

Introduction

Forward movement is not helpful if what is needed is a change of direction

-David Fleming

What if every home could produce its own energy? What if that energy was clean and renewable and cost less than most electricity rates from public utilities? What if enough energy was produced onsite to also power household transportation at much less cost than fuel-burning vehicles? The answers are obvious; first, nearly all homes would be built or renovated to these less costly standards, and sustainable housing would no longer discriminate by wealth. Second, Americans would quickly transition to electric vehicles for household transportation needs and, third, the U.S. would slash greenhouse gas emissions in half just by transitioning residential energy to solar, and private transportation to electric (powered by cleaner energy). These are not utopian dreams, but choices available today for nearly all Americans, and at financially favorable terms. Solar photovoltaic systems can generate enough clean energy to power most homes and the transportation of occupants, and it is already less expensive than utility rates across the nation. Additionally, the combination of lower-cost energy with high-quality, code-minimum construction provide a least-costly package for the homeowner and less ecological damage. Unfortunately, this is not widely known; we need tools beyond the mind to understand the concepts of amortization and the time value of money, and the principles and tools of finance are largely absent from residential construction analysis. This resource uncovers this mystery and effectively communicates the real cost of these choices.

This book is about changing directions in how we think about, design, and construct housing in the United States. With over a million new homes built each year in the U.S., and many more renovated, only a tiny fraction attempt or achieve sustainability. The conventional wisdom and inertia in the industry is based on outdated information on energy choices and misinformation on construction choices. With good intentions, and perhaps the best that could have been done until recently, a *green building movement* has pushed approaches that price most homeowners out of the market. Their models emphasize more robust wall systems and complicated mechanical solutions with the aim of reducing energy use and waste. Unfortunately, those systems are cost-prohibitive to most homeowners and perhaps the primary reason for so few sustainable homes today. Ironically, these heavy envelope systems, built in the name of sustainability, exert a heavy toll on resources and the environment, yet do not yield significant or offsetting benefits. This study shows the surprisingly poor tradeoffs of thermal envelope upgrades over the full life-cycle of the home.

This book offers a fresh analysis, integrating evolving energy technologies with building science, economics, finance, and ecology to provide a new vision for sustainable housing that is less costly, less resource-intensive, and slashes greenhouse gas emissions. The broad conclusions suggest a stark departure from current practice and common assumptions, and they are consequential in a new paradigm that should speed the transition to sustainable outcomes in

both the housing and transportation sectors of the economy. The new approaches also democratize sustainability, removing current barriers of wealth as entry to responsible choices. Some of the proposals and logic may seem counterintuitive, and contrary to many of the assumptions driving an entrenched orthodoxy in the building industry. The ideas may also, at first glance, feel like environmental heresy; our research team certainly encountered them that way. However, we allowed the data and analyses to lead us to the new discoveries and directions expressed in this text, which we expect will now speed a transition to sustainable housing and private transportation. Some of the ideas forged in the green building movement are still relevant today, in limited scope and context, but our findings upend most of the large priorities in how we allocate resources to achieve sustainable building. We argue that this is a critical moment to step back for a fresh view of the overall impact of the whole house, over the full life cycle, including both embodied and operational ecological impacts. We have discovered and identified surprising solutions that require a paradigm shift in thinking and action that will not only serve the greater good, but that are within surprisingly easy reach.

We want this book to be accessible to a broad and diverse audience, including homeowners, builders, architects, scientists, politicians, bureaucrats, and anyone working in the home finance and real estate markets. We've therefore structured the book to accommodate a wide range of readers, and reading styles. Organized by topic, each chapter begins with a set of **opening questions** to be addressed and analyzed, and a **summary and conclusions** section near the end provides the most simple and succinct answers to those questions. The bulk of each chapter, between the opening questions and closing responses, contains the **data and analysis** that substantiate the findings and claims, and a **case study** section grounds it all in an actual test-bed project. Finally, we have included a list of **dos and don'ts** at the end of each chapter related to the topic, as well as a whole-house list in the Epilogue. We hope you read the entire book sequentially, but we expect some will jump directly to these various sections, or use the text as a reference. If summary conclusions are questioned, the reader should be sure to consult the data and analyses at the heart of each chapter.

Adding further texture and context is a set of short essays, sprinkled through the text, written by seasoned professionals and industry experts. The perspectives and terminology of builders and architects are unique to the trade, and readers who work in or near the industry will find familiarity in the voices and language of these pieces. Industry professionals will be critically important in the turn toward sustainable housing, and we expect they will benefit from reading how others confronted these new ideas and how it reshaped their thinking. These essays are added as standalone callout boxes, termed *Industry Perspective*.