



Elon Musk, Frugal Engineer



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Tesla's game-changing batteries for the home are a page straight out of India's frugal engineering playbook.

Elon Musk is out to change the world, again. At a [recent press conference](#), the Tesla CEO introduced Powerwall, a suite of batteries designed to enable homes, businesses, and utilities to store up both solar energy and power from the grid. The idea is that by reducing the volatility of supply and demand, the batteries will shrink users' electric bills by [as much as 25 percent](#). This technology should also make it possible for utilities to increase renewables' share of the energy mix. And, perhaps most intriguingly, Powerwall theoretically may allow homes to go off-grid completely.

"Our goal is to fundamentally change the way the world uses energy," Musk told reporters.

First Things First

We've long since learned to expect the unexpected from Musk. Whether the economics of Powerwall itself are sustainable or not, it will change the current structure of competition in its industry, much like Tesla is doing in solar powered vehicles, or PayPal did in the online payments space. Musk has been hailed in the media as a one-of-a-kind visionary who relentlessly strips business problems back to Aristotelian **first principles**, tossing out protocol and received wisdom. To us the core of his creativity— an ability to rethink business challenges from the roots up, so as to match new tech capabilities to basic consumer needs—looks rather familiar. This “let's start from scratch” mindset is what we see as deeply related to frugal engineering.

The “First Principles” of Frugal Engineering

Powerwall batteries are a classic example of “frugal engineering”, a term coined in 2006 by Renault-Nissan CEO Carlos Ghosn to describe how Indian engineers manage to do more with less. Embracing this approach has allowed Ghosn to do what was previously thought impossible, such as introduce an **SUV-style compact car** for the Indian market at the very competitive price of 300,000 rupees (US\$4,700). “We started with a white sheet of paper”, explains Renault executive Gérard Detourbet, a statement that Elon Musk could just as easily have made.

In our book **India Inside**, after examining several successful and unsuccessful examples, we identified six underlying principles which seemed central to frugal engineering efforts in India (and are very likely relevant to other markets):

1. **Robustness:** The Indian “use environment” is one of the most varied in the world. Companies must necessarily build products for stability in use across a variety of environments—from monsoons to desert climates, from densely populated megacities to remote villages with no power, and so on. For instance, Nokia's 1100 and Micromax's Xi1 handphones launched in India set new global standards for robustness.
2. **Portability:** In environments like India, consumer mobility cannot be assumed even for the consumption of physical asset-intensive services for example, health care). Small and lightweight become highly desirable product attributes in order to take the service to the consumer

rather than the other way around. GE's portable ECG and ultrasound machines are iconic instances.

3. Leapfrog technology: Since many product categories are entering quite late in the life of the technology into markets like India, there is a possibility for producers to enter directly with cutting-edge technology, rather than deal with the economics of choosing between adopting a new technology and incremental upgrading of older technologies and infrastructures (because the latter simply do not exist in such contexts). Mobile phones, for instance, have made landline technology simply irrelevant in large parts of India.
4. Megascale production: Capturing market segments in India means access to enormous populations but with low purchasing power; the path to profits often involves driving costs down through production at massive scale. The economics of Renault's Kwid and the pioneering (if still being refined) Tata Nano rest on this principle.
5. Service ecosystems: Low purchasing power also implies that companies have had to be clever about how to leverage local service ecosystems – whether in financing, or in after-sales service – to allow adoption. For example, solar power firm Selco has worked with rural banks in southern India on financing plans to enable adoption; makers of electrical inverters in India have given tough competition to foreign players because of their cheaper products that have lower reliability but can be serviced cheaply.
6. Defeaturing: The most important of these principles, which we called the process of “ditching the junk DNA” of product features that tends to accumulate in products over time. Musk calls this “first principles thinking” and Ghosn's colleagues call it “white sheet design”. This is what enables designers to leverage the first five principles in order to build solutions that meet the harsh design constraints of markets like India.

Frugal engineering as the science of re-inventing the wheel

Ditching the “junk DNA of design” or first principles thinking is a bet on the potential returns from re-inventing the wheel. These can sometimes be large because technological evolution, like biological evolution is myopic. Our current products and services look the way they do because of path-

dependent processes; if we had to rewind and replay the tape of history it is not clear we would end up here again. For instance, the default location of the car engine—at the front of cars—may reflect their evolution from horse-drawn carriages. This is why breaking free of history and starting afresh can in some instances lead to the discovery of dramatically better alternatives.

This is the message at the heart of frugal engineering and Elon Musk's first principles thinking. The challenge is to understand when such an approach can be rewarding (versus just ending up... reinventing the wheel) and in systematising the design thinking that underlies such breakthroughs. More on this in our next post.

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