The last few years have witnessed an unprecedented increase in the number of novel bacterial species that hold potential to be used for metabolic engineering. Historically, however, only a handful of bacteria have attained the acceptance and widespread use that are needed to fulfill the needs of industrial bioproduction – and only for the synthesis of very few, structurally simple compounds. One of the reasons for this unfortunate circumstance has been the dearth of tools for targeted genome engineering of bacterial chassis, and, nowadays, synthetic biology is significantly helping to bridge such knowledge gap. Against this background, in this review, we discuss the state of the art in the rational design and construction of robust bacterial chassis for metabolic engineering, presenting key examples of bacterial species that have secured a place in industrial bioproduction. The emergence of novel bacterial chassis is also considered at the light of the unique properties of their physiology and metabolism, and the practical applications in which they are expected to outperform other microbial platforms. Emerging opportunities, essential strategies to enable successful development of industrial phenotypes, and major challenges in the field of bacterial chassis development are also discussed, outlining the solutions that contemporary synthetic biology-guided metabolic engineering offers to tackle these issues.