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PLANNING

With the Power at Hand

Examining the merits of distributed energy.

It's simple logic:

Your electricity and heating can be created almost twice as efficiently when both are produced and used together onsite.

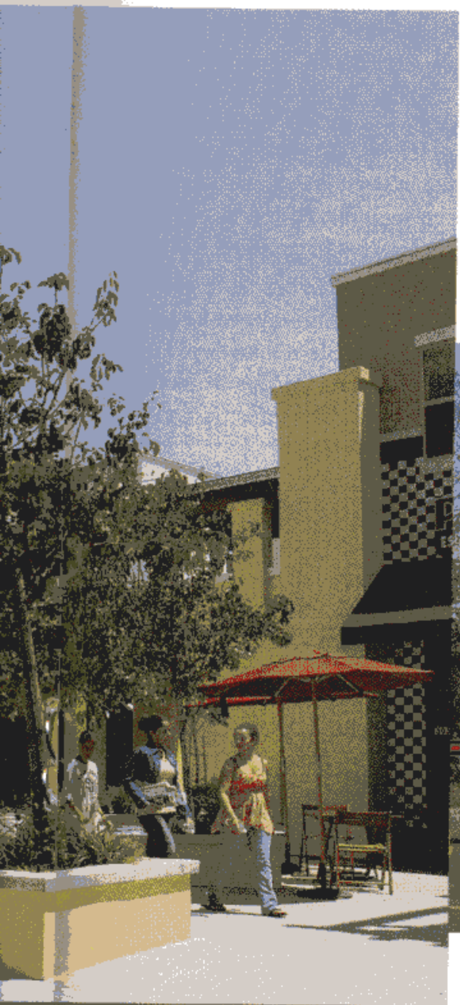
By David Engle

Instead of buying your power from a central plant far away—and losing seven to 10 percent of it in long-haul transmission (while paying extra for the privilege)—making your own localized or "distributed" energy can tap into clean, renewable, small-scale resources close at hand. Efficiency soars because fuel that was formerly being expended only for heating can instead cogenerate electricity too (a process known as combined heating and power, or CHP). The result: reduced energy consumption and lower economic and environmental costs.

Distributed energy resources—a catch-all phrase referring to an array of technologies—are so logical, in fact, that communities of the future should probably be designed from the ground up, with DERs selected and configured to suit local needs.

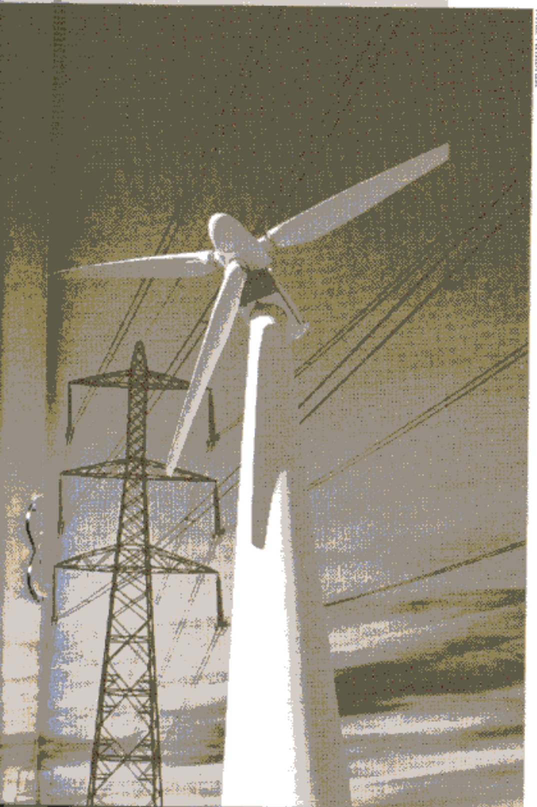
Doug Newman, a planner by training and currently executive director of the

In Chula Vista, California, innovations include "energy-smart" designs (left) and distributed energy resources such as a wind turbine (bottom). Acrion Technologies converts landfill gas to liquefied methane truck fuel (in tank at right below) at its demonstration site at the Rutgers EcoComplex environmental research and extension center.



Mike Armbrust

Photo courtesy Mack Trucks, Inc., Acrion Technologies, Air Products, CHART Industries



Mike Armbrust

Global Energy Center for Community Sustainability (GECCS) at the Gas Technology Institute in Des Plaines, Illinois, explains the underlying rationale: Integration of DER with sustainable urban design, he says, "offers the U.S. an enormous opportunity to reduce our national energy consumption and its impact on our economy and the global environment."

Moreover, our nation's past "sins" in permitting sprawling, inefficient urban development are now partly to blame for the unflattering distinction of having our cities consume more energy per capita than anywhere else in the world—by a wide margin. Newman's organization estimates that 70 percent of this energy consumption "is directly influenced by the spatial separation of residential, commercial, industrial, and civic land uses and by our dependence upon private automobiles to move between them."

The good news is that we can readily improve. We can dramatically reduce fuel consumption and air emissions through better planning. By emphasizing more mixed use development served by convenient public transit, and designing for high-performance DERs and shared district energy systems, our energy "gluttony" can be brought in line, and our cities can even serve as role models. "Planners take responsibil-

Hydroexcavation Comes of Age

A roadblock, the flashing blue lights of highway patrol cars, and the pungent odor of a gas-line leak hint at the danger involved in conventional excavation work. An alternative method of digging called hydroexcavation may make the work safer.

Hydroexcavation, the use of pressurized water and vacuum systems to dig, had its start during the California Gold Rush days, with hydraulic mining. When placer deposits played out, miners used water pressure to expose the gold, leaving the region's hills an eroded mess.

Today's hydroexcavation does a much cleaner job. Uncontaminated material vacuumed from an excavation site consists primarily of soil and water. Contractors can simply deposit it in landfills instead of storm sewers.

Emergency repairs can be made quickly and safely. "Theoretically, you could damage lines if pressures of 5,000 to 10,000 pounds per square inch were applied directly to an uncased cable," says Randy McElroy, senior vice president of McElroy, Inc., in Meridian, Mississippi. "But usually you can shave around cables as you see them."

A slight drawback is that hydroexcavation is slower than mechanical excavation. A backhoe or track hoe can move many more yards of material out of the way faster than hydroexcavation, which is a more point-specific type of digging that is not recommended for large-scale operations.

In 2004, McElroy got a $500,000 contract from the city of Laurel, Mississippi, according to Bill Keener, a contract operator with Severn Trent Services, which operates and maintains water and sewer services for cities all over the world, including the city of Laurel. Severn Trent had construction oversight over McElroy's excavation project.

With hydroexcavation, damage was kept to a minimum, Keener says, and that was especially important because an optical cable line and a main telephone trunk line were involved. "The use of this new method saved our customers and the city of Laurel many dollars as compared to conventional methods," he notes.

Hydroexcavation is also more expensive than conventional excavation work, McElroy says, but when the costs of restoration work and disrupted operations or utility service are factored in, this method is very attractive.

Joseph Schotthoefer, operations manager with Doetsch Industrial Services, based in Warren, Michigan, says that municipalities are currently seeing a great increase in the use of this technology to service water valve boxes. Such locations require a precise cut.

"The conventional method, which involves digging up sidewalks in front of homes, creates a lot of damage followed by massive concrete restoration work," says Schotthoefer. "With hydroexcavation, you can easily dig a two-foot-square hole or less to service such equipment. Even if this takes more time initially than conventional excavation work, it is still faster in the long run because you are saving money on concrete work, restoration, minimal backfill, and minimal disruption to the community."

Peter Hildebrandt

Hildebrandt is a writer in Leesville, South Carolina.

ity for the energy-related impacts of our work," Newman says.

Putting words into action, Newman's organization and a team of city planners, architects, engineers, and developers are now formulating just such "energy-smart" designs for three large-scale developments to be built on 1,500 acres in Chula Vista, California, near San Diego. They're the first three in a series of high-efficiency, low-impact communities planned for a 6,000-acre tract of land that will eventually house more than 70,000 residents.

In launching this extraordinary initiative, the city of Chula Vista aims to become a national and global model of community-scale energy efficiency and sustainable resources management. A long list of co-participants includes the California Energy Commission and the U.S. Department of Energy.

DERs for meeting peak demand

Apart from such visionary undertakings, more immediate and critical energy-supply issues are also spurring interest in DER. Specifically, there's a looming problem with electrical supply and demand: In some locales the latter is now outstripping both the supply of power and the capacity of transmission lines to deliver it. For example, New York, Las Vegas, Boston, San Diego, and other fast-growing cities "are facing incredible challenges in terms of providing electricity on-peak"—that is, the busiest weekday hours, notes John Kelly, executive director of the Distributed and Sustainable Energy Resources Center at the Gas Technology Institute. Over the next 20 years, he adds, "New York City alone will need another 3,000 megawatts" from multiple new sources.

The problem isn't simply rising demand, but

A crew is using hydroexcavation to uncover a sanitary sewer (far right) at a house in a suburb of Detroit. This process is used to verify exact depth and location prior to a directional drilling operation. A close-up of the uncovered sewer (right).

the exorbitant cost incurred in serving these occasional peak loads. Electricity from special peaking plants must be transported, often across long distances, to serve urban customers for only a few hours a day—yet plant overhead continues round the clock. Moreover, inbound transmission lines are already overtaxed, and it's getting tough to find sites for new plants.

The most viable solution, Kelly says, is for urban areas to undertake "something very different" in terms of power strategizing: They must learn to rely less on central power stations and more on "moderate-scale CHP in the one- to 10-megawatt range"—that is, on distributed energy.

A different breed

More about the public benefits of DER later. First, consider the goals and benefits being sought by the onsite generation system's owner. There are several, even beyond the CHP efficiencies described above. The following is an example that is probably typical of thousands of DERs that are now churning out kilowatts nationwide.

A factory or office building is equipped with a natural gas-fueled engine capable of yielding up to several megawatts. (One megawatt is roughly the power needed for 1,000 homes.) From this, the system owner immediately gains the peace of mind derived from much-needed backup power—a hedge against grid blackouts or other failures.

Second—and often of significant economic value: The generator can serve as either a primary or secondary power resource to meet peak-load conditions—the time of day when the utility's kilowatt-per-hour rates sometimes soar.

Third, by having the power produced onsite, the owner eliminates the utility line item charges for long-range transmission and distribution. According to a study conducted by the Gas Technology Institute several years ago, national kilowatt-per-hour rates then averaged about seven cents; of this, only two cents went for generation, while nearly five cents were eaten up by transmission and distribution.

What's the combined value?

Through prudent energy resource scheduling, a skillful facility manager might easily trim off enough from local utility bills to pay back the investment surprisingly quickly—although the timeframe varies widely. A break-even point may arrive within a few years if local electric rates remain high and the cost of natural gas is low. (Currently, gas prices are high and are expected to remain so indefinitely.) On the whole, assuming reasonably stable fuel markets and climate conditions, the owner might easily recoup all costs and then begin to save many thousands or even millions of dollars on energy bills over the course of the equipment's typical 20-year life-cycle.

Better still, if the engine runs extensively, it's occasionally possible for the owner not only to escape the high electric rates of the utility company, but to receive compensation from it, via "net-metering." In such arrangements, the surplus power that is generated on the site is fed back to the local electric grid; the utility company's meter spins the opposite way.

Even if local market conditions are less favorable, an investment in onsite power may turn out well anyway if the CHP efficiencies can be extended: Again, the fuel that is already being purchased to provide heating at a facility is now providing electrical generation first. The generator's engine exhaust heat is being captured to use as before.

Sweetening the value even more, besides doing this double duty, the exhaust heat can often be channeled to produce combined cooling, heating, and power (CCHP) because heat is also usually required in chilling cycles. These "tri-generation" designs bring efficiency rates of 80 or 90 percent—or about double the norm.

There's also a significant negative side to the equation, of course. The owner of onsite power generation must pay the cost of operation and maintenance; deal with equipment failure; gamble on future fuel and electricity "spark-spreads" (price differentials); bear the interconnection costs and standby charges imposed by the utility; and foot the bill for emissions controls, which can be expensive. These factors in combination can pose serious challenges to ownership.

Finally, note that, while this CHP scenario represents the most typical DER array, other technologies abound. Renewable solar photovoltaics, wind turbines, and fuel cells are obviously increasingly important players in the mix.

Many thousands of distributed energy resources are now at work nationwide, typically in industrial plants (plastics, chemicals, painting, petroleum refining, food processing, laundries), and in residential or quasi-residential facilities (hotels, campuses, detention centers, nursing homes, hospitals). Multikilowatt generators also adjoin hundreds of landfills and wastewater treatment plants, where they tap renewable methane from decomposing waste; they can contribute substantially to community power needs.

At many federal government sites, particularly military bases, distributed energy is becoming almost a standard approach to saving utility costs and improving energy efficiency. Public buildings in sunny regions also tend to make ideal showcases for solar photovoltaics and other renewable energy systems; in these cases, the high initial cost can be more readily justified than in the private sector.

Public benefits are many

Now, back to the attractiveness and value of onsite energy to communities and planners.

Besides their importance in increasing the local supply of electricity, other significant benefits that the industry touts are: cost deferral (postponing the construction of expensive new power plants or substations); transmission and distribution relief; sometimes (although not always) reduced net pollution emissions with CHP; improved fuel efficiency; easy integration of clean renewable energy sources such as solar photovoltaics; and much-prized localized control.

By virtue of their diversification and redundancy, DERs can also enhance local energy security and public safety by mitigating the negative consequence of power outages, brownouts, and voltage interruptions. The buzzword here is energy surety, a concept first applied decades ago for the rigorous needs of nuclear plants and in weapons maintenance. "Surety" actually encompasses "energy safety, security, and reliability," says David Menicucci, who oversees energy surety research at Sandia National Laboratory in New Mexico; his primary client is the U.S Department of Defense.

Virtually every military base, he notes, now enjoys some energy surety from distributed energy. He thinks civilian communities could also benefit, just as the military now does, but they might have to scrap the decades-old utility-grid model and replace it with a more flexible distributed network.

Still another benefit: DERs potentially

Photos this spread: Doetsch Industrial Services

A Nuts and Bolts Glossary

Distributed energy resources. An array of hardware and usage concepts loosely defined as "power production occurring at or near its end use." Distinctions are sometimes made between distributed generation (a grid-interconnected resource), and distributed energy (which may or may not be grid-attached).

Customer- vs. utility-owned. Most distributed energy resources are owned and run by the end user (or by an energy services vendor), but utilities also use local, strategically positioned engines to provide peaking power, solve transmission bottlenecks, respond to demand surges, and for emergency backup.

Standby power. Emergency reserve or backup energy is crucial for public safety agencies and certain industries. Backup generators—a form of distributed generation—are sometimes upgraded to provide "peak shaving" or other onsite generation needs.

District power. Hundreds of localities in the U.S. (and others worldwide) have built combined heating and power-distributed energy plants at college campuses, military installations, government complexes, and industrial parks. These enjoy both efficiencies and economies of scale.

Japan and Europe use distributed generation and district power extensively. Denmark, which gets more than half its energy from distributed resources (wind turbines) and district heating and power, is the world leader.

Internal combustion (reciprocating) engines turning attached generator coils (gen sets) make up the bulk of energy resources worldwide. Cheapest to own and run are diesel-fueled engines, used largely for emergency power (but limited in their running time by air quality laws).

Engines fueled by natural gas are needed for long-term or semicontinuous operation. Caterpillar, Cummins, and Waukesha are the U.S. leaders among engine makers; imports are fairly limited. These engines offer relatively low initial cost; readily suitable exhaust heat for cogeneration; and good load following characteristics (turning on or off for peak shaving, and so on, depending on rates and surge needs). They often require costly emissions controls.

Gas turbines. Typically used for megawatt-scale power generation, gas turbines are best for continuous (baseload) operation rather than load-following. Cutting edge turbines use exhaust gas recirculation, lean fuel premixing, or steam boosting. Large power plants often use multiple turbines.

BCHP (building combined heating and power). Systems that produce combined heating and cooling, and more than 100 kilowatts of power promise the highest efficiencies (in the 80 to 90 percent range). In recent years, several home-scale BCHP systems in the two-to-six kilowatt range have entered the U.S. market.

Industrial heat recovery. Blast furnaces, petroleum refineries, and other heavy industries that produce enormous quantities of heat can capture the heat to make steam-powered electrical generation.

Microgrids. Still quasi-experimental, localized subgrids tailored for industrial parks and new communities, combining multiple hybrid distributed energy resources, are an important future technology.

enable communities to enjoy choice in the matter of power generation. Although the eclipse of the utilities' monopoly is still a long way off, there's a slow but encouraging trend toward more flexibility and options. On this score, recent regulatory moves in California, Massachusetts, New Jersey, Ohio, and Rhode Island now allow cities and towns to aggregate the local electricity loads of homes, businesses, and the public sector, and then to shop among a range of energy solutions. Given the rise of laws favoring "community choice aggregation," well-informed planners would seem well-suited to make future decisions about energy.

Continuing education

Are they prepared for the change?

Ingrid Kelley—who two years ago helped to draft APA's policy on energy—suggests that "most planners are still relatively unequipped" to address energy-related zoning issues pertaining to, say, wind turbine ordinances or dairy farm biogas. In her experience, she adds, graduate-level planning programs do not yet require courses on energy, let alone on distributed energy.

Several new resources are becoming available to help bridge the knowledge gap. One is the new energy and planning section of *Planning and Urban Design Standards*, written by Doug Newman. The book was published this spring by John Wiley and Sons (and edited by Bill Klein, AICP, and Megan Lewis, AICP, of the APA staff).

A second development is the launching this March of what Newman describes as "a national research and training collaborative dedicated to energy-smart community development." The National Energy Center for Sustainable Communities facilitates research and training initiatives between San Diego State University, the University of California at San Diego, and other universities and research institutions nationwide. Newman's GECCS, SDSU's Center for Energy Studies, and the city of Chula Vista are participants.

The new center's mission will be to encourage the development of "practical tools and training for planning professionals and developers," says Newman.

Eventually, the NECSC will become part of the national technology demonstration site for sustainable community development in Chula Vista. In effect, the whole city will become a DER showcase. On display at sites around the city will be CHP, CCHP, "renewable energy, district energy, and demand-response technologies in upwards of 15 to 20 separate technology demonstrations," Newman says.

All photos this page courtesy National Renewable Energy Lab, top and middle photo Bob Allan; bottom photo Warren Gretz

Participating students and researchers will be able "to install, monitor, and verify the operational energy efficiency and emissions performance" of DER technologies "in typical municipal and community applications," he adds. Local officials and developers will be invited "to come and see for themselves how these systems operate."

Meanwhile, those interested in acquiring the knowledge and skills needed to participate in community energy planning can enroll for academically accredited training at the adjacent NECSC facility.

All of this is critically needed now, Newman says, in light of the nation's almost frantic pace of urban redevelopment. This pace is projected to continue for decades. We are, he says, "literally rebuilding" our cities—and we have a chance to do it right this time.

David Engle is a frequent contributor to *Distributed Energy* magazine.

Top: harvesting corn for ethanol. Middle and bottom: In the U.S., biodiesel is made primarily from soybean oil or from recycled restaurant cooking oil.

Resources

Online. Learn about the Gas Technology Institute at www.gastechnology.org. Chula Vista's National Energy Research Center is described on the "What's New" page at www.ci.chula-vista.ca.us. APA's energy policy is at www.planning.org/policyguides.

Find links at the online reference library at www.distributed-generation.com. See the U.S. Department of Energy website for material on energy efficiency and renewable energy: www.eere.energy.gov.

Industry groups. See U.S. Combined Heating and Power Association: www.uschpa.admgt.com. World Alliance for Decentralized Energy: www.localpower.org. California Alliance for Distributed Energy Resources: www.cader.org.

Trade magazines. These include Distributed Energy, www.distributedenergy.com, and Cogeneration and Online Power Production, www.earthscan.co.uk.

A Professional Focus

Planners are uniquely positioned to address many issues in their communities, including energy needs. But do they always see the connection between energy and smart growth, affordable housing, and economic development?

In August 2005, the American Planning Association partnered with the Environmental and Energy Study Institute (a Washington-based nonprofit that focuses on sustainability) to get answers to that very question. Their nationwide survey assessed planners' knowledge about how to integrate energy concerns and community planning—and it looked at educational needs.

A total of 377 APA members responded to the survey. Almost 63 percent of them were public-sector planners; the rest worked in the private sector, the nonprofit sector, or universities. The survey was conducted online, and the results were published in the March/April issue of APA's *PAS Memo*. Because of the modest response rate, the results are largely anecdotal. Here are some of the key findings.

Most respondents said they believe that energy is closely connected to their jobs as planners, primarily as it relates to transportation, sustainable development, smart growth, environmental protection, and economic development.

The survey results were decidedly mixed with regard to policies and regulations. Planners noted that they generally address energy only indirectly, in conjunction with other livability or smart growth goals. Nearly 90 percent of respondents indicated that their jurisdiction promotes pedestrian pathways as a transportation alternative; more than 75 percent encourage bicycle commuting; and more than a quarter encourage transit-oriented development.

A smaller percentage of respondents directly encourage energy efficiency and the use of renewable energy technologies. Almost half said they currently provide builders or developers with information about energy efficiency in new construction; one-third indicated that their community requires public buildings to be energy efficient; and more than 50 percent said that their communities are using alternative energy technologies (largely solar).

APA and EESI are now developing a program for planners who want to be agents of change on the energy front. That program may include workshops on the connection between land-use planning and energy, and on land-use practices that encourage energy efficiency. Another product may be written materials (manuals, articles, reports) that address energy issues.

With gas over $3 per gallon, it is essential that planners prepare their communities to use energy more efficiently now.

Learn more about the APA-EESI partnership online at www.planning.org/energy or contact the team at energy@planning.org.

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