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This Issue:
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Tyrone Williams (left) and Will Spence (right), master planners from U.S. Army Corps of Engineers' Savannah District, locate electrical tie-in points while developing plans for the new trigeneration plant at U.S. Army Garrison Natick, Mass. Photo by George Jumara. Page 26

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Creating roadmaps to energy-effective installations

by Jerry Zekert and Mark L. Gillem

"Our military's heavy reliance on fossil fuels creates significant risks and costs at a tactical as well as strategic level. They can be measured in lost dollars, reduced mission effectiveness and in U.S. Soldiers' lives."

– Dorothy Robyn, deputy under secretary of defense for installations and environment, in testimony before congressional subcommittee, Jan. 27, 2010

Deputy Under Secretary Robyn's challenge to the Department of Defense is to reduce reliance on fossil fuels. Meeting that challenge requires a broadened prospective approach to planning and developing installations and the consumption and use of energy.

By harnessing the comprehensive nature of master planning, military installations can create a broad strategy to achieve energy independence while preserving military capabilities, enhancing quality of life and creating sustainable communities that promote wellness and vitality.

Certain concise planning strategies can reduce direct energy consumption installationwide.

Increased density

Research has found that more dense development uses less energy and emits less greenhouse gas by a factor of 2.0 to 2.5 than less dense neighborhoods. At Fort Lewis, Wash., by following sustainable development principles, vehicle miles travelled could be reduced by 11.4 million miles per year, resulting in a carbon dioxide emission reduction of 12.9 million pounds per year and a per-family annual savings of more than $1,500.

Density matters in terms of sustainable development. Doubling density beyond 30 employees per acre, or 13 residents per acre, is associated with more than a 30 percent decrease in vehicle miles traveled and total air pollution. When more compact development patterns are used, Rutgers University researchers found that construction costs were reduced: road costs by 25 percent and utility costs by 10 percent.

Infill, mixed-use development

Planners should support building up rather than out in already developed areas. This strategy of infill development supports increased densities and reduced utility runs.

Roundabouts provide several advantages in traffic flow and reduced costs. Graphic by The Urban Collaborative LLC

Mixed-use development reduces parking demands by as much as 30 percent, because parking can be shared among uses with different peak demand periods. Dense or mixed-use zones, facilitating combined heat and power district systems, can double the efficiency of primary energy use in a district. According to the Federal Energy Management Program, concentrated mixed-use development can support district energy systems, reducing carbon generation by 30 percent and energy consumption by as much as 50 percent.

Mixed-use districts also more appropriately balance out energy use. In areas where living and working are within one district, the system can operate at increased efficiencies since energy-use peaks are offset. For example, a chilled water system could have 50 percent diversity resulting in a need to install less air conditioning across the district.

Interconnected street networks

Most installations use a hierarchical street network with few connections and long runs to reach low-density, sprawling development. The direct costs of hierarchical networks include the energy costs for the extra street lights that are needed and the additional traffic lights required to control traffic at the intersections of collector and arterial streets.

On an interconnected street network, the preferred solution, roundabouts replace signals at intersections and reduce energy use. One study found that 25 roundabouts replacing existing traffic signals in Burlington, Vt., would equate to more than 20 percent of that city's energy reduction goal. Several studies have also found that roundabouts reduce resource use and pollution, enable higher density land uses and foster increased transit and nonmotorized travel modes.

District energy

District energy systems produce steam, hot water or chilled water at a central plant. The steam or water is then piped underground to individual buildings for space heating, domestic hot water heating and air conditioning. As a result, individual buildings served by a district energy system do not need their own boilers or furnaces, chillers or air conditioners.

The International District Energy Association maintains that district energy systems are 100 percent efficient because the steam or water arrives at the building ready to use. This compares favorably to the 80 percent or less efficiency when burning natural gas or fuel oil at a building. In addition, district energy systems can use the "reject heat" that results from burning fuel to produce electricity at a power plant, dramatically increasing the overall efficiency with which useful energy is extracted from the fuel.

On military installations where sprawl exists, the lines for district energy systems simply run too far, which increases line loss, maintenance costs and inefficiencies. When combined with the reliability of ➤

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district plants, where four chillers take the place of 100 in separate buildings, a more compact layout increases the efficiencies of the utility lines. Also, a district storage system can be used, which adds to cost effectiveness.

Infill development and increased density reduces runs and makes district energy more efficient. District systems can work on a small scale, infill plans obviating the need to redo an entire post. District systems also create room for renewable energy sources now or in the future as technology changes. District systems can use plug-and-play renewable systems, which may not make economic sense on a building-by-building basis.

In district systems, planners can take advantage of the benefits of combined heat and power. A system that can generate heat and power can potentially be 67 percent efficient versus the 33 percent efficiency of a utility-line-dependent system. This efficiency results in overall reductions in energy consumption and allows for the use of renewable sources at an appropriate time.

This energy-effective area development plan involves compact development, interconnected streets and narrow buildings. Graphic courtesy of Jerry Zekert

Building designs

While planning normally does not consider the specific design of a particular building, there are critical building design strategies that can significantly reduce energy consumption.

Solar-ready buildings – Siting and constructing solar-ready buildings can prepare installations for a more efficient future. Building orientation, however, is not as critical with most military buildings, since they are internally heat load dominated. Rather than focus on passive solar layouts, buildings should be designed to accommodate photovoltaic panels, cross ventilation and natural lighting.

Mixed-use buildings – Buildings that combine compatible uses in one footprint can reduce energy use. More floor area can be provided under one roof.

Connected buildings – According to one researcher, connected buildings, like attached dwellings as opposed to separate dwellings, reduce the external envelope exposed to the outside environment and thus reduce heat loss and gain, lowering heating and cooling loads. Other advantages include efficient use of space in the urban context and savings in construction cost and maintenance due to shared walls. Rowhouses, for example, use up to 35 percent less energy than similar sized single-family homes.

Narrow buildings – In administrative buildings, which account for a sizable percentage of military installation facilities, energy consumption for artificial lighting can account for nearly half of all energy use. Additional air conditioning capacity is also needed to remove the heat generated by artificial lighting. The first strategy to make buildings like this more sustainable is to reduce the demand for artificial lighting, and the best way to do this is to create narrow wings that allow natural light into the buildings.

Many European countries, for example, limit building widths to less than 50 feet. Many buildings built before the 1930s in the United States and in Europe meet this limit, but with the rise of air conditioning, building widths grew substantially. In some cases, floor plate widths have increased to more than 120 feet. As a result, access to natural light and ventilation was compromised.

More recently, narrow-wing buildings have been making a comeback due to their environmental benefits. In Europe, the first example was built in 1987 for the Netherlands International Bank. The designers employed narrow floor plates, interior louvers in the top third of windows that bounce light to the ceilings, operable windows and interior atriums. The benefits were significant. The former headquarters used 422,801 British thermal units per square foot, but the new headquarters uses 35,246 Btu per square foot, a reduction in energy use of more than 90 percent. The energy savings in 1987 U.S. dollars totaled $2.6 million annually, and the payback was a remarkably short three months.

Planning and energy

Master planning is a comprehensive process that formulates a development strategy for the long-term use of our installations. Energy use is one of the major considerations that must be factored along with sustainability, low-impact development, and anti-terrorism and force protection.

The recommended planning and design strategies in this article provide a roadmap to evolving into a net-zero installation. Using these techniques prevents the ➤

New direction for master planning

by Kathryn J. Haught

The update of Army Regulation 210-20, *Real Property Master Planning for Installations*, is nearly complete. The old regulation will cease to exist and will be included as Chapter 10 in AR 420-1, *Army Facilities Management*, within this fiscal year. The update will address the question: how can we better execute master planning to assist headquarters' planning and support the installation?

The new regulation continues the use of real property master planning digests, installation design guides, capital investment strategies and long-range components. Employing vision statements has been added, and short-range components are eliminated.

The update accentuates *process* rather than end products. End products are included, though, and have been more clearly defined to more accurately reflect how garrisons do planning.

The new regulation emphasizes 10 planning tenets:

- form-based coding,
- area development planning,
- sustainable development,
- sustainable building design,
- natural and cultural resource preservation,
- planning for healthy communities,
- critical infrastructure risk management,
- anti-terrorism and force protection,
- facility standardization, and
- spatial data management.

These tenets are essential for constructing a master plan that meets all the needs of the installation, including the needs of Soldiers, Civilians, Families and of the Army as a whole. Army planners have been working with many of these precepts for years. Other tenets are new to the Army master planning regulation, although not necessarily new to installations. Adding these tenets to the regulation and applying them at the garrison level ensures that they will receive the emphasis necessary from decision makers.

The new regulation stresses the use of **form-based codes**, which codify the installation's IDG standards in a graphic plan. This type of code puts less weight on land use and more on building appearance and massing.

While the form of the building will, to a certain extent, drive the function, this type of code will allow for more mixed-use development. Mixed-use development permits greater efficiencies in planning and promotes the conservation of one of the Army's most important and quickly shrinking assets — real estate.

Form-based codes will be used to formulate "illustrative plans" and "regulating plans."

Illustrative plans use form-based codes to depict proposed building configurations. This will help the installation establish the capacity of the installation — an invaluable and long overdue tool for helping headquarters make more informed stationing decisions. Using the requirements data in the Real Property Planning and Analysis System for comparison, installations will be able to better plan for existing missions without adversely impacting potential new missions.

Regulating plans replace land-use plans and regulate only the most essential physical requirements for developing parcels, such as buildable areas, minimum and maximum building heights, parking locations and acceptable uses.

The new regulation also emphasizes **area development plans** that can be consolidated into an installation development plan. Area development plans will enable the garrison to consider the installation's missions and plan for each accordingly.

In the past, planning was done without consideration of long-term effects, but the Army has been integrating **sustainable development** and **sustainable building design** now for several years. The Army realizes the importance of preserving not only its own resources but those of the local community, the region and the state.

Sustainability principles help the Army to be more prudent with real estate, natural resources and manmade resources. Sustainable design can be tailored to each particular installation.

Natural and cultural resource preservation overlaps sustainable design in the principle of minimal disruption to ecological and historical assets. These tenets together give planners the tools to provide for their communities' needs while preserving natural and manmade assets.

Planning for healthy communities is one of updated regulation's new tenets. ➤

Acronyms and Abbreviations	
AR	Army Regulation
AT/FP	anti-terrorism and force protection
CIRM	critical infrastructure risk management
IDG	installation design guide
NEPA	National Environmental Policy Act
OACSIM	Office of the Assistant Chief of Staff for Installation Management

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diversion of precious range and training areas for solar farms or other dedicated energy production areas. They help create sustainable development that preserves an installation's capability to respond to rapidly changing Army missions.

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