments. Estidama legislation differs from European systems such as BREAM (British Research Establishment Environmental Assessment Method) and LEED (Leadership in Energy and Environmental Design). It has a 'four pillar' philosophy, requiring social, economic, cultural and environmental sustainability of new developments. For example, it takes into consideration the environmental impact of the extreme climate of the region, where humidity often reaches 100% and temperatures top 48°C.

In February 2011, the *National* newspaper reported that 50–60% of electricity generated in Abu Dhabi is consumed by buildings, a figure much higher than the 30–40% global average noted by the United Nations Environment Programme. In this climate a great deal of energy is used in keeping buildings cool.

It is possible to use sustainable design in a desert climate to increase the efficiency of energy and water consumption. Recycled or locally sourced building materials can help to reduce the carbon footprint of urban development. Many new buildings in the city, for example, are using locally produced reflective glass rather than concrete. If the mandates of the Pearl Rating System are applied consistently, Abu Dhabi could reduce energy demand from new projects by 25% and water requirements by 20%.

Case study: the Masdar Initiative

The Masdar Initiative was established in 2006 with the aim of making Abu Dhabi a centre for innovation in clean energy (it is also known as the Abu Dhabi Future Energy Company, ADFEC). It rapidly stimulated investment, research and development in the renewable energy sector. The Norman Foster-designed



Figure 1 Map showing the location of Abu Dhabi

Masdar City has built upon the environmental legacy of the UAE's founding father Sheikh Zayed Bin Sultan Al Nahyan and will reach the highest 5 Pearl Standard.

The word *masdar* means 'source' in Arabic and refers to the aim to be the world's benchmark for sustainable development. The government of Abu Dhabi has provided \$15 billion of funding spread through the following five integrated units:

- Masdar City
- Masdar Institute
- Masdar Power
- Masdar Carbon
- Masdar Capital

Sustainable urban living

Once it is completed, by around 2021, the 7 km², zero carbon, zero waste Masdar City will house 40,000 residents and 1,500 businesses working in the clean technology field. As Abu Dhabi diversifies its energy sector, it is hoped that the project will create 70,000 new jobs and increase Abu Dhabi's GDP by more than 2% a year.

The carbon used during the construction of Masdar City is planned to be 30% less than that used in other city developments. Once the city is built, carbon emissions should fall to zero. During the construction of the Masdar Institute 1,800 m² of certified



Solar panels incorporated into the roof of the Masdar Institute

timber was taken from sustainable sources. Low embodied carbon concrete, with reduced cement content, was sourced and produced locally. The sustainable design of the city, with buildings closely-packed to throw shade on public spaces and other buildings, will cut energy demand for air conditioning by half. A *barajeel*, or wind tower, incorporated into the design of the institute, will drive cool air and a fine water mist into the central atrium.

The original plan was for Masdar City to be car free, with no-one living more than 200 metres from a personal rapid transit system (PRT) using driverless electric vehicles with embedded magnets and onboard sensors. The vehicles designed by Zagato were found to be too expensive and, since the Masdar budget has been cut, it is likely that the transport infrastructure will have to be redrawn. For now, a fleet of ten Mitsubishi i-MiEV new generation electric vehicles are being trialled. The cars, powered by a 16 kWh lithium-ion battery, have a top speed of 130 km h⁻¹, a range of 150 km and can be fully charged in an hour.



The PRT pod will remain a concept design, only travelling as far as the Masdar Institute

Sustainable technologies

At the heart of the project, and the first area to be constructed, is the Masdar Institute. It has been developed in conjunction with the Massachusetts Institute of Technology (MIT) in the USA, and will be both a world-class graduate research centre and the focus for renewable energy technologies. By the end of 2011 the \$800 million headquarters was due to be completed, housing the International Renewable Energy Agency (IRENA) and the GE ecomagination centre. The knowledge-based economy fostered at Masdar is intended to act as a catalyst towards a more sustainable future in the middle east.

The second completed project at Masdar is the 10 MW solar photovoltaic farm. This produces up to 17,500 MW of clean energy annually, reducing carbon emissions in the city by 15,000 tonnes, equivalent to taking 3,300 cars off the road. The venture is in partnership with China's Suntech Power Holding and the US firm First Solar. The sand storms common in this region have reduced output by 30%, and with no mechanised cleaning system, the solar panels have to be cleaned by hand. A future Masdar scheme, if the master plan is not redrawn, is the 100 MW Shams 1 **concentrated solar power** (CSP) plant. It is to be the largest CSP plant in the world and will save a more substantial 175,000 tonnes of carbon dioxide.

Abu Dhabi not only has plans to diversify its own energy sector but intends to become a key global player, exporting clean energy technology as well as hydrocarbons over the next 100 years. Masdar Power has projects across

the renewable energy sector. International projects include:

- the 1,000 MW London Array offshore wind farm
- an onshore wind farm providing 25% of the Seychelles' energy needs
- three Spanish CSP plants that will produce 67 MW of electricity and power 90,000 homes

The secretary general of the United Nations, Ban Ki-Moon, said at the World Future Energy Summit, 'Abu Dhabi is becoming justifiably renowned as a hub for progress...we are on the brink of an exciting sustainable future — clean energy for all'.

Carbon capture and storage

Masdar Carbon is a joint venture between the Abu Dhabi National Oil Company (ADNOC) and German energy company E.ON to develop one of the world's largest **carbon capture and storage** (CCS) projects. From 2013, the project will capture 5 million tonnes of carbon dioxide every year from the power plants and heavy industries of Abu Dhabi and pipe it for injection into oil and gas reservoirs to enhance oil recovery. This will allow the current practice of injecting imported natural gas into oil reservoirs to end. It will simultaneously:

- reduce Abu Dhabi's gas import bill
- maintain oil production levels
- help to lower the emirate's carbon footprint

According to the UN's Intergovernmental Panel on Climate Change (IPCC) CCS technology has the potential to reduce carbon emissions by up to 90%. Masdar CCS has already been recognised under the UN Clean Development Mechanism of the Kyoto Protocol.

Going nuclear in the middle east

The latest report by the UN's IPCC highlights the necessity of using nuclear power as well as renewables, if global energy demand is to be met without exacerbating global climate change.

In December 2009 the government-owned Emirates Nuclear Energy Corporation (ENEC) was established. The UAE's nuclear energy programme will fulfil the rapidly increasing industrial and domestic energy demands of the emirate, while diversifying the energy sector and securing future energy supplies. The current ENEC schedule puts the first of four advanced power reactors (APR) online by 2017, with all units operational by 2020. National annual energy demand will reach 40,000 MW by 2020, a fifth of this supplied by nuclear power. With the Japanese nuclear incident in the forefront of people's minds, these developments will be followed closely.

Conclusion

The government of Abu Dhabi has set itself some ambitious plans for the diversification of its economy, energy sector and urban landscape. Political will and funding are in plentiful supply in a city where the focus is

on the future. The Masdar Initiative aims to make Abu Dhabi a centre for clean technology. Whether it will be a success for the economy, environment and people living here remains to be seen.

Questions for discussion

1 Abu Dhabi's Department of Transport has announced that a second motorway is soon to be built between the capital and Dubai. Rents are up to 50% lower in Dubai than in Abu Dhabi. What would you expect residents in Abu Dhabi to do?

2 Consider whether the technology used to build Masdar City could be replicated elsewhere in the world? What factors might be a barrier to such schemes?

3 What are the benefits and costs of developing nuclear energy after the Japanese nuclear incident?

Further reading

For a stunning satellite image of Abu Dhabi go to: www.tinyurl.com/ca4sjy6

The Report: Abu Dhabi 2010: www.oxford-businessgroup.com/full_content/energy-120

Masdar official website: www.masdar.ae/en/home

The *National* article by Sultan al Jaber, 28 February 2011: www.tinyurl.com/d5nzwba

UN Report, 'State of the World Population 2007: Unleashing the Potential of Urban Growth':

www.tinyurl.com/cynvgtw

Plan Abu Dhabi 2030 (September 2007) Abu Dhabi Urban Planning Council:

www.tinyurl.com/cyt33lb

The World Future Energy Summit (WFES) website: www.worldfutureenergysummit.com

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Key points

- Oil production in Abu Dhabi is not sustainable, either for the economy or for energy supply.
- The Masdar Initiative is an attempt to showcase clean technology and diversify the economy.
- Carbon emissions in cities can be cut substantially by carbon critical design and government legislation for sustainable buildings.
- Nuclear power and renewables will make up a more diverse future energy mix for the United Arab Emirates.



The iconic *barajeel* or wind tower, a focal point of the Masdar Institute



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