



WHY SYSTEMS THINKING, RATHER THAN NEW TECHNOLOGIES, WILL JUMP-START THE CLEAN-TECH ECONOMY

BY MARK W. JOHNSON

Whether they focus on wind power, solar power, clean coal, geothermal, biofuels, or something even more exotic, most efforts to wean the world economy from its dependence on oil view the challenge in technological terms. And the bulk of both public and private-sector investments have been made in companies using conventional business models aimed at fitting clean technologies into existing systems.

Sadly, history shows that this rarely works. Startups predictably struggle when competing head-on against incumbents in established markets. Disruptive market forces could over many years enable clean technologies to supplant fossil fuels the way the PC replaced the mainframe. But we won't have to wait that long if we can deliberately effect a wholesale shift in our energy infrastructure.

To be sure, this is an ambitious goal that requires thinking on a grand scale. The key, I believe, is to understand that in a major infrastructural shift, technologies don't replace other technologies. Rather, systems replace *systems*. Thomas Edison grasped the systemic nature of technological transformation a century ago when he introduced the electric light bulb. He realized that the technology he envisioned—no matter how innovative—

couldn't by itself sweep aside the kerosene-based lighting industry.

Instead of asking how he could solve the technical problem of inventing a light bulb, Edison asked how he could get consumers to switch from kerosene to electricity. He understood that despite the many advantages of electric light, it would replace kerosene only if it had its own, economically competitive network.

So, while scores of people worldwide worked on inventing a light bulb, Edison conceived a fully operational system. His technical platform included generators, meters, transmission lines, and substations, and he mapped out both how they would interact technically and how they would combine in a profitable business.

It had been widely assumed, for instance, that low-resistance filaments were most appropriate for light bulbs because they minimized the amount of energy lost as heat. But Edison determined that to make electric light economically competitive with kerosene lamps, he would have to limit the amount of costly copper used in transmission. Thus he'd need a high enough voltage to maintain current within a narrow wire—which meant a high-resistance filament in the light bulb itself.

Edison's search for a lamp filament "was conditioned by cost analyses," the science historian Thomas Hughes wrote in the journal *Technology and Culture*. "In his notebooks pages of economic calculation are mixed with pages reporting experimental data. . . . His originality and impact lie . . . in this synthesis."

But an innovative business model wasn't enough to bring this revolution-

ary technological system to market. Edison also needed to test it out in a friendly foothold market, and he needed a leg up from favorable government policy. Accordingly, for his first small-scale trial, he chose close-packed Lower Manhattan, which was filled with Wall Street firms eager to be on the technological cutting edge, whose employees worked long into the night.

It was not coincidental that these were the very people who could fund its expansion. And he used his public standing to acquire regulatory support—for example, to get the needed permits despite opposition from the lamplighters' union.

To move from oil to a clean-tech infrastructure requires similar systems thinking. Governments and businesses must consider projects that balance four components: An enabling technological system conceived in the context of an innovative business model, implemented through a careful market adoption strategy, aided by supportive government policy.

This is a tall order, for which there are few models. But two intriguing systemic experiments are under way: Better Place, which is building a complete, competitive electric-car network, and Masdar—the organization set up by the government of Abu Dhabi to create a self-sustaining, carbon-neutral city, in a bid to become the Silicon Valley of the clean-tech industry.

It's easy to dismiss these big, bold, coordinated projects as quixotic, but when you consider that the \$15 billion Abu Dhabi is investing in Masdar is but a fraction of the \$100 billion President Obama has pledged to U.S. clean-tech efforts, it's clear that what

TEAM TIP

Look at what systems need to change or be in place before you implement an innovation.

we lack is not resources but vision. What we need now is not armchair critics but more such experimenters in systems thinking—the Thomas Edisons of clean tech. ■

Mark W. Johnson is chairman and co-founder of innovation consulting and research firm, Innosight. He is the author of *Seizing the White Space: Business Model Innovation for Transformative Growth and Renewal* (Harvard Business Press, 2010) and a co-author of *The Innovator's Guide to Growth* (Harvard Business Press, 2008).

This article was excerpted from “How to Jump-Start the Clean-Tech Revolution,” which originally appeared in the *Harvard Business Review*. The current version originally appeared at www.environmentalleader.com and is reprinted with permission.