




<b>Prüfbericht-Nr.:</b> <i>Test Report No.:</i>	21249680.002	<b>Auftrags-Nr.:</b> <i>Order No.:</i>	21249680	
<b>Kunden-Referenz-Nr.:</b> <i>Client Reference No.:</i>	1863314	<b>Auftragsdatum:</b> <i>Order date:</i>	2020-05-26	
<b>Auftraggeber:</b> <i>Client:</i>	LONGi Green Energy Technology Co., Ltd. No. 388, Middle Hangtian Road, Chang'an District; Xi'an, Shaanxi; P.R.China			
<b>Prüfgegenstand:</b> <i>Test item:</i>	Photovoltaik (PV) Module <i>Photovoltaic (PV) modules</i>			
<b>Bezeichnung / Typ-Nr.:</b> <i>Identification / Type No.:</i>	Siehe Abschnitt 6 <i>See section 6</i>			
<b>Auftrags-Inhalt:</b> <i>Order content:</i>	Messung des optischen Reflexionsgrads von Photovoltaik (PV)-Modulen <i>Measurement of Optical Reflectance of Photovoltaic (PV) Modules</i>			
<b>Prüfgrundlage:</b> <i>Test specification:</i>	Siehe Abschnitt 1 <i>See section 1</i>			
<b>Wareneingangsdatum:</b> <i>Date of receipt:</i>	2020-08-04			
<b>Prüfmuster-Nr.:</b> <i>Test sample No.:</i>	Siehe Abschnitt 6 <i>See section 6</i>			
<b>Prüfzeitraum:</b> <i>Testing period:</i>	2020-08-24 – 2020-08-24			
<b>Ort der Prüfung:</b> <i>Place of testing:</i>	Köln <i>Cologne</i>			
<b>Prüflaboratorium:</b> <i>Testing laboratory:</i>	TÜV Rheinland Solar Energy Assessment Center			
<b>Prüfergebnis*:</b> <i>Test result*:</i>	N/A			
<b>compiled by / erstellt:</b>		<b>reviewed by / kontrolliert:</b>		
03.09.2020		03.09.2020		
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Expert Signiert von: Lorenz Rimmelspacher		Reviewer Signiert von: Johannes Stang		
<b>Sonstiges / Other:</b>	<b>Keine / none</b>			
<b>Zustand des Prüfgegenstandes bei Anlieferung:</b> <i>Condition of the test item at delivery:</i>	Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>			
* Legende:	1 = sehr gut P(ass) = entspricht o.g. Prüfgrundlage(n)	2 = gut F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	3 = befriedigend F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	4 = ausreichend N/A = nicht anwendbar
Legend:	1 = very good P(ass) = passed a.m. test specification(s)	2 = good F(ail) = failed a.m. test specification(s)	3 = satisfactory F(ail) = failed a.m. test specification(s)	4 = sufficient N/A = not applicable
5 = mangelhaft N/T = nicht getestet				
5 = poor N/T = not tested				
<p><b>Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.</b></p> <p><i>This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i></p>				

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**Liste der verwendeten Prüfmittel**  
**List of used test equipment**

<b>Prüfmittel</b> <i>Test equipment</i>	<b>Prüfmittel-Nr. / ID-Nr.</b> <i>Equipment No. / ID-No.</i>	<b>Kalibrierdatum</b> <i>Date of calibration</i>	<b>Traceability</b> <i>Rückführbarkeit</i>
Reflectance standard	05AA01-0320-3961	2020-06-22	NIST
Stabilised Deuterium/Tungsten-halogen light source	3051	No calibration required	
Integrating sphere			
Spectroradiometer	2199/2200		

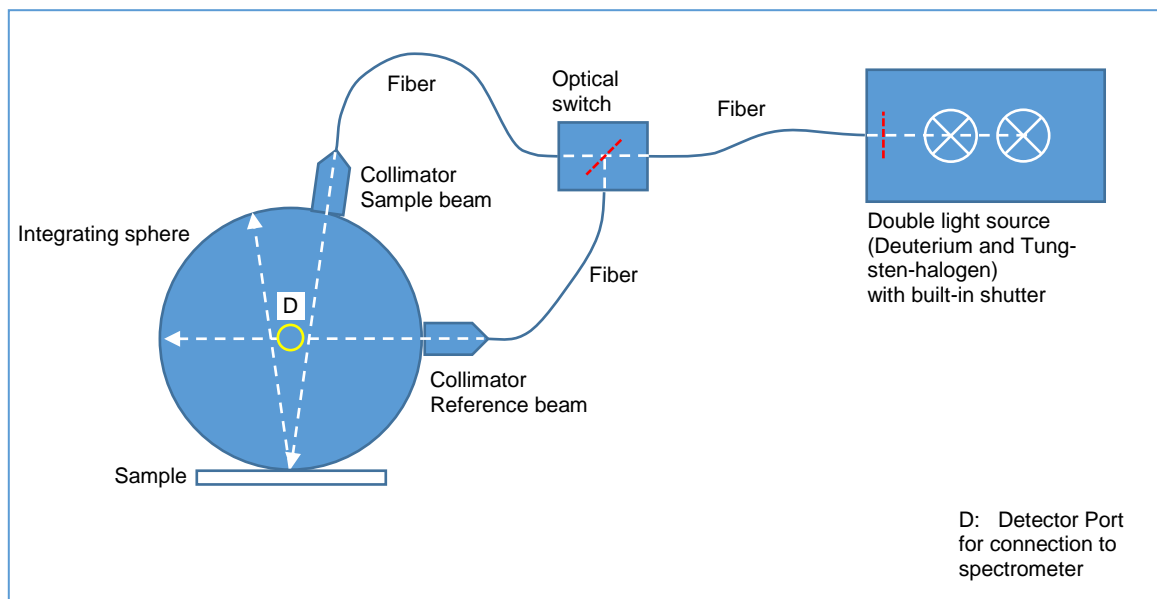
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<b>1</b>	<b>Test specification</b>	
	<b>QMA 2.581.102 (TÜV Rheinland Energy GmbH)</b>	Optische Transmissions- und Reflexionsmessung
	<b>ISO 13468-2:1999</b>	Plastics – Determination of the total luminous transmittance of transparent materials – Part 2: Double-beam instrument
	<b>ISO 9050:2003</b>	Glass in building – Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors
<b>2</b>	<b>Setting of tasks</b>	
	<ul style="list-style-type: none"> <li>Spectral hemispherical optical reflectance of one PV module shall be measured analogous to ISO 13468-2:1999, but extended to the wavelength range 300 nm to 1600 nm.</li> <li>“External light reflectance” shall be calculated according to ISO 9050:2003.</li> </ul>	
<b>3</b>	<b>General information</b>	
	none	
<b>4</b>	<b>Abbreviations possible in the report</b>	
	WL	– Wavelength
<b>5</b>	<b>General remarks</b>	
	Throughout this report a point is used as the decimal separator.	
<b>6</b>	<b>List of test samples</b>	
	Manufacturer	LONGi Green Energy Technology Co., Ltd.
	Module type	LR4-60HPB-355M
	Module technology	Mono c-Si half cut cells
	Sample S/N	LRR903039200701100010
	Sample No.	HV2020003100
	Measurement location(s)	4 locations as specified in Figure 2
	Supplementary information:	
	none	

**7 Measurement of spectral optical reflectance**

The procedure used here is analogous to the determination of spectral transmittance described in section 7 and 8 of ISO 13468-2. The test set-up is shown in the figure below. The sample is irradiated by a beam whose axis has an angle of  $8^\circ$  with respect to the vertical on the sample surface. Spectral reflectance is measured in the wavelength range 300 nm to 1600 nm. Measurement is performed using an integrating sphere with 150 mm inner diameter, suitable to collect the entire (hemispherically) reflected light. The measuring spot size is 10 mm in diameter.



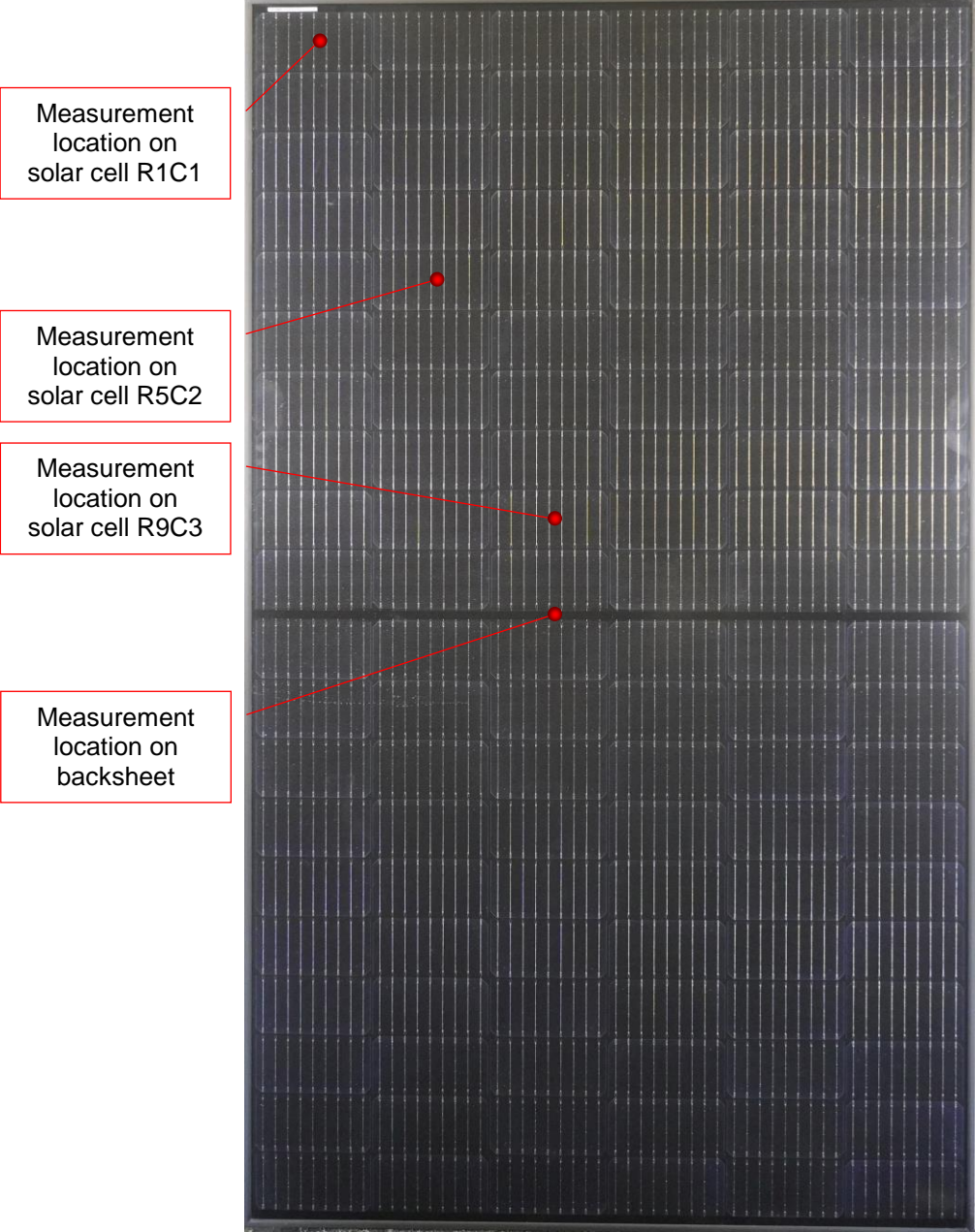
Based on the resulting spectral optical reflectance curves, the ISO 9050 external light reflectance is calculated, which involves weighting by:

- a) D65 solar spectral irradiance in accordance with ISO/CIE 10526
- b) Spectral luminous efficiency for photopic vision (standard observer for photometry) in accordance with ISO/CIE 10527

For the detailed calculation specification, see Annex 1.

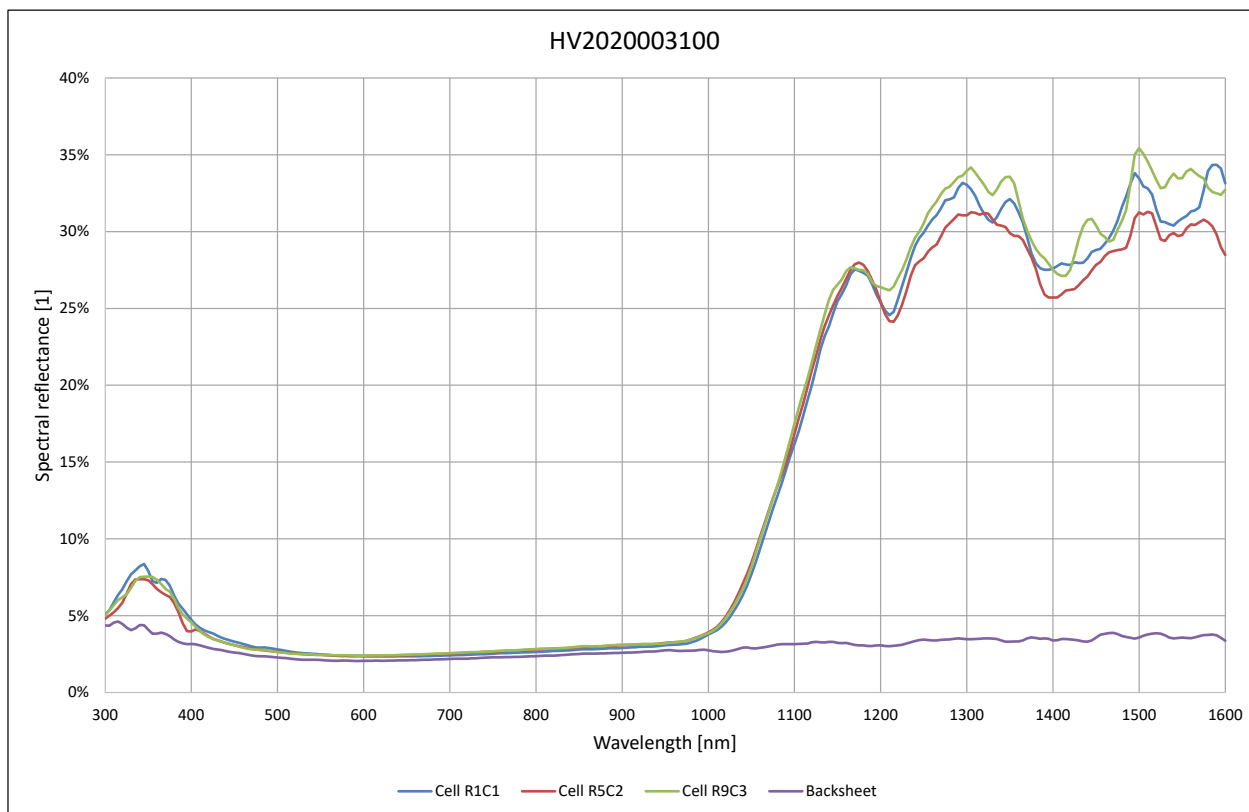
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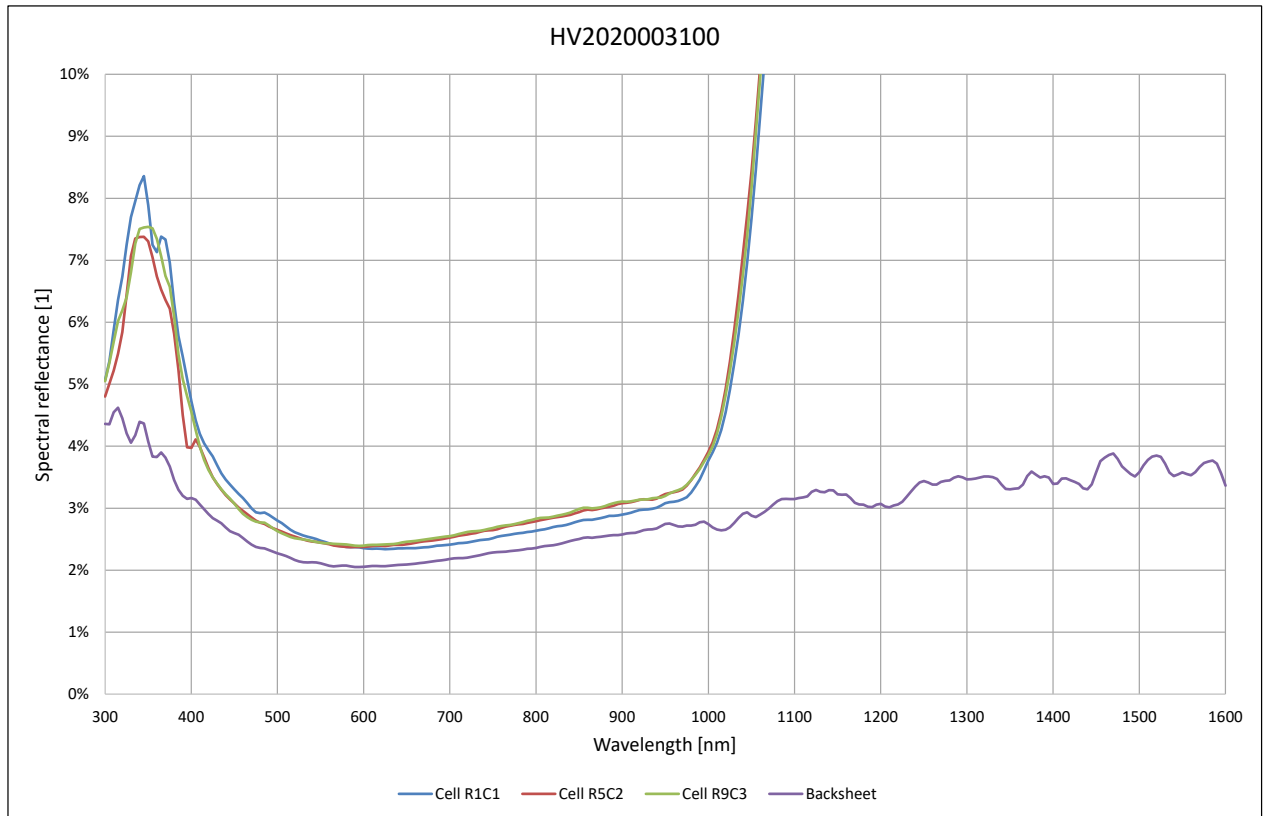
Test date	2020-08-24
Sample No.	HV2020003100
No. of measurement locations	4, as specified in the picture below
	
Row (R) and column (C) of the tested solar cells are indicated.	

Measurement location	ISO 9050 External light reflectance	Average
Cell R1C1	2.5%	2.5%
Cell R5C2	2.5%	
Cell R9C3	2.5%	
Backsheet	2.1%	

- When measuring on a solar cell, external light reflectance of the PV module surface is on average 2.5%, with a very good agreement between the investigated solar cells.
- When measuring between the solar cells, external light reflectance of the PV module surface is 2.1%, based on one measurement location.



Measured spectral hemispherical reflectance curves



Measured spectral hemispherical reflectance curves (detail)

Supplementary information:

none

**Annex 1: Calculation of ISO 9050 external light reflectance  $\rho_{v,o}$  (ISO 9050, section 3.4.1)**

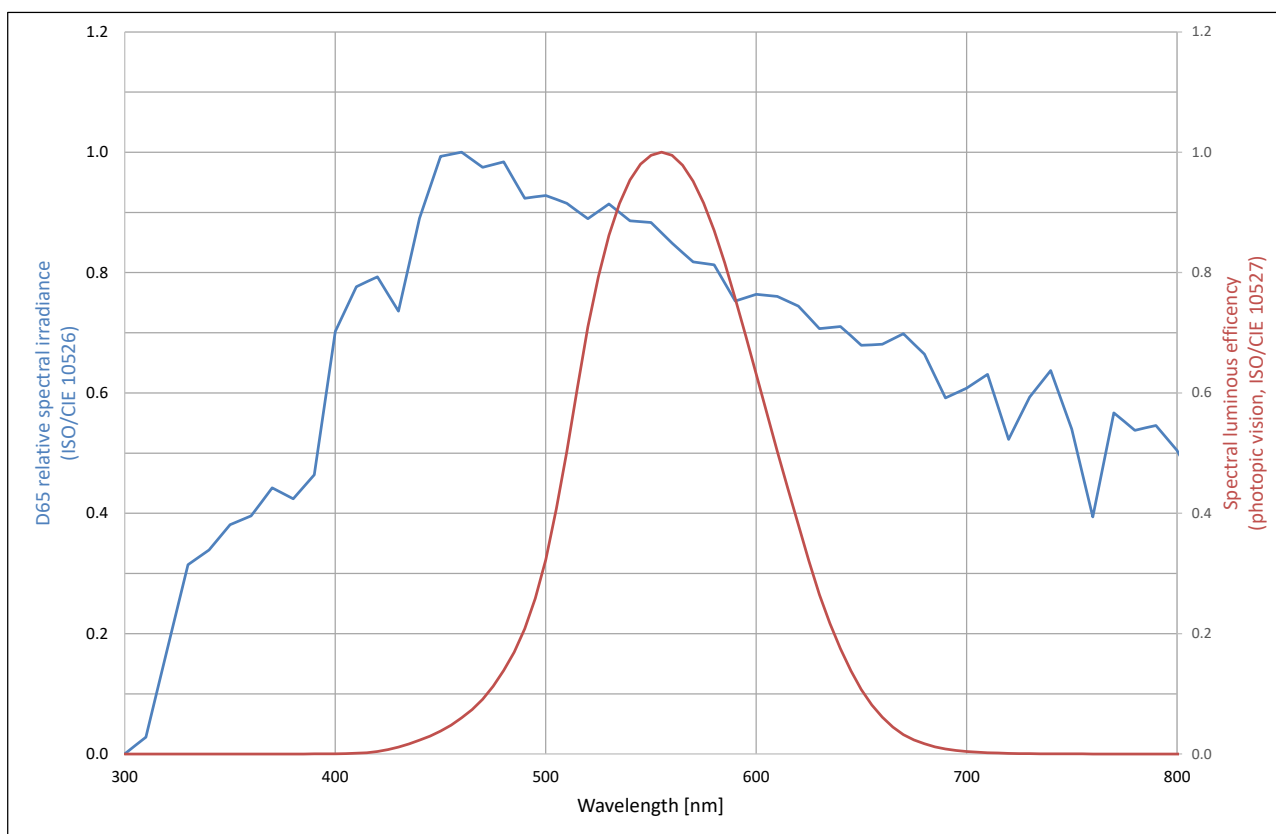
$$\rho_{v,o} = \frac{\sum_{\lambda = 380 \text{ nm}}^{780 \text{ nm}} \rho_o(\lambda) D_\lambda V(\lambda) \Delta\lambda}{\sum_{\lambda = 380 \text{ nm}}^{780 \text{ nm}} D_\lambda V(\lambda) \Delta\lambda}$$

$\rho_o(\lambda)$  is the spectral external reflectance of the glazing

$D_\lambda$  is the relative spectral distribution of illuminant D65 (see ISO/CIE 10526)

$V(\lambda)$  is the spectral luminous efficiency for photopic vision defining the standard observer for photometry (see ISO/CIE 10527)

$\Delta\lambda$  is the wavelength interval



D65 relative spectral irradiance and Spectral luminous efficiency