URBAN WIND POWER

WHAT IS URBAN WIND POWER?

Wind energy is an indirect form of solar energy. Approximately 2% of the solar energy that reaches the earth's surface is converted to kinetic energy in wind. Wind turbines convert kinetic energy to electricity with zero emissions. Average annual wind speeds of 6.5 m/s or greater at 80m are viable for commercial use. New technologies, however, are expanding the wind resources available for commercial projects in applications to the urban and suburban built environment [1].

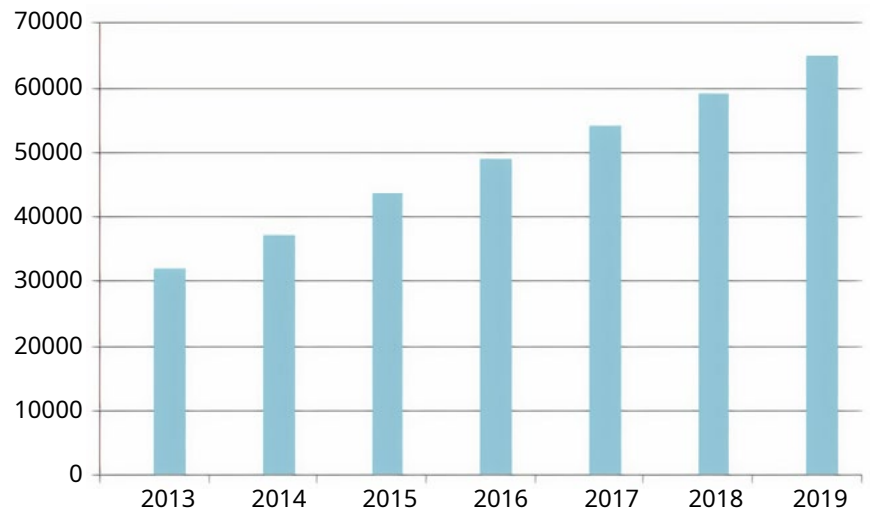

Figure 1: Global Installed Capacity of Wind (MW) [2]

A CLOSER LOOK AT URBAN WIND POWER

Wind Farm

A wind farm is a wind park that has a group of wind turbines built close together at a particularly windy location. The size of wind farms varies from tens to several hundred wind turbines, depending on the potential of the location. Most of the onshore wind farms in the world are located in China, India and the United States. The onshore wind turbines are spaced at 30m apart to double their output. This sort of placement is called 'micro-siting'.

Figure 2: Wind turbines on Urban Building Roofs. Source

Urban Wind Turbine (UWT)

UWTs are available in various shapes and sizes and each type of UWT operates best under different conditions. The choice of UWT model for a potential installation site should be studied carefully. For each type of location, there will likely be at least one type of UWT that would best suit the conditions of that particular location.

Figure 3: Urban Wind Turbine [3]

KEY FACTS

60.4 GW of new installations brings global cumulative wind power capacity up to 651 GW in 2019. **China and the USA remained THE WORLD'S LARGEST ONSHORE MARKET**, together accounting for more than 60% of new onshore additions [5].

The technical potential of wind energy is **20,000–50,000 TWh PER YEAR,** whereas the world electricity consumption as of today is 25,679 TWh [7].

It takes a wind turbine **3 to 6 months to produce the energy** that goes into producing, operating and recycling the wind turbine after its 20 to 25 year lifetime [6].

In 2020, wind power in the EU will **avoid the emission of 333 million tonnes of CO_2** – 29% of the EU's 20% greenhouse gas reduction target [6].

USA wind energy sector **EMPLOYS ABOUT 100,000 PEOPLE and has potential to employ more than 600,000 workers** in manufacturing, installation, maintenance and supporting services by 2050 [8].

Approximately **696g OF CO_2 WILL BE AVOIDED** for every kWh of wind energy used [9].

Wind power's **overall impact on birds, bats, other wildlife, and natural habitats IS EXTREMELY LOW**, compared with other human-related activities [6].

TABLE 1: OVERVIEW OF SELECT COMMERCIALLY-AVAILABLE WIND TURBINES FOR URBAN USE

	Small Horizontal Axis Wind Turbines	Lift-based Vertical Axis Wind Turbines	Drag-based Vertical Axis Wind Turbines
Rated power (kW)	0.1 - 10 kW	0.75-60 kW	0.5 - 10 kW
Rotor type	3- or 5- bladed upwind; 3-blade downwind	3-5 vertical blades	Multi-tier, multi-scoop rotors
Rotor diameter (m)	1.4-10.2 m	1.2-10 m	1-2.36 m
Mounting	Ground	Ground, rooftop	Ground, rooftop
Cut-in wind speed (m/s)	2.5 m/s	2.5 m/s	3 m/s
Cut out wind speed (m/s)	25 m/s	25 m/s	25 m/s

Source: https://www.topsectorenergie.nl/sites/default/files/uploads/Urban energy/publicaties/Report Urban Wind Energy TKI RVO.pdf

Figure 4: Roof Mounted 1 kw Vertical Urban Wind Turbine. Source

FINANCIAL FACTS

Large scale wind farms cost about 1,000 $/kW – 2,000 $/kW and small-scale wind farms cost around 3,000 $/kW. Hence the cost decreases with the increase in the size of wind farms [5].

How much do you earn if you have a wind farm? Taking location, size and rated capacity into consideration, there is a massive return on wind farm investment.

Turbines suitable for urban use can face capital expenditures between 5,675 $/kW for a 20 kW residential project, and 4,300 $/kW for a 100 kW commercial project. Larger projects cost less per unit of installed capacity and power generated. Balance of system (BOS) costs could make up 41.2% – 54.6% of total capital costs depending on project size, with the cost of the turbine making up the rest. [4]

TABLE 2: REPRESENTATIVE COSTS FOR SMALL/DISTRIBUTED WIND PROJECTS [4]

	Residential turbine (20 kW)	Commercial turbine (100 kW)
Capital expenditure ($/kW)	5,675	4,300
Turbine cost ($/kW)	2,575	2,530
Balance of system cost ($/kW)	3,100	1,770
Operation and maintenance ($/kW/year)	35	35
Net capacity factor (%)	29.5%	32.5%

IMPORTANT POINTS TO BE CONSIDERED FOR UWT:

1. Turbines should be preferably placed on large buildings with a flat roof.
2. Investigate which turbine type and model is the best for the chosen building or location.
3. The turbine model and the local wind regime are the most important factors determining energy yield.
4. The minimum recommended average wind speed at a UWT location is 5.5 m/s.
5. The mast or building roof should be approximately 50% taller than the surrounding objects.
6. The lowest position of the rotor has to be above the roof by at least 30% of the building height.

GHG Emissions Reduction by UWT

Electricity generated by UWTs reduces GHG emissions by the following quantities per kWh: 0.566 kgCO_2/kWh, 0.15 gNO_2/kWh, 0.42gSO_2/kWh.

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