# ADB Rooftop Solar Project Shading Analysis

This annex shows how the Asian Development Bank (ADB) conducted its shading analysis, given that ADB headquarters is particularly subject to shading from the southwest of the building. Showing ADB's shading analysis is meant to assist developers with managing possible shading surrounding their own solar projects, since it can seriously compromise solar system performance.

ADB's shading analysis involved obtaining and comparing results using two different methods.

The first method is called the spherical picture method. As will be described in more detail, it essentially involves taking photographs of the view of the sky that the solar array will experience. This gave a quick impression of the solar window of the sky without external data gathering, and included the effects of shading from all nearby structures and from all obstructions on the roof.

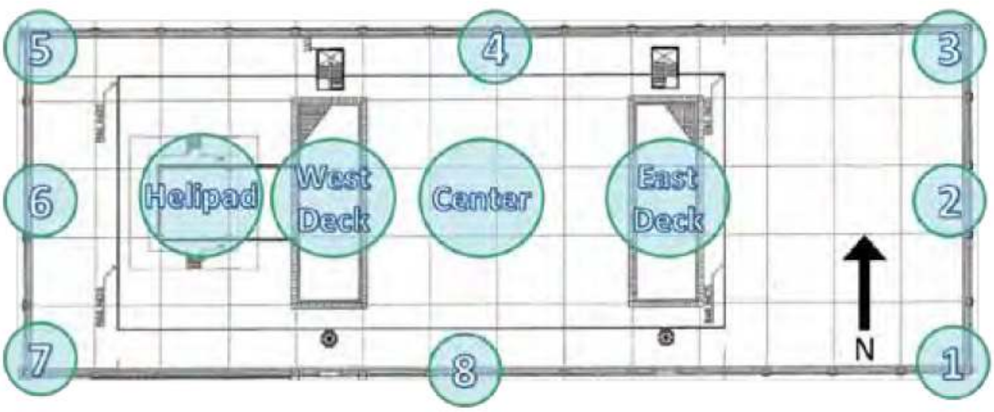
The second method utilizes simulation software, which models shading using a three-dimensional (3D) modeling tool that tracks the sun's path for the specific location of the site. After tracking, the software calculates the shading effect of the surrounding buildings based on the height, area, and orientation of each with respect to the location of the solar array.

In comparing results from both methods, the first method yielded a performance ratio of 1.7% higher than the second method, which is equivalent to a 1.23% higher annual energy production.

## A4.1 Spherical Picture Method

The first method requires a digital camera with a fish-eye lens, a compass, a GPS device, and image processing software. ADB took pictures with the camera pointing directly upward from each of the locations of the roof shown in Figure A4.1, and processed the images to remove all but the obstructions from the images (Figure A4.2).

**Figure A4.1: Locations of Photographs for Shading Analysis**

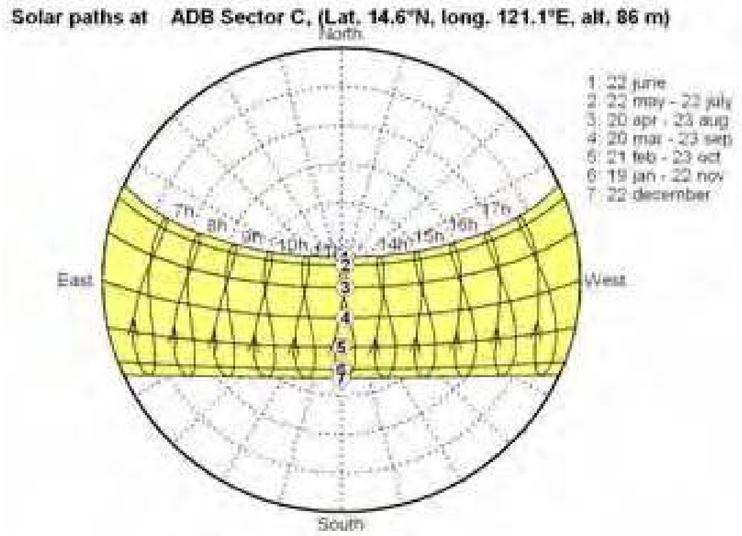



Source: ADB.

**Figure A4.2: Processed Spherical Photo from Point 1**

Source: ADB.

**Figure A4.3: Solar Path Chart Developed for the ADB Rooftop Solar Power Project**




Note: ADB's Headquarters is located on the northern hemisphere. In a solar path chart of this type, the sun's position is taken from the perspective of an observer facing the equator. Thus, east appears on the left and west appears on the right.

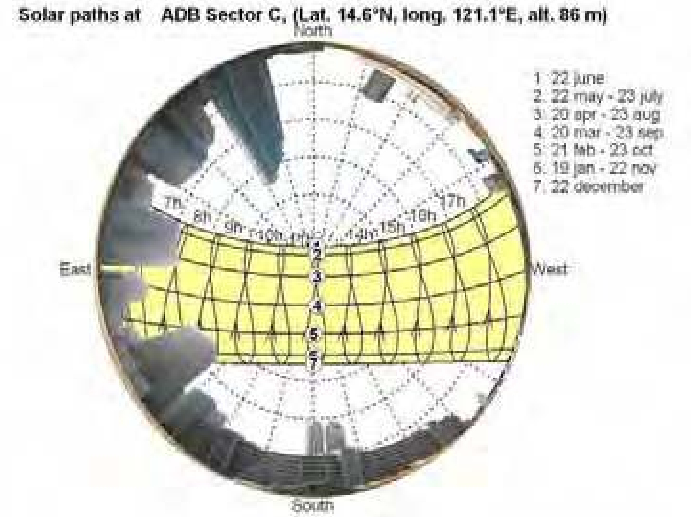
Source: ADB.

Next, ADB generated a solar path chart specifically for the latitude and longitude of the roof (Figure A4.3) using photovoltaic system design software.[1] This chart shows the path of the sun for the location at various times of the year.

The processed spherical photo was then overlaid on the solar path chart to determine shading (Figure A4.4).

[1] ADB used the software PVsyst, available at http://www.pvsyst.com

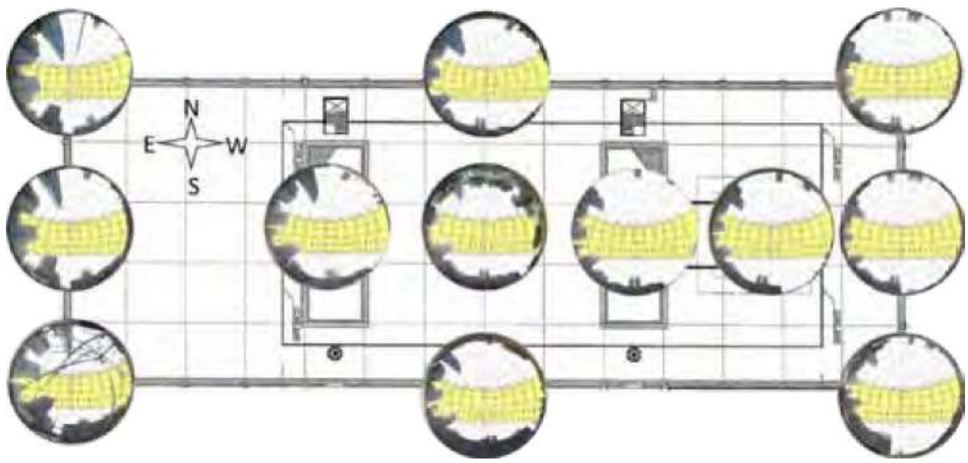
Figure A4.4: Spherical Picture Overlaid on the Sun Path, Used for Shading Charts




Note: ADB's Headquarters is located on the northern hemisphere. In a solar path chart of this type, the sun's position is taken from the perspective of an observer facing the equator. Thus, east appears on the left and west appears on the right.

Source: ADB.

Figure A4.5: Spherical Pictures Overlaid on the Sun Path Charts at Each Roof Location (Reversed East–West Direction)



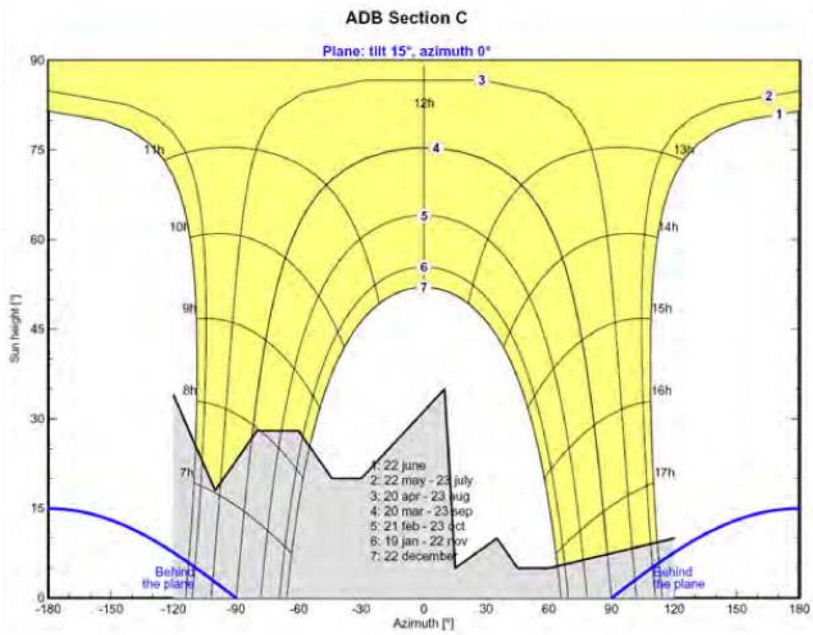

Note: ADB's Headquarters is located on the northern hemisphere. In a solar path chart of this type, the sun's position is taken from the perspective of an observer facing the equator. Thus, east appears on the left and west appears on the right.

Source: ADB.

Figure A4.5 shows the overlaid charts at each of the locations investigated.

ADB then manually translated the azimuth and angular height of the buildings onto the far horizontal shading diagram from the photovoltaic system design software, as shown in Figure A4.6.

**Figure A4.6: Far Horizontal Shading Diagram for Point 1**




Source: ADB.

## A4.2 Simulation Software Sketch-Up Method

The second method requires the physical dimensions of the roof and surrounding structures. These can be collected using city maps containing building information, from a physical survey, or using satellite images and the known number of floors in surrounding buildings.

ADB collected data on surrounding buildings (Table A4.1) and used a satellite image to determine the exact location, orientation, and dimensions of the buildings.

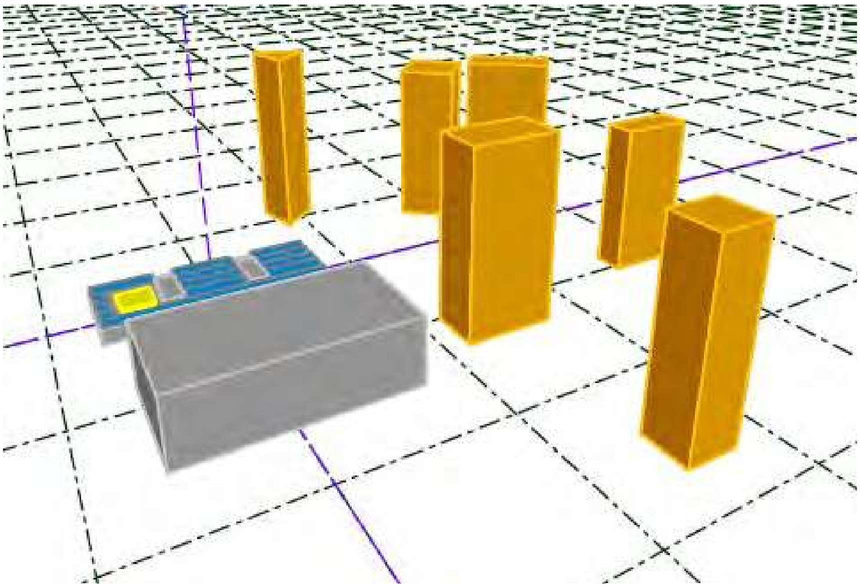
**Table A4.1: Buildings Surrounding ADB Headquarters**

| Name of Building | Number of Floors |
|---|---|
| Malayan Plaza | 40 |
| Oakwood Joy-Nostalg Center (new) | 41 |
| Jollibee Plaza | 34 |
| East Oak Galleria (new) | 46 |
| City Land Mega Plaza | 40 |
| Robinson Equitable Tower | 45 |

Source: ADB.

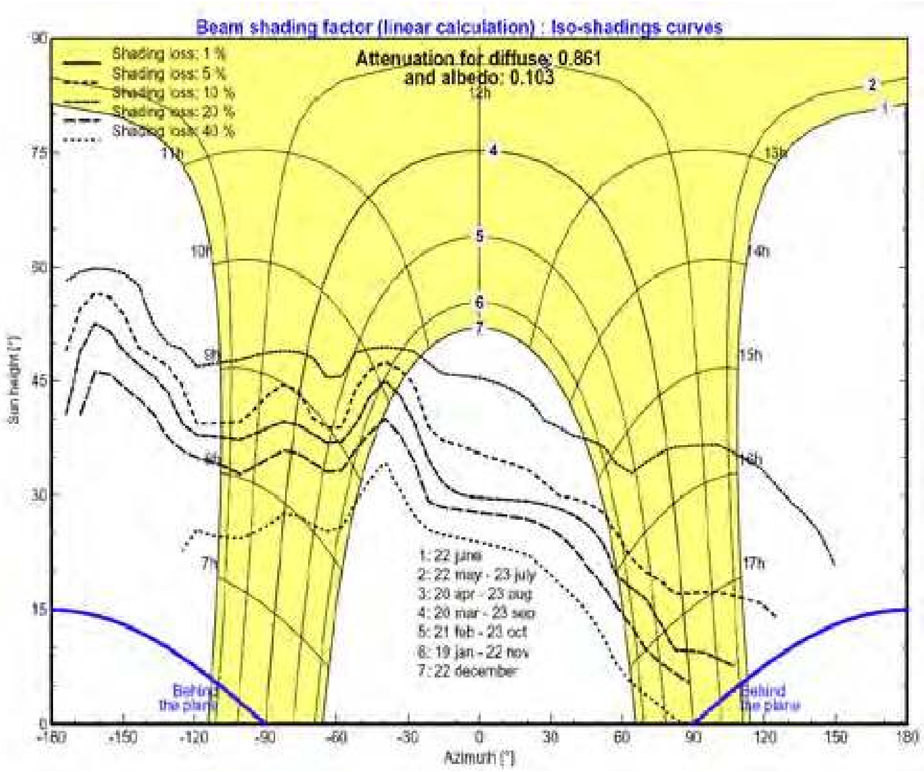
ADB used the 3D modeling tool within the photovoltaic system design software to translate the collected building data, and also the size, tilt, location, and orientation of the proposed solar arrays into a 3D map, as shown in Figure A4.7. Figure A4.8 shows the shading diagram that the software automatically produced.

## Figure A4.7: 3D Map of ADB Headquarters and Surroundings



Source: ADB.

## Figure A4.8: Iso-Shading Diagram Using 3D Map as Input



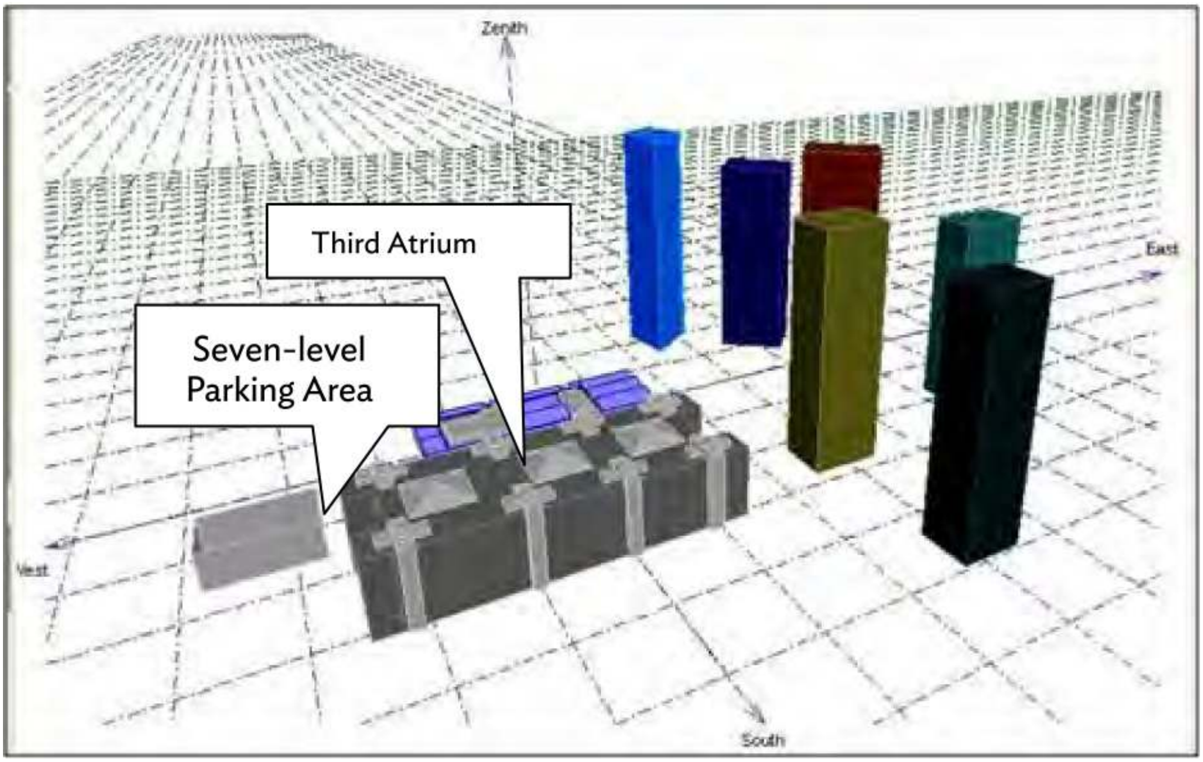

Source: ADB.

## A4.3 Future Structures

ADB will construct two additional buildings in the future that can affect the shading of the solar array on the roof of Segment C (Facilities Block): a seven-story parking area and a third atrium. ADB added these structures to the shading model (Figure A4.9) to produce a shading map that takes them into account.

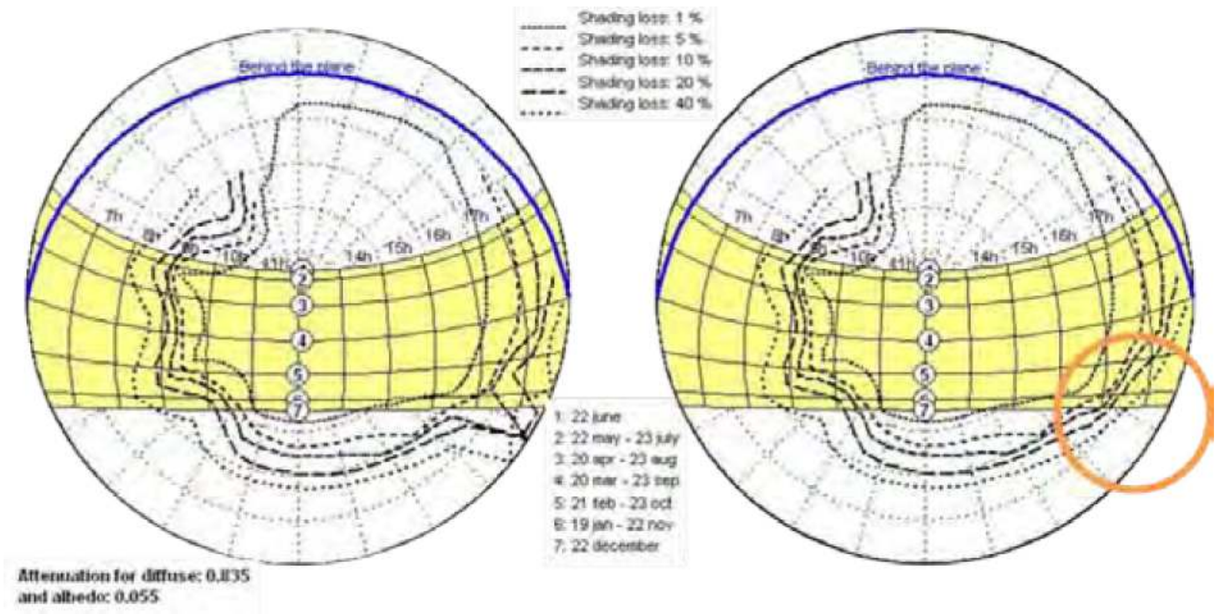
The new structures will cast shade from the southwest, as shown in Figure A4.10.

**Figure A4.9: 3D Map of ADB Headquarters and Surroundings, Including Future Structures**




Source: ADB.

## Figure A4.10: Increased Shading from Future Structures (in Orange Circle) Shown Using Iso-Shading Curves




Note: ADB's Headquarters is located on the northern hemisphere. In a solar path chart of this type, the sun's position is taken from the perspective of an observer facing the equator. Thus, east appears on the left and west appears on the right.

Source: ADB.