

A Renewable Energy Community: Key Elements

Technical Report

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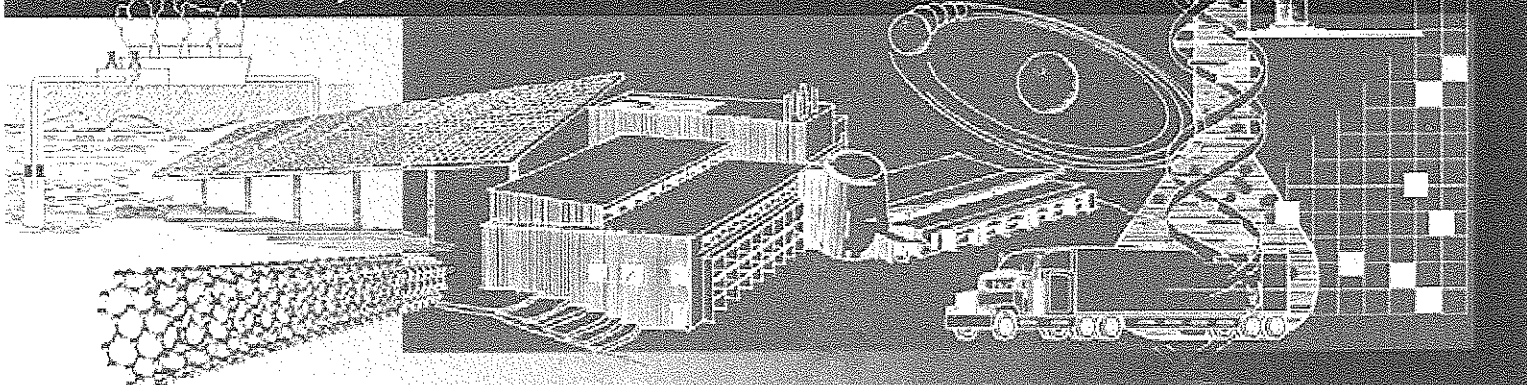
A reinvented community to meet untapped customer needs for shelter and transportation with minimal environmental impacts, stable energy costs, and a sense of belonging

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I. Introduction

The Problem: Dwindling Supply of Non-Renewable Energy Resources

Supplying adequate clean energy to a rapidly industrializing world is one of the 21st century's greatest challenges. Worldwide energy consumption is expected to increase 54% from 2001 to 2025.⁵ The challenge of providing energy is compounded by concurrent efforts to reduce energy-related pollution and greenhouse gas emissions.

Between 2003 and 2025, the United States' population will grow by 58 million people,⁶ subsequently causing an increase in new building construction. With this growth comes the inevitable growth in consumption of energy, water, food and other non-renewable supplies—unless we change the way we design new communities.

The Renewable Energy Community concept is about advocating innovation—looking at a way to reinvent communities to meet untapped customer needs for shelter and transportation with minimal environmental impacts, stable energy costs, and a sense of belonging.

A Solution: Build Vibrant Renewable Communities to Mitigate Energy Supply Issues

In 2005, NREL embarked on an initiative to assess the feasibility and understand the barriers of developing Renewable Energy Communities to help America overcome its ever-increasing dependence on fossil fuel and all the associated problems that accompany it.

The Renewable Energy Community, as conceptually defined by NREL, is a state-of-the-art community in which integrated, renewable energy technologies play the primary role in meeting the energy supply and demand needs of its residents, with the possibility of providing excess energy back to the grid or other communities. At a minimum, this community will have near-zero or zero-energy homes (ZEHs), integrated transportation modes with advanced vehicles, local renewable energy generation, and incorporate sustainable living practices. The community will provide economic benefits and a positive impact on quality of life. A Renewable Energy Community places added emphasis on the energy element of a “sustainable community” by being powered largely from renewable energy and by integrating power systems for homes and vehicles (see

Integrating the Renewable Energy Community as a whole system can accrue significant benefits. Cost advantages from the *systems approach*—linking homes with vehicles and addressing energy issues on a community level rather than on individual households—can be gained compared to the costs of each individual part. Some financial benefits are reduced monthly expenditures with more renewable/energy efficient equipment; tax

⁵ Energy Information Administration “International Energy Outlook 2004”.

⁶ Heid, Jim. Greenfield Development Without Sprawl: the Role of Planned communities. Urban Land Institute.

advantages and financial incentives (ex. green bonds⁷); and “green” mortgages that incorporate advanced vehicles along with renewable technology.

Developing these communities requires “systems thinking” which is a discipline for seeing wholes. It is a framework for understanding interrelationships rather than individual elements; for seeing patterns of change rather than static snapshots. “Today, systems thinking is needed more than ever because we are becoming overwhelmed by complexity.”⁸

In this systems approach scenario, new business opportunities will emerge and many industries will benefit including car companies, developers, builders, utility companies, the community itself, and the renewable technology industry. In addition, increasing the amount of renewable energy generation will reduce the use of fossil fuel, our nation’s reliance on foreign sources of energy, and subsequently the amount of carbon entering the atmosphere.

Research Methods

NREL is assessing the feasibility of developing Renewable Energy Communities by drawing on information from several assessment efforts:

- Experience with ongoing collaboration working with several “green” developers grappling with these energy issues
- Survey of builders, developers and stakeholders about their use of and interest in renewable energy technologies
- Literature review and analysis related to Renewable Energy Communities
- Cross-discipline information gathering approach from all NREL renewable energy/efficiency areas.

Research Results

The research reveals that there is little information available on how to integrate renewable technologies as a system in community building design. Findings revealed only a handful of examples where developers are taking a comprehensive and systematic approach to developing new communities with aggressive energy efficiency and renewable energy goals in mind. NREL’s preliminary analysis is showing that a systems approach—linking homes with vehicles and addressing energy issues on a community level versus individual households—can be cost-effective and possibly even profitable.⁹

Energy use in aggregation represents not only a greater demand but also presents new opportunities. For example, analysis on the community system level may identify some technical approaches as optimal, when they are not suited to smaller levels of

⁷ Green Bonds are an innovative initiative to generate sustainable income for a variety of environmental conscious projects. JP Morgan: http://www.jpmorgan.com/pages/jpmorgan/news/JENIlaunch_Feb07

⁸ Senge, P. 2006. The Fifth Discipline. 5-22.

⁹ Penney, T. and J. Elling. 2006. Plugging In to Renewable Communities. Solar Today 20 (3):22-25 http://www.solartoday.org/2006/may_june06/plugging_in.htm.

aggregation, such as cogeneration, district heating, larger scale wind or solar generation, car-sharing, or changes in land use/zoning.

Research results do show some examples of various renewable and/or sustainable steps that developers are taking, which can ultimately move towards our Renewable Energy Community vision. These examples are included in the paper as well as in an Appendix.

Purpose of this Paper

To help combat this information and expertise gap, NREL authors created this paper for builders/developers and stakeholders interested in building such a community by outlining the necessary elements to design a Renewable Energy Community using a systems view approach, and including examples of each element and the stakeholders involved. The elements can be thought of as a progression of steps—not necessarily in order—but, nonetheless, building on each other towards such a community.

Understanding the progression inherent in these elements is also a logical way to share the information. The use of the terms “element” and “step” are used interchangeably throughout this paper. A reference list is also provided in the Appendix that cites further examples, stakeholders involved, and contact information (if available). This is not a comprehensive list; it is information that has become available to date to the NREL authors.

II. Key Elements for a Renewable Energy Community

NREL has outlined five elements needed to become a Renewable Energy Community:

1. Sustainable Design Approach
2. Solar/Zero Energy Buildings and/or Micro-Grids
3. Advanced and Energy Efficient Transportation
4. Utility Role Expansion—Power Generation and Load Management
5. Putting it All Together for a Renewable Energy Community.

Essentially, each element builds on the other elements to ultimately form a Renewable Energy Community. To date, there are examples of innovation occurring in all five of these elements; however, there are only a few examples that actually begin to put all five elements together to construct a true Renewable Energy Community. Included in the descriptions of each element are some examples, as well as the key stakeholders necessary to make a Renewable Energy Community a reality. These key stakeholders consist of builders; developers; auto manufacturers; utility companies; and local, city, municipal, and federal policy makers. (For additional examples of each element see the Appendix.)

1. Sustainable Design Approach

This first step is described as the development of communities for which planners, builders, and developers make a concerted effort to build environmentally compatible, less automobile-dependent developments that attract residents seeking a sustainable

lifestyle. In general, sustainable design aims to produce places, products, and services in a way that reduces the use of non-renewable resources, minimizes environmental impact, and relates people with the natural environment. In most examples of sustainable communities found in the literature, the energy strategy is primarily about energy efficiency.

For the Renewable Energy Community, sustainable design can reduce energy use for both buildings and transportation.

For buildings, efficient home design and orientation can reduce the need for building energy use before ever buying any energy equipment by maximizing the use of passive solar design (to minimize solar gain in warm climates, and maximize in cool climates), daylighting, and natural ventilation and shading. There are many degrees of sustainable design that can be applied to individual buildings and/or communities. For instance the Packard Foundation identifies six categories of buildings ranging from the “market building”, defined as a conventional building, to a “living building”, defined as one that has a net zero annual impact on the environment from an operational standpoint.^{10, 11}

Similarly, for transportation, efficient community layout that places schools, shops, and other services close to homes and business, making it easy to get places without driving and offering attractive bicycle and walking paths, can greatly reduce vehicle miles traveled per household. This would in turn reduce the amount of energy needed for transportation—while improving quality of life—even before any expenditures are made for vehicles.

These are all elements that can contribute significantly to decreasing the conventional energy requirements of a home or building. In general, these communities aim to include attributes such as:

- Energy efficient construction (i.e. building envelope, HVAC systems, and appliances)
- Passive solar design and lot positioning
- Community layout to reduce vehicle use, increase walkability, and provide access to mass transit
- Recycling and water conservation
- Ecological integrity
- Social equity
- Cultural and historical vitality.

What is
the house
load??

¹⁰ Packard Foundation. 2002. Building for Sustainability Report. Available at: <http://www.hpsarch.com/TitlePageSpecial/2002-Report.pdf>

¹¹ In between the “market building” and the “living building”, the report defines four other buildings meeting various levels of sustainable design. <http://www.bnim.com/fmi/xsl/research/packard/index.xsl>.