Casa Del Zorro PDS2019-AD-19-028

Solar Glare Letter Study

2-26-2020

180 Johnson St

Middletown, CT 06457

Casa Del Zorro Solar Glare Letter Study

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1. Glare Study Overview

Greenskies Clean Energy ("Greenskies"), in partnership with SD Renewables, has been engaged to develop a solar installation (the "Project") on behalf of and for the benefit of Casa del Zorro Resort (the "Resort") in Borrego Springs. As part of the Project application process and in order to specifically address potential or stated concerns of Project neighbors, and comments received from both the Borrego Springs Community Planning Group and Planning & Development Services Department for the County of San Diego County, Greenskies conducted a letter study to evaluate whether the proposed solar Project will create adverse glare impacts the surrounding neighbors and roadways.

The following study also evaluates potential glare impacts on air traffic to the two nearest airports. Due to their distance locations from the project site, which exceed the 2 mile distance required for FAA review, a full FAA study was not performed.

2. Project Description

The proposed Project (PDS2019-AD-19-028) is a 750 kW AC single axis tracking solar PV generator. The location of the Project is 3845 Yaqui Pass Rd, Borrego Springs, immediately across the street from the entrance to the Resort. The proposed Project includes 2,333 solar modules, five inverters, and will be mounted on a portion of a 6.54 acre site, using a racking system that tracks the sun in the E-W direction. The figure below shows the proposed Project layout.

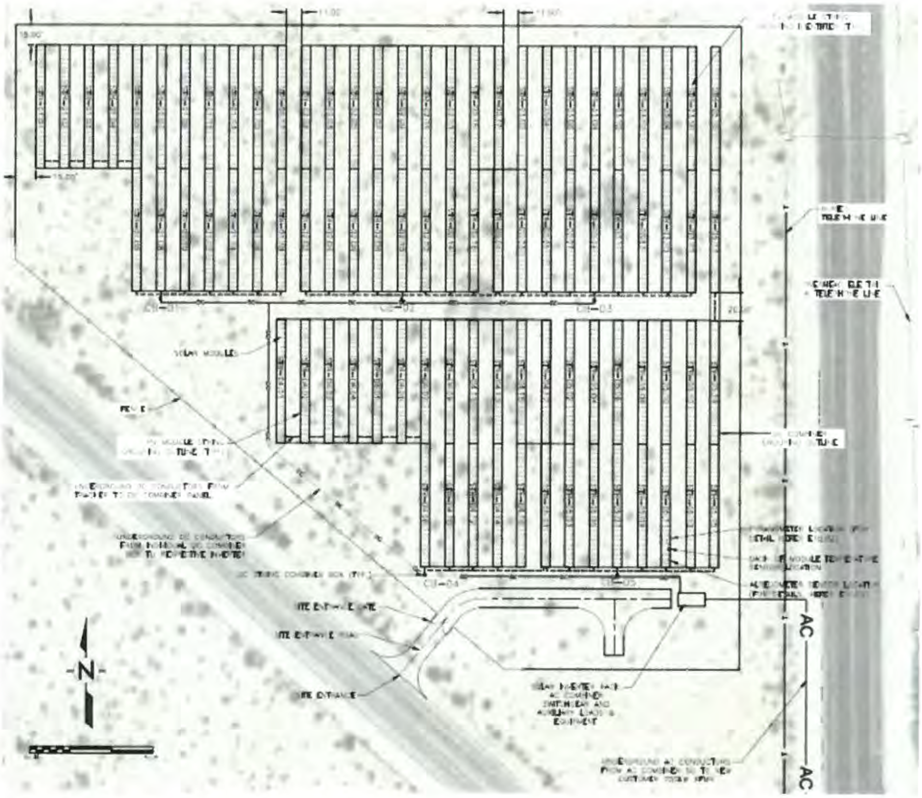

Figure 1. Site layout

The Project is also proposed to include a six foot tall chain link fence that will be visually opaque due to the inclusion of solid slats.

The Project will include a concrete pad with electrical equipment and electrical conducts will go underground, crossing the road to connect to the Casa Del Zorro Resort's existing electrical infrastructure. One hundred percent of the energy generated by the Project will be used onsite by the Resort.

The PV modules will be no taller than eight feet at maximum and as confirmed by independent view simulations (see Appendix A for full details on Project visual simulations), will be almost completely visually obscured by the fence. The modules also include an anti-reflective coating the helps to absorb as much solar irradiance into the module as possible, substantially reducing the amount of potential glare. Appendix B contains additional details about the anti-reflective coating.

3. Study Methodology

3.1 Description

The glare study was conducted using an analysis tool, Solar Glare Hazard Analysis Tool, that was developed by the Sandia National lab and licensed by Forge Solar. This tool is widely accepted in the solar industry and determines when and where solar glare can occur throughout the year from a user-specified PV array as viewed from user-prescribed observation points. The potential ocular impact from the observed glare is also determined, along with a prediction of the annual energy production. Configurations can be quickly modified (e.g., tilt, orientation, shape, location) to identify a design that mitigates glare while maximizing energy production.

The study aims to identify glare issues, characterize the behavior of the glare and evaluate whether or not there are significant glare impacts. The study specifically focused on reviewing potential impacts to nearby residences, and the roads to the North and East of the project site. Four representative viewpoints (see Figure 2 below) were selected for analysis of glare impact.

3.2 The assumptions included in the model for the analysis are:

-- DNI varies and peaks at 1,000.0 W/m^2
-- Analyze every 4 minute(s)
-- 0.5 ocular transmission coefficient
-- 0.002 m pupil diameter
-- 0.017 m eye focal length
-- 9.3 mrad sun subtended angle
-- Timezone UTC-8
-- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
-- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
-- Detailed system geometry is not rigorously simulated.
-- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
-- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
-- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. -- --
-- Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
-- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
-- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
-- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

3.3 The PV system in the model is characterized by the following data:

-- Single Axis Trackers

-- Panel Orientation: North/South

-- Panel Rotation Limits: ± 52 degrees

-- Rack Height: 4.5 feet above grade

-- Stow Angle: 0.0 degrees

Component Data

PV Array(s)

Name PV array 1
Axis tracking Single-axis rotation
Tracking axis orientation 180 0 deg
Tracking axis tilt 0 0 deg
Tracking axis panel offset 0 0 deg
Maximum tracking angle 52 0 deg
Resting angle 52 0 deg
Rated power -
Panel material Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error 9 16 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	ft	ft	ft
1	33 210674	-116 331953	529 65	0 00	529 65
2	33 210903	-116 331953	527 74	0 00	527 74
3	33 210889	-116 330397	524 87	0 00	524 87
4	33 209868	-116 330402	529 00	0 00	529 00
5	33 209888	-116 330992	531 91	0 00	531 91
6	33 210162	-116 330992	530 30	0 00	530 30
7	33 210158	-116 331416	531 30	0 00	531 30
8	33 210422	-116 331416	529 40	0 00	529 40
9	33 210427	-116 331658	529 81	0 00	529 81
10	33 210665	-116 331658	529 19	0 00	529 19
11	33 210669	-116 331953	529 65	0 00	529 65

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	ft	ft	ft
OP 1	33 208260	-116 329995	544 66	0 00	544 66
OP 2	33 207034	-116 331126	560 53	0 00	560 53
OP 3	33 210302	-116 334368	542 57	0 00	542 57
OP 4	33 211199	-116 333639	530 81	0 00	530 81

The array location and four viewpoints are show in the figure below:

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Greenskies
a Clean Focus company

SDRenewables

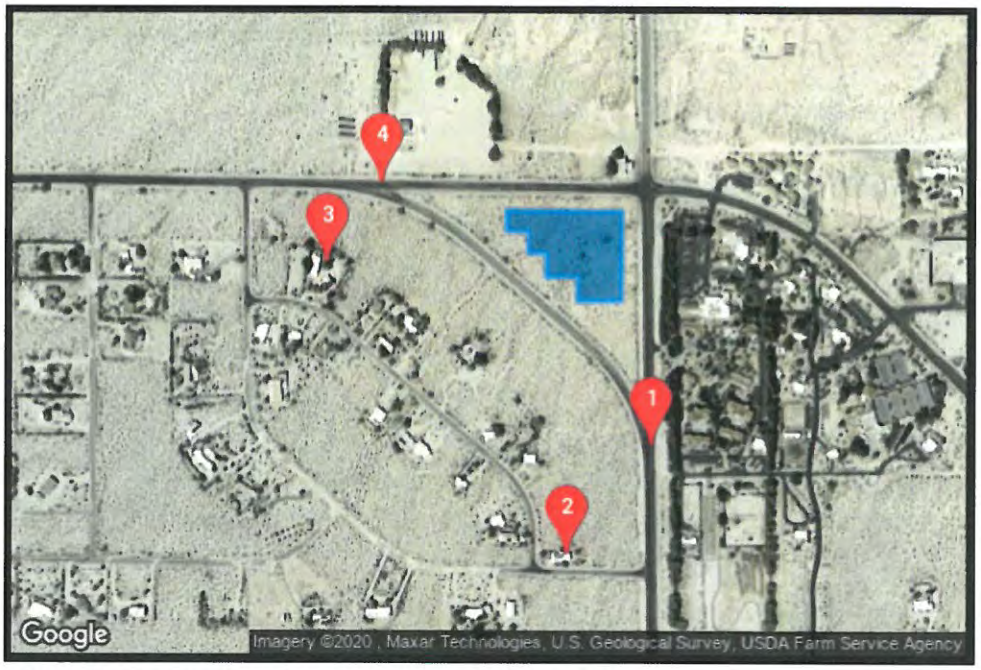

Figure 2. Proposed project location and viewpoints

3.4 Air traffic review

To study possible impact to airports, the location of nearby airports were mapped. The Borrego Valley Airport is 3.25 miles from the project site and the Borrego Ranch Airstrip is 2.9 miles. Both airports exceed the 2 mile distance required for FAA review.

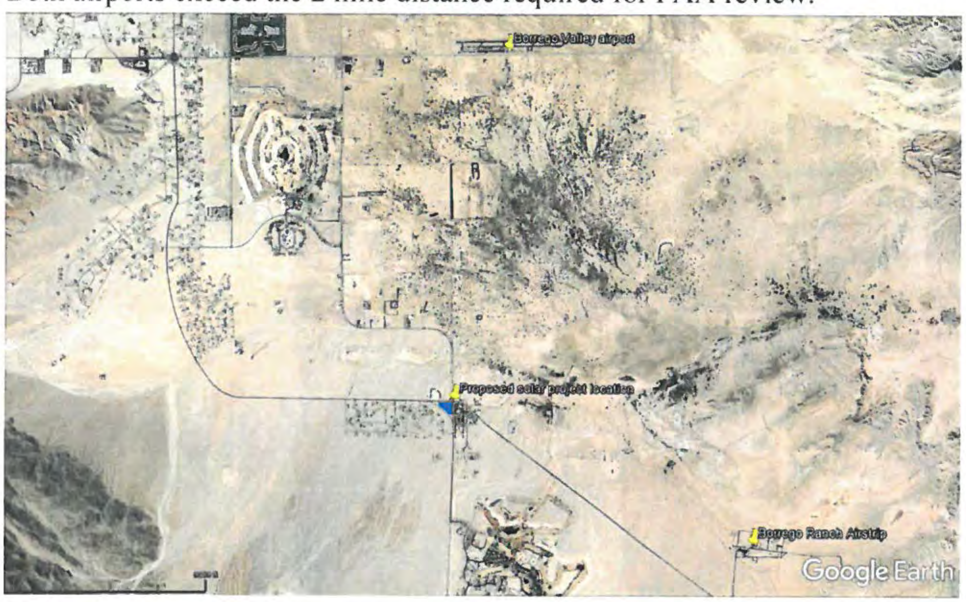

Figure 3. Airport Location

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As can be seen in the Figure 3 map, the Borrego Valley Airport is due North of the proposed project site, and the runway is oriented East-West. The modules will track in the East and West direction and will never point north. The landing and takeoff path is in line with the runway in the East-West direction; with airplanes in the flight path near the airport and with the large distance to the proposed project the modules, will never be angled towards the planes, thus glare should not be an issue to pilots.

Similarly, for the Borrego Ranch Airstrip, the location is nearly three miles south of the proposed project, and the flight path in to the airport comes from the North West. By the time planes are reducing altitude for landing, they will be well past the proposed project location. Take off will not be an issue at all, as planes will go in the opposite direction as the proposed project.

4. Results

The analysis described above resulted in no glare impacts at any of the viewpoints being found.

Resort-temp-0

Aviation Report | Print | Open in editor | More | Delete config

ground based single axis tracking

Created **Feb. 21, 2020 3 p.m.**
Updated **Feb. 21, 2020 3 p.m.**
DNI **varies** and peaks at **1,000.0 W/m^2**
Analyze every **4** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC-8**
Site Configuration ID: 35845.6627

Glare Analysis Summary | PV Array Results

Summary of Results No glare predicted!

PV name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	0	-

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PV array 1

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
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Figure 4. Results

To add a degree of conservatism to the analysis, the project was modeled without the inclusion of any fencing that will obscure line of site views of the array. As previously noted and as depicted by independent view simulations, the entire array will in fact be surrounded by a six foot perimeter fence it would be mitigated by the fencing.

In conclusion, based on the results of Solar Glare Hazard Analysis Tool, no material glare impacts are anticipated for any of the nearby residents, for any vehicular traffic passing by the project location or for nearby air traffic accessing the local airstrips.

Appendix A

Visual simulations

(Attached)

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SOURCE: DUDEK 2020

DUDEK 0 150 300 Feet

Figure 1

Key View Map

Casa Del Zorro Solar Project

SOURCE: DUDEK 2020

DUDEK

FIGURE 3A

Key View 2 Existing - Deep Well Trail

Casa Del Zorro Solar Project

SOURCE: DUDEK 2020

DUDEK

FIGURE 2A

Key View 1 Existing - Yaqui Pass Road at Deep Well Trail

Casa Del Zorro Solar Project

SOURCE: DUDEK 2020

DUDEK

FIGURE 4A

Key View 3 Existing View - Borrego Springs Road at Deep Well Trail

Casa Del Zorro Solar Project

SOURCE: DUDEK 2020

DUDEK

FIGURE 5A

Key View 4 Existing - Zuni Trail Location #1

Casa Del Zorro Solar Project

SOURCE: DUDEK 2020

DUDEK

FIGURE 6A

Key View 5 - Existing Zuni Trail Location #2

Casa Del Zorro Solar Project

SOURCE: DUDEK 2020

DUDEK

FIGURE 7A

Key View 6 Existing - Zuni Trail Location #3

Casa Del Zorro Solar Project

Appendix B

Anti Reflecting Coating

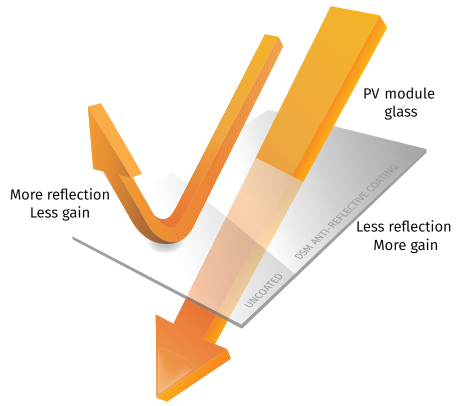
DSM Anti-Reflective coating for solar glass.

Crystal-clear light transmission for a 3% performance boost.

Our Anti-Reflective (AR) coating for solar glass sets the benchmark in the solar industry today. It gives you a consistent 3% performance boost (measured extensively in flash tests) and can be applied to a wide range of solar applications, including c-Si, thin-film, concentrated photovoltaic modules and solar thermal collectors.
Same sun. More power.™

3% MORE POWER

IP PATENT PROTECTED



Our Anti-Reflective coating is a legacy innovation with the best anti-reflective properties in its class. The patented materials science behind it is based on reversing the traditional nano-porous silica coating.

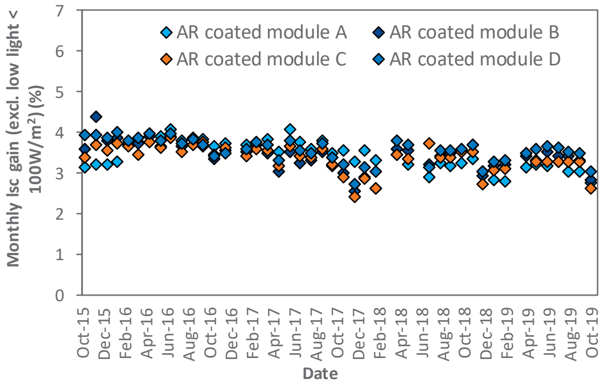
NUTRITION · HEALTH · SUSTAINABLE LIVING

DSM
BRIGHT SCIENCE. BRIGHTER LIVING.

BENEFITS:

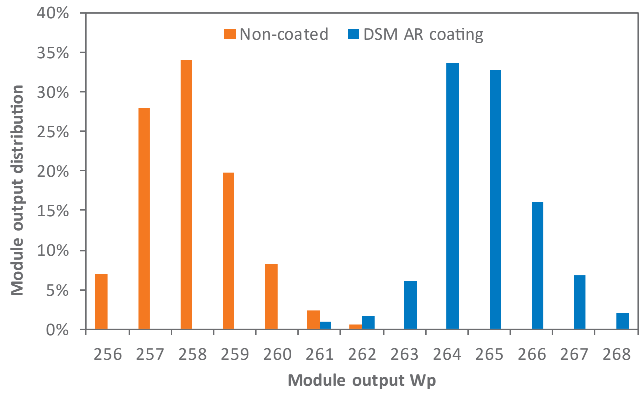
- Significantly higher transmission compared to blank glass.
- Up to 3% higher output gain compared to non-coated modules, resulting in a higher Wp-class distribution.
- Extra power gain due to angular effect, eg, the coating is even more effective during morning and evening hours.
- Extensively evaluated durability in accelerated weathering tests conducted in accordance with IEC 61215.
- Longest track record in the industry for consistent batch-to-batch performance.
- Extremely easy-to-clean, and mechanically robust during module production and assembly.
- Suitable for use on both rolled (patterned) and float glass.
- Applicable on either one side or both sides of the glass.
- Technology can be incorporated into the tempering process.
- No additional curing step required for tempered glass.
- Applicable to a wide range of cell types, module technologies and solar applications.
- Convenient to apply using various technologies, including roller, spray, aerosol, slot-die and dip coating.

MONITORING IN STATE OF THE ART FACILITIES

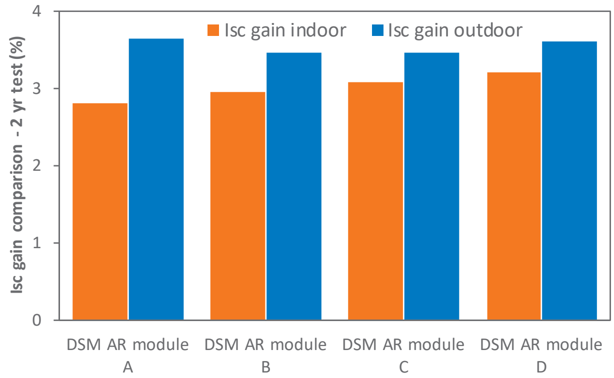


We monitor the Isc performance of up to 16 modules, measured simultaneously at five-minute intervals under maximum load in the Netherlands - which was established in partnership with Fraunhofer ISE.

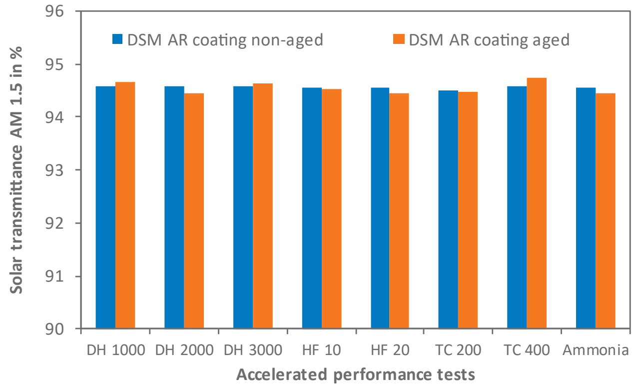
INCREASED POWER GAIN



EXTRA POWER DUE TO ANGULAR EFFECT



DURABILITY IN AN EXTENDED IEC TEST PROGRAM



THE PURPOSE BEHIND THE POWER

As a global science-based company, our purpose at DSM is to use our expertise in solar materials and technology to create clean and affordable energy for all. In fact, our strategy is specifically aligned with United Nations' Sustainable Development Goals 7 ('Ensuring access to affordable, clean energy for all') and 13 ('Taking urgent action to combat climate change'). For our customers, this means offering you expert advice and technical support that enables you to maximize your competitive advantage – wherever in the world you are.

For more information: info.samesunmorepower@dsm.com or visit www.dsm.com/solar

DSM

PV MODULE REFLECTION – GLARE

PV MODULE REFLECTION – GLARE

When light falls on a surface it is split; some of the light traverses the surface (transmission), some light enters the surface and is lost (absorption) and some is redirected away from the surface (reflection). In order for a PV module to produce as much power as possible, the cover glass is optimized for high transmission. This is why Hanwha Q CELLS PV modules have cutting-edge anti-reflective coatings (ARC) in order to maximize transmission and limiting the possibility for reflections.

Each of these actions, transmission, absorption and reflection, can be measured as a proportion of the original light falling on the surface, eg. T + A + R = 100 %. For our purposes it is only necessary to look at the proportion of this original light, as the intensity of the light falling on the surface of the PV module glass will change with numerous factors including different system configurations, locations and times of both the day and year.

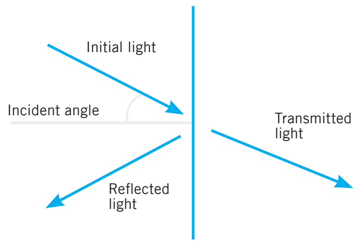


Figure 1: Light falling on a surface

The proportion of light reflected from any surface is dependent upon the angle at which the light hits the glass, called the incident angle where 0° is direct light and 90° is parallel to the surface. The proportion of reflected light can be calculated for different incident angles using the Fresnel equations. For a sheet of glass it would be necessary to calculate the reflection twice, once for the frontside of the glass and once for the backside. However as the rear of PV module glass is connected to an EVA and light absorbing PV cell it is only necessary to consider the frontside effect. To calculate the reflection the refractive index of the involved media is needed. As an example air has an index of 1, for normal "window" glass the value is around 1.5, for water it is 1.33 and for PV module glass it is around 1.25. From these figures alone it is possible to, correctly, presume that the glass used in PV modules creates less reflected light than normal "window" glass or a body of water. Figure 2 shows the curves of these different cases, along with measurements by TÜV Rheinland of Hanwha Q CELLS modules. It can be seen that the proportion of light reflected starts close to zero but rises as the incident angle gets closer to 90°.

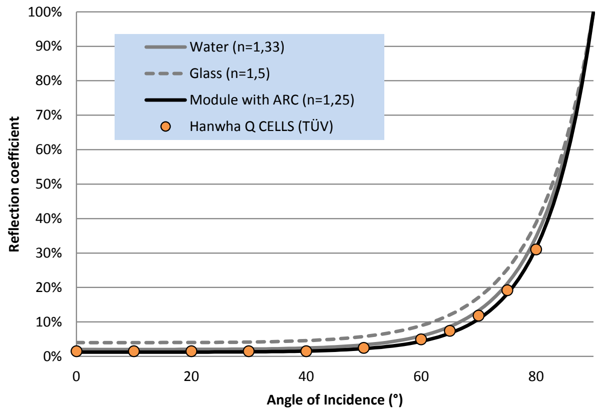


Figure 2: Reflection vs. incident angle

CONCLUSION

From both the theoretical and measured data it is clear that ARC glass used in all Hanwha Q CELLS currently produced PV modules reflects less light than both naturally occurring features, such as bodies of water, and common manmade structures. Moreover for incident angles below 55° less than 4 % of the initial light is reflected away from the PV module.

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Q CELLS