4. Photoluminescence

\[
\begin{align*}
\tau_{12 \text{ K}} &= 0.89 \pm 0.01 \text{ ms} \\
\tau_{\text{RT}} &= 0.86 \pm 0.01 \text{ ms}
\end{align*}
\]

**Figure S24** - $^5\text{D}_0$ decay curves of \([\text{Eu(H}_2\text{cmp})(\text{H}_2\text{O})]\) (6) recorded at room-temperature (black) and 12 K (red). The emission was monitored at 616.5 nm and the excitation was performed at 393 nm.
**Figure S25** - Excitation spectrum of \([(\text{Gd}_{0.95}\text{Eu}_{0.05})(\text{H}_2\text{cmp})(\text{H}_2\text{O})]\) (12) recorded at room-temperature by monitoring the \(\text{Eu}^{3+}\) emission at 616.5 nm.
Figure S26 - Time-resolved emission spectra of [(Gd$_{0.95}$Eu$_{0.05}$)(H$_2$cmp)(H$_2$O)] (12), with an initial delay of 0.05 ms, at 300 (black line) an 12 K (red line) excited at 272 nm. The inset shows an expansion of the Gd$^{3+}$ emission. Please note: the spectra were not corrected for the spectral response of the monochromators and the detector.
Figure S27 - Decay curves of [(Gd_{0.95}Eu_{0.05})(H_{2}cmp)(H_{2}O)] (12) recorded at room-temperature for the $^5D_0$ state of Eu$^{3+}$ (red) and the $^6P_{7/2}$ state of Gd$^{3+}$ (black) emission.
5. Thermograms

Figure S28 - Thermograms for [RE(H$_2$cmp)(H$_2$O)] [where RE$^{3+} = $ Y$^{3+}$ (1), La$^{3+}$ (2), Pr$^{3+}$ (3), Nd$^{3+}$ (4), Sm$^{3+}$ (5), Eu$^{3+}$ (6), Gd$^{3+}$ (7), Tb$^{3+}$ (8), Dy$^{3+}$ (9), Ho$^{3+}$ (10) and Er$^{3+}$ (11)].
6. Vibrational Spectroscopy

6.1 - FT-IR

Figure S29 - ATR-FTIR for [RE(H₂cmp)(H₂O)] [where RE³⁺ = Y³⁺ (1), La³⁺ (2), Pr³⁺ (3), Nd³⁺ (4), Sm³⁺ (5), Eu³⁺ (6), Gd³⁺ (7), Tb³⁺ (8), Dy³⁺ (9), Ho³⁺ (10) and Er³⁺ (11)].
6.2 - FT-Raman

Figure S30 - FT-Raman for [RE(H$_2$cmp)(H$_2$O)] where RE$^{3+}$ = Y$^{3+}$ (1), La$^{3+}$ (2), Pr$^{3+}$ (3), Nd$^{3+}$ (4), Sm$^{3+}$ (5), Eu$^{3+}$ (6), Gd$^{3+}$ (7), Tb$^{3+}$ (8), Dy$^{3+}$ (9), Ho$^{3+}$ (10) and Er$^{3+}$ (11).
7. References
