While model order reduction is a promising approach in dealing with multi-scale time-dependent systems that are too large or too expensive to simulate for long times, the resulting reduced order models can suffer from instabilities. We have recently developed a time-dependent renormalization approach to stabilize such reduced models. In the current work, we extend this framework by introducing a parameter that controls the time-decay of the memory of such models and optimally select this parameter based on limited fully resolved simulations. First, we demonstrate our framework on the inviscid Burgers equation whose solution develops a finite-time singularity. Our renormalized reduced order models are stable and accurate for long times while using for their calibration only data from a full order simulation before the occurrence of the singularity. Furthermore, we apply this framework to the 3D Euler equations of incompressible fluid flow, where the problem of finite-time singularity formation is still open and where brute force simulation is only feasible for short times. Our approach allows us to obtain a perturbatively renormalizable model which is stable for long times and includes all the complex effects present in the 3D Euler dynamics. We find that, in each application, the renormalization coefficients display algebraic decay with increasing resolution, and that the parameter which controls the time-decay of the memory is problem-dependent.