

Building small: In many industries, economies of size is shifting to economies of numbers

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For decades, "bigger is better" has been the conventional path to efficiency in industries ranging from transportation to power generation. Food once grown on small family plots now comes overwhelmingly from factory farms. Vessels that carried 2,000 tons of cargo have been replaced by modern container ships that routinely move 150,000 tons. But now, new research shows, we are on the cusp of a radical shift from building big to building small—a change that has profound implications for both established and emerging industries.

Many industry sectors are nearing or have reached a tipping point in which efficiency of unit size is being replaced by efficiency of numbers, according to a recent study by Garrett van Ryzin, the Paul M. Montrone Professor of Private Enterprise at Columbia Business School, Caner Göçmen, Ph.D. candidate at Columbia Business School, and Eric Dahlgren and Klaus S. Lackner of Columbia University's School of Engineering and Applied Science. Rather than relying on custom-built, large-scale units of production – e.g. massive thermal power plants - industries can benefit from a shift to small, modular, mass-produced units that can be deployed in a single location or distributed across many locations – e.g. photovoltaic (PV) panels mounted on utility poles.

[Conventional wisdom](#) holds that capital cost per unit of capacity decline with increasing unit size. Other efficiencies of unit size arise from manufacturers' ability to spread out the fixed-costs components of

production, as well as factors such as operator labor and design costs. This alternative approach to infrastructure design offers new possibilities for reducing costs and improving service, the researchers found.

The authors identify three driving forces underlying this shift. First, [new computing](#), sensor, and communication technologies make high degrees of automation possible at a very low cost, largely eliminating the labor savings from large units. Second, mass production of many small, standardized units can achieve capital cost savings comparable to or even greater than those achievable through large unit scale. And third, small-unit scale technology provides significant flexibility—a benefit that has been largely ignored in the race toward ever-increasing scale and one which can significantly reduce both investment and operating costs.

This trend—observable in nascent form in several industries ranging from small, modular nuclear reactors, chlorine plants, and biomass energy systems to data centers—is resulting in a switch from large to small optimal unit scale, the authors found. The shift mirrors a similar revolution that began thirty years ago in the supercomputer industry. The traditional approach to producing higher capacity and greater speed in computing was to build increasingly powerful, specialized machines with ever-increasing processing power. This came to a halt in the mid-1990s, when it became cheaper to employ mass-produced processors and high-capacity memory from the burgeoning personal computer industry. Soon, the researchers conclude, many more industries will learn to "think small" and thereby reap the benefits of this new paradigm in production.

Provided by Columbia Business School

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