

BOOKS & ARTS

Plugged into the matrix

The rise and potential fall of the US electricity grid.

The Grid: A Journey Through the Heart of Our Electrified World

by Phillip F. Schewe

Joseph Henry Press: 2007. 320 pp. £16.99, \$27.95

Paul M. Grant

Neo looks down and spies a black cat slinking past the door. A moment later, a completely identical cat also moves by the opening. "Whoa!" he exclaims. "Déjà vu!" "No," a very concerned companion observes. "It's a glitch in the Matrix... a serious one."

The science-fiction film *The Matrix* explores a virtual-reality world where all the inhabitants are plugged into, and have their lives proscribed by, a mysterious and pervasive computer program... or machine... or both? In the real world, we are also plugged into a similar kind of matrix, the ever-present electricity grid. In a similar way to Neo, those of us in the developed world are dependent on, and have our welfare largely controlled by, the constant presence and reliable operation of a vast electrical network. Yet few fully fathom its operation and our utter dependence upon it — except when it stops working.

In *The Grid*, Philip Schewe, a particle physicist turned science writer, becomes our guide to understanding the grid's history, present intricacies and issues. Our journey begins as an airline passenger arriving for a night-time landing at a New York City airport. If you've ever made such a flight, you will have been greeted by a wondrous vista: downtown Manhattan ablaze with light created by electron pressure and motion, generated by falling water as far away as Quebec and transmitted over thousands of miles of interconnected, invisible networks. Except this evening is Thursday 14 August 2003, and at 4:20 in the afternoon the electrons stopped moving in the Big Apple. Beneath you, all is in darkness. Schewe is showing us a 'black cat glitch' in our electrical Matrix.

The ensuing tale of the trauma and panic wrought by the power failure is riveting, albeit told in a style that some readers might find rather florid. Nonetheless, his description of the tribulations suffered on that day, and on several other even more serious occasions, reveals the underlying ability of the grid to generate 'shock and awe' with its capacity to both deliver power and also withhold it. Schewe often takes off on flights of philosophical



OWAKH-KULLA/CORBIS

A show of power: a grid stretched across North America keeps the lights burning bright in Manhattan.

speculation about the grid's social impact, diversions that some will take as unnecessary distractions (I didn't). But he also put his boots on the ground, visiting power plants and dispatch control rooms at major utilities, and even spending several days with a transmission-line maintenance crew, revealing the human side of those responsible for the health and well-being of the US electricity system.

The North American electricity grid has been called the world's largest and most complex machine. Schewe traces the development of electricity from the founding fathers of its fundamental physics to Thomas Edison, with his direct current (d.c.) circuit link-up of light bulbs powered by the Pearl Street generation station. Standing in line too is Nikola Tesla, the inventor of the polyphase alternating current (a.c.) system, who flowed Niagara Falls hydro-power 'uphill' on overhead transmission lines a remarkable 35 kilometres to the industrial city of Buffalo. However, Schewe's description of the rise of two other important contributors to the creation of the grid, Samuel Insull and David Lillenthal, deserves special note.

Insull was Edison's personal assistant

when he founded General Electric and later Commonwealth Edison, which by the 1930s was the largest utility company in the world. The English-born Insull, although not an engineer, essentially invented the substation and the urban distribution system, a mini-model for the regional and national grids that were to emerge later. But perhaps Insull's greatest achievement was conceiving the franchised electricity utility company, which, under the oversight of publicly appointed regulators, generated and delivered low-cost electricity to urban consumers and an assured dividend to its investors, often the same people. The concept proved immensely successful and quickly spread throughout the nation.

The career of David Lillenthal couldn't have been more different. A graduate of Harvard Law School in the 1920s, Lillenthal believed that electric power belonged to the people. His law-school thesis dealt with the future of US electricity, and he later brought his populist principles to bear as one of the founding directors, and later the chairman, of the Tennessee Valley Authority (TVA), a mammoth public-works project in the rural mid-Atlantic

states. Primarily set up for flood control, the TVA also, under Lilienthal's guidance, brought affordable electricity generated by its hydroelectric plants to American farm communities and towns. In the 1920s and 1930s, a vast number of US farmers had deplorable living conditions, without electricity or clean water. The lack of electricity stemmed not from an inability to generate it, but from the cost of delivering it using long-distance transmission lines. Schewe chronicles Lilienthal's behind-the-scenes political machinations against the opposition of the investor-owned power industry as he sought to realize his dream of a completely electrified America.

There is no doubt that the TVA and other federal rural electrification efforts were out-and-out welfare projects funded at public expense in the finest traditions of a socialist state. But they were also one of the best investments the nation ever made on behalf of its citizens. Lilienthal had expanded Insull's mini-grid to a national scale, bringing electricity to Americans everywhere. The lives of these two men reveal that society benefits from both private and public investment in the electricity enterprise. The challenge is to strike the appropriate balance.

Today the US grid and its clones in Europe, Asia and South America are in trouble. Collapses and power failures occur everywhere on an almost yearly basis, and Schewe exposes many examples in depressing detail. In the United States, the average price of electricity continues to rise along with fuel prices. Only nuclear-generated power has been stable in terms of consumer cost, and in some states it has declined significantly. Deregulation has not worked. In 2001, problems with electricity supply brought down California's governor and severely damaged the state's economy. Considering electricity as a commodity strains the laws of both physics and economics. Unlike corn, gas, precious metals and jet airliners, electricity is difficult to park somewhere until demand for it ripens. It is best used as soon as it is made. And restructuring the industry has left the grid in the dark. Who now should be responsible for its maintenance, expansion and improvement?

Schewe discusses all the current 'hot' issues affecting the grid and the electricity industry in general. There are thorough discussions of renewable energy sources, energy efficiency, the emission of noxious (SO₂) and non-noxious (NO_x, CO₂) gases, heavy metals (mercury and thallium), nuclear safety, the siting of infrastructure and other environmental concerns. The author points out the growing demand for electricity worldwide, and the balance that must be struck between improving the human condition and damaging the Earth.

The Grid sets the scene but offers little in the way of solutions. However, that wasn't the intent. The book is an outstanding historical narrative and commentary on the grid past and present, and is a valuable contribution to

understanding its future challenges. Having said that, I wish more detailed discussion had been included on a few promising technologies already on the shelf, such as high-power electronics and superconductivity. The former, mentioned briefly in the context of a 'smart grid', has the potential to drastically reduce the occurrence of large-scale power failures by deploying a combination of sensors, computation and hockey-puck-size silicon switches to

create detours around circuit roadblocks when the electron traffic jams up. And we could start implementing it right now. It would be costly, but so was the TVA and rural electrification. What's lacking today is the political will of the past to make the smart grid an investment for the public good. ■

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The stem-cell story

Stem Cell Now: A Brief Introduction to the Coming Medical Revolution

by Christopher Thomas Scott

Plume: 2007. 272 pp. £9.99

Cell of Cells: The Global Race to Capture and Control the Stem Cell

by Cynthia Fox

W. W. Norton: 2006. 512 pp. \$26.95, £16.99

Stem Cell Wars: Inside Stories from the Frontlines

by Eve Herold

Palgrave MacMillan: 2006. 256 pp. \$24.95, £15.99

Justine Burley

The promise of stem-cell research has captured the imagination of people around the world. Given the public's intensifying interest in the area, it was perhaps inevitable that stem-cell science would enter the 'popular science' genre. Books of this sort can excite people about research in general, acquaint them with recent developments in a specific field, equip non-specialists with factual knowledge, serve as a resource for patients or politicians, and update scientists on the rough-and-tumble of their own discipline. Rarely does a single work succeed in doing all these things well, even when that is the author's aim. And so it is with three new books about stem cells.

Christopher Scott's little book *Stem Cell*

Now is fundamentally a primer on stem-cell research, suitable for lay readers and freshmen. It offers accessible descriptions of stem-cell science and analysis of associated ethical and political issues. Discussion of these aspects is sweeping and incomplete, but this is no pitfall for anyone seeking a grounding in the basics. The strongest chapters, which make up the first half of the book, are those dealing with factual knowledge: the properties of stem cells, their potential applications and apparent limitations. Responsibly, Scott is circumspect about existing evidence for the plasticity of certain sorts of adult stem cell; he advances no exaggerated claims about the current state of the art in human embryonic stem-cell research; and he makes plain that cell therapy is not the sole contribution it can make to human medicine.

Cynthia Fox's *Cell of Cells* is a rather big book that will be of most interest to those working in the stem-cell field. This fast-paced, journalistic, not-without-depth treatment of the issues (again, scientific, ethical and political) is peppered with gossip but still manages to be serious. As a presentation of developments in stem-cell research between 2003 and 2006, the book is already rather dated, but it is informative and provides insight into the shape of things to come. The author mounts a persuasive case for the need to conduct research using both embryonic and adult stem cells, and



Stem-cell researcher Woo Suk Hwang remained popular at home in Korea despite publishing fraudulent data.

JO YONG HAK/REUTERS