



Achieving Low-Cost Solar PV:

**Industry Workshop Recommendations for
Near-Term Balance of System Cost Reductions**

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THIS REPORT

Solar photovoltaic (PV) electricity offers enormous potential to contribute to a low-carbon electrical system. However, costs must drop to fundamentally lower levels if this technology is to play a significant role in meeting U.S. energy needs.

“Balance of system” (BoS) costs (all costs except the PV module) currently account for about half the installed cost of a commercial or utility PV system. Module price declines without corresponding reductions in BoS costs will hamper system cost competitiveness and adoption.

This report summarizes near-term cost-reduction recommendations that emerged from Rocky Mountain Institute’s *Solar PV Balance of System Design Charrette*,¹ an industry-wide event organized in June 2010.² It focuses on BoS costs for rigid, rectangular modules installed in commercial and utility systems up to 20 MW capacity. The design strategies and recommendations in this report lay the foundations for near-term cost reductions of ~50% over current best practices. These reductions exceed current trajectories, and if implemented, can enable greater solar PV adoption.

We hope this report will prove useful to a wide range of solar industry stakeholders and interested observers. In particular, our recommendations are targeted at equipment manufacturers, PV system installers, project developers, financiers, government program administrators, and potential new entrants.

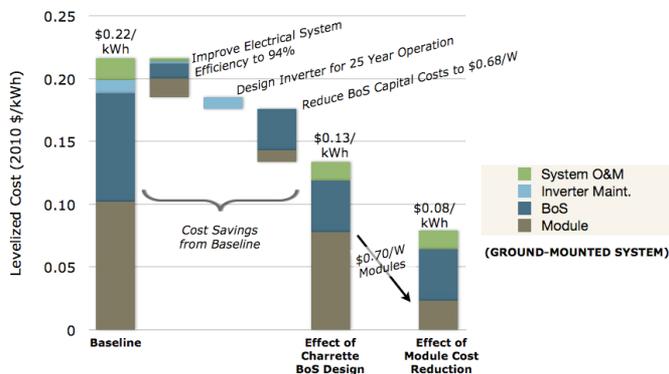
Beyond the near-term focus of this report, many diverse and potentially “game-changing” PV cells and module technologies are being developed and/or launched. Some of these could prompt drastic cost reduction, but even if those technologies succeed, their ability to scale quickly is unknown so the country cannot wait for a technological breakthrough.

Finally, it is important to recognize that solar PV is only one piece of a low-carbon energy system, which must include a portfolio of efficiency and clean technologies.

¹ A charrette is an intensive, transdisciplinary, roundtable design workshop with ambitious deliverables and strong systems integration. Over a three-day period, the Solar PV BoS charrette identified and analyzed cost reduction strategies through a combination of breakout groups focused on specific issues (rooftop installation, ground-mounted installation, electrical components and interconnection, business processes) and plenary sessions focused on feedback and integration.

² Some of the recommendations emerged after the charrette, through discussions with participants and other contributors.

Figure 4. Levelized Cost of Electricity Estimate for Charrette Ground-Mounted System Design



A Comprehensive Industry-Wide Effort is Needed Now

In order to realize these cost reductions, coordinated action is necessary. Specifically, Figure 5 lists high-priority activities to enable and accelerate cost-reduction efforts. Several of these activities address challenges specific to structural, electrical, or process cost-reduction ideas. A diverse, regularly collaborating group of stakeholders needs to lead and contribute to these recommendations. These measures are described in more detail in the main body of the report and in Appendix B.

In addition to the activities proposed for each focus area, a coordinated effort is required to tie together the disparate BoS cost drivers. One idea suggested at the U.S. Department of Energy (DOE)'s August 2010 *\$1/W Workshop* could tie together the disparate cost drivers: a standard tool that provides an analytic view of costs across the BoS. Building on existing models, such a

publicly available integrative modeling module could be used to evaluate the impacts on LCOE of specific design strategies—from module to installation—across the value chain. It would also allow designers, customers, regulators, and manufacturers to accurately analyze trade-offs between different designs, codes, incentive programs, contract structures, financing schemes, and economics in terms of system performance and impact on LCOE.

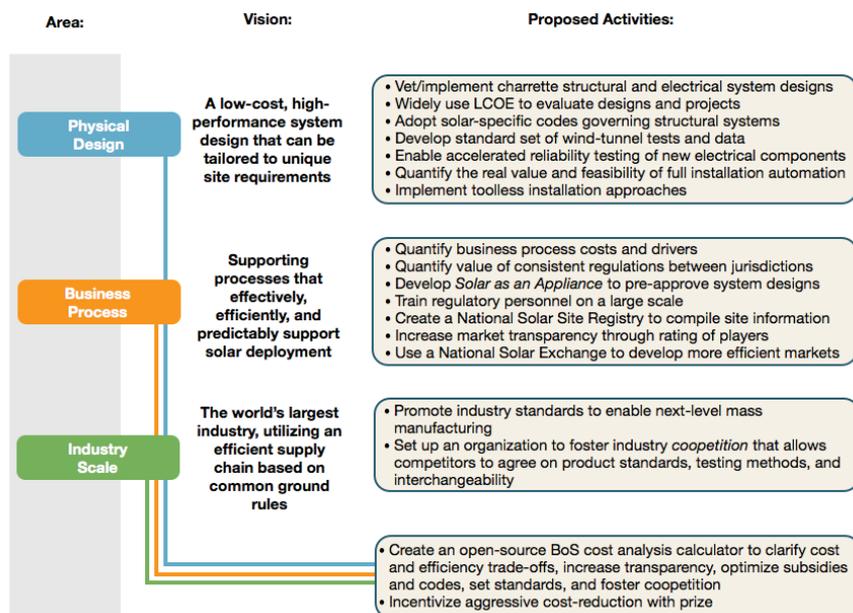
Overall, the activities described in this report will enable cost reduction and increased adoption by promoting:

- Lifecycle cost decision making;
- Industry competition to promote standardization;
- An increased focus of development efforts on high-potential sites and designs;
- The ability of regulatory officials and financiers to evaluate projects efficiently;
- The ability of regulators to set subsidies at optimal levels and to sunset them judiciously;
- An increased consistency of regulations across utility and government jurisdictions; and
- The acceleration of updates to structural and electrical codes.

Beyond this Work: Next-Generation Systems Will Offer Additional Possibilities

The Solar PV BoS Design Charrette effort focused on conventional technologies and a less-than-five-year implementation timeframe. Significant work is required to achieve the \$0.60–0.90/watt cost targets described in this report. To reduce solar PV power prices beyond these targets (\$0.50/watt and below), innovative BoS approaches will be necessary.

Figure 5. Proposed Industry Activities to Support Cost-Reduction Goals



Such approaches may include building-integrated systems, DC-electric microgrids, concentrating PV technologies, bio-based structural systems, or fundamentally different photovoltaic technologies, such as paint-on products or cells that enable the use of radically different mounting structures. BoS cost reductions will also be achieved as module efficiencies continue to improve, adding more wattage per unit area of racking and per dollar of project cost, independently of the savings described in this report.

Regardless, current BoS approaches have the potential to considerably drive down system costs and will likely remain dominant for a while.