THE NANO-GRID: A SUSTAINABLE RESOLUTION TO THE ENERGY INFRASTRUCTURE CRISIS

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Overview

Complexity is a cumulative problem-solving strategy based on centralization, control, and specialization. It leads to deteriorating marginal returns on investment and eventually system collapse by institutionalizing rigidity where flexibility is called for. As a strategy, it destroys diversity within and resilience of the system it purports to build and protect. A search for alternative approaches that are small scale, decentralized, local, adaptive – flexible – must be undertaken to restore system sustainability, diversity and resilience.

Perhaps nowhere is the rigidity and vulnerability of complex systems more evident than in contemporary urban energy and energy-water infrastructures. These infrastructures are enmeshed with the socio-economic systems of the regions they serve. System inadequacies and failure become issues not just of inconvenience but of urban value, regional socio-economic health, general social justice, and even national security.

This paper is dedicated to the conceptual exploration of an alternative approach to the design and management of energy and energy-water infrastructures. We call it *the nano-grid*. We explore a much-needed paradigm shift away from conventional energy systems practice and current thinking/practice regarding renewable energy, toward the edge of the field now termed “advanced energy”. A case example of fielded technology is used to demonstrate the suggested *nano-grid* paradigm shift and the ways in which it embodies and engenders system flexibility, diversity, and resilience.

Methods

The methods utilized to conduct our work are founded in the principals and practice of financial valuation. This discipline allows us to identify the rewards, risks, and uncertainties of a proposed or actual complex system and demonstrate quantitatively how various strategic and design choices and options will affect system value. Since our work is still primarily conceptual, we make extensive use of research of the literature and support our conclusions with empirical evidence gathered from a real world, operating solar/thermal power company that has developed a new technical field, *thermovoltaics*, also termed Highly Concentrated Photovoltaic Thermal (HCPVT).

Results

Demonstration of the *nano-grid’s* potential for successfully addressing a broad range of critical considerations that remain obstacles to sustainable energy and energy-water infrastructures.

Conclusions

In a world in which financial resources are becoming increasingly limited but energy and energy-water infrastructure demands increasingly astronomical, we can continue to design and build huge, costly, inflexible systems that exacerbate the very problems they purport to address and then impose these systems on stakeholders by regulatory diktat and tax schemes. Or, we can begin to explore and adopt flexible, small-scale, affordable systems that transform problems into benefits and self-organize through ingenious local capabilities and initiatives. The *nano-grid*, as exemplified in our case study, takes the second path.

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