DIANE M. DALE

Hali'imaile

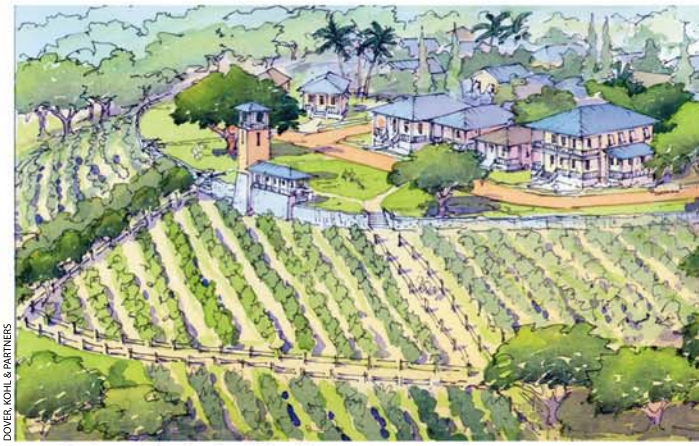
A new community in Maui will benefit from a more sustaining approach to development that integrates spatial planning, site systems, and built form.

FOR MORE THAN A DECADE, the sustainable development movement has been transforming the practice of architecture, refocusing attention beyond a building's aesthetics to the impacts the building has on the natural environment of which it is a part. This approach requires from the outset a collaborative and integrated effort among architects, planners, engineers, and people in other disciplines. This is a new design paradigm—a systems-based conceptualization process that brings building performance considerations such as energy use and indoor air quality into the earliest stages of design.

More recently, a new renaissance in town planning has been unfolding, bringing sustainable design strategies to the forefront of urbanism. The successful systems-based model of green building design is being scaled up to the level of community planning as planners realize that achieving more sustainable communities will require an understanding of the impacts of building and systems long before they are designed.

William McDonough + Partners, an architecture, community design, and consulting firm known for its role in sustainability thinking, has been a part of this transformation. Interested in discovering how the early focus on the systems that service buildings can lead to more innovative master planning and organization strategies for new communities, the firm is developing and refining a planning framework to translate sustainable design strategies of the architecture practice into guidance for larger-scaled land planning projects.

Called the Cradle to Cradle Framework for Development, the approach creates a new model of sustainable planning by introducing a systems-based conceptualization process at the earliest stages of planning. Two systems—energy and water—are of particular interest in this approach. Energy and water systems link buildings to place and therefore are critical to the health and regenerative capacity of the site and the region, and the people who live there.



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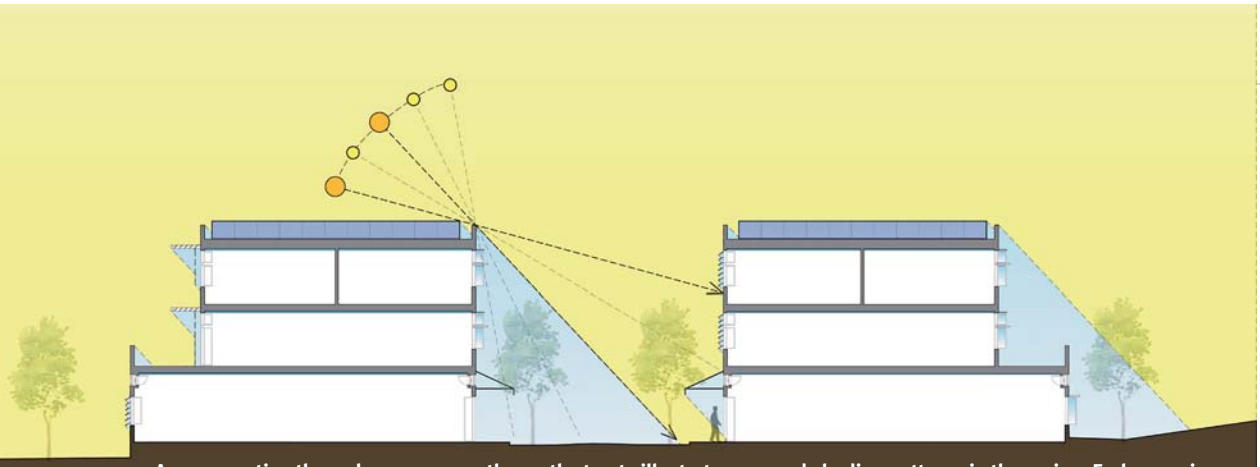
A preliminary sketch of Hali'imaile, a new community planned for Hawaii.

A Case Study

Application of this planning framework is perhaps best understood through the work that was done at Hali'imaile, a 526-acre (213-ha) new community being developed by Maui Land & Pineapple Company and A&B Properties. The goal of the development is to provide more affordable and environmentally sustainable workforce housing options in Maui's upcountry.

The new land-planning frame conditions to guide the venture began with lessons learned from



A cross-section through narrower north–south streets illustrates sun and shading patterns in the spring. Early-morning sun provides light but little heat, so it can be controlled by interior blinds. Late-afternoon sun brings both light and heat, so exterior shading strategies are used to block direct sunlight before it penetrates building interiors.

A cross-section through wider east–west streets illustrates winter sun and shading patterns. In the Northern Hemisphere, the sun remains relatively low in the southern sky during the winter, casting long shadows on the north side of buildings but illuminating the southern facades.

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the systems-based conceptualization process that has brought performance considerations into the earliest stages of building design and has dramatically changed the way buildings are designed and constructed. By translating this sustainable design model into the vocabulary and scale of community planning, the firm sought to initiate an equally profound transformation at this broader level.

The work drew inspiration from the regenerative design philosophy developed in *Cradle to Cradle*, the 2002 book by architect William McDonough and German chemist Michael Braungart. The philosophy, which is modeled on natural cycles, helped the firm reconnect the community with the *ahupua'a*, the traditional Hawaiian method of subdividing land based on resource distribution. The divisions generally would occur in wedge-shaped pieces running from mountain peak to ocean shore and would vary in width based on the richness of the resources in the wedge—e.g., wedges would be wider in dry areas of the island to compensate for the lack of resources and be narrower in richer, taro-producing areas to spread the wealth. The architecture firm outlined the environmentally intelligent systems that would shape the organization and pattern of the traditional neighborhood development (TND) community and inform important design decisions at the site, neighborhood, and community scale.

Energy and water systems quickly became central to the aims of the work at Hali'imaile. To address them effectively, the designers collaborated with the London office of WSP Energy and Hawaii-based civil engineers Engineering Solutions, working together for 18 months to develop the framework of sustainable energy and water strategies that would serve as a reference tool for the TND planning team, Dover Kohl & Partners.

Energy Data and Analysis

The analysis focused on how renewable energy sources could inform the organization and pattern of land planning. Site climate analysis revealed that Maui's abundant sun and wind, combined with a year-round temperate climate, could be channeled to reduce the amount of energy typically needed in homes and to provide a clean and renewable source of energy. Trade winds from the northeast provide consistent cooling breezes, and the island's location near the equator means that the sun is comparatively high in the sky for most of the year—ideal for solar energy production.

On Maui, consumption of fossil fuels for housing typically is very high due to demand for energy-intensive

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The Hali'imaile site will include multiple reservoirs, open-air irrigation ditches, and gulches on the periphery to optimize the flow and use of water.

air conditioning. Passive design strategies were investigated to reduce energy demand for buildings, and parameters were identified that would achieve longer periods of indoor comfort without a need for air conditioning. Benchmarking showed that the pursuit of comfort in hot and humid conditions across cultures was based on similar design principles: reduce heat gain by incorporating good building orientation and shading, and increase air movement.

Working with the WSP engineers, McDonough was able to analyze building performance in relation to solar orientation, and from that to propose the optimal location of rooms in a house in relation to the time of day the room is typically occupied. This is a subtle but contributing factor to the success of passive strategies. In a climate like Maui's, it is also desirable to locate a lanai—a deep, covered porch common to Hawaii—in accordance with the specific conditions of the site to provide a comfortable living space while the indoors is being cooled by evening air, thus increasing building performance. Because most communities are composed of streets lined with mirror-image homes, one side of the street likely will take better advantage of such passive comfort strategies.

TND communities are readily identifiable by an urban grid street pattern. The narrow cross-section of the urban street receives high praise for promoting pedestrian-friendly communities. The project presented the opportunity to integrate energy strategies with urban design goals through proper orientation of the urban grid.

At Hali'imaile's latitude, the optimal solar orientation for buildings is on a street grid rotated 15 degrees north of east. This grid rotation ensures that all facades get some direct sunlight most of the year, thus supporting daylighting and energy production strategies.

When the wider streets are aligned on the nominal east–west axis of this grid, the long side of the building mass is exposed to the south and north. This is beneficial to passive energy strategies because solar gains from the south are more readily controlled by fixed overhangs and shading devices. Likewise, when narrow streets run perpendicular to the wide streets, aligned on the nominal north–south axis, less of the building mass is exposed to the low-angled afternoon sun. Within this block organization, building massing and vegetation can be used to shade adjacent buildings.

To be effective at reducing energy demands, enhanced ventilation needs to be delivered at the building and neighborhood scale. In Maui, the optimal solar orientation of the street grid parallels the direction of the prevailing winds. Thus, the street grid for solar access also captures the trade winds. Yet within the compact pattern of TND projects, overall building ventilation can be challenging. The relationship of building massing, orientation, and available open space determines how well the trade winds can infiltrate neighborhoods. When buildings are located closer together, it creates a microclimatic event called the "wake effect," which reduces the effectiveness of the ventilation. The placement of houses along Hali'imaile's streets considers "wake interference" to achieve optimal ventilation. Strategically located open spaces further encourage blockwide wind infiltration and building ventilation.

In general, upscaling building energy strategies to the community scale has only subtle visual impact on the organization of the master plan. The primary effects

At Hali'imaile's latitude, the optimal solar orientation for buildings is on a street grid rotated 15 degrees north of east. Passive energy strategies are maximized when the wider streets are aligned on the nominal east–west axis of this grid.

are the orientation of the street grid and the use of street and building width for solar reduction and creation of ventilation patterns. Secondary effects include new approaches to infrastructure—the team also proposed a district-cooling system using neighborhood absorption chillers connected to solar panels—and the potential for new street experiences as suggested by the initial energy study that located rooms in relation to solar exposure and use pattern, meaning one side of the street would not match the other.

While subtle visually, energy modeling reveals a 20 percent energy savings when the energy reductions per building are extrapolated communitywide. Likewise, carbon dioxide emissions would be reduced by about 15 percent compared with an average community. Affordability is also improved: reducing energy demand in homes through passive strategies reduces by up to 20 percent the photovoltaic surface area required to meet energy needs, resulting in lower first costs for implementation and reduced operating costs.

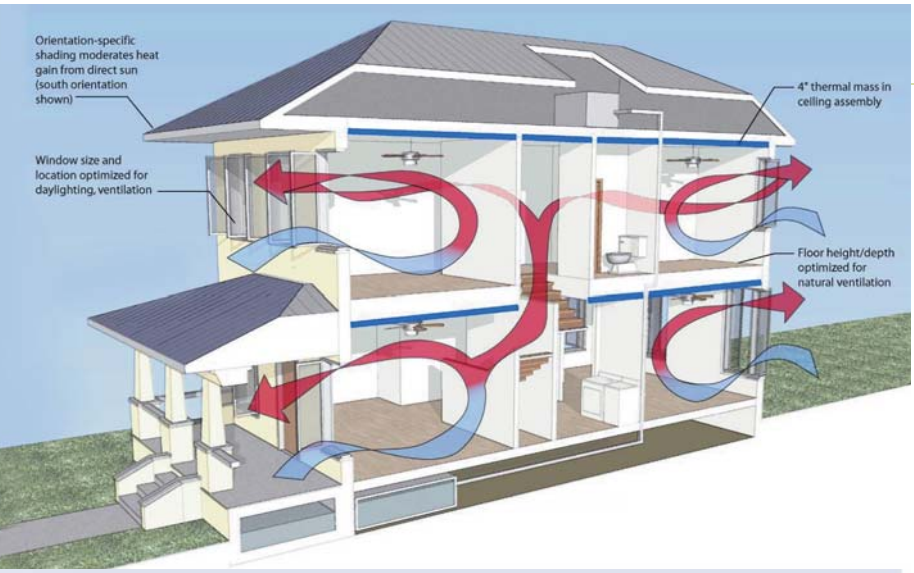
Water Data and Analysis

Analysis also focused on how sustainable water strategies would inform land planning structure and organization. Upcounty Maui relies on a surface-water catchment system for irrigation and drinking water. While water is plentiful in the wet winter months, Hali'imaile is plagued by sharp competition for water between farmers and residents during the dry summer months.

According to Maui planning standards data, under a conventionally developed infrastructure, water use per capita for the 2,700 residential units planned for Hali'imaile would require nearly 1 billion gallons (3.8 billion liters) per year of potable water, with nearly half that demand needed for irrigation. At the same time, the land area comprising the Hali'imaile site would receive the equivalent of about 850 million gallons (3.2 billion liters) of water from rainfall, more than half of which typically would be carried away from the site in the storm sewer system.

An optimized water scenario was modeled that significantly reduced the demand for potable water by creating a balanced, on-site water budget that incorporates a number of sustainable design practices. At the building scale, water-efficient fixtures and the use of water at its optimal and appropriate levels of quality reduce demand for potable water. For example, rainwater is captured and used for toilets and laundry. At the community scale, aggressive rainwater harvesting practices are employed for irrigation and for site infiltration. Organic nutrients are captured from the wastewater stream and recycled.

By using these aggressive capture/reuse strategies throughout the community, the optimized site water



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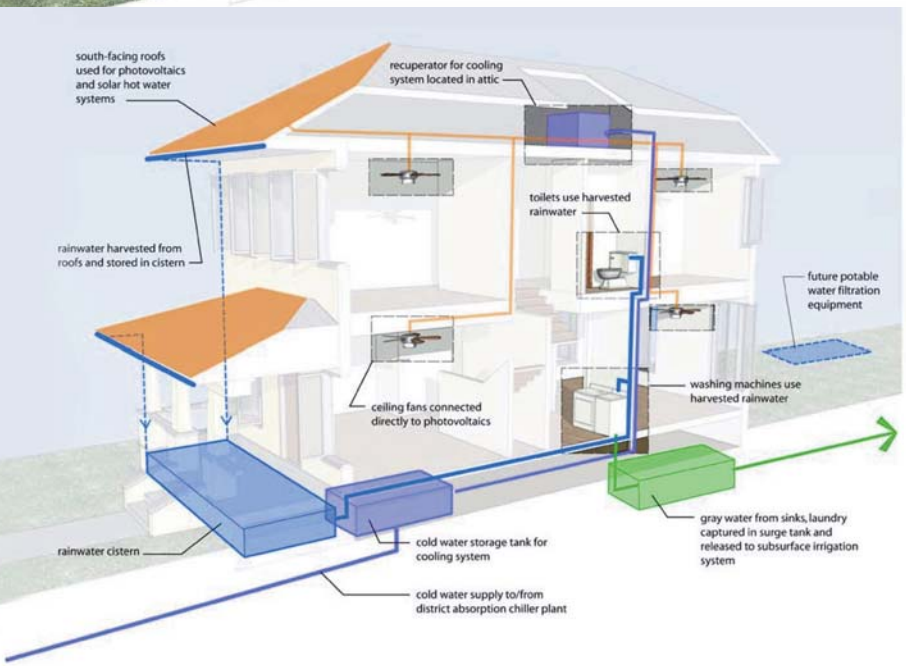

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Homes in Hali'imaile will be designed to optimize natural heating, cooling, ventilation, and lighting techniques (top) and incorporate resource-efficient mechanical, electrical, and plumbing equipment (bottom).

budget projected a 60 percent reduction in the use of well water for indoor uses. Even more impressive, the flow of sanitary wastewater can be reduced by 90 percent when the wastewater is treated on site and used for irrigation. Finally, site stormwater runoff can be fully eliminated by the site strategies to capture rainwater.

The opportunity to integrate water strategies in the earliest stages of planning is paramount for success because these strategies require space. The development program will include sufficient land area to integrate rainwater harvesting strategies within open space and at the building scale, to fit bioswales in the streetscape to capture and cleanse stormwater, and to anticipate and provide for future use of neighborhood-scaled, biologically based wastewater treatment.

Frameworks and Implementation

McDonough + Partners began its work on the framework in late 2004. The architecture firm engaged in discussions with the team of project collaborators; the outcome was sustainable design strategies at the site, block, and building scale that informed organization and detailing of the master plan.

In spring 2006, Dover Kohl led a TND-based community workshop on site in Hali'imaile. The framework, which was presented to the community at the workshop, was well-received in part because of its emphasis on sustainable design and its sensitivity to traditional Hawaiian resource management. The architects participated in the workshop design sessions to share their information and expertise as well as to ensure that the planning outcomes of the workshop incorporated the framework.

The planning and analysis work on energy and water was assembled in a report and presentation for distribution to the team charged with developing the spatial plan for Hali'imaile. The framework helped to redirect the team's approach by firmly placing systems-based thinking at the front of the land planning process. The planning team used the framework as guidance in developing the concept plan, with particular emphasis on street orientation, spatial organization of neighborhoods, and pattern of open space to incorporate energy and water strategies. TND housing types were adapted to incorporate ventilation strategies. The framework continues to inform the team's work as the master plan proceeds through the extensive public review and approval process mandated by Hawaiian land use regulations.

By translating architectural and engineering strategies into a language addressing community planning, the framework has created a land planning approach from a new perspective—focused at the interface and integration of spatial planning, site systems, and built form. This system-based approach, modeled for the upcountry of Maui, represents early steps toward new and innovative solutions that can apply to the planning of healthy, regenerative communities worldwide. **ULG**

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Developing Sustainable Planned Communities is available at www.uli.org/bookstore, or by calling 800-321-5011.