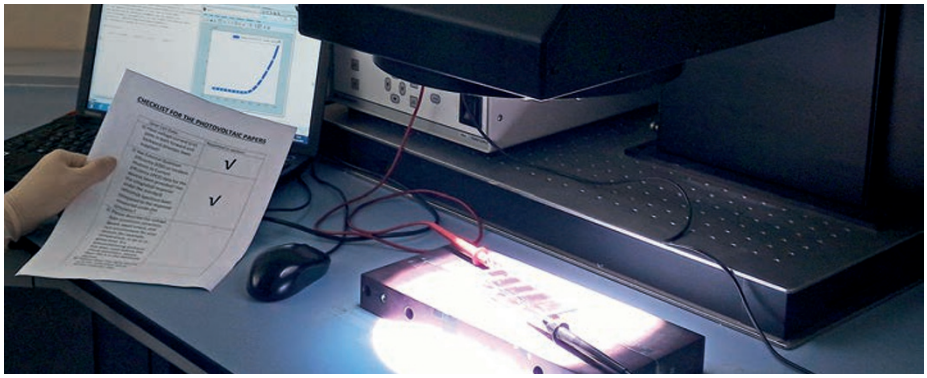
A checklist for photovoltaic research

To aid the reproducibility of published results for photovoltaic devices, from now on we will ask authors of relevant manuscripts to complete a checklist of key technical information that must be reported.

The fundamental properties of organic–inorganic perovskites and their promising technological potential have breathed new life into basic and applied research in photovoltaics. Such enthusiastic activity has also revived the debate on best-practice procedures to be adopted when determining and reporting photovoltaic performance[1]. In the last few months, discussions between experts in solar cells and editors from the Nature family of journals have converged in the identification of key technical and procedural information about the characterization of photovoltaic devices based on any material system. To improve transparency and reproducibility in the field, this information should be included in published manuscripts. To this end, the key points have been summarized in a checklist, which we will ask authors of pertinent manuscripts to fill in, should their manuscript be sent for peer review. The document, which will be available for downloading from http://www.nature.com/authors/policies/solarchecklist.pdf, mirrors the life-sciences checklist adopted by Nature journals to help authors adhere to data-reporting standards[2].

The aim of this initiative is to provide authors with a memorandum of the basic best-practice procedures for the characterization and description of photovoltaic performance. Most of the technical and statistical information requested in the checklist — such as current–voltage scan conditions, the size of the solar cells and the number of tested samples — applies to any study reporting the characterization of a photovoltaic device. Such information will also have to be detailed in the manuscript. The checklist also allows authors to include comments and to mark some of the requested details as not applicable, should these be irrelevant for the validation of the findings. Editors and peer reviewers will have access to the filled-in checklist to ensure that manuscripts fulfil the transparency and reproducibility standards expected by the community.

Besides technical information, the checklist asks authors to clarify whether the performance of their devices has been confirmed by independent certification laboratories. Several groups within the photovoltaics community are in favour of such validation being mandatory when claims of world-record efficiencies are made, and we encourage researchers to corroborate their results in this way whenever possible[3]. Yet we appreciate that, when novel materials or solar-cell architectures are being explored, the combination of prototypes with non-optimized stability and long waiting lists for certification at international standards laboratories may impede a timely accreditation of efficiency measurements. This should, of course, not prevent exceptional results from being published; however, extra care should be taken by authors in describing the adopted characterization procedure and in providing statistical evidence of performance reproducibility. This and other best practices — such as the reporting of average efficiency values alongside best-device performance, and the inclusion of information on the maximum device stability verified in the lab — should help to provide a fair picture of the potential of photovoltaic materials, and may reduce the typically high expectations put on the shoulders of young technologies when they are at too premature a stage.



LUISA DE MARCO

Checking the performance of a solar cell.

It is also worth noting that characterization procedures optimized for a specific photovoltaic technology may not be straightforwardly applicable to other systems. In fact, some materials may present peculiar behaviour (such as the well-known hysteresis of perovskite solar cells[4]) that may require careful tuning of the measurement protocol. More complex architectures — for instance, tandem solar cells — need specific precautions (and different experimental set-ups) for the extraction of correct efficiency values[5]. It is thus likely that, with the advent of new photovoltaic technologies, some of the current best practices in characterization will need to be refined further. As shown in the past[6], direct collaboration of researchers with accredited standards laboratories is an effective strategy to benchmark established characterization procedures for novel materials and architectures. Also, dedicated international workshops and initiatives such as round-robin studies involving independent laboratories have been organized to define testing protocols for the comparison of reports on the stability of organic solar cells[7], and there are analogous ongoing discussions concerning hybrid photovoltaic systems. We therefore encourage researchers working on photovoltaics to continue to provide us with feedback on best-practice considerations and on the reporting checklist in particular.

We thank the experts who have provided us with essential information for the preparation of the checklist. We are confident that it will become a useful tool to fulfil the high standards of transparency and reproducibility that the photovoltaics community is committed to. ❐

References

1. Web focus on Performance of photovoltaics; http://www.nature.com/nmat/focus/photovoltaics-performance/index.html
2. *Nature Mater.* **14,** 133 (2015).
3. *Nature Photon.* **8,** 665 (2014).
4. Snaith, H. *et al. J. Phys. Chem. Lett.* **5,** 1511–1515 (2014).
5. Timmreck, R. *et al. Nature Photon.* **9,** 478–479 (2015).
6. Li, G. *et al. Nature Mater.* **4,** 864–868 (2005).
7. Reese, M. O. *et al. Solar Energy Mater. Solar Cells* **95,** 1253–1267 (2011).

Corrected after print: 5 November 2015

Correction

In the version of the Editorial 'A checklist for photovoltaic research' originally published (*Nature Mater.* **14,** 1073; 2015), in ref. 2, the page number should have been '133'. Corrected in the online versions after print 5 November 2015.