Supporting Information

Fullerene derivative with a branched alkyl chain exhibits enhanced charge extraction and stability in inverted planar perovskite solar cells

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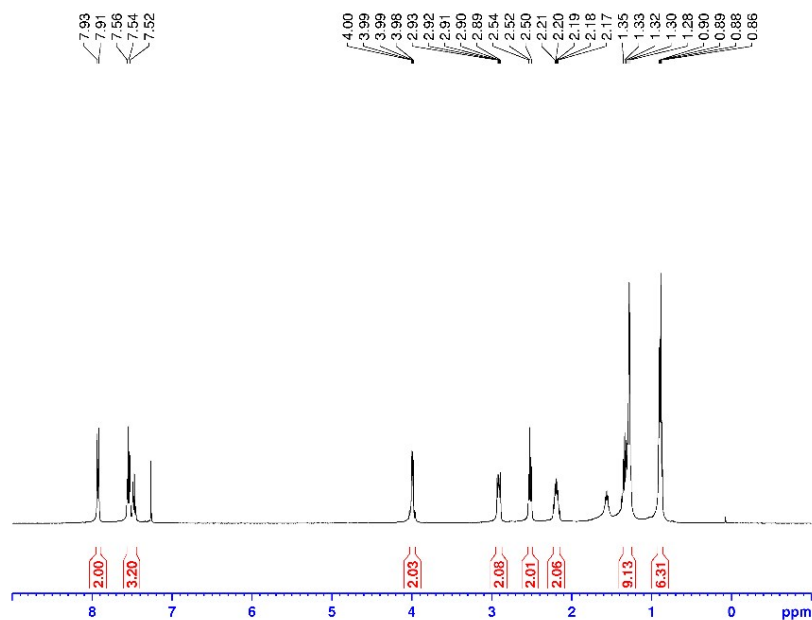[†]These authors contributes equally to this work.

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Figure S1. ^{1}H-NMR (600 MHz; CDCl$_3$, 298 K) of PC$_{61}$BEH

^{1}H NMR (600 MHz; CDCl$_3$, 298 K) δ (ppm) 7.92 (d, J = 12.7 Hz, 2H), 7.55 (d, J = 13.2 Hz, 2H), 7.52 (t, J = 13.5, Hz, 1H), 3.99 (q, J = 12.3 Hz, 2H), 2.91 (m, 2H), 2.52 (t, J = 13.8 Hz, 2H), 7.92 (m, 2H), 1.32 (m, 9H), 0.88 (m, 6H).
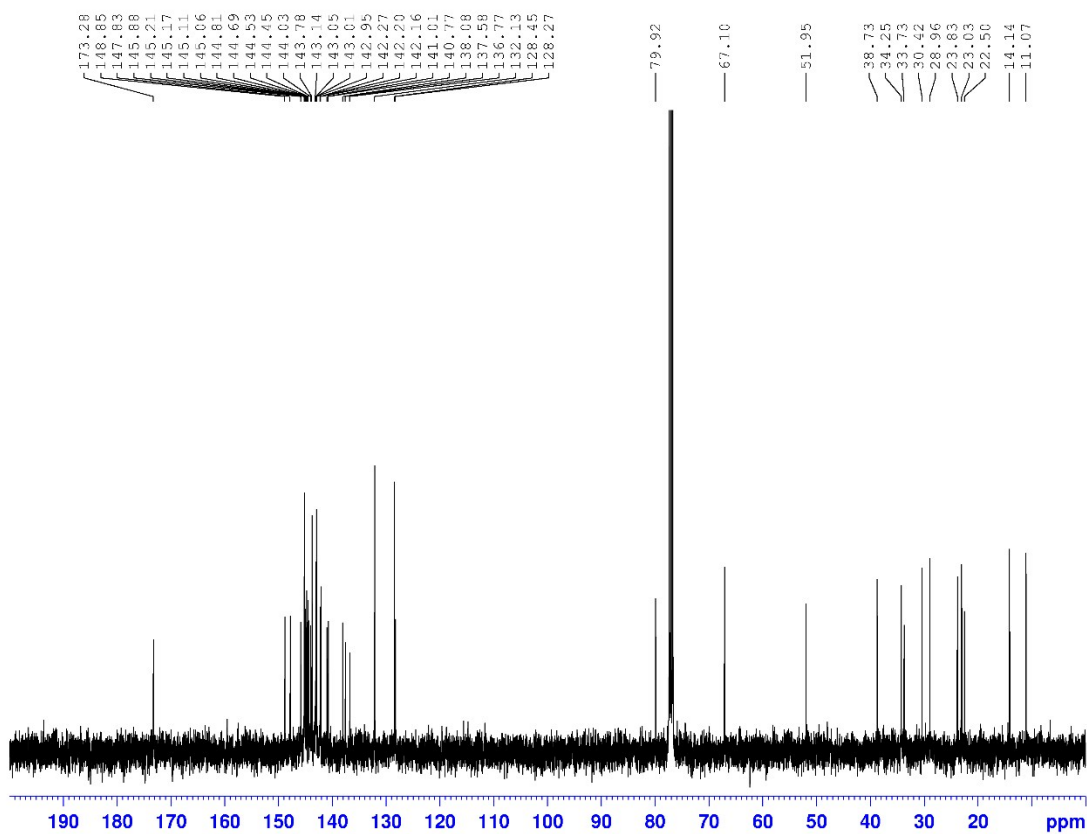
Figure S2. ^{13}C-NMR (150 MHz; CDCl$_3$, 298 K) of PC$_{61}$BEH.

^{13}C NMR (150 MHz; CDCl$_3$, 298 K) δ (ppm) 173.28, 148.85, 147.83, 145.88, 145.21, 145.17, 145.11, 145.06, 144.81, 144.69, 144.53, 144.45, 144.03, 143.78, 143.14, 143.05, 143.01, 142.95, 142.27, 142.20, 142.16, 141.01, 140.77, 138.08, 137.58, 136.77, 132.13, 128.45, 128.26, 79.92, 67.10, 51.95, 38.73, 34.25, 33.73, 30.42, 28.96, 23.83, 23.03, 22.50, 14.14, 11.07.
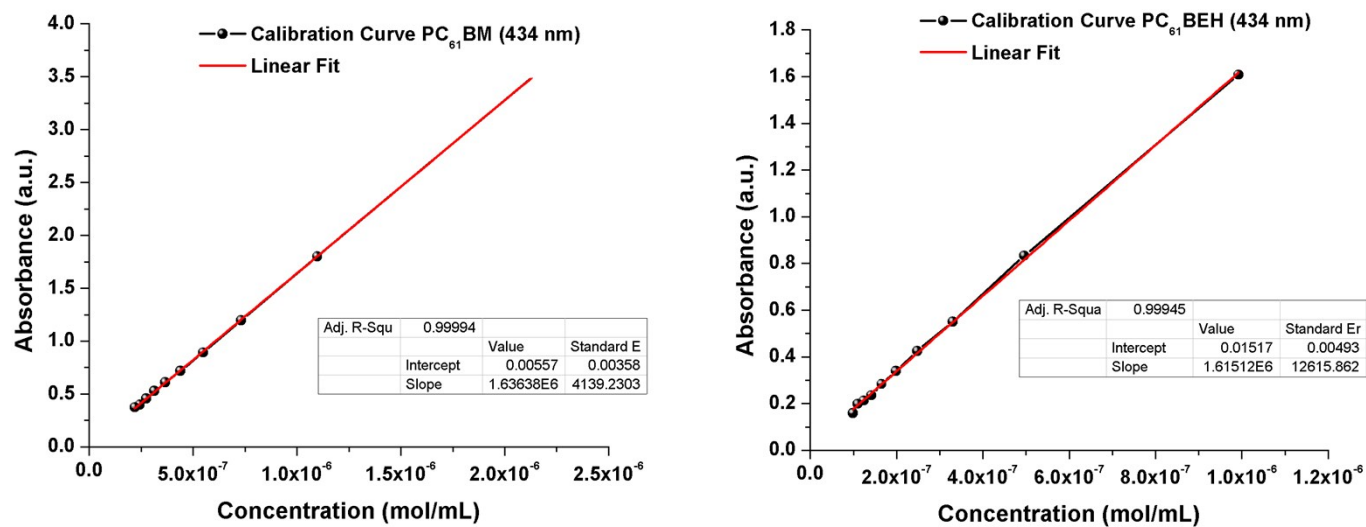
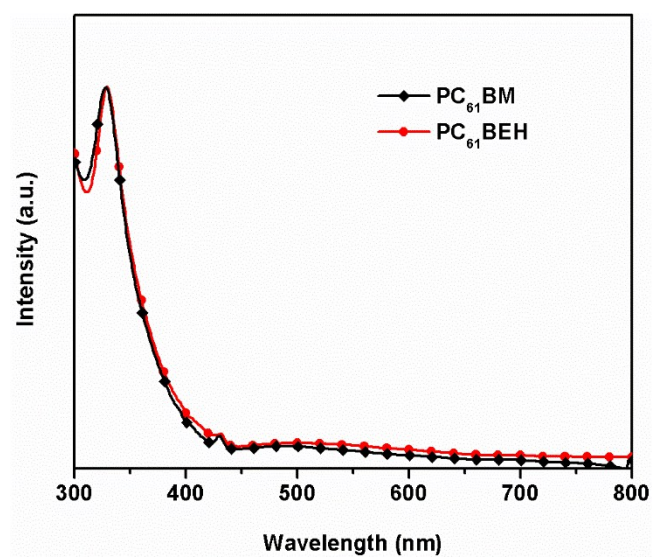**Figure S3.** Calibration curves for $PC_{61}BM$ and $PC_{61}BEH$ in chlorobenzene at 434 nm.

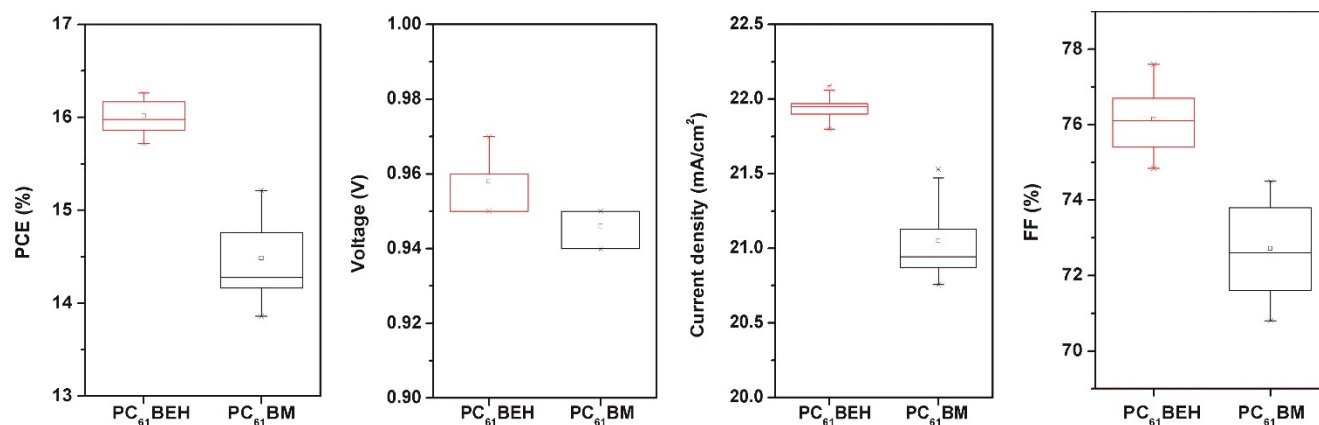**Figure S4.** UV-Vis absorption spectra of $PC_{61}BEH$ and $PC_{61}BM$ in toluene solution.

Figure S5. The statistic diagram of the device PCE, V_{oc}, J_{sc} and *FF* measured for 20 individual devices based on PC$_{61}$BM and PC$_{61}$BEH ETMs.
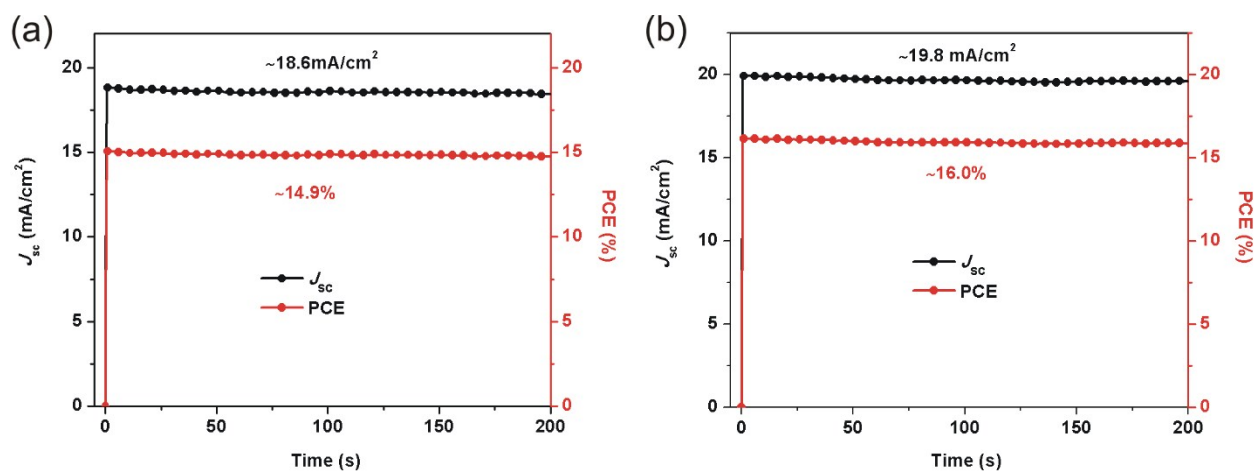

Figure S6. Maximal steady-state photocurrent output at the maximum power point for a) PC$_{61}$BM (at 0.8 V) and b) PC$_{61}$BEH (at 0.81 V) based device and its corresponding power output.
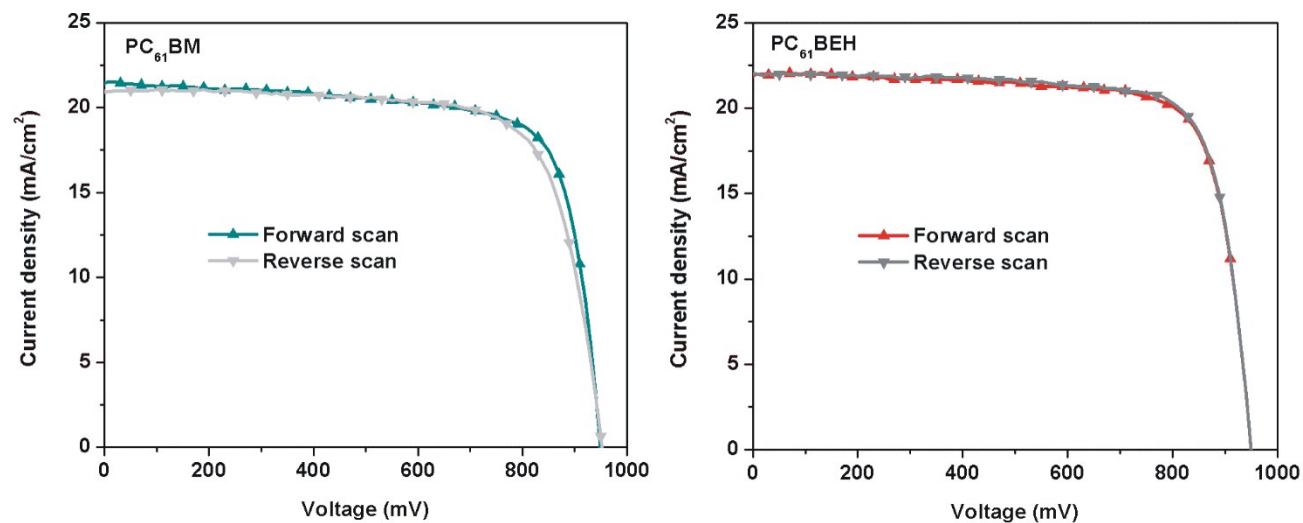
Figure S7. *J-V* curves of the inverted planar perovskite solar cells based on $PC_{61}BM$ and $PC_{61}BEH$ with respect to forward and reverse scan directions (The scanning rate was 100 mV/s).

Table S1. Redox Potentials of $PC_{61}BM$ and $PC_{61}BEH$.

Compound	$E^{0/-}$	$E^{-/-2}$	$E^{-2/-3}$
$PC_{61}BM$	-1.03	-1.41	-1.90
$PC_{61}BEH$	-1.03	-1.41	-1.89

Table S2. Rct and Rrec values obtained from $PC_{61}BM$ and $PC_{61}BEH$ based devices.

Device	Rct(Ω)	Rrec(Ω)
$PC_{61}BM$	3119	16658
$PC_{61}BEH$	1711	18331