Making the Electric Grid Smarter

"It's not cool without power" said the front-page headline in the *Dallas Morning News*, Saturday, June 15, 2009. The story was about how 60,000 people in the Dallas-Fort Worth (DFW) Metroplex area tried to live and work with no electricity for almost four sweltering summer days when the thermometer consistently hovered in the mid-90s. Strong winds, felled trees, and lightning strikes had darkened *ca.* 500,000 homes and businesses in this region. The more tangible effects were perishable food spoilage and the lack of lights or air conditioning. However, there were also safety issues associated with non-functioning traffic lights, economic losses associated with manufacturing plant and brokerage shut-downs and inoperable credit-card transactions, and even life/death issues associated with sick and elderly people reliant on electric power to keep machines (*e.g.*, dialysis equipment) running and their body and medicines cool. It is a fact that 41% more electrical outages affected 50,000 or more consumers in this country in the second half of the 1990s than in the first half of the decade. It is even worse in other under-developed and developing parts of the world where brown-outs and black-outs are an integral part of the daily routine. The electric grid in the U.S. and in most other countries was designed with three goals in mind: to provide power (a.) cheaply, (b.) reliably, and (c.) in a ubiquitous fashion within the geographic region that it serves. However the explosive population and economic growth has overburdened the grid to the extent that it has begun to significantly lag demand in many parts of the world.

The electric power grid is the largest interconnected machine on earth. In compiling a list of 20 engineering accomplishments that transformed life as we know it today, the U.S. National Academy of Engineering ranked grid electrification as number one. To gain a perspective, the highway system ranked eleventh and the Internet took 13th place on this list. Because electricity has to be consumed the moment it is generated (well, literally, considering electron transit times!) the grid represents the ultimate in just-in-time product delivery. Tom Friedman, in his book, *Hot, Flat, and Crowded* refers to the publically regulated utility system as a "big all-you-can-eat-for-five-dollars buffet." He explains that the reason utility companies have been able to deliver power cheaply is because the public and the regulators have not demanded that the power be generated in a carbon-free and efficient manner. Note that the grid mandates for supplying power reliably and ubiquitously also work against efficiency because the utilities have to overbuild supply capacity (or "reserve margin") to meet peak load demand.

Thus the current grid system is not very "smart" (Tom Friedman even calls it dumb!) in several ways. For example, in a smarter grid with distributed generation, the consumer will be able to sell back to the utility, any excess, unused power that is locally generated by him/her. Both reliability and efficiency are improved by right price signals and "plug-and-play" smart devices that will allow the easy integration of clean, renewable energy sources like the sun and wind along with the millions of plug-in hybrid electric vehicles. With smart grid concepts such as "islanding," distributed generation continues to seamlessly deliver power during supply interruption from the centralized utility so that situations like what the DFW region experienced in June can be avoided.

How far are we from a Smart Grid? Intense R&D is on-going in both industry and academia in many parts of the world to address energy management issues related to the grid integration of renewable energy sources (at levels higher than 20%), advanced power and control components, sensor and measurement technologies, artificial intelligence, etc. Importantly, it is worth noting that transformative paradigms such as wireless communication and microelectronics were made possible only by industry-wide agreement on a multitude of common standards. The members of ECS are poised to play a key technical role in the emergence of the Smart Grid, particularly in the area of energy storage technology and renewable energy. Finally, I would like to thank my Power Engineering faculty colleagues at UT Arlington, Drs. Wei-Jen Lee and Babak Fahimi, for comments and feedback on drafts of this editorial. Stay tuned.

Raj K.

Krishnan Rajeshwar
Editor

The Electrochemical Society
INTERFACE

Published by:
The Electrochemical Society (ECS)
65 South Main Street
Pennington, NJ 08534-2839, USA
www.electrochem.org

Editor: Krishnan Rajeshwar, rajeshwar@uta.edu

Guest Editor: Albert Fry, afry@wesleyan.edu

Contributing Editors: Donald Pile, donald.pile@gmail.com; Zoltan Nagy, nagyz@email.unc.edu

Managing Editor: Mary E. Yess, mary.yess@electrochem.org

Production & Advertising Manager:
Dinia Agrawala, interface@electrochem.org

Advisory Board: Nancy Dudney *(Battery)*, Barbara Shaw *(Corrosion)*, Durga Misra *(Dielectric Science and Technology)*, Lili Deligianni *(Electrodeposition)*, George K. Celler *(Electronics and Photonics)*, S. R. Narayan *(Energy Technology)*, Prashant V. Kamat *(Fullerenes, Nanotubes, and Carbon Nanostructures)*, Jeff Fergus *(High Temperature Materials)*, Venkat Srinivasan *(Industrial Electrochemistry and Electrochemical Engineering)*, Cornelis R. Ronda *(Luminescence and Display Materials)*, Isao Taniguchi *(Organic and Biological Electrochemistry)*, Wesley Henderson *(Physical and Analytical Electrochemistry)*, Peter Hesketh *(Sensor)*

Publication Committee Chair: Subhash Singhal

Society Officers: Paul Natishan, *President;* William D. Brown, *Vice-President;* Esther Takeuchi, *Vice-President;* Fernando Garzon, *Vice-President;* Johna Leddy, *Secretary*; John R. Susko, *Treasurer*; Roque J. Calvo, *Executive Director*

Statements and opinions given in The Electrochemical Society *Interface* are those of the contributors, and ECS assumes no responsibility for them.

Authorization to photocopy any article for internal or personal use beyond the fair use provisions of the Copyright Act of 1976 is granted by The Electrochemical Society to libraries and other users registered with the Copyright Clearance Center (CCC). Copying for other than internal or personal use without express permission of ECS is prohibited. The CCC Code for The Electrochemical Society *Interface* is 1064-8208/92.

Canada Post:
Publications Mail Agreement #40612608
Canada Returns to be sent to:
Bleuchip International, P.O. Box 25542,
London, ON N6C 6B2

The Electrochemical Society Interface (USPS 010-327) (ISSN 1064-8208) is published quarterly by The Electrochemical Society (ECS), at 65 South Main Street, Pennington, NJ 08534-2839 USA. Subscription to members as part of membership service; subscription to nonmembers is available; see the ECS website. Single copies $7.00 to members; $15.00 to nonmembers. © Copyright 2009 by The Electrochemical Society. Periodicals postage paid at Pennington, New Jersey, and at additional mailing offices. POSTMASTER: Send address changes to The Electrochemical Society, 65 South Main Street, Pennington, NJ 08534-2839.

The Electrochemical Society is an educational, nonprofit 501(c)(3) organization with more than 8000 scientists and engineers in over 70 countries worldwide who hold individual membership. Founded in 1902, the Society has a long tradition in advancing the theory and practice of electrochemical and solid-state science by dissemination of information through its publications and international meetings.