Breaking Down the Barriers:
Challenges and Solutions to Code Approval of Green Building

by

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ABSTRACT

Building codes are perceived by many as a challenge to building innovation, including sustainable approaches to building and development ("green building"). Others argue that building codes are not a challenge to green building because existing code provisions allow for the use of alternatives that meet the intent of the building code. The Development Center for Appropriate Technology led an effort to research issues related to building regulatory challenges for green building through an internet-based survey, administered from July 1 to August 31, 2001. The "code user" version of the survey, addressing the experience of people seeking to gain code approval for green building projects, was completed by 198 respondents. The "code official" version examined the perspectives of those who approve or deny building plans and received 56 responses. The results revealed that building codes frequently present barriers to the approval of green building alternatives. Those barriers are both technical and non-technical in nature. Both groups of respondents overwhelmingly indicated that supporting information for alternatives accompanying plans was the most significant factor in gaining code approval. Non-technical factors were about as likely to affect approval as is a conflict with the intent of the code. A set of recommended strategies for gaining approval and recommendations for training of both code users and code officials is offered.

INTRODUCTION

Building codes and related regulations exist to safeguard the public health, safety, and general welfare from fire and other hazards attributed to the built environment. The building regulatory system has done a good job of minimizing the risks commonly associated with buildings such as fire, structural integrity, means of escape in an emergency, and so forth. However, building regulations are also widely acknowledged to inhibit innovation due to their complexity and the preponderance of prescriptive rather than performance-based provisions. Almost all codes have

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provisions for alternative designs, materials, and methods of construction that are cited as evidence that codes are not a barrier to alternative or innovative approaches to building (e.g., International Code Council 2000).

In reality, both situations are true. The provisions for alternatives provide a way to introduce innovative or alternative approaches and get them approved. At the same time, the codes present a significant practical barrier to innovation (e.g., Volokh 1996, Duncan 2000, and Foliente 2000) because using these provisions are often difficult, time-consuming, and expensive, and the results are dependent on many factors. Thus, while in theory it is possible to get almost anything approved with enough time, money, and technical resources, in practice few projects have unlimited budgets and open-ended schedules.

Most efforts to build more sustainable or "green" building and development projects include a wide array of innovations and alternatives. People involved in doing such projects have long had difficulty getting their projects and plans approved. Direct and indirect experience with such challenges led the Development Center for Appropriate Technology (DCAT), a non-profit organization in Tucson, Arizona, to focus on sustainability and codes since 1995. DCAT created the *Building Sustainability into the Codes* program in order to formally address this problem.

DCAT's research revealed a set of problems as well as a high-leverage opportunity for change. The key problems were:

- **Buildings have large negative environmental, resource, health, and other consequences.** Many negative consequences are tangible, large-scale, long-term threats to human health, safety, and welfare. These consequences are present throughout the building lifecycle: resource acquisition, transportation, manufacture, construction, maintenance, operation, modification, eventual demolition, and disposal. These impacts have remained mostly outside the scope of concern of building regulations.

- **Building regulations tend to increase rather than diminish the larger impacts.** This is largely due to the lack of awareness of the risks and unintended consequences inherent in current practice. Since avoiding these unintended consequences is a major part of the motivation for green building and sustainable development, such goals are often in conflict with the regulations that are designed to facilitate current practice.

- **Lack of organizational capacity for change.** This lack of capacity exists within organizations that promulgate codes. The lack of awareness described above precludes the process of addressing the problems. At the jurisdictional level, where regulations are adopted and enforced, usually there are insufficient time and resources available to educate and train staff about alternatives and the processes by which they can be accepted and approved.

- **Lack of participation in code change and code development processes by those trying to use alternative approaches.** This is the result of the lack of understanding of the workings of the building regulatory system and unfamiliarity with the opportunities that exist to change the codes. Those who understand the problems and the need for

change must participate in the code change and development process in order to minimize or eliminate the larger impacts described above.

DCAT developed an integrated set of strategies to address these problems:

- **Develop awareness of the unintended consequences and risks** inherent in current practices and of the comparative risks and benefits of alternative approaches in meeting the intent of the code. Make clear that the responsibility to address the unintended threats to public health, safety, and welfare is a fundamental part of the responsibility of the building regulatory process.

- **Increase the capacity for change** through education, training, and involvement of all stakeholders in the code development process.

- **Shift the primary responsibility for this work** to organizations that have the logical and natural responsibility to address sustainability as an essential part of protecting public safety, health, and welfare.

Another problem that DCAT's experience revealed was that the technical merits of a system may not be understood properly by the building department when asked to approve some materials. In some cases, building departments require the alternative to follow the procedures or use methods prescribed for what is thought to be a similar system. For example, building officials may require adobe buildings to be built using the same design criteria as for concrete masonry unit construction, or rammed earth buildings to be designed and built as though they are low-strength concrete structures. There are both technical and perceptual problems that must be addressed to overcome such challenges. Similar problems have occurred in understanding the differences between light-gauge steel frame construction and wood frame construction, or insulated concrete forming systems with conventional masonry systems.

DCAT identified three main categories of code-related problems: 1) provisions in the codes or standards that are problematic for sustainable building because they require something to be done that has deleterious environmental consequences, or because they preclude the use of a safe and environmentally preferable option; 2) provisions that should be in the codes but are not, such as provisions appropriately covering older, less technological, but long-established and proven materials and methods of construction such as adobe or rammed earth; and 3) problems which are more general or structural, such as the prescriptive nature of most codes which has served to limit or inhibit innovation or the use of alternatives. Also included in this last group is the lack of balance between the need to minimize risk to people in specific buildings and the need to minimize the collective and more generalized risks to the public from the cumulative and often distant environmental consequences of buildings and the building industry.

The historical lack of awareness and concern about the generalized risks from the often pollution-intensive, energy-intensive, and/or resource-intensive ways of building which are included and fully accepted in existing codes has meant that concerns about environmental impacts and sustainability have played minimal roles in establishing building code requirements

or setting the levels of acceptable risk. Thus, in many cases, the codes have ignored significant health and safety issues such as indoor air quality, the toxicity of materials and chemicals used in building (e.g., asbestos, lead, and formaldehyde), or the impacts on non-renewable resources or global climate change.

Despite the hundreds of stories and complaints heard about code problems for green building, DCAT could not find any formal studies or research into the actual experiences of those on either side of the building regulatory process. As a result, DCAT initiated the effort to carry out such a research project. This survey represents the first comprehensive effort to gather information about building regulation and green building. The survey was intended to develop a more thorough understanding of the barriers, identify the most common problems, and seek successful strategies to overcome them. The overall goal is to use the information to assess and prioritize specific areas that need the most attention in order to facilitate the shift toward best sustainable building and development practices.

METHODOLOGY

DCAT convened a task group to assist in the survey development. Task group members included individuals from the International Conference of Building Officials (ICBO), the U.S. Green Building Council, the Rocky Mountain Institute, the American Institute of Architects Committee on the Environment, and various other organizations, architects, builders, engineers, and building specialists. This task group assisted in informing the content of the survey, with ICBO and DCAT sharing the responsibility of drafting the survey questions.

The primary data collection for the survey was accomplished through a pair of similar surveys specifically designed for each of the two primary groups of people who deal directly with building codes. One was for those who participate in any way with the process of producing buildings, including designing, engineering, building, manufacturing materials, developing, or who are otherwise involved in the plans that are submitted for code approval (“code users”). The other version was for those who develop, administer, and apply the codes (“code officials”). The primary differences between the two versions were in the way the questions were worded, based on the differing roles, and a few questions that were appropriate only to the specific group.

Dr. Robert Done, Assistant Research Professor at the Eller College of Business and Public Administration at the University of Arizona was contracted to assist in the design of the two survey instruments and to administer the survey. The survey was introduced on DCAT’s web page which then linked the viewer to the actual survey posted on a website controlled by the survey administrator (see Appendix A for text of introductory material). The survey was promoted through publications, conferences, e-mail listserves, and websites related to architecture, building codes, alternative building, and energy-efficiency. Specifically, the survey was announced on the websites of ICBO, Southern Building Code Congress International, American Institute of Architects Committee on the Environment, U.S. Department of Energy's Center of Excellence for Sustainable Development, and the New Buildings Institute. The announcement was published in magazines such as *Solar Today*, *Builder Magazine*, *Building Standards*, *Interiors and Sources*, and *Standardization News.*

The survey was available via the Internet from July 1, 2001 through August 31, 2001. The survey administrator performed quantitative analyses on the data collected and together with DCAT staff, compiled the results and drew conclusions.

A variety of statistical techniques were used to explore the survey data. Cluster analysis was used to group respondents together according to the pattern of their responses. Correlation analysis was used to measure the strength of relationship between two variables. Chi-square analysis was used to detect differences in the number of responses to a survey question. Much of the data are also reflected in percentages. Some percentages may sum to more than 100 if respondents were allowed to select more than one response. Other percentages may sum to less than 100 if respondents did not answer all questions.

RESULTS AND DISCUSSION

The results of this survey project revealed a number of useful and important pieces of information. Some of the quantitative results showed the degree to which the problem appears to exist and which areas appear to be the most problematic for both code users and code officials. The survey identified specific aspects of codes that tend to be most problematic, strategies and processes that are the most and least likely to be successful in gaining code approval, and some interesting information about the ways in which perceptions of the codes and the code approval process differ between code officials and code users.

Sample Characteristics

The code official survey was completed by 56 respondents (see Table 1). More than half of the code officials were currently employed as building officials. More than three out of four code officials had experience as building officials and almost half had experience as a general contractor. The code officials reported a median of 25 years of professional experience (including 13 years of code official experience) and a median of five years of experience with green building projects. Almost half of the code officials had worked in the Southwest U.S. and very few had worked outside of the continental United States. The vast majority of the code officials had experience with residential buildings and about half had experience with commercial buildings. About half of the code officials were familiar with local green building and energy efficiency programs, but less than 25% were familiar with other green building programs, organizations, and information resources. Close to 30% had participated in local green building and energy efficiency programs and less than 10% had participated in most other green building programs, organizations, and information resources.

The code user survey was completed by 197 respondents (see Table 1). Almost 60% of the code users had architectural experience and less than 20% reported having other types of professional experience. The code users reported a median of 20 years of professional experience and a median of six years of experience with green projects. About 45% of the code users had worked in the Southwest U.S. and very few had worked outside of the continental United States. About two-thirds of the code users had experience with both residential and commercial buildings. More than half of the code users were familiar with a variety of green building programs, organizations, and information resources. Somewhat less than half of the code users have

participated in green building programs, organizations, and information resources.

(Table 1 is presented on pages 6-11. Text of report continues on page 12.)

Table 1
Sample Characteristics

Characteristic	Sample	
	Code Official	Code User
Occupation		
Building Official	53.6	N/A
Plans Examiner	19.6	N/A
Inspector	14.3	N/A
Other	12.5	N/A
Years as Code Official[1]	13.0	N/A
Professional Background		
Design		
Architect	21.4	58.9
Engineer (civil)	10.7	3.6
Engineer (mechanical)	8.9	6.1
Engineer (structural)	8.9	1.0
Interior designer	1.8	4.1
Landscape architect	3.6	4.1
Construction		
General contractor	46.4	17.3
Developer	12.5	7.1
Owner-builder	26.8	15.2
Subcontractor	17.9	5.1

Notes: All values are percentages unless otherwise indicated. N/A = Not Asked.
[1]Median value

Table 1, cont'd.
Sample Characteristics

Characteristic	Sample	
	Code Official	Code User
Professional Background (cont'd.)		
Government		
Planner	7.1	3.0
Building official	78.6	1.5
Other	14.3	8.1
Other		
Building owner	25.0	10.7
Manufacturer or supplier	3.6	4.6
Other	3.6	16.2
Professional Experience[1]		
Overall		
Years	25	20
Projects	100	100
Green		
Years	5	6
Projects	5	8

Notes: All values are percentages unless otherwise indicated.
[1]Median value

Table 1, cont'd.
Sample Characteristics

Characteristic	Sample	
	Code Official	Code User
Geographical Area		
Northeast U.S.	14.3	41.1
Southeast U.S.	17.9	26.9
Midwest U.S.	26.8	29.9
Northwest U.S.	35.7	30.5
Southwest U.S.	48.2	44.7
Hawaii	1.8	6.1
Alaska	5.4	5.6
Canada	1.8	8.6
Mexico	0.0	5.6
Other	5.4	18.3
Building Types		
One or two family residential	94.6	75.1
Multi-family residential	82.1	51.3
Manufactured/modular housing	62.5	14.2
Commercial	89.3	70.6
Retail	82.1	42.1
Institutional	62.5	60.4
High-rise	50.0	19.8

Note: All values are percentages unless otherwise indicated.

Table 1, cont'd.
Sample Characteristics

Characteristic	Sample	
	Code Official	Code User
Building Types (cont'd.)		
Industrial	62.5	31.0
Temporary/emergency	39.3	10.7
Other	12.5	16.8
Program Familiarity		
Programs		
LEED (Leadership in Energy and Environmental Design)	16.1	67.5
BEES (Building for Environmental and Economic Sustainability)	16.1	39.1
Local/regional green building program	50.0	64.0
Local/regional utility program	46.4	48.7
Organizations		
USGBC (U.S. Green Building Council)	21.4	51.3
AIA-COTE (American Institute of Architects Committee on the Environment)	19.6	50.3
ASPSR (Architects, Designers, and Planners for Social Responsibility)	12.5	24.4
Congress for New Urbanism	3.6	10.2
Urban Land Institute	21.4	23.4

Note: All values are percentages unless otherwise indicated.

Table 1, cont'd.
Sample Characteristics

Characteristic	Sample	
	Code Official	Code User
Program Familiarity (cont'd.)		
Information Resources		
Environmental Resource Guide (AIA)	10.7	54.8
Green Building Advisor	17.9	47.2
GreenSpec	12.5	54.8
Sustainable Building Technical Manual	12.5	28.4
Environmental Building News	19.6	67.5
Environmental Design and Construction	12.5	53.3
Other	7.1	18.8
Program Participation		
Programs		
LEED	7.1	45.2
BEES	1.8	14.2
Local green	30.4	44.2
Local utility	26.8	29.9

Note: All values are percentages unless otherwise indicated.

Table 1, cont'd.
Sample Characteristics

Characteristic	Sample	
	Code Official	Code User
Program Participation (cont'd.)		
Organizations		
USGBC	5.4	33.7
AIA-COTE	10.7	28.4
ASPSR	5.8	22.1
Congress for New Urbanism	2.4	6.4
Urban Land Institute	5.4	18.6
Information Resources		
Environmental Resource Guide	7.1	38.1
Green Building Advisor	7.1	29.4
GreenSpec	7.1	35.0
Sustainable Building Technical Manual	1.8	21.3
Environmental Building News	17.9	50.8
Environmental Design and Construction	7.1	39.6
Other	3.6	13.7

Note: All values are percentages unless otherwise indicated.

Why Green Alternatives are Approved or Denied

Code officials were asked the three most frequent reasons for denying and approving a green alternative. Tables 2 and 3 show the rates of endorsement by code officials for the reasons.

Table 2
Code Officials' Reasons for Denial of Green Product, Material, System, or Design Application

Reason	*N*	Percent
Insufficient supporting information to satisfy safety concerns	40	71.4
Insufficient knowledge or technical expertise with the product, material, system, or design	30	53.6
Clear conflict with the intent of the code	28	50.0
Insufficient time in the building department to conduct sufficient research to understand the product, material, system, or design	18	32.1
General unfamiliarity with the product, material, system, or design	15	26.8
Personal experience with failure of the product, material, system, or design	9	16.1
Other	7	12.5
Inability of building department to meet tight schedule of applicant	6	10.7
Knowledge of problem of the approach in other jurisdictions	6	10.7

Cluster analysis of the reasons endorsed at least 25% of the time revealed that code officials were clustered in the following three groups:

Group	Reason
A	Clear conflict with the intent of the code
	Insufficient supporting information to satisfy safety concerns
B	Insufficient knowledge or technical expertise with the product, material, system, or design
C	General unfamiliarity with the product, material, system, or design
	Insufficient time in the building department to conduct sufficient research to understand the product, material, system, or design

Thus, code officials' primary reasons for application denial were incompatibility with the letter or spirit of the code, lack of knowledge, and lack of time to acquire knowledge.

Table 3
Code Officials' Reasons for Approval of Green Product, Material, System, or Design Application

Reason	*N*	Percent
Sufficient supporting information provided to satisfy safety concerns	46	82.1
Knowledge of success of the product, material, system, or design	24	42.9
Familiarity with the product, material, system, or design	22	39.3
Specific training in the product, material, system, or design	17	30.4
Ability of building department to conduct sufficient research to understand the product, material, system, or design	14	25.0
Schedule of the applicant allows for sufficient time to work out safety concerns	10	17.9
Personal experience with the product, material, system, or design	7	12.5
Other	7	12.5

Cluster analysis of the reasons endorsed at least 25% of the time revealed that code officials were clustered in the following three groups:

Group	Reason
A	Sufficient supporting information provided to satisfy safety concerns
B	Familiarity with the product, material, system, or design
C	Specific training in the product, material, system, or design
	Knowledge of success of the product, material, system, or design
	Ability of building department to conduct sufficient research to understand the product, material, system, or design

Thus, code officials' primary reasons for application approval were satisfaction with safety concerns and knowledge of the green product, material, system, or design.

Inadequate Information, Lack of Technical Knowledge Most Likely to Result in Denial
Among the code officials who responded to the survey, the most commonly stated reasons for denying green alternatives were lack of adequate supporting information (71.4%), and insufficient technical knowledge about the alternative (53.6%) (see Table 2).

Conflict with Code Cited Frequently by Code Officials, Raises Further Questions
50% of the code officials indicated that a clear conflict with the intent of the code was a reason for denying applications for a green product, material, system, or design (hereafter summarized as a "green alternative") (see Table 2). This raises two important questions which warrant further study. The first is whether these code conflicts are due to actual threats to health, safety, or welfare because of the technical inadequacy of the proposed alternative, or whether the conflict is the result of the way the code establishes the technical requirements. In other words, the fact that a proposed alternative was found to be in clear conflict with the code does not necessarily establish that the alternative is unsafe or unsatisfactory in meeting the intent of the code. It is possible that the conflict results from the way the code is written or structured rather than with the technical merits or faults of the alternative. The second question raised is whether the code officials were referring to conflict with the *intent* of the code (which, in general, is to protect the public health, safety, and welfare) or the *letter* of the code (which lays out specific criteria that must be met, presumably in order to meet the intent of the code). Further inquiry into which interpretation code officials use would be very informative.

Existing Code Provisions Not Highly Influential in Approval or Denial of Alternatives
Table 4 shows the effect of specific code provisions on application approval and denial.

Table 4
Existence of Code Provisions and Effect on Approval or Denial of Green Product, Material, System, or Design Application

	Sample							
	Code Official				Code User			
	No		Yes		No		Yes	
Effect	*N*	%	*N*	%	*N*	%	*N*	%
Did the existence of a specific code provision (other than the alternative materials and methods provision) contribute to the approval of a green product, material, system, or design?	41	73.2	15	26.8	139	84.8	25	15.2
Did the existence of a specific code provision contribute to the denial of a green product, material, system, or design?	33	58.9	23	41.1	85	64.9	46	35.1

Chi-square analyses revealed that significantly ($p < .001$) more code officials considered a specific code provision to not contribute to application approval than considered a specific code provision to contribute to application approval. However, the number of code officials who did and did not consider a specific code provision to contribute to application denial was not significantly different. Significantly ($p < .001$) more code users considered a specific code provision to contribute to neither application approval nor denial than considered a specific code provision to have any such effect.

The percentage differences between the code officials and code users were not significant. Thus, code officials considered a specific code provision to not contribute to application approval while code users considered a specific code provision to contribute to neither application approval nor denial.

In other words, respondents from both groups did not find that existing codes strongly affect the decision regarding green alternatives. As the results of other questions in the survey showed, other factors contributed more to that decision.

Both Technical and Non-Technical Factors Affect Approval and Denial of Alternatives

Applying the survey results to the actual processes of designing, submitting, gaining approval, and constructing buildings reveals the need for a finer set of distinctions in describing the problems. These include how particular problems are perceived and understood by the different sectors and how those differences might help with the process of ultimately resolving code approval problems. For example, the overall survey results point to two different though intricately related problems in gaining acceptance for alternatives: 1) the technical requirements of the codes and the technical merits of the alternatives, and 2) the factors that actually affect the approval or denial of the use of those alternatives.

Code officials are charged with responsibility for protecting the public welfare. To do so, they depend on their ability to interpret the technical requirements of the codes and whether the technical merits of the alternatives meet those requirements. Thus, their understanding of both the codes and the supporting information supplied for green alternatives is critical in determining the outcome for a given project. The reasons for rejection reported by the code officials surveyed were both technical (clear conflict with the intent or the letter of the code, insufficient supporting information to satisfy safety concerns, insufficient knowledge or technical expertise with the alternative) and non-technical (general unfamiliarity with the alternative, insufficient time in the building department to conduct sufficient research to understand the alternative) (see Table 2). Likewise, the factors that contributed to the approval of an alternative were both technical (sufficient supporting information, specific training in the alternative) and non-technical (familiarity with the alternative, knowledge of success of the alternative, ability of building department to conduct sufficient research to understand the alternative) in nature (see Table 3).

Therefore, the quality of the information submitted, the training given a particular code official, time available, previous knowledge, and/or similar experience – in other words, non-technical factors of the actual merits of the alternative – are very important in approval or denial. Code users, however, indicated much of the supporting information provided with applications was technical (i.e., engineered design and calculations, test results, and other technical information)

(see Table 7 below). Therefore, it appears that approval decisions are made on non-technical factors about as often as on the actual technical merits of the submitted alternatives and their ultimate performance in terms of health, safety, and public welfare.

Application Process for Green Alternatives

Choosing Not to Include a Green Alternative

Code users were asked if the had ever not specified or included a green alternative because they thought it would not be approved. 34.6% (*N* = 62) said no, and 65% (*N* = 117) said yes. For those who responded yes, they were asked what the primary basis for this reasoning was. The rates of responses are outlined in Table 5.

Table 5
Code Users Reasons for Not Specifying or Including Green Product, Material, System, or Design Application

Reason	*N*	%
Expectation of additional time necessary to gain approval	27	22.7
Lack of sufficient/available supporting information	24	20.2
Knowledge of rejection by building department of similar material, system, or design	19	16.0
Experience of past rejection by building department of similar product, material, system, or design	16	13.4
Expectation of additional money necessary to gain approval	14	11.8
Other	13	10.9
Lack of confidence in quality of supporting information	6	5.0

Nearly two-thirds of the code users (65%) reported that they had not specified or not included a green alternative because they thought it would not be approved. The leading reasons reported for the decision not to include green alternatives were the expectation of additional time necessary to gain approval (22.7%) and the lack of available or sufficient supporting information to support their permit application (20.2%). This indicates a fairly high level of concern and the expectation that gaining approval for green alternatives will be difficult and add time to the process. It also indicates that in many cases, the person submitting the green alternative for approval is not confident enough in the adequacy of the supporting materials to expect to be able to gain approval. Over 30% of the respondents based that decision on either knowledge (16%) or actual experience of rejection of the alternative by the building department (13.4%). This reinforces a long-standing supposition among those working to create more acceptance for green building among the building codes community that the problem of gaining code approval for green alternatives is not a simple problem concerning what is in the codes but a mix of perception, and the availability of what code officials will consider adequate supporting information.

Successful Strategies Ranked Consistently Among Code Users and Code Officials

Table 6 shows the rates of endorsement by code officials and users for strategies that have been used to gain approval for green alternatives.

Table 6
Strategies Used to Gain Approval of Green Product, Material, System, or Design Application

	Sample			
	Code Official		Code User	
Strategy	*N*	Percent	*N*	Percent
Providing adequate supporting information	43	76.8	126	64.0
Starting the approval process early to allow time to work with the building department	33	55.4	108	54.8
Involving the building department staff early in the design process	31	55.4	103	52.3
Providing precedents of code approval of similar approach in other jurisdictions	19	33.9	68	34.5
Providing contact information for building officials in other jurisdictions with experience in the green approach	18	32.1	60	30.5
Using outside experts	16	28.6	60	30.5
Persistence/patience	10	17.9	100	50.8
Other	7	12.5	20	10.2

The correlation between the rank order of the code officials and users strategies is .86 ($p < .01$). Therefore, the ranking of strategies used to gain approval were virtually the same between the two groups. Some type of time element as well as supporting information were the most selected strategies. Elements of time included both starting the process early and taking the time to engage the building staff early in the process. These results demonstrate that both code officials and code users are in agreement on a set of successful strategies. The only significant difference was that “persistence/patience” was marked by 50.8% of code users and only 17.9% of code officials. That difference in perception is interesting. It may be that the people who submit alternatives start early, do all the work of gathering and providing supporting information, and then go through the process of resubmitting with more information, have a heightened awareness of their effort and of their need to be persistent or patient. Whereas code officials, who are routinely doing their job and dealing with many more projects and plans, do not particularly notice how much extra effort or time is required and put in by those seeking approval for green alternatives. Since persistence and patience were cited as a successful strategy by half of the code users, it appears to be a useful strategy to recommend to applicants.

Supporting Information Submitted with a Green Alternative a Key to Gaining Approval

Among code users, 80.2% (N = 142) provided supporting information in seeking initial approval for a green alternative, while 19.8% (N = 35) said that they did not. Table 7 shows the rates of endorsement by code users for the types of supporting information and their correlations with application approval or denial (rates of approval or denial are reported below):

Table 7
Types of Supporting Information Provided with Green Product, Material, System, or Design Application

Information	*N*	Percent	*r*
Engineered design and calculations	87	61.3	.06
Test results	76	53.5	.07
Historical or other precedents	70	49.3	-.01
Contact information for other jurisdictions or building officials knowledgeable with the product, material, system, or design	50	35.2	.18*
Other technical information	79	55.6	.12
Other non-technical information	43	30.3	-.17*
Other	7	4.9	.05

* $p < .05$

Of various reasons for approval of green alternatives, 82.1% of the code officials cited sufficient supporting information as contributing to the approval of an application. Most of the code users (80.2%) reported submitting supporting information with the application containing a green alternative. The majority of the information was technical in nature. However, examination of the correlation between the different types of information and whether the application was approved or not revealed that providing contact information for other code officials familiar with the green alternative had a significant positive correlation with approval. Supplying other non-technical information was a significant predictor of application denial, though the nature of that information was not specified by respondents and would be interesting to research further.

Slightly over half (55.5%, N = 91) of code users were granted initial approval for a green alternative and 44.5% (N = 73) were denied. For those who were denied, code users were asked to select all of the next steps they took. Table 8 shows the rates of endorsement by code users for all of the next steps and the correlation between all of the next steps and ultimate application approval.

Table 8
Next Steps Taken Following Initial Denial of Green Product, Material, System, or Design Application

Next Step	*N*	Percent	r
Resubmitted with additional supporting information	22	30.1	.57*
Modified green approach with alternative green approach that would meet code requirements	9	12.3	.17
Removed rejected green approach and replaced with conventional/code acceptable approach	28	38.4	-.43**
Met with building department representative to advocate for approval of green approach as submitted	16	21.9	.12
Met with building department representative to discuss how the green approach could gain approval	21	28.8	.16
Other	16	21.9	-.30*

* $p < .05$; ** $p < .01$

Thus, code users' primary response to application denial is removing green components, but this is a significant ($p < .01$) predictor of ultimate application denial, as were other next steps ($p < .05$). Resubmitting with additional supporting information was a significant ($p < .01$) predictor of ultimate application approval.

As a result of taking steps to gain approval after initial denial, 45.8% ($N = 38$) said approval was not eventually granted and 54.2% ($N = 45$) said approval was eventually granted.

When an application was initially denied, the highest percentage of code users (38.4%) chose to remove the alternative altogether when resubmitting plans for approval. Interestingly enough, this strategy had the strongest correlation with subsequent denial of the application. This raises more questions than answers – perhaps the original denial was not only because of the green alternative but because other aspects of the application did not fit with the code. What emerges, regardless of this somewhat anomalous result, is that the most common response to initial denial for an alternative was for that alternative to be removed before resubmitting. The next most common strategy that 30.1% selected was to resubmit the application with additional supporting information, which, upon analysis turned out to be a significant predictor of subsequent application approval. This again supports other results indicating that adequate supporting information is among the most important criteria in gaining code approval for a green product, material, system, or design.

Persistence and Patience Increase Likelihood of Approval

The results on page 9 and 10 also reveal that most applications that included a green alternative were successful in gaining approval with persistence – a little over half of the respondents were granted approval upon initial application. Of the approximately half who were denied, 54.2% gained approval when the application was resubmitted after the applicant took additional steps.

This indicates that overall, with persistence and adequate support information supplied, about three-quarters of the code user respondents were ultimately successful in getting their alternatives approved.

Certain Green Alternatives Face Greater Approval Challenges

There are specific alternatives for which code approval has been particularly problematic, namely green approaches to plumbing, designs, and materials. These approaches include examples such as greywater re-use or wastewater treatment strategies, integrated design, and recycled or re-used materials, respectively. When seeking approval for these alternatives, code users may want to be particularly diligent in pursuing the above strategies.

Table 9 shows the extent to which areas have approval problems as reported by code officials and code users:

Table 9
Types of Green Product, Material, System, or Design that Face Approval Problems

	Sample	
	Code Official	Code User
Area	%	%
Design	20.2	19.0
Electrical	8.0	5.6
HVAC	16.1	9.6
Materials	19.3	10.5
Plumbing	15.1	18.3
Site	12.2	13.0
Other	16.1	7.5

Thus, plumbing, designs, and materials experience the highest percentage of approval problems. A comparison of responses between code officials and code users revealed that significantly more code officials than code users considered HVAC ($p < .05$), Materials ($p < .001$), and Other ($p < .01$) to be approval problems.

CONCLUSIONS

The statistical analyses yielded a set of conclusions that are valuable and will provide guidance for the next steps to be taken in response to the information gathered by this project. This set of conclusions can be categorized into two areas: problem areas for green alternatives related to code approval and effective strategies to gain code approval for green alternatives. The first set of conclusions is identified below, followed by a discussion. The second set of conclusions is addressed in the following section.

Areas problematic to code approval of green alternatives

Denial Related to Conflict with the Code and Lack of Supporting Information

Conclusion 1: Applications are more likely to be denied if they are in clear conflict with the intent of the code or if they lack sufficient supporting information about the green product, material, system, or design to satisfy safety concerns.

The survey results made clear that conflict with the code and insufficient supporting information were key reasons for denying the use of green alternatives. The prevalence of these factors indicates that the challenges for acceptance of green alternatives go beyond the technical merits of the alternative to the bases on which decisions for approval or denial are made.

Green alternatives are denied approval for both technical and non-technical reasons. Through experience and contact with code officials and code users, DCAT has identified various examples of these reasons. Some technical concerns relate to actual performance of designs, materials, or methods and the known or verifiable health, safety, or public welfare threats resulting from them. Others relate to the lack of recognized standards, test results, or other technical data to support the ability of the alternatives to meet the intent of the code. This is often true for both for new alternatives and for many older, widely used non-industrial alternatives such as earthen building technologies. Non-technical and administrative problems include those resulting from perceptions and preconceptions, lack of information or prior experience, lack of expertise to judge the technical merits, and lack of time to research or analyze the alternative.

Thus green alternatives submitted for approval – even those designed and sealed by registered architects and engineers – are frequently denied approval for all the reasons stated above. This applies to both new high-tech materials and products, highly sophisticated designs, and for ancient simple practices that have been used successfully around the world for hundreds of years. It can be true even for alternatives with extensive evaluation, testing, and acceptance in other countries or other regions of the U.S.

The fact that non-technical factors affect the alternative approval process about as often as the actual technical merits indicates that there are two problems that must be addressed: 1) both the technical aspects of the codes and the need for alternatives submitted to be accompanied by adequate technical information in support of their compliance, and 2) the whole set of factors that are not technical in nature but still result in rejection of alternatives submitted for approval, regardless of their technical merit. Some of these factors can be addressed through specific training for code officials, both in terms of how to use the alternative designs, materials, and methods provisions in the codes, and in the specific technical merits and adequacy of various alternatives. Similarly, the development of better supporting technical materials and information for the alternatives is needed as well as training or education for code users about what qualifies as adequate supporting information, and what are the most effective strategies for gaining approval.

Existing Code Provisions Only Partially Responsible for Denials

Conclusion 2: Both code officials and code users considered an existing code provision more likely to contribute to the approval of a green product, material, system, or design application, but only code users considered a code provision to contribute to the denial of such applications.

Existing code provisions were found to have minimal impact on the approval or denial of alternatives that are not currently covered by the code. Other factors influence the decision – adequate supporting information being one of the most influential.

However, there are instances where the alternative is viewed as similar enough to the standard design, material, or method it is replacing to result in requirements for the alternative to meet prescriptive requirements of the existing provisions. This can compromise the viability of the alternative by placing requirements that are not appropriate. Green alternatives must be presented and accepted based on the integrity of the alternative as part of a whole building, whole system, or set of systems, fully considering the differences from the standard practice or product being replaced.

Green Alternatives are Often Not Submitted Because of Code Challenges

Conclusion 3: Applications for green products, materials, systems, or designs are avoided because supporting information will take too long to acquire or does not exist.

The survey results confirmed what DCAT found through direct experience and informal research: some code users choose not to include green alternatives in the first place for a variety of reasons and that alternatives are frequently removed as options if they receive initial denial. Thus, the notion that the code approval process hinders the use of green alternatives is supported by the results, but for both technical and perceptual reasons. Removing this barrier requires greater support for code users and code officials alike and is addressed in the recommendations below.

RECOMMENDATIONS

This section will both identify what strategies the survey demonstrated as effective in gaining code approval for green alternatives as well as other recommendations that will help make building regulations and green building more compatible with each other.

Effective strategies for gaining code approval of green strategies

The following conclusions relate to effective strategies:

Conclusion 4: Applications are more likely to be approved if they are accompanied by sufficient supporting information about the green product, material, system, or design to satisfy safety concerns.

Conclusion 5: Successful application strategies are characterized by strong communication linkages between code officials and users that are established at an early stage.

Conclusion 6: Providing contact information with other knowledgeable building officials increases approval of initial applications for green products, materials, systems, or designs.

Conclusion 7: The most effective step in getting denied applications approved is resubmitting with additional supporting information.

Based on these conclusions and the data that generated them, a set of recommended strategies for improving the likelihood of gaining approval for a submitted alternative is listed below.

Strategies to Improve Chances of Code Approval of Green Alternatives

- Provide supporting technical information adequate to satisfy safety concerns – this was clearly the most important factor in gaining approval.
- Provide other information such as case studies of successful use of the alternative and contact information for building officials familiar with the alternative.
- Start the process early.
- Involve building department staff early.
- Be persistent and patient.

Improving the Compatibility of Building Regulations and Green Building

The results of this survey suggest several other areas for recommended actions:

1) **Addressing technical issues related to approval of alternatives.** The ability to continue to collect, refine, analyze, and respond to specific problems such as those identified in this survey would yield continuous potential improvements in the codes and in the ability of both code officials and code users to respond more appropriately to the actual technical merits and problems related to alternative designs, materials, and methods of construction. Support mechanisms should be sought for such ongoing research, analysis, and corrective activities, including developing appropriate committees and liaisons in both the code organizations and in green building and alternative technology organizations.

2) **Researching alternatives**. Survey respondents overwhelmingly identified adequate supporting information as key to approving alternatives. However, one of the clear problems that exists for many alternatives is that they are either non-proprietary systems that are in the public domain or are approaches such as passive solar, passive ventilation, or delighting which do not require specific products but are merely design strategies. In both instances, the alternatives which lack a large industrial basis for financial support for research, testing, and development. Financial support must be found to develop the type of technical supporting information needed for these alternatives. A coalition made up of the code organizations, green building and design organizations, and other interested parties could approach the federal government for support for such activities to be carried out in the national laboratories and at research universities.

3) **Training on meeting the code requirements.** There is a need to develop training and information resources for code users about how to better understand and satisfy code requirements in order improve the code approval rates for alternatives.

4) **Training on code interpretation related to alternatives**. Technical training for code officials is necessary that is focused on alternative materials and approaches, methods of analyzing the code both in terms of letter and intent when dealing with alternatives and use of alternative designs, materials, and methods provisions.

NEXT STEPS AND FUTURE RESEARCH DIRECTIONS

A small percentage of survey respondents provided details on their experiences with green building and codes. Both the number of responses and the degree of detail currently available is insufficient to draw any major conclusions. Further in-depth research into specific case studies would reveal details about the data collected in this study.

Further research into code officials' understanding of "a clear conflict with the intent of the code" would assist in determining if there is a distinction being made between the intent of the code and the specific provisions, which may not always be clear in the case of alternatives. This would include determining whether the specific approval or denial is related to a problem with the alternative or with code (e.g., does the code require something that is irrelevant or inappropriate for a specific alternative system because the requirement is carried over from a different system). This could lead to a set of code change proposals as well if specific problems are found to be the result of code-related rather than alternative-related issues. It could also lead to specific research and testing to verify the ability of the alternative to meet appropriate requirements.

DCAT will use the results of this study to direct future work. Follow-up research on case studies is already planned. DCAT has begun to conduct training for both code users and code officials and the contents of future training will target some of the problem areas and successful strategies identified in this study and future follow-up research. DCAT has already established relationships that will facilitate this work, namely with the U.S. Green Building Council and its Greening of the Codes Committee and partners in the green building and building regulatory communities.

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Appendix A

Introductory Pages to the Codes Survey
(posted on www.dcat.net with a link to the actual survey)

A Survey of Building Codes and Regulations

WHY A BUILDING CODES SURVEY?

In response to the growing shift toward sustainable building design and construction, the Development Center for Appropriate Technology, a 501(c)(3) non-profit organization, has created a program called "Building Sustainability into the Codes." This program addresses the need to create a more sustainable context for building regulation to facilitate the shift to more sustainable practices, through participation in the code development process as well as education and training for building officials and others involved in the building industry. To facilitate this effort, DCAT convened a working group of building and design professionals to develop a survey to identify specific areas in building regulations that pose challenges to best sustainable practices.

The purpose of this survey is to test the following assumptions and to collect data on the experiences of code users and code officials.

Building codes provide challenges to green building because:

- Many of the design approaches, materials, methods, and systems that are often included in green building are not included in current codes, standards and regulations.
- While code provisions exist for the approval of alternative materials and methods, code users and code officials are not always experienced in finding ways for an alternative to meet those provisions.
- There is often limited certifiable information on which to base approvals.
- Time limitations and funding often hinder code officials and code users in their efforts to gain approval for alternative approaches.
- Within the experiences of code users and code officials, there are creative approaches, solutions, and suggestions that can serve as the basis for overcoming these challenges

WHO SHOULD TAKE THIS SURVEY?

Anyone who has experience with green building projects:

CODE USERS, such as builders, architects, engineers, designers, consultants, landscape architects, materials manufacturers or suppliers, building owners, owner-builders and others who have sought code-approval for green building projects.

CODE OFFICIALS, such as building officials, plans examiners, inspectors, fire officials, planning officials, code consultants, model code organization staff, and others in the position of regulating building.

SURVEY STRUCTURE

There are two surveys, pursuing similar, though slightly different paths. One is specifically for code officials, and is designed to focus on the challenge that community faces as we move toward more sustainable building. The second is focused on the challenges faced by code users. Both surveys are accessible by following the link below.

RESULTS

The results from this survey will be compiled and analyzed to develop a prioritized set of strategies to address the challenges identified. The results, analysis, and conclusions will be widely distributed through national publications as well as through the DCAT website.

We invite you to read some more background on the survey below.

To complete the survey, please click on the CodesSurvey icon below.

We thank you for the time and heart you put into your practice, and into this survey.

Sincerely,
David Eisenberg, Loretta Ishida, Tony Novelli

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INVITATION

Through this survey, we welcome feedback on your experiences. This is a chance to approach these issues from a constructive, thoughtful place. DCAT has been successful, through many years of work, in creating a constructive dialog between building regulators and people practicing sustainable building approaches, we are now poised to advance the cause of sustainability in buildings now more than ever before. Within this context, we hope you join our commitment to this collaboration. The survey is an attempt to understand, from all points of view, what kind of challenges building codes present to green building, how people have faced those challenges, and how together we can work to resolve those challenges. Therefore we encourage you not to blame individuals, building departments, organizations, or firms, but to extract from your experience the key issues that need to be addressed to forward sustainable building and development practices.

FUNDING AND SUPPORT

This research is sponsored by the Development Center for Appropriate Technology (DCAT), with partial funding from the Merck Family Fund. Although we have had generous funding from Merck for developing this project, the survey itself and associated costs with its development, compilation, analysis, and follow-up are not fully funded by this support. We are seeking additional support from a variety of sources, including the green building, design, engineering, development, and related communities in order to maximize the accuracy, integrity, and effectiveness of this overall effort. If the results of this survey and the potential outcomes resulting from the effort to address the challenges it identifies will be of benefit to you, your organization,
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profession, or industry, please consider helping support this effort financially. Donations to DCAT for this purpose are tax deductible.

DCAT's program, "Building Sustainability into the Codes," is supported by grants from the Wallace Global Fund, the Turner Foundation, the Compton Foundation, and by a growing number of individuals and organizations.

TERMINOLOGY

Because of the overuse and popularity of terms such as “sustainability” and “green building” their meaning has become broad and nebulous. Therefore, we offer our understanding of these two terms in the context of this survey.

Green Building. Green building includes methods and approaches to construction and development that pay attention to, and offer improvements in one or more areas, such as: material toxicity, indoor air quality, energy efficiency, use of integrated design principles, waste reduction and recycling, super-insulation, passive design, permaculture and other site-based approaches, use of locally derived, sustainably harvested materials, and others.

Sustainability. In the context of the building industry, a sustainable approach is one that, when measured against healthy, accurate feedback loops in tune with the full life-cycle of a material or practice, shows a zero-net negative impact. In other words, it can be maintained at a particular pace indefinitely based on all available accurate information about its impacts, and such information is constantly re-examined and expanded to fill gaps that emerge.

Regenerative practices. These are practices which offer more back to the systems they are reliant upon than they extract or otherwise deplete.

Please click here for a more in-depth discussion of sustainable building practices and other related terminology. To take the survey, please see below.

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GLOSSARY OF TERMS

Alternative materials and methods code provision: Sections in all existing codes giving guidance for approval or designs, materials and methods of construction not specifically covered by the code.

Battery power storage systems: Battery systems that are designed to store power in batteries that has been generated by solar photovoltaic, wind, micro-hydroelectric, or other site-based power generation systems, as well as to store grid power in some grid-connected power systems.
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Code users: People who comply with codes, such as builders, architects, engineers, designers, consultants, landscape architects, materials manufacturers or suppliers, building owners, owner-builders and others who have sought code approval for green building projects.

Code Officials: People who ensure code compliance, such as building officials, plans examiners, inspectors, fire officials, planning officials, code consultants, model code organization staff, and others in the position of regulating building.

Daylighting: Daylighting optimizes the use of natural light through design considerations to illuminate the interior of buildings during the day. Common daylighting strategies include the proper orientation and placement of windows, use of light wells, light shafts or tubes, skylights, clerestory windows, light shelves, reflective surfaces, and shading, and the use of interior glazing to allow light into adjacent spaces.

Green building: Green building refers to the process of designing and constructing buildings in ways that minimize their negative ecological impacts. This includes concern for the full life cycle impacts of buildings from the acquisition of resources and materials, transportation, processing, manufacture, distribution, installation, use, maintenance, repair, and ultimate disposal. Green building usually also includes efforts to ensure energy efficiency, material and resource efficiency and healthy and safe indoor environment in terms of the toxicity of materials and indoor air quality.

Green development: Green development is a development approach that benefits or has minimal negative impacts to the local and larger environment, uses resources efficiently (including community resources), and is sensitive to the existing local culture and community.

Green materials, products, and systems: Green materials, products, and systems have many of the following characteristics: are durable, are low-maintenance, have low-embodied energy (energy required to acquire, transport, manufacture and install), are locally available, are made from recycled or renewable resources and can be recycled or renewed, have low toxicity, produce little pollution or waste, and have minimal negative ecological impacts.

Greywater systems: Greywater systems take water used once for washing clothes or bodies and distribute that water for secondary use, typically for subsurface irrigation of landscaping.

Integrated Design: Integrated design is a design process that treats the entire building as a system comprised of subsystems. This design approach optimizes the overall performance of a building by making design decisions that connect the performance of the various components of the building together, so that, for example, improvements in solar orientation and thermal envelope of the building, combined with proper use of daylighting, allows the HVAC systems to be downsized, saving energy, materials, maintenance, equipment costs, etc. Because these systems are typically not integrated, the minimum performance requirements for various components or systems are often higher than are actually needed for such high-performance designs.

Micro-hydroelectric systems: Micro-hydroelectric systems generate electricity by harnessing the flow of a stream or some other small-scale flowing water source. Surplus electricity is often stored in a battery storage system for later use.

Passive solar design: Passive solar design of buildings maximizes the use of the sun for heating during cool weather and minimizes solar gain from the sun in warm weather. Design features typically include south-facing orientation of windows for winter sun (in the northern hemisphere), general east-west orientation of the building, roof and overhangs that provide shade from the summer sun but allow the winter sun through the windows, and thermal mass in the interior to store heat or coolness and maintain more constant temperatures within the structure. Good insulation is typical also for most of the building envelope, to control heat loss and gain.

Passive ventilation: Passive ventilation relies typically on using both convective air flows that result from the tendency of warm air to rise and cool air to sink and taking advantage of prevailing winds. Many passive ventilation systems rely on the building users to control window and vents as dictated by site conditions and conditions within the building.

Solar thermal water heating: Solar thermal water heating uses the energy of the sun to provide or supplement a building's hot water supply. This can be for both domestic hot water and for building heat, usually through radiant heat systems.

Solar photovoltaic systems: Solar photovoltaic systems harness the energy of the sun and convert it into electricity. This electricity can be used as either direct current (DC) power or alternating current (AC) power if an inverter is used. Surplus electricity is often stored in a battery storage system for later use.

Solar thermal air heating: Solar thermal air heating uses the energy of the sun to heat air either for direct space heating or to heat the thermal mass of the building or heat storage systems (such as water tanks, rock pits).

Water harvesting systems: Water harvesting systems collect rainwater for use after a rain event. Features in the system can include catchment / storage systems such as gutters and cisterns, landscaping features (swales, basins, etc.) to direct the rainwater to plants and / or hold the water to slow the infiltration rate.

Wind power systems: Wind power systems convert the energy of the wind into electricity. Surplus electricity is often stored in a battery storage system for later use.