The present work deals with m-th order compact Sobolev embeddings on a domain $\Omega \subseteq \mathbb{R}^n$ endowed with a probability measure ν and satisfying certain isoperimetric inequality. We derive a condition on a pair of rearrangement-invariant spaces $X(\Omega, \nu)$ and $Y(\Omega, \nu)$ which suffices to guarantee a compact embedding of the Sobolev space $V^m X(\Omega, \nu)$ into $Y(\Omega, \nu)$. The condition is given in terms of compactness of certain operator on representation spaces. This result is then applied to characterize higher-order compact Sobolev embeddings on concrete measure spaces, including John domains, Maz'ya classes of Euclidean domains and product probability spaces, among them the Gauss space is the most standard example.