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Clean Energy: Building New Solutions

An interview with Nalin Kulatilaka, Boston University School of Management Wing Tat Lee Family Professor in Management, Finance and Economics Department

Your research on clean energy focuses on the "built environment." Why approach it from this angle?

Climate change and energy security have not only brought energy policy to the forefront of national debate, but have also catalyzed a steady flow of private sector capital to alternative energy investments. Yet most of the attention and resources are being directed either towards large-scale energy generation technologies (such as biomass, nuclear, wind and solar, and geothermal) or the transportation sector.

However, nearly 45% of all energy used in the U.S. is consumed in residential, commercial, and industrial facilities. Very little attention is being paid to this built environment, but there's a rich opportunity here for new energy generation, storage--and most importantly, conservation--technologies.

What would these "energy conservation opportunities in the built environment" look like?

For example, fossil-fuel based energy use in buildings can be drastically reduced through already available technologies, such as new building materials, more efficient heating and cooling systems, better insulation, and use of solid state lighting. Fossil fuel use in building can be substituted by capturing locally available sources of energy: solar thermal and photovoltaic, wind, geothermal heat sinks.

What's more, investments in clean energy and energy conservation make good economic sense -- short payback periods, high returns on investment.

Why then don't we see more wide spread adoption?

We think there are several reasons.

- **Fragmented Information and expertise:** End-use customers don't know where to start, or how to piece together all the required know-how. The information is available, but it's scattered and takes time to acquire.
- **Lack of Up-Front Capital:** Relatively large up-front costs are needed to acquire energy savings that pay out over years, and future benefits are uncertain, and even poorly understood.

- **Mismatched Incentives:** Builders, operators, and users tend to be three different parties. As a result, those who have control over investment and operating decisions rarely have to pay the energy bills. This creates mismatched incentives.
- **Legacy Infrastructure:** In almost every dimension, our economy is designed for cheap energy derived from fossil fuels. The transition to clean technologies and energy efficiency must overcome our current legacy infrastructure.
- **One-Size Does Not Fit All:** The problems vary by location, e.g., cooling needs in Texas vs. heating needs in New England. So do the solutions: the amount of sun and wind varies tremendously across the country, as does a host of factors that create significant local differences in energy cost.

Given these obstacles, current organizations are ill-equipped to integrate the technologies and bring together the expertise needed to finance and operate new, energy-saving systems.

What solution do you propose?

We propose an integrated, three-pronged solution.

The first prong involves new energy intermediaries that can bridge these gaps to provide one-stop shopping for the broad range of expertise required to achieve energy efficiency and clean technology adoption. We can eliminate the up-front cost barrier through secured financing (which I'll explain as the second prong of the solution in a moment). Then, by splitting the value of savings between the intermediary and the end user, we can create the right incentives for energy-saving behavior by the end consumer, and the right investment decisions by the intermediary. This will bring two forces that are in contrast under the current set-up—incentives and decisions—into alignment.

The profit motive here is the key to the transition, as it forces these vendors to search out and define the package of offerings that will entice customers to adopt. National policy pronouncements will not be as effective as incentives provided by local companies that adapt their offerings and strategies to the local conditions.

Next is financing, as I mentioned briefly before. We propose that energy saving investments be funded by "clean loans." Unlike conventional loans where the loan payments are fixed in advance, these loans will be paid back from the actual energy savings.

This requires establishing (pre-investment) a baseline energy use, calculating the expected energy use after the investment (to write the loan contract), and measuring actual energy use (to settle the contract payments). The energy use will depends on several factors: climate, features of the building, fixtures and appliances, and behavior of users (or "how you drive your house"). Furthermore, the energy bill depends on the prevailing energy prices. This makes the savings (and actual loan payments) uncertain, creating a challenging problem to design and price the loan. I can tell you how we plan to address this challenge when I describe the specific projects on which we're working.

But first, I'll explain the third aspect of the solution, involving the up-side benefits created by the first two prongs: The energy saving investments—or new technologies and appliances provided by the intermediaries and funded through the financing I just mentioned—not only reduce the energy bill, but also create a number of other valuable attributes. They reduce greenhouse gas emissions and become the ultimate renewable energy source, not requiring any fossil fuels whatsoever. In addition, these appliances encourage a shift in end-users' energy consumption away from peak periods. By using communication networks and creating the necessary control infrastructure, energy intermediaries can pool usage across a large number of users, and then capitalize on the value of these attributes through emerging markets, such as those for carbon credits, renewable energy credits, forward capacity markets, etc.

You mention projects on which you're working that address the multiple challenges inherent in this three-pronged solution. What are they?

I'm working on a range of projects to yield solutions with a consortium of colleagues from across the School of Management (SMG) and the whole University, in fact. The work on business networks of N. Venkatraman, from SMG's Information Systems department, informs our concept about the network of firms needed to support the clean energy ecosystem. My research on business platforms with John Henderson, also from Information Systems (IS), forms the conceptual foundation for the energy intermediary.

My past work on real options has yielded insight into how to value uncertain future benefits stemming from clean investments. I wrote about real options and risk in my book *Real Options: Managing Strategic Investment in an Uncertain World* (Harvard Business School Press, 1999), co-authored by Martha Amram, president of Growth Options Insights and a senior fellow at the Milken Institute. Now, working again with Milken, we're applying these concepts to funding investments in clean energy adoption in the built environment. Over the next year, we'll be organizing a series of financial innovations labs that bring together experts from the financial community with those in the energy industry.

In addition, my theoretical work with Lihui Lin from IS, on licensing and contracting, is the backdrop for some of the loan contract design issues I'm exploring to overcome the challenges raised before concerning financing. By aggregating energy use across a large number of users, energy service companies can use new markets to transfer the various risks involving variables such as shifts in pricing, weather, etc.

Then, with colleagues and industry partners—such as Actus-Lendlease, the Cambridge Housing Authority, and Nielsen Media Research—at SMG's Institute for Leading in a Dynamic Economy (BUILDE), I'm studying ways of measuring energy use and providing instant feedback and incentives to influence user behavior and promote more efficient energy use. Nitin Joglekar in SMG's Operations and Technology Department and John Henderson of IS are both collaborating on this as well, along with Martha Amram from Milken. Over the summer, we're launching a pilot study to actually install "smart meters" in about 100 residential units in different types of housing, and we're excited to see the results this yields.

Finally, through work with peers at BU's College of Engineering, we're exploring ways of pooling groups of energy users to shift electricity use away from peak demand periods and enable the demand side to participate in load management programs.

So the research involves many different players across multiple disciplines within the School of Management and BU at large. Essentially, we're tapping the resources and the broad perspectives across the University to pool our knowledge and build the network of solutions required by this complex challenge.