



R

RESEARCH REPORT

INTEGRATED COMMUNITY
SOLUTIONS:

REGINA'S AFFORDABLE, SUSTAINABLE
HOUSING DESIGN CHARRETTE



HOME TO CANADIANS
Canada

CMHC—HOME TO CANADIANS

Canada Mortgage and Housing Corporation (CMHC) is the Government of Canada's national housing agency. We help Canadians gain access to a wide choice of quality, affordable homes.

Our mortgage loan insurance program has helped many Canadians realize their dream of owning a home. We provide financial assistance to help Canadians most in need to gain access to safe, affordable housing. Through our research, we encourage innovation in housing design and technology, community planning, housing choice and finance. We also work in partnership with industry and other Team Canada members to sell Canadian products and expertise in foreign markets, thereby creating jobs for Canadians here at home.

We offer a wide variety of information products to consumers and the housing industry to help them make informed purchasing and business decisions. With Canada's most comprehensive selection of information about housing and homes, we are Canada's largest publisher of housing information.

In everything that we do, we are helping to improve the quality of life for Canadians in communities across this country. We are helping Canadians live in safe, secure homes. CMHC is home to Canadians.

You can also reach us by phone at 1 800 668-2642
(outside Canada call 613 748-2003)
By fax at 1 800 245-9274
(outside Canada 613 748-2016)

To reach us online, visit our home page at www.cmhc.ca

Canada Mortgage and Housing Corporation supports the Government of Canada policy on access to information for people with disabilities. If you wish to obtain this publication in alternative formats, call 1 800 668-2642.

Integrated Community Solutions: Regina's Affordable, Sustainable Housing Design Charrette



Final Report

Prepared For:

Robert Bjerke, Community Services Department
City of Regina

And

Thomas Green, Policy and Research Division,
Canada Mortgage & Housing Corporation

By

Ken Coutu
Integrated Controls Ltd.

March 2003

Publication Information

This research project was funded by Canada Mortgage and Housing Corporation (CMHC). The contents, views and editorial quality of this report are the responsibility of the author(s) and CMHC accepts no responsibility for them or any consequences arising from the reader's use of the information, materials and techniques herein.

Coutu, Ken & Guy, Murray.
Regina Affordable Sustainable Housing Charrette

© 2003 Canada Mortgage and Housing Corporation, and the City of Regina. All rights reserved. No portion of this book may be reproduced, stored in a retrieval system or transmitted in any form or by a means, mechanical, electronic, photocopying, recording or otherwise without the prior written permission of copyright holders. Without limiting the generality of the foregoing no portion of this book may be translated from English into any other language without the prior written permission of the copyright holders.

Project Team

City of Regina Project Manager:
Robert Bjerke, Housing Co-ordinator, Community Services Department, City of Regina

CMHC Project Manager:
Thomas Green, Senior Researcher, Policy and Research Division, CMHC

Project Leader:
Murray Guy, Principal, Integrated Controls

Facilitators:
Ken Coutu, Integrated Controls
Kelly Winder, Kelln Consulting/Integrated Controls
Rob Dumont, Saskatchewan Research Council
Greg Allen, Sustainable Edge (formerly Allen Kani Associates)

Executive Summary

A design charrette sponsored by Canada Mortgage and Housing Corporation (CMHC) and hosted by the City of Regina took place on January 10, 2003. The purpose was to solicit ideas and explore the opportunities for a pilot project that would demonstrate affordable, sustainable housing development on a vacant school site located in Regina's inner city based on initial design and feasibility work for the site.

Design charrettes are becoming more common in design practice and are an excellent way to bring a range of expertise and interests together to collaborate and create effective solutions to multifaceted projects. The Regina Affordable Sustainable Housing Charrette was very successful in presenting a vision and potential path towards creating healthy affordable housing and a community asset for the City of Regina.

The project goal was to create design strategies that can reduce operating costs while providing comfortable housing that protects the health of the occupants and the environment. Thirty-five key individuals contributed their expertise and time over an intensive day of presentations and discussion. They included technical experts, representatives from the local neighbourhood, and participants from various partner organizations.

The degree of enthusiasm and positive ideas as well as the degree of consensus achieved during the charrette reflect the shared realization of the participants for the extensive benefits that such a well-planned healthy housing project could bring to the housing occupants, as well as the surrounding neighbourhood.

Résumé

La Société canadienne d'hypothèques et de logement (SCHL) a parrainé une charrette de conception tenue le 10 janvier 2003 par la ville de Regina. Cette activité avait pour but de solliciter des idées et d'explorer la faisabilité d'un projet pilote qui contribuerait à faire la démonstration d'un ensemble résidentiel à la fois abordable et durable aménagé sur le terrain d'une école désaffectée situé au cœur de Regina.

Les charrettes sont de plus en plus courantes dans le milieu de la conception; elles sont un excellent moyen de réunir divers talents et intérêts autour d'un même projet afin de trouver des solutions efficaces à des créations complexes. La *Regina Affordable Sustainable Housing Charrette* a très bien réussi à présenter une vision et une avenue possible pour créer des logements abordables sains et un actif collectif intéressant pour Regina.

Cette charrette avait pour but de mettre sur pied des stratégies de conception susceptibles de réduire les frais d'exploitation tout en procurant des logements confortables protégeant la santé des occupants et de l'environnement. Trente-cinq personnes ont fait profiter le groupe de leur expertise au cours d'une journée intensive d'exposés et de discussions. Il y avait des experts techniques, des représentants du quartier et des participants délégués par divers partenaires.

Le degré d'enthousiasme, les idées positives de même que le consensus qui ont marqué la charrette reflétaient bien le fait que les participants comprenaient les avantages importants qu'un ensemble sain aussi bien planifié pourrait apporter tant aux occupants qu'au quartier environnant.



National Office

Bureau national

700 Montreal Road
Ottawa ON K1A 0P7
Telephone: (613) 748-2000

700 chemin de Montréal
Ottawa ON K1A 0P7
Téléphone : (613) 748-2000

Puisqu'on prévoit une demande restreinte pour ce document de recherche, seul le résumé a été traduit.

La SCHL fera traduire le document si la demande le justifie.

Pour nous aider à déterminer si la demande justifie que ce rapport soit traduit en français, veuillez remplir la partie ci-dessous et la retourner à l'adresse suivante :

Centre canadien de documentation sur l'habitation
Société canadienne d'hypothèques et de logement
700, chemin de Montréal, bureau CI-200
Ottawa (Ontario)
K1A 0P7

Titre du rapport: _____

Je préférerais que ce rapport soit disponible en français.

NOM _____

ADRESSE _____

rue

App.

ville

province

Code postal

No de téléphone () _____

Table of Contents

Project Team	i
Executive Summary	ii
Table of Contents	iii
Introduction	1
Background	2
The Charrette	2
Design Goals	3
Design Parameters	3
Design Philosophy	3
Design Objectives	4
Site Description	5
Site Development	6
Resource Use	11
Building Envelope and Geometry	12
Building Systems	14
Integrated Waste Management and Greenhouse Facility	18
Conclusion	19
Appendix 1 List of Participants	20
Appendix 2 Design Charrette Agenda – January 10, 2003	21
Appendix 3 CMHC’s Healthy Housing™	22
Appendix 4 Sustainable Technologies, Systems And Measures For Affordable Housing At The St. Joseph’s School Grounds	24
Appendix 5 St. Joseph’s Affordable & Sustainable Housing Project presentation by Murray Guy	35
Appendix 6 Integrated Design Process presentation by Ken Coutu	38
Appendix 7 LEED Green Building Rating System presentation by Ken Coutu	40
Appendix 8 Strategies for Alternative Energy Use and Redistribution at the Building Envelope presentation by Kelly Winder	42
Appendix 9 Affordable Advanced Housing – A Case Study – The Dumont Residence presentation by Rob Dumont	60
Appendix 10 An Advanced Multi-Unit Residential Concept Building for the Prairie Climate - report highlight	68

Introduction

Current economic and demographic conditions have led to a well-recognized need for the creation of a diverse array of affordable housing solutions across Canada. At the same time, it is critical that housing built today will provide a healthy environment that is sustainable in terms of energy and resource use and impacts on land, air and water. There is a growing understanding that successful approaches to affordable housing include a consideration for long term operating and maintenance requirements, the broader issues of support systems for occupants, and the health and sustainability of communities. “Least capital-cost” housing is not necessarily affordable housing.

In response to these challenges, a charrette workshop was held in Regina on January 10th, 2003. The aim of the workshop was to develop affordable and sustainable urban infill housing design solutions for the closed St. Joseph school site in Regina, Saskatchewan that could create an affordable and desirable community to live in, revitalize the urban environment, and dramatically reduce impacts to natural systems.

The Regina Affordable Sustainable Housing charrette brought together a wide range of partners to initiate a process to design, develop, construct and monitor the development of affordable sustainable housing in an inner-city neighbourhood of Regina. The project goal was to create design strategies that can reduce operating costs while providing comfortable housing that protects the health of the occupants and the environment. The project drew together current “best practices”, recognized leaders and key supports to develop some of the most resource and energy efficient affordable housing in Canada.

35 key individuals (Appendix 1) contributed their expertise and time over an intensive day of presentations and discussion (Appendix 2). They included technical experts, representatives from the local neighbourhood, and participants from various partner organizations.

The design charrette was sponsored by Canada Mortgage and Housing Corporation (CMHC), and hosted by the City of Regina. The planned project is a multi-sector partnership that the City of Regina has undertaken with CMHC, the Saskatchewan Housing Corporation (SHC), the McGill School of Architecture Affordable Homes Program, and other local partners including the Saskatchewan Research Council (SRC). In addition to the strong partnerships developed through the initial design component of the project, Ehrlo Community Services, a local a non-profit housing and housing support provider is working with the partners on the development of this site.

Background

The proposed concept for affordable sustainable housing on the closed St. Joseph School site builds on groundwork from a design studio project on affordable solar housing designs for Regina involving a partnership between the City of Regina, CMHC, SHC and the McGill School of Architecture during the Winter 2002 semester. In that project, the St. Joseph school site was one of 7 inner city sites identified by the City as having high potential for developing affordable housing that could provide much needed housing units while also having a positive influence on the community if done well. The project concepts also included sustainable housing approaches such as passive solar design and CMHC's Healthy Housing™ principles (Appendix 3). The result of the studio was a number of design concepts for affordable solar housing for specific sites in Regina.

To further develop the design concept specific to the St. Joseph site, Allen Kani Associates was engaged to outline and assess various technical opportunities for sustainable and affordable housing development on the site (Appendix 4).

In preparation for the charrette itself, an information package was put together including the background material discussed above, as well as copies of presentations that were given during the charrette. Copies of this material are included in the Appendixes 5-10 at the end of this report.

The Charrette

The initial discussion at the charrette centered on the perceived conflict between creating affordable housing and adding sustainable housing features. It was pointed out that the basic approach to affordable housing and passive solar housing is the same. Start with a small footprint building that makes good use of vertical space, i.e. multi story, with a simple building form to minimize complexity, reduce construction costs and building heat loss. Then improve the building envelope to increase comfort, minimize operating and maintenance costs and reduce or eliminate mechanical systems, and thereby cover the costs of the better building. Lower heating and cooling loads make heat gain and cooling from natural systems practical, such as passive solar, shading and natural ventilation. An integrated design approach allows each component of the building to provide more than one function, thereby reducing costs.

It was noted during the charrette that people generally have difficulty relating to broad global issues such as Kyoto, climate change and even space and water constraints in Regina where there is so much physical space all around. More public education and awareness was seen to be required. It was also recognized that although many of the approaches examined in the charrette are established and utilized in other sectors, few examples of affordable and sustainable housing exist and a demonstration of such housing would be very beneficial. Additional funding and support through a variety of sources including the Federation of Canadian Municipalities (FCM) Green Municipal Funds, programs available through Natural Resources Canada's Office of Energy Efficiency, the emerging partnership of the Sustainable Communities Institute in Regina or other sources may be available to assist in supporting and demonstrating of some of the technologies described in this report.

The charrette participants also noted that this community would likely house people with a mix of incomes and could be a stepping-stone to home ownership. Many occupants could benefit from education and support in several areas and therefore consideration should be given to integrating home maintenance and ownership components with support programs for the occupants. In addition, a maintenance protocol is required to ensure adequate and efficient operation and maintenance.

The following sections highlight the design approach, specific project details, and key discussions points that arose from the charrette workshop.

Design Goals

The St. Joseph's site pilot project will use an integrated design approach (Appendix 6) to create a housing project that is affordable to families in Regina with incomes below \$39,500 while meeting the environmental standards for a platinum project under the Leadership in Energy and Environmental Design (LEED) green building rating system (Appendix 7). The primary emphasis will be on effective simple solutions to meet the project objectives while also considering technologies and approaches that reflect significant innovation where appropriate.

Design Parameters

1. 30 apartment dwelling units
2. 50 ground-oriented dwelling units
3. \$100k/unit cost including land
4. 1 parking stall/dwelling plus visitor parking and parking for the community center
5. Reuse of gymnasium as part of a community center that includes space for a daycare, offices, meeting rooms and multipurpose space
6. Affordable housing to families with incomes less than \$39,500.
7. LEED platinum rated sustainable design
8. Develop strategies to accommodate two levels of funding
 - A: Low or no cost strategies that optimize total life cycle cost
 - B: Designs that demonstrate a high level of sustainability and have longer-term paybacks (Greater than 10 years)

Design Philosophy

Affordable healthy housing is an important component in the creation of healthy children, caring communities and a sustainable city. The best things in life are free: the sun, the rain, the wind and the ground upon which we tread and are given to us without measure. The St. Joseph affordable sustainable housing project will optimize the benefits of these natural features, capitalize on existing urban amenities, and enhance the surrounding community environment.

Design Objectives

This project will provide an opportunity to revitalize the community by linking the adjacent school, swimming pool, park and this housing development. The proposed site layout shall optimize the following design objectives and facilitate meeting the LEED platinum standards.

1. **South orientation and solar access for each dwelling unit.** Utilize the potential for passive and active solar heating and cooling. Provide architectural solar shading on the South. Deciduous trees can be used for shading on East and West orientations, ensuring to not shade any solar collectors.
2. **Minimize the impact of roadways and parking lots.** Locate parking under significant buildings including the apartment with appropriate ventilation considerations. Consider carports and with green roofs and investigate parking opportunities with the hospital. Provide secure bike storage and consideration for an automobile transportation cooperative.
3. **Low maintenance, xeriscaped landscape design.** Incorporate appropriate local planting materials and recycled material from the existing school. Low maintenance lawns for play areas. Collect all rainwater from the site.
4. **Develop a positive, safe sense of place throughout the project.** Crime Prevention through Environmental Design (CPTED) is routinely used by the City and should inform the site. Facilitate child monitoring and safe, easy access to outdoor spaces. Provide strong visual links from living areas to play areas, park and school grounds.
5. **Reuse a maximum amount of material from any demolished buildings on site.** Provide brick planters and benching adjacent to dwelling units and along pathways. (Recycled brick)
6. **Utilize environmentally friendly renewable resources throughout.** Select building material that minimize total life cycle costs, embodied energy and off gassing. Provide a recycling depot, on site composting and education.
7. **Accessible units should be integrated throughout the development.** A higher percentage of lower income populations typically have a physical disability.
8. **Create a strong community link and orientation to the Gym and community center.** Include services such as a laundromat, reference library, social/training room and community run convenience store in addition to offices, recreation facilities and daycare. Include intranet services linking the housing units to the centre utilizing information technology.

Site Description

An aerial photograph is shown in Figure 1. The key points to note are:

1. The site is roughly rectangular with the long side running from north to south and is adjacent to Thomson School - an elementary school and schoolyard on the north and the municipal Maple Leaf Park to the east. Maple Leaf Park includes an outdoor pool and mature landscaping. A senior's centre and high-rise apartment is also located directly east of the park.
2. The General Hospital, one of Regina's two hospitals, is located across a Toronto Street to the west of the site. Toronto Street is used by emergency vehicle access in addition to regular traffic related to Thomson School.
3. The neighbourhood has a range of residential building forms including low and high-rise apartments, townhouses and single detached houses. Single detached houses are predominant to the south of the site, across 14th Avenue.
4. The existing school structure has not been maintained since the school closed and has deteriorated significantly. The gymnasium for the school, however, would be retained in the future development as part of a community centre for the neighbourhood.
5. The site has little variation in topography and few natural features apart from several mature trees.

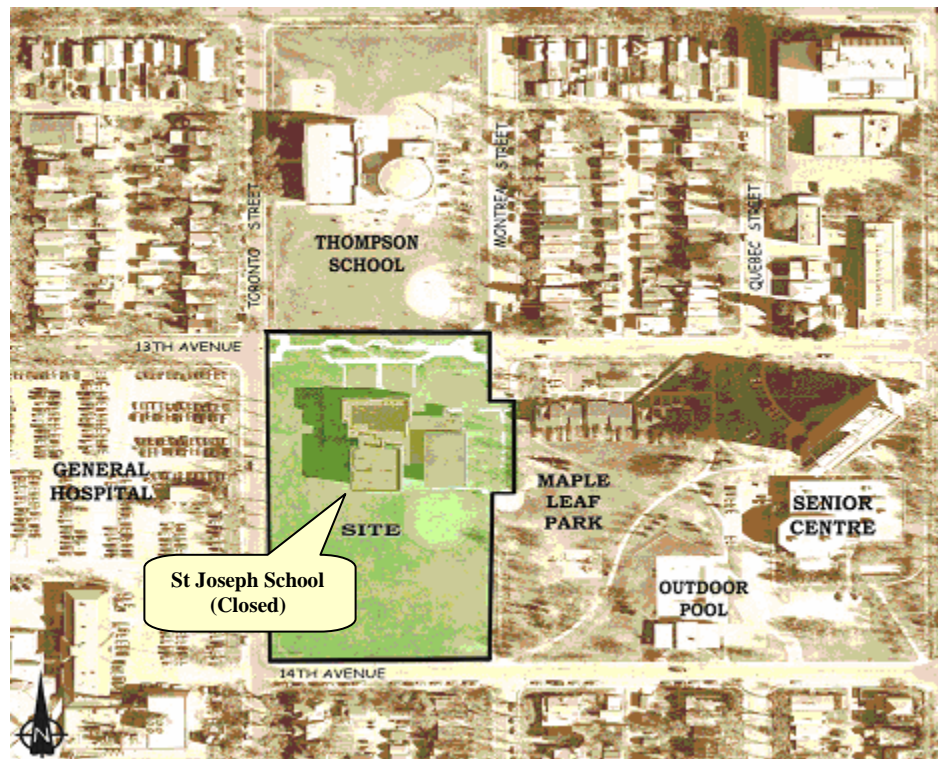


Figure 1 – Aerial Photograph of the St. Joseph School Site

Site Development

Key factors in setting the site plan:

1. Important attributes and amenities should be mapped, retained, enhanced and complimented.
2. The southern edge of the site has access to 14th Ave. The properties along this edge were set aside as possible properties for sale. Garages may be considered for these units, as may separate fenced back yards. These units would also have excellent solar exposure, which can be easily taken advantage of in some manner. A single row of houses with few irregularities makes for an envelope with minimal losses.
3. Two possible placements for the apartment complex were explored through the charrette - locating the apartment building on the north end of the site (Figure 2) or alternately locating the apartment to the south of the existing gym and integrating the building with the community center (Figure 3). Key to any placement of an apartment or larger complex is ensuring that solar access for the remainder of the buildings on site would not be disrupted. Both alternatives were felt to be potentially viable depending on more detailed design and analysis.
4. Parking could be included under the apartment structure to reduce the site surface area required for parking. Surface parking to the east for the community centre should attempt to retain and incorporate the existing trees.
5. Proposed structures on the site should be modeled on the CMHC FlexHousing™ concept. The units will likely retain greater usefulness over the life of the project by including adaptable and accessibility features in the design from the outset.
6. Significant open spaces on site could be landscaped to catch storm water run-off. Grey water and storm run-off could be collected and used for toilet water and site irrigation.
7. An attempt should be made to recover the entryway from the existing school and incorporate it into the new community centre to provide some continuity and history. Reuse of demolition waste as thermal mass in the new units may be possible.
8. Sunlight access to planned outdoor activity areas throughout the site should be considered.

Integration with the Community

The charrette participants saw the addition of a community centre for this area as very important. There is no facility of this type currently located within the neighborhood and the centre would provide a focal point for the community and the demonstration aspects of the project. The existing gym should be retained as part of this new facility, unless inspection of its physical condition precludes its use. If the gym is not retained where it is, it was suggested that a new structure could be built to the north on the site, accessible by Montreal St.

Orientation of at least some of the residential units could be skewed to the east to provide visual contact with the neighbouring park for views and family surveillance. A hierarchy of outdoor play spaces in convenient locations would be desirable for parental supervision of children of different ages. As well, outdoor recreation amenities such as a seasonal pleasure skating rink would complement the community centre and support neighbourhood interaction.

Pedestrian and Vehicular Access and Parking

Good pedestrian access throughout the site and connections to the Community Centre and neighbouring park are a priority.

It is very important to have vehicular access to the community centre that does not interrupt the pedestrian flow through the housing complex. All vehicular access to the community centre should be through the north end of the site.

Toronto Street is a particularly busy north-south street on which ambulances and city buses proceed. Thus, it is desirable to have only limited access from Toronto Street into the housing complex. On the south side, however, more access would be possible, such as direct drive-in access from the street for individual units.

It was recognized that the number of parking stalls available for staff and visitors on the adjacent hospital is inadequate and overflow on street parking has been identified as a significant neighbourhood issue. Sufficient on site parking for the project is essential. Given the affordable nature of the project, a single parking space per dwelling unit should be provided with additional parking for visitors and for the community centre. Surface parking in clusters throughout the site is imagined with parking also located under the apartment building. Suggestions included a partnership with the adjacent hospital to develop a parkade on the General Hospital site to accommodate both the hospital's parking requirements as well as some of the parking for the housing development.

A shared bus shelter could be installed for the Toronto Street buses for use by the hospital staff as well as the residents of the housing project. It was recognized that this is an urban site and city transit is already nearby, but alternative bus stop locations could be investigated. Car-sharing programs could also be initiated for residents.

Building Form

Because of the long heating season, it is desirable to minimize the surface area of a building relative to its volume. Thus, U shaped, L shaped or T shaped dwellings should generally be avoided.

Building Orientation

Solar access to all buildings on the site is essential. To achieve this, taller buildings must not block the solar access to shorter buildings. All buildings must be oriented for passive solar gain. Thus the taller apartment building, although only three stories, should be carefully sited, and most likely placed toward the north part of the development. The Dumont residence in Saskatoon provides good lessons and ideas relating to the proposed ground-orientated units (Appendix 9), and the CMHC Advanced Multi Unit Residential Concept Building for the Prairie Region was seen as a good model for the apartment building (Appendix 10).

The 50 ground oriented dwellings should be distributed as east-west rows of townhouses throughout the remainder of the site, ensuring good solar access during winter. Because of the pleasant view of the park, it may be possible to orient some of the units slightly (up to 15 degrees) toward the east.

During the charrette the participants identified general schematic approaches for the site but did not have sufficient time to develop these into site plans.

The following diagrams (Figure 2 and Figure 3) were developed after the charrette as examples of two possible approaches to the site design based on the concepts developed by the participants.



Figure 2 –Example Site Plan Scheme A



Figure 3 – Example Site Plan Scheme B

Landscaping

The outdoor environment currently consists of a schoolyard. It is important that the area be developed with care for the environment, particularly with the use of site water, and excavated material.

An inventory of existing trees and other important natural features on the site should be conducted. The goal should be to retain all trees, or at least relocate them where original locations cannot be maintained.

It is desirable to minimize the use of water through carefully designed landscaping technologies, xeriscaping, and similar technologies using low maintenance, indigenous plant material. Lawn sections could also be used throughout the site plan to provide better play/use areas for children and families.

Erosion, Storm Water Management and Rain Water Use

Landscaping and drainage should facilitate rainwater collection. In general, storm water should be either held or infiltrated into the ground rather than being dumped into the storm water sewers. This can be done as part of the landscaping features, for example by using swales.

Rainwater should be collected on-site for use on the grounds. One inexpensive technique is to use barrels placed at the base of the down pipes from the eaves troughs. This water can then be used for watering outdoor plant material. The special barrels have techniques to prevent mosquito growth and to be child-safe.

Resource Use

Demolition

Materials from deconstruction should be reused on site or elsewhere where possible. The existing bricks in the St. Joseph's School are felt to be of a poor quality, soft brick, and it is felt that they could not likely be used directly in the building in the new units. However, it is possible that the bricks could be crushed and used for other purposes, such as landscaping material or as granular material poured beneath slabs or for the party/fire walls between units.

Existing buildings on the site, the gym primarily, are to be retained for re-use as is, if possible, based on an analysis of their condition.

Construction waste management

A construction waste management plan should be implemented, with the goal of maximizing the re-use and recycling of building materials and reducing inputs to landfills.

Materials

Locally sourced, high durability products and materials are to be specified, with a focus on reducing the on-going operating energy costs of the housing project. It was noted during the charrette that the most significant life-cycle cost component is energy use during the operational life of the building, which far exceeds the embodied energy in the building materials.

Embodied energy

It was generally felt that wood framed building structures, in general, are to be favoured because of the lower embodied energy compared to steel or steel and concrete structures. However, Regina has a unique soil condition with very expansive swelling clay soils and considerable attention should be paid to the foundation design of the units, and engineered concrete basements are proposed.

Building Envelope and Geometry

The design and construction of a superior building envelope and an energy efficient lighting system will enable the selection of smaller, more efficient and economical mechanical and electrical systems. It is expected that with appropriate heat recovery systems combined with solar hot water systems, a gas-fired boiler may not be required except as a back-up. Using domestic water for cooling, ice storage and incorporating proper shading it is projected that a central cooling plant will not be required (as per the CMHC Prairie Region MURB design).

Building Envelope and Floor Construction

A high quality energy efficient building envelope is required. A well insulated high R-value building envelope was seen as very important. Various designs including double stud walls, 38mm x 140mm (2" x 6") plus 38mm x 70mm (2" x 3") strapping, and 38mm x 140mm (2" x 6") exterior with insulating sheathing were all discussed and values of up to R40 were suggested for the walls and R60 for the ceiling. Insulation levels should be optimized to minimize the life cycle costs. A final choice can be made when the computer models for the building complex are established.

Clear span floor framing is desirable for narrow row units. Engineered joists should be used for floor framing. Consideration should be given to using wall systems with high thermal mass. Thermal mass can be increased in party walls using recycled brick from the site. A metal deck with masonry topping can add thermal mass for the solar design. Both of these techniques would also enhance acoustic privacy.

A tightly sealed vapor barrier should be installed and tested with pressure tests and/or thermography. Air sealing between apartments is a significant consideration, and needs to be adequately solved.

Although basements are expensive and the clay soil conditions in Regina are extremely problematic, well-built basements should be provided. The public has a definite

preference for housing with basements, and alternatives to a full basement are also expensive since engineered solutions are required.

Basements need high insulation levels, with below grade walls insulated to at least R20. Rigid insulation could be considered at least down to a 4-foot level on the exterior basement walls, with water barrier and/or lateral Styrofoam skirt frost protectors used under the topsoil to reduce frost penetration and to keep water away from the building. Consideration should be given to rigid rock wool drainage insulation as it replaces drainage boards but provides insulation value. The floor slab should be insulated beneath to at least R10.

Negative experiences with wood basements in Regina soil conditions were noted. Therefore, it is recommended that basements be concrete with a poured in place foundation and concrete footing and a non-structural concrete floor. Back-fill should be used under the basement floor slab. Consideration could be given to the use of fly ash in the concrete, recycled concrete, and even the use of local slag as fill below the slab. The City could help in the acquisition of these materials (since they already make use of some of these products) and the resulting demonstration would dispel some of the apprehension for using such materials in buildings.

Some bi-level (or “Toronto split”) style units could be provided throughout the site, thus allowing a separate dwelling unit partway into the ground (while still ensuring full winter solar access). It was recognized that these units would not be optimal for barrier-free ground level access, but that other units on the project site would be developed with physical access in mind (i.e. design a variety of unit types).

Fenestration Design

Windows should be located to provide nice views and to maximize the benefits of day lighting and passive solar heating. Minimal glazing should be used on North, East and West exposures. Larger windows than typical should be used for basements with assurance for full winter sun exposure. Southern exposure glazing should be designed to provide 40 percent or more of the heating load from passive solar gain. To prevent overheating, it is desirable that the south windows have architectural shading devices, such as overhangs. Windows that are less than full wall height facilitates summer shading and increase perceived security. Fixed exterior overhangs work well in our climate given the low sun angles in winter and higher sun angles in summer. Operable shading such as awnings should also be considered. Consideration should be made for occupant or temperature controlled external window covers.

High performance windows are a critical component of the system and should be used. Low maintenance wood window frames with thermal breaks are recommended. Newer windows on the market now include triple glazing, low-e coatings, argon and krypton gas fills and low conductivity spacer bars. Glazing type should be optimized to minimize the life cycle costs.

It is also important for the windows to provide good air tightness. Generally, hinged windows are recommended as opposed to sliding windows.

Exterior and Interior Finishes

The exterior finishes should have high durability and modest embodied energy. For the roofs, a number of alternatives including metal roofing were discussed. These have the advantage of longer life than asphalt and the steel can be recycled after the lifetime of the structure. Potential exterior finishes for the walls include stucco, or pre-painted hardboard siding. Suggestions included developing a vibrant colour scheme reminiscent of other winter city climates such as Scandinavia rather than typical earth tones that can appear dull through the months with snow on the ground.

It was felt that a vinyl siding would not be appropriate exterior finish material in a multi-family environment. It is quite vulnerable to damage, particularly in the wintertime and a ball hitting it or other impacts could crack the fragile vinyl.

Interior finishes will need to be durable and have very low off gassing of organic compounds. No VOC water based latex paints should be used. Wood products should be formaldehyde-free, and the use of toxic glues, particleboard and vinyl flooring should be eliminated.

Gypsum board is a common interior finishing material for walls and ceilings and is likely one of the most cost-effective products. For flooring, various alternatives including cast-in-place concrete that is stamped and coloured are possible, given that floor heating pipes can be incorporated into the concrete. Consideration should be given for ceramic tiles in kitchens, hardwood floors in the living room and marmoleum for travel areas and bedrooms due to the long life of those materials.

Building Systems

The building systems should be designed to maximize energy and resource efficiency, to minimize the total life cycle cost for tenants and the facility, and to facilitate ease of operation and effective regular maintenance and repair.

District Heating

A central system for collection and distribution of hot water can be used for heating and domestic hot water. Such a system located in the apartment building would allow easy access for service, and would provide economies of scale in installation, purchase, maintenance, and operation over individual heating plants in each unit. However, for the individually owned units, individual heating and hot water systems would avoid the complication of handling monthly payments for space and water heating. In the ground-oriented units, the use of a single hot water heater for both space and water heating could be investigated. The decision between a central heating system and individual dispersed systems should be made based upon detailed analysis of the costs and implications for operating and maintenance. An advanced integrated mechanical system may also be possible.

Power Distribution and Generation

Saskatchewan now has green power available through SaskPower, however consideration should be given to reducing demand on the SaskPower grid. The first step is to conserve energy use, and the second step includes the possibility of generating electricity on the site using photovoltaics, or a co-generation unit in which natural gas is used to power a micro turbine. The micro-turbine would be used for both heat and electricity generation. On-site centrally generated electricity would then be distributed to the units. A partnership with SaskPower to sell excess power might be possible. Fuel cell technology may also be feasible in the near future, and a centralized power source would enable easy fuel switching as improved systems become available. Further study on the feasibility and costs of these concepts is needed and would likely require additional funding to implement.

Passive Solar

It is very important that the buildings be oriented so that either the back or front of the dwellings can be facing south for passive solar gain. The interior functional layout of the units must also be designed appropriately. The general suggested approach is to provide a south facing glazing area of approximately 15% of the floor area. For example, if there are 50 m² on one floor, then roughly 7.5 m² of south facing window area could be provided. Increased building mass and effective air circulation must be provided to ensure a comfortable living environment.

A computer simulation can be used to optimize the south glazing to floor area ratio based on the internal mass of the structure. Excessive glass should be avoided as it contributes to overheating during the summer season and high heat loss in the winter. Strategies for increasing the internal mass of the structure are placing scrap gypsum board in the interior partitions or adding concrete topping for the floors. A passive solar high mass wall constructed from recycled brick could also be used as an interior feature wall. These techniques also decrease landfill waste.

Active Solar System

It was felt that it generally would be better to have an active solar system in a more centralized location to have some economies of scale and reduce costs. Perhaps the area around the community centre could have a central energy generation unit with some active solar. The system could utilize conventional solar thermal collection or high temperature concentrating collectors in combination with electrical power generation from steam. This heat would be distributed using warm water piping for both space heating and domestic hot water. Very well insulated pipes must be used to avoid potential heat losses in the distribution piping. An agreement with the city to heat the pool in the adjacent park would provide a sink for excess summer heat generation. Experts in district heating systems should be consulted to make use of the best current technology.

A ground source heat pump should also be considered, especially if cooling is required. Another possibility is to use a solar-wall on the south facing façade of the gym or community center to preheat air for the building.

Heating Ventilation and Air Conditioning (HVAC) Systems

It was envisioned that hot water would be used to distribute energy for space heating and for domestic hot water to the units. The energy requirements for distributing the space heating in the units via hot water would be modest. Within the individual units, several systems can be used to distribute the heat. These include in-floor radiant heating, baseboard convectors, or fan coils. In-floor radiant piping can be used for cooling as well as heating. The fan coil system has the advantage of distributing ventilation air as well as the space heating. Baseboard convectors (radiators) are one of the most common heating systems for multi-family units. Using smaller areas and zones can reduce the cost of the systems as the building envelope would be very efficient.

Cooling Systems

In properly designed residential units, artificial cooling systems are not generally required in the Regina climate. Cooling can be provided through a night purge. Natural ventilation can be achieved through effective design placement of operable windows, and ceiling fans can be used to enhance the effect. Additional cooling could be provided by running domestic water supplied to laundry or showers through an in-floor piping system that would normally be used for radiant heat in the winter. This would have the advantage of pre-heating the water as well.

Ventilation Systems and Air Tightness

A tightly sealed vapor barrier should be installed and tested with pressure tests or thermography. Since the dwellings will be tightly sealed, it is very important to provide proper ventilation. The CSA F 326 Standard provides guidance on this. It is important that the ventilation air be distributed throughout the dwelling units, including the bedrooms. It was noted that Saskatchewan has experienced some problems with air balancing in homes, so this is also an area that needs to be addressed.

Heat recovery should be provided on the exhausted ventilation air. The most common system used in energy efficient housing is an air-to-air heat exchanger, or heat recovery ventilator, although some buildings have used an underground duct which preheats the ventilation air. Fans on the heat recovery ventilator can be used to distribute the ventilation air. Current North American heat recovery ventilators have electricity consumption values as low as 49 watts (Nutech Lifebreath Model 155 Max or see www.hvi.org). A German company makes a unit requiring only 20 watts.

Investigation is required into whether individual unit heat recovery ventilators or larger ones serving multiple dwelling units are more appropriate. Centralized collection of all building exhaust with a single high efficiency heat exchanger could be used. A solar wall could be used to preheat the outside air. In-ground preheating of ventilation air can also be used.

Natural ventilation is possible in the warmer periods of the year. It is very important to incorporate cross flow ventilation cooling through the units in the warm summer periods.

Heat Recovery

Heat can be recovered from the ventilation air as previously discussed, and also from grey water. For example, a product called GFX (www.nomorecoldshowers.ca) is available that can recover about 20% of the heat in the water being exhausted from the house. It will also reduce the size of the heating system required for the hot water.

Controls

The use of the Internet is of interest in terms of communication within the complex, but generally a fairly conventional approach was seen for controls. Night setback thermostats are desirable. The control of the ventilation should be separate from the control of the temperature. A simple method of indicating on-going energy and water use for a home may be useful as an awareness and education tool. It has also been shown to be an effective way to reduce household consumption patterns.

Energy Monitoring

Individual meters should be used for heat and electricity to encourage frugal utility use, and to prepare tenants for future home ownership. Generally, people are more careful about energy use if it is monitored individually rather than a single bulk meter for the complex. Heat meters utilized widely in some European countries could be used to sub-meter energy consumption within individual units. Accurate monitoring is also an important part of collecting research data to evaluate and refine the performance of the systems.

Domestic Water

Water use is an important consideration in Regina. Careful control of interior water use through the selection of low flow showerheads, water efficient clothes washers, and low flush toilets is highly recommended. Grey water or rainwater can also be used to supply water to toilets through a second distribution system.

Lighting and Appliances

It is important to have high efficiency lighting systems and appliances in the house to minimize energy use, heat generation and reduce any cooling loads. In general, compact fluorescent and fluorescent lamps are greatly preferred over incandescent lighting systems. T5/T8 lighting should be provided in common areas and where appropriate in dwelling units. Consideration should also be given to LED lighting where appropriate. Compact fluorescent lighting should be provided for task lighting. Occupancy and day lighting control for common area lighting should be provided. Outdoor light pollution should be minimized by utilizing carefully placed low wattage lights.

To encourage people not to replace compact fluorescent lamps with incandescent at a later date, one option is to provide permanent fixtures using bayonet or plug-in type compact fluorescent lamps as opposed to screw-in type lamps. Another approach is to offer bulk buying of efficient light bulbs through the activities of the centre.

Low energy appliances are essential to reducing the electrical loads and should be specified. The EnerGuide Label identifies the energy consumption of appliances and should be used as a guideline, and appliances with an Energy Star rating should be used as a minimum. Typically, this is applied to stoves, refrigerators, washers, dryers and dishwashers. Occupants should be informed of the benefits of Energy Star ratings for other appliances as well to minimize electricity consumption.

Phantom loads (standby losses) can contribute significantly to electrical consumption. Wherever possible appliances with low standby mode power should be used and encouraged. A further suggestion was to include a central switch for non-essential power should be provided at the main exit from each dwelling unit.

Appliances should be bought in bulk to ensure energy efficient models are chosen and to obtain a good price. A rent-to-own program could be set up so that tenants can afford good quality, energy efficient appliances. Tenants choosing not to purchase appliances could use a laundromat with front-loading wash machines in the community centre for use. Provision for heat recovery on dryers in the suites as well as in the laundromat should be incorporated throughout.

Quality Assurance

A strong recommendation was that performance targets be set for those aspects of the building that are quantifiable, such as building air tightness testing, water flow for water fixtures, energy use for air to air heat exchangers, motor minimum efficiency values, etc. All buildings should be fully commissioned and monitored to ensure the performance targets are met.

Integrated Waste Management and Greenhouse Facility

Investigation should be made into a system such as the Living Machine Sewage Treatment and low flush or waterless toilets as part of the overall water management strategy for the site. This could perhaps involve a partnership with the Saskatchewan Science Centre or other appropriate interested group. Including this approach to the waste treatment would provide a valuable opportunity to demonstrate and assess the usefulness of this type of technology in a controlled setting. As well it was felt this would require significant additional funds, but should be explored, as it would represent a sustainable approach to the site.

Conclusion

The design charrette was very successful in presenting a vision and potential path towards creating healthy affordable housing and a community asset for the City of Regina. The degree of enthusiasm and positive ideas as well as the degree of consensus achieved during the charrette reflect the shared realization of the participants for the extensive benefits that such a well-planned healthy housing project could bring to the housing occupants, as well as the surrounding community.

The charrette provided an effective format that allowed diverse participants to contribute their expertise and opinions, and focus on the overall goal of developing high quality affordable housing that is appropriate for families and the community while also incorporating effective sustainability solutions.

A key to the success of the charrette itself and the project to date is the highly developed partnerships formed through the project's evolution from concept to detailed design planning, all under a clear and strong vision of an affordable and sustainable healthy community for Regina families.

Appendix 1

List of Participants

1	Murray Guy (Facilitator)	Integrated Controls
2	Kelly Winder (Facilitator)	Kelln Consulting / Integrated Controls
3	Ken Coutu (Facilitator)	Integrated Controls
4	Rob Dumont	Saskatchewan Research Council
5	Greg Allen	Allen Kani Associates
6	Bob Bjerke	City of Regina - Housing Co-ordinator
7	Bruce Rice	City of Regina - Senior Policy & Research Analyst
8	Juan Estepa	City of Regina - Co-ordinator of Landscape Design
9	Kerry Hilts	City of Regina – Co-ordinator of Open Space & Facility Planning
10	Mark Sylvester	City of Regina – Community Consultant
11	Fred Searle	City of Regina - Project Planner
12	Thomas Green	Canada Mortgage and Housing Corporation (CMHC)
13	Daniel Messett	CMHC
14	Ray Sieber	Saskatchewan Housing Corporation (SHC)
15	Ron Sotski	SHC
16	Helen Finucane	Ehrlo Community Services
17	Carole Bryant	Ehrlo Community Services
18	Doug Rogers	Regina Affordable New Homes Foundation
19	Rod Stutt	Saskatchewan Institute of Applied Science and Technology (SIAST) Arch & Building Technologies Program
20	Reg Forbes	SIAST – Arch & Building Technologies Program
21	Dave Edwards	David W. Edwards Architect
22	Gary Kreke	BBK Engineering
23	Barry Novak	Alfa Engineering
24	Grant Dawson	Hooker-Dawson Associates
25	Leila Francis	Core Community Group
26	Bernie Ryma	Sask Energy
27	Denis Belliveau	NRC/ Sask Construction Association
28	Bob Schad	University of Regina
29	Robert Greenwood	Sustainable Communities Institute
30	Terry White	Solar Energy Society of Canada (SESCI)
31	Vic Ellis	Ecology Products International / SESCO
32	Pam Novak	Recorder (Dome Britannia Properties)
33	Ray Gosselin	Tallgrass Design

Appendix 2

Design Charrette Agenda - January 10, 2003

- 8:00 Coffee, Registration and Welcome
- 8:30 Opening Remarks - Thomas Green, CMHC
Bob Bjerke, City of Regina
Murray Guy, Integrated Controls
- 8:50 Project Overview - Helen Finucane, Ehrlo Community Services
- 9:10 Introduction to Leed - Ken Coutu, Integrated Controls
- 9:25 Introduction to the Integrated Design Process - Ken Coutu, Integrated Controls
- 9:40 Presentation of AKA Report - Greg Allen, Allen Kani Associates
- 10:00 Nutrition Break
- 10:15 Background for small group sessions - Murray Guy, Integrated Controls
- 10:30 Small Group Session - Site Plan
- 11:30 Group Discussion on Site Plan Designs
- 12:00 Lunch Break
- 12:30 Precedents – CMHC Study Building, Kelly Winder, Integrated Controls
Dumont House, Rob Dumont, SRC
Past Experiences, Greg Allen, Allen Kani Associates
- 1:15 Background for small group sessions - Murray Guy, Integrated Controls
- 1:30 Small Group session - Technical
- 2:15 Nutrition Break
- 2:30 Small Group session - Technical (cont.)
- 3:30 Small Group presentation of technical designs
- 4:30 Wrap-up, Recommendations and Next Steps
- 5:00 Adjournment

Appendix 3

CMHC's Healthy Housing™

Healthy Housing is a key component of a sustainable future. At all levels, housing and our environment are inextricably linked, and together they form our living conditions, support our social well-being, and influence our health. Energy, materials, water, and land are all consumed in the development and operation of housing, while the quality of our natural and built environment affects our capacity to lead healthy lives for generations to come.

To address these needs, Canada Mortgage and Housing Corporation (CMHC) developed the Healthy Housing™ initiative, incorporating a vision of housing that is both healthy for the occupant, and healthy for the planet. Healthy Housing offers indoor environments with excellent air quality, lighting and acoustics; minimizes construction and domestic waste; optimizes the use of existing infrastructure; utilizes environmentally benign and renewable materials; uses renewable energy and resources efficiently; is readily adaptable to meet changing lifestyles; and is affordable. At CMHC, Healthy Housing is sustainable development, and includes environmental, economic and social dimensions of well-being.

The CMHC Healthy Housing concept is based on five key principles that guide the design and construction of sustainable housing:

- Occupant Health;
- Energy Efficiency;
- Resource Conservation;
- Environmental Impact;
- Affordability.

The Five Principles of Healthy Housing™

Occupant Health

Healthy Housing promotes pleasing and comfortable indoor environments with superior quality indoor air, water and lighting as well as minimizing exposure to background sound and radiation irritants. Daylighting strategies provide natural light to all living areas and maximize site benefits and views. Careful selection of building materials, finishes, furnishings and maintenance products optimize the quality and health of the indoor environment.

Energy Efficiency

The Healthy House reduces energy use in all home functions, in all seasons of the year, through effective planning and design. It relies on optimum site orientation and design density, a high quality building envelope, use of renewable energies, efficient heating and ventilation systems, appliances and fixtures, and reduced consumption of electricity and fuel. Healthy Housing also reduces the energy used in the manufacture and distribution of building materials and during house construction, and incorporates embodied energy analysis that includes life cycle costing as well as first cost factors.

Resource Conservation

The Healthy House approach respects and conserves our natural resources. Planning densities and design goals promote solutions that are adequately scaled to occupant's needs and desired activities. Building materials are specified from renewable resources, construction waste is reduced and well managed, and durability of building components is emphasized. Healthy Housing uses alternative water and wastewater systems, and site design and landscaping provide for on-site storm water retention and reduced infrastructure costs.

Environmental Impact

Healthy Housing encourages site planning and community design that reduces land requirements, promotes resource-efficient landscaping, and considers broader community issues such as efficient transportation, reduced infrastructure, and preservation of natural features. Durability and longevity of designs are emphasized, taking into account future adaptations of buildings where possible. The Healthy House approach also involves reduced housing related emissions that contribute to greenhouse gas production and global warming, both during the construction process and in the ongoing operation and maintenance of the home.

Affordability

Healthy Housing principles are applicable to all housing forms, styles and price ranges. Homes appropriately scaled to their occupant's needs are cheaper to own and operate, while attributes emphasizing flexible and adaptable design solutions enable the home to easily adjust to an occupant's changing needs and capabilities, both financial and physical, over their lifetime. Thus, Healthy Housing is able to respond to the diverse dynamics of the Canadian demographic profile today, while being able to readily adapt to the evolving needs of tomorrow.

Appendix 4

Sustainable Technologies, Systems And Measures For Affordable Housing At The St. Joseph's School Grounds

Submitted to: Bob Bjerke, City of Regina,
December 16, 2002

By:

Greg Allen, Allen Kani Associates

Introduction

The City of Regina contracted Allen Kani Associates to provide a report that outlines and assesses various technical opportunities for advancing sustainability of the housing development being planned for the St. Joseph's School grounds. This work is intended to inform the planning and design of the new neighbourhood and to provide a basis for feasibility studies of alternative infrastructure in order to determine the advisability and financial requirements for their implementation.

The propositions brought forth in this report advance development practices that would place this project in the vanguard of sustainable communities, encompassing key issues relevant to national and provincial policies and priorities. The prospect of an entirely renewable energy supply that is affordable addresses greenhouse gases and air quality issues while site-level water harvesting and regeneration holds great potential for regions experiencing water depletion. Other important areas of sustainability concerns that are addressed are: transportation, food, construction, and ecology.

The project could undergo a LEED assessment with the likelihood of achieving platinum status for environmental performance.

Such a far-reaching set of measures, if they are to be realized, will require a high level of commitment from the project participants. The high level of importance being placed on sustainable city initiatives worldwide, at all levels of government, and at the community level bodes well for support and enablement.

Site Plan

Approach

It is possible to achieve 100% of the housing with south orientation providing a no-cost thermal performance benefit in heating and cooling. This can be accomplished with a variety of site layouts and a mix of building forms, depending on the density and overall concept for the site. The housing and site design should consider the diverse needs of the community as well as the potential occupants over the life of the housing development to ensure ongoing sustainability. Vehicular access to parking and through the site would preferably be for resident use only and be safe for children and pedestrians. Hard paving should be minimized to promote infiltration and vegetation. Cycling and pedestrian accommodation with links to public transit and off-site routes should be the priority. Areas for gardening and recreation are desirable. An extensive tree canopy and privacy hedges would enhance the microclimate and provide natural habitat.

Prescriptive Measures

1. Vehicular circulation and Parking

A one-way north-south laneway through the centre of the block linking to the access road for the community centre off Montréal St. provides a servicing route and accommodates angle parking along the laneway on both sides. The laneway is consistent with the downtown block format restricting use to residents. Guest parking could use street and community centre parking.

2. Housing configuration

All housing units should be oriented to provide for 100% solar access within 15 degrees of south. Several approaches to the site can accomplish this and could effectively include townhouses (some could be accessible at grade with second units above) and apartments that could be integrated with the proposed neighbourhood centre. For example assuming all or most of the housing type is row housing 2-storey grade access, a 5.7 m standard unit width, it is possible to accommodate 60 grade accessed dwellings in rows of six running east-west at a 23.6 m spacing.. This arrangement provides 100% south orientation for passive solar design, large yards, street frontage compatibility on 14th Ave., good access to the park and Toronto St., and privacy from public thoroughfare. Sidewalks between rows provide north and south entries to units and car-free circulation. More units and size diversity would require some to be stacked and could also include apartments. Avi Friedman's "Next Home" approach is one effective and flexible model that may be considered.

3. Landscaping

Rows of deciduous shade trees between housing rows provide summer shade. Coniferous hedge planting along Toronto St. and the north side of the block provides wind shelter and privacy. Swales flanking the laneway and branching east and west along the row-housing sidewalks, vegetated with water-tolerant species, would support stormwater biofiltration, conveyance, and ecological diversity. For major storm events, the swales would drain to a "slough" garden near the community centre. Vegetated rooftops could provide personal gardening space while adjacent parkland might be considered for community food gardens. The community centre parking area could be configured to be fully tree-canopied with runoff led to infiltration plantings. Selection of plant species should consider native compatibility, diversity, wildlife support, drought tolerance, and functional appropriateness.

Cost/Benefit

The proposed measures are inherently cost-reducing. Space use and amenity optimization, passive solar access, and stormwater management are achieved without compromise.

Space Conditioning

Approach

Although Regina experiences large seasonal temperature extremes, it enjoys year-round high solar availability, low summer humidity, and cool summer nights. It has long been established that very low heating and no cooling loads are achievable by passive means alone. It is reasonable to consider a design objective of a virtually zero space-conditioning requirement for the housing. The small residual load can be served with a minimal cost supply system offsetting the capital cost of improved envelope. The performance benefits include low operating and maintenance costs, silent operation, enhanced comfort and air quality, resource savings, and minimal pollution.

Prescriptive Measures

- Below-grade walls RSI 3.5 (R20), slab RSI 1.7 (R10)
- Walls insulated to RSI 7 (R40)
- Roof insulated to RSI 10 (R57)
- Flat roofs insulated to RSI 5.5 (R30) if vegetated
- North/south windows RSI 1.5 (R8), SHGC 0.65
- East/west windows RSI 2.0 (R11), SHGC 0.25
- South glass area/floor area ratio 15%
- East, west and north glass area/floor area ratio <5%
- Interior high-mass walls and floors minimum 100 mm thickness of masonry
- Diffusion of solar gains to conditioned spaces
- Air-tightness to 0.5ACH @ 50Pa
- 80% effectiveness energy recovery of exhaust heat and moisture to intake air
- Preheat makeup air with ground tube
- Operable openings >5% floor area located high and low for natural ventilation
- HVAC consists of hot water convectors in ceiling cavity providing radiant floor/ceiling delivery and ventilation supply air to floor cavity distribution
- Space and domestic hot water supplied by district energy system
- Greywater heat recovery on shower drains to preheat cold water to shower

The conversion of the gymnasium to a community centre could apply similar measures as a retrofit using an exterior standoff wall, displacement ventilation, roof replacement, and an attached greenhouse to the south wall as strategies.

Cost/Benefit

Thermal upgrade over SBC for 100m² row house unit:

windows: 20 m ² x \$50/m ²	= \$1000
walls: 60m ² x \$20/m ²	= \$1200
below-grade: 50m ² x \$10	= \$ 500
improved air tightness	= <u>\$ 200</u>
<u>incremental cost</u>	= <u>\$2900</u>

Mechanical

district hot water distribution	= \$2000
convectors and controls	= \$1000
ERV	= \$1500
less conventional HVAC	= <u>(\$6500)</u>
<u>incremental savings</u>	= <u>\$2000</u>
net capital cost	\$ 900

Estimated annual savings of 75% of \$800/yr = \$ 600

Payback = 1 ½ years

Other benefits include avoidance of air conditioning costs, improved comfort and air quality, central maintenance, and low impact of energy price increases.

District Energy System

Approach

The proposed housing density supports consideration of a district heating system. By providing central hot water production, the cost of individual boilers or furnace and hot water heaters is avoided. Technologies that reduce or displace fossil fuel consumption are more feasible at larger scales; such as solar thermal, heat storage, cogeneration, ground-source heat pumps, and high-efficiency, low NO_x boilers. Regular maintenance and system upgrades are obviated. Domestic cold water supply can also be recirculated to provide ground-source temperature for preheating outdoor air to HRV's, space cooling, if desired, and potentially refrigeration heat rejection. Distribution may be readily accommodated through the basements of row houses and a central utilidor.

The prospect of displacing all fossil fuel usage has obvious implications for supporting the Kyoto Accord and sheltering households from escalating energy costs.

Prescriptive Measures

Locate central plant at the community centre with an access tunnel under a central north-south lane to run all services: electrical, water, heating, wastewater, stormwater, and communications. Microturbines producing about 75 kW of power and 150 kW of water heating, fuelled by natural gas and convertible to alcohol, would supply most of the energy needs. Alternatively, a high-temperature solar array producing steam power and hot water (e.g. Duke Solar's Solar Roof) could be installed on the gymnasium roof. With net metering of electricity and large thermal storage, all of the energy needs could be provided by renewable sources. The potential exists for generating sufficient power to cover transportation needs as electric or hydrogen vehicles come on-stream.

The solar cogenerator could be enhanced with seasonal thermal storage – if 100% solar supply was desirable or economically justifiable. NRCan is currently interested in demonstrations of this concept. One approach is to use vertical loops in the ground requiring approximately 100 wells, each 60 m deep.

Electricity generation would be grid-connected on a net-billing arrangement. Individual dwellings would be submetered for energy services, including thermal supply, at rates sufficient to cover capital and operating costs.

Cost/Benefit

By eventually providing all of the site energy from solar, consumers receive a relatively fixed cost, unaffected by anticipated rises in electricity and natural gas prices. Thermal load projections for an average household are 3 MWh/yr for domestic hot water and 2 MWh/yr for space heating. Electricity demand is estimated at 3 MWh.

The central solar cogeneration plant with a peak production of 200 kW of electricity and 400 kW thermal is estimated to cost \$800,000. Assuming an amortization rate of 6% and operating and maintenance of 4%, the average household energy costs would be \$1000/yr, which is less than current levels. The average cost of energy produced would be about \$110/MWh or comparable to electricity rates.

The utilidor concept, commonly used on institutional campuses, provides ease of maintenance and new utility servicing installation. The savings are realized in future years avoiding costs of excavation and paving replacement. Overhead electricity distribution is avoided. There are some offsetting savings to conduits and piping over buried infrastructure.

These favourable economics are obtained by virtue of full avoided costs of supply through net billing and low financing costs. The former will require negotiations with Sask Power and the latter will possibly be obtained through an FCM Green Municipal Investment Fund agreement. Considering the potential realization for zero greenhouse gas emissions, the proposition should be very attractive to public institutions.

Electrical Load Efficiency

Approach

Electrical load may be reduced by more than 50% over average levels cost-effectively and without loss in amenities. In turn, the production of 100% green power on the site is facilitated and household affordability is improved. Careful selection of appliances and lighting, large reductions in HVAC demand through system design, and inducements to occupants in purchases and use of plug loads offer strategies for load reduction.

Prescriptive Measures

1. Refrigerators

Select smaller, low Energuide rated equipment under 350 kWh/yr. For greater savings, custom units with heat rejection to cold water distribution and highly-insulated cabinets with under-counter drawers could be considered

2. Cooking appliances

Gas range tops and ovens could replace electrical load but contributes nitrous oxides to the indoor air unless directly vented. Without other gas loads, the service charges would result in high operating costs unless household services were collectivized. For electrical appliances, convector ovens and halogen cooktops will reduce demand.

3. Washing machines

Horizontal axis with high spin dewatering can reduce water use and drying energy. Some equipment has sophisticated controls to reduce hot water usage by tailoring to laundry loads.

4. Clothes Drying

With improved spin-drying, it is possible to passively dry clothes on hangers, clothes-lines or drying cabinets. Alternatively, tumbler dryers without heat may be feasible.

5. HVAC

By using hydronic radiant or convective heat distribution, the sizable load of forced-air systems is avoided.

By using upsized ductwork and heat exchangers with low pressure loss filters and flow sensors to signal cleaning, blowers may be selected at much lower wattages. Ventilation air exchange using conventional HRV blowers imposes a large load often over 1000 kWh/yr. With stack exhaust and good air-tightness of the dwelling, it is possible to rely on passive venting for much of the time. Some developmental work is warranted.

Hydronic circulation should also be scrutinized for efficiency improvement by upsizing piping and employing high efficiency, variable-flow circulation pumps.

6. Lighting

For built-in fixtures, placement, fixture type, lighting levels, lamp and ballast type, and controls should be carefully selected. T-8 fluorescents with electronic dimmable ballasts are appropriate for general illumination. Compact fluorescents should be accommodated for other lighting needs. LED's may be considered for night-lights and entryways.

7. Television

For standard sets, a wall switch may be used to turn the outlet for set off and avoid standby usage. It is now feasible to consider LCD computer screens for television or video viewing. Home computers are preferably Energy Star designated with automatic sleep mode.

8. Phantom loads

Various devices have been introduced into residential usage that continuously draw small wattages. Most are discretionary and attention to selection can significantly reduce electricity consumption.

9. Submetering

By providing a common service from the utility and setting up a prorated billing system on household submeters, the site generation can be financed and utility service charges can be minimized. A rate structure that provides a low initial blockrate and charges extra for high consumption will induce conserving practices. The primary objective should be to minimize household energy costs, not rates of energy units.

Cost/Benefit

Most of these measures have modest impacts on capital cost and often improve amenity value. Yearly savings over conventional usage are in the range of \$400. With site generation, there will be a large reduction in greenhouse gas emissions from Saskatchewan's coal-fired generators over a business-as-usual site development, in the range of 7 tonnes of CO₂ /yr per household.

Construction Materials

Approach

The environmental impact of buildings extends beyond their operation to include material life-cycle, construction, and demolition. Design specifications and construction practices should reflect consideration of such issues as embodied energy, longevity, local sourcing, recycled content, end-of-use implications, and toxicity in addition to cost and performance. Product selection, assembly detailing, and construction methods are factors of sustainability outcomes.

Prescriptive Measures

1. Structural Materials

Consider rammed-earth, adobe, or fly-ash substitution for cement for high mass separating walls thereby reducing CO₂ emissions of concrete while providing thermal mass, sound isolation, and fire separation.

2. Exterior Walls

Use light steel framing double-wall construction with drywall air barrier detailing, cellulose insulation, vapour-permeable membrane over exterior, sheathed in 25 mm rigid rockwool, and clad with cement/wood fibre board. The materials are largely recycled and recyclable with low embodied energy and low cost.

3. Windows

Frames and sashes of fibreglass with insulated cores outperform other choices for longevity, air seal, and thermal efficiency. Heat Mirror 88+ with Bayform spaces and krypton fill offer the best thermal performance and economics.

4. Floor and roof

Open web steel trusses and steel decking provide clear span flexibility and recyclability. Flat roofs with vegetation could be insulated with 100mm isocyanate above a TPO membrane and 50mm rigid rockwool underneath.

5. Other Materials

A long list of preferable selections of products is required to handle interior finishes and furnishings. PVC should be avoided where suitable alternatives exist due to harmful emissions in production, combustion, and disposal. Ozone-depleting refrigerants should be avoided. Low-outgassing materials for finishes, floor coverings, and cabinetry are highly desirable to avoid air contamination. Where possible, local sources of sustainable resource products are preferred, using materials such as strawboard and other agriculturally derived sources. Reused materials such as from the school demolition are optimal choices since embodied energy is preserved and landfill is avoided.

Cost/Benefit

Embodied energy in the extraction, processing and delivery of building materials constitute several years of building operating energy; hence prudent selection will reduce greenhouse gas emissions. The use of recycled, reusable components supports long-term sustainability and economics. The avoidance of potentially harmful products is of obvious benefit to public health and the ecosystem. Conscientious sourcing will help support the local economy and businesses that practice good stewardship.

Water Supply, Sewage and Stormwater

Approach

Regina currently enjoys plentiful supply from the South Saskatchewan River and returns treated wastewater and stormwater back to the river. Water quantity and quality issues are becoming critical concerns, particularly in the Prairies. Studies have indicated that climate change is reducing snow accumulation in the Rockies with serious implications for river flow in summer. With demands for agricultural irrigation rising, urban water conservation could well become a priority in Regina.

Water usage may be greatly reduced through various strategies ranging from waterless compost toilets to xeriscaping. Wastewater treatment technologies are available that can regenerate water to high quality for reuse. Stormwater and snowmelt can be harvested, treated, and stored. Nutrient content of sewage is usable for horticultural purposes.

Prescriptive Measures

1. Compost toilets

These provide an optimal solution for human waste using waterless or microflush commodes. Servicing is typically an annual harvesting of humus and stabilized leachate for landscaping or agriculture. The composters can be located in a common service area at a basement end but requires placement of washrooms above. Chopped kitchen vegetable and fruit scraps can be added as well. The remaining greywater discharge requires smaller conveyance piping, easier treatment, and reductions in sludge formation.

2. Living Machine

A centralized greywater treatment facility employing primary filtration, ecologically engineered processing, and subsurface irrigation of greenhouse growing beds could be used to regenerate a high quality water source and grow commercially valuable produce. A 400 m² greenhouse attached to the south end of the gymnasium is envisaged.

3. On-site stormwater management

Rain and meltwater capture and conveyance to a central cistern for filtration and reuse could be implemented. Vegetated roofs may also be worthwhile, providing retention and biofiltration as well as providing garden space, natural habitat, and urban heat island effect; however, harvestable water is reduced. Ground level landscaping with trees, planted swales, and infiltration water gardens could address stormwater reception on-site and enhance livability. Wherever possible, hard surfaces could employ various forms of permeable paving. Stormwater sewers should not be necessary.

4. Water-efficient appliances

Water conserving devices should be selected such as aerating faucets, low volume showerheads, and water-saving clothes-washers.

5. Low-demand landscape irrigation

Mulching, drought-tolerant vegetation, shade trees, and subsurface irrigation could be employed to reduce quantities. Secondary quality water such as ground-level rainwater storage with pumping may serve the purpose.

6. Potable water site filtration

Using treated greywater and roof-capture rainwater, reverse osmosis such as Zenon's Zeeweed system, and UV sterilization could provide high-quality potable water service. The potential exists to rely entirely on site-sourced supply.

Cost/Benefit

Assuming water, sewer, and stormwater drainage services are entirely provided on-site, the avoided costs of municipal charges are in the order of \$750/yr for each household. The net capital cost/household over connecting to municipal services is estimated as follows:

Compost toilets	\$5000
Greywater treatment	\$2000
Water purification and supply	\$2000
Stormwater Management	<u>\$1000</u>
Total	\$10,000/yr

Operating costs are in the order of \$500/yr. The simple payback is in the order of 45 years. Without a detailed study, the economics are very uncertain.

The merits of demonstrating the technical feasibility of such a proposition are nevertheless compelling. It is generally the case that water and sewer services are highly subsidized as essential municipal requirements, hence the full societal avoided costs are not reflected in charge rates. Most significantly, the prospects of water shortage and applications to other communities already experiencing serious water resource issues indicates the worthiness of pursuing financing for this advanced approach.

Next Steps

In order to meet construction schedules without unduly compromising design alternative assessments, it is important to undertake a concentrated design development process right away. The following steps are proposed:

Design Charrette

Early in January a workshop is to be held with key participants, design consultants, and resource-persons. The charrette will have a facilitator and critical design options will be explored resulting in a preliminary design.

Feasibility Study Funding Application

Many of the sustainable technology options will require a more detailed design and economic and technical assessment performed. Since receipt of funding and completion of work may prejudice timelines, there will need to be consideration of construction sequence and conventional servicing fallbacks.

Design Team and Process

The selection of the design team and project management structure will need to be undertaken as soon as possible. A prescribed integrated design process (IDP) should be established to expedite decisions and capture the synergies of a transdisciplinary approach. The City may draw upon models of IDP developed by the C2000 program and others.

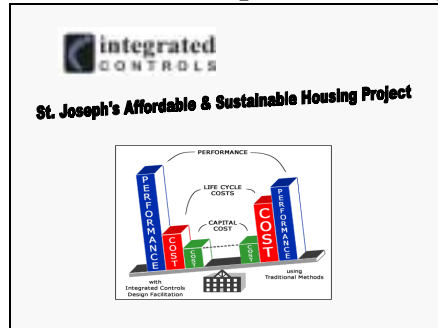
Construction Phase Planning

The design team and project management, at an early stage, will need to work out a logical work sequence that would allow construction to proceed before some elements are fully documented.

Appendix 5

St. Joseph's Affordable & Sustainable Housing Project presentation by Murray Guy

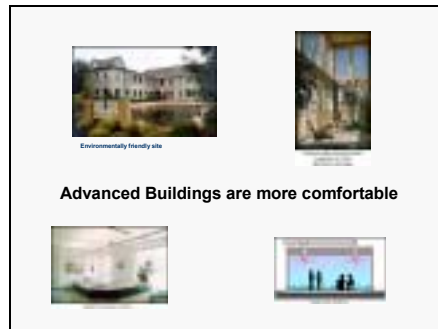
Slide 1



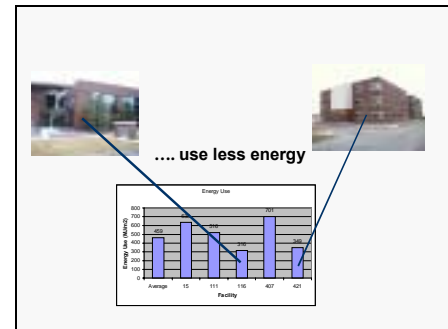
Slide 4



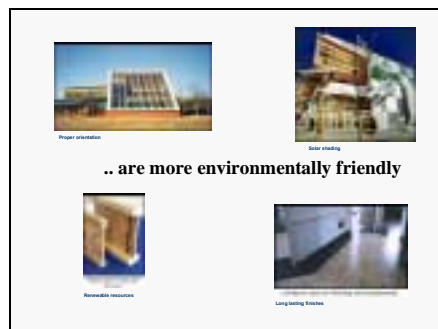
Slide 2



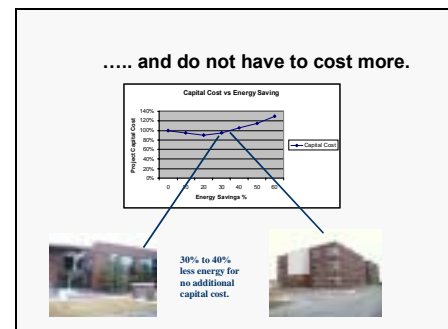
Slide 5



Slide 3



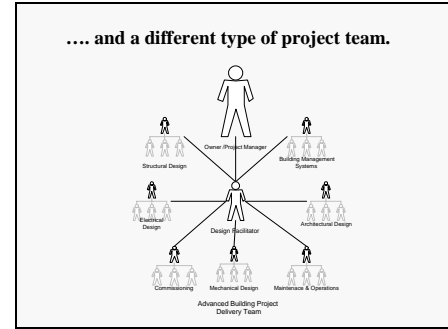
Slide 6



Slide 7



Slide 10

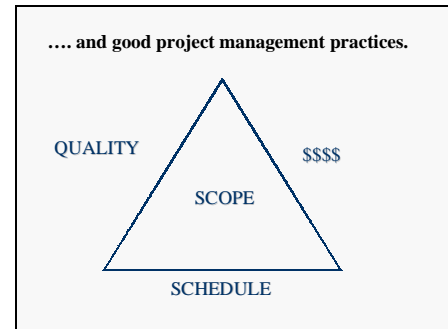


Slide 8

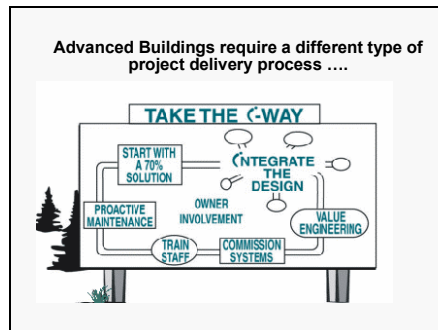
TLC = Capital Cost + Energy Cost + Maintenance Cost + Utility

...so it makes financial sense to spend more capital if we want to minimize the total life cycle cost of ownership.

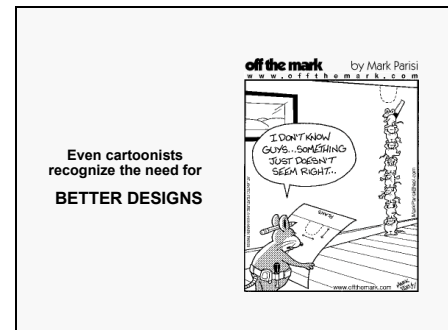
Slide 11



Slide 9



Slide 12



Slide 13

St. Joseph's Sustainable & Affordable Housing Project GOAL



Sustainable Use of Resources



Affordable: Minimize Cost

Optimize

Housing: Maximize Lifestyle



Slide 16

... perform better & will help



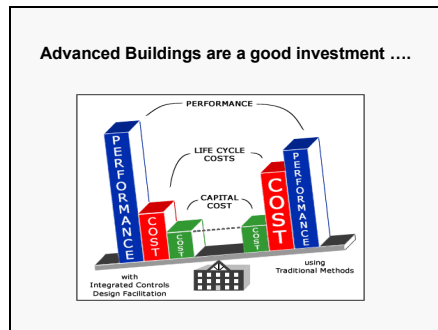
Devils Lake, May Long Weekend 2002

...preserve the environment for future generations.

Slide 14



Slide 15



Appendix 6

Integrated Design Process presentation by Ken Coutu

Slide 1

An Introduction to the

INTEGRATED DESIGN PROCESS

Ken Coutu, P.Eng.
Project Manager



Slide 4

New Design Goals

- Do we have to change the process just because the goals are different?

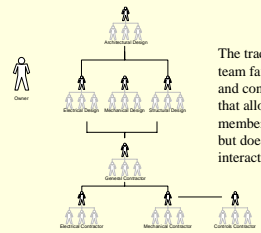
Slide 2

CONSTRUCTION GOALS

<ul style="list-style-type: none"> TRADITIONALLY Low First Cost Fast Track Operation and Maintenance Costs not a primary concern Divide and Conquer 	<ul style="list-style-type: none"> CURRENTLY Sustainable Design Lowest Life Cycle Cost Operation and Maintenance Costs Primary Concern Collaborative Approach
--	--

Slide 5

Traditional Design Team



The traditional design team favours a divide and conquer approach that allows each team member to specialize, but does not facilitate interaction.

Slide 3

SUSTAINABLE DEVELOPMENT

- Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Slide 6

Disincentives to Sustainable Designs

- Financial models based on short term returns on capital
- Just-in-time design process does not allow for a team approach
- Mechanical and electrical engineers are rarely consulted at the conceptual design stage, when opportunities for design tradeoffs are the largest
- Consultants fees based on size of systems designed
- Designers concerns about liability are most easily met by over-sizing

Slide 7

Disincentives (Cont.)

- Vendors continue to sell 'Tried and True' technology
- Buildings typically are not fully commissioned until the fifth year
- Operating procedures for building systems are rarely well documented
- Buildings are not operated optimally

Slide 10

Required Steps to an Integrated Design

- Make the commitment
- Designate an Integrated Design Co-ordinator
- Incorporate the Integrated Design Process into Project Documents
- Establish Performance Based Fees
- Identify Integrated Design Strategies

Slide 8

So What is the Answer?

Use an Integrated Design Process!

Slide 11

Required Steps (Cont.)

- Do a Whole System Analysis
- Base Design Decisions on Life Cycle Economics
- Follow Through – ensure integrity of design through tender and construction
- Commission
- Reap the benefits

Slide 9

Integrated Design Team

The integrated design team utilizes a collaborative approach that requires the co-operation of each team member to achieve the design.

Slide 12

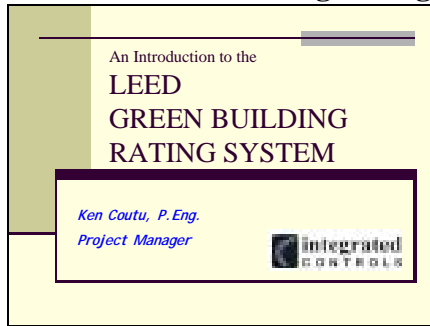
Conclusions

- Traditional process is not conducive to sustainable designs
- Integrated Design Process is a new approach that overcomes traditional barriers
- End result is buildings that cost less to operate and maintain, are more comfortable and do not cost more to build

Appendix 7

LEED Green Building Rating System presentation by Ken Coutu

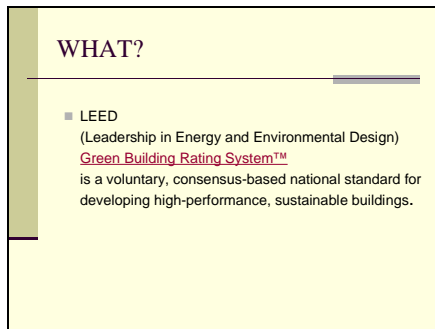
Slide 1



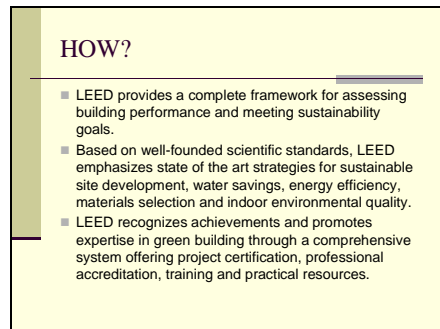
Slide 4



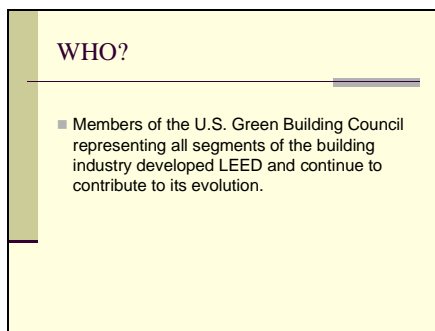
Slide 2



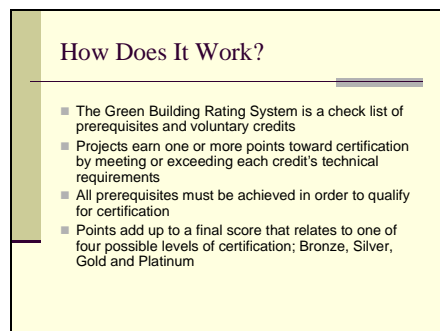
Slide 5



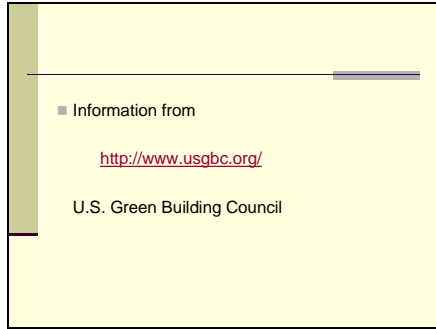
Slide 3



Slide 6



Slide 7



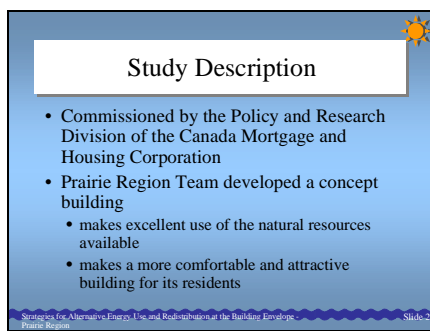
Appendix 8

Strategies for Alternative Energy Use and Redistribution at the Building Envelope presentation by Kelly Winder

Slide 1

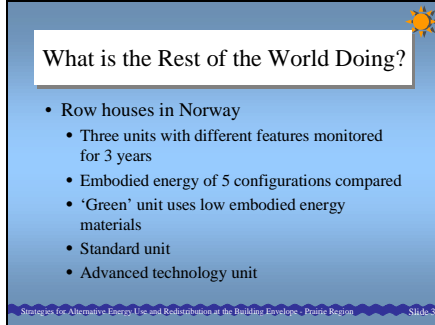


Slide 2



The Policy and Research Division of the Canada Mortgage and Housing Corporation (CMHC) commissioned various groups across the country to investigate Strategies for Alternative Energy Use and Redistribution at the Building Envelope. Integrated Controls, along with the Saskatchewan Research Council and Monty Samson, Architect, have developed a concept building that makes excellent use of the natural resources available and makes a more comfortable and attractive building for its residents.

Slide 3



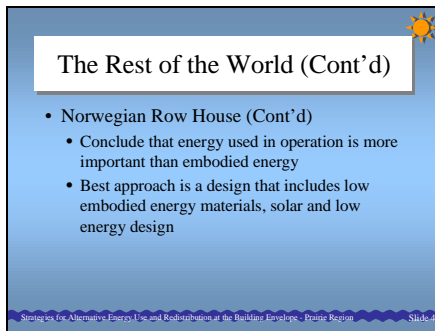
What is the Rest of the World Doing?

- Row houses in Norway
 - Three units with different features monitored for 3 years
 - Embodied energy of 5 configurations compared
 - 'Green' unit uses low embodied energy materials
 - Standard unit
 - Advanced technology unit

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 3

Winther and Hestnes describe a row house in Norway that has been constructed and monitored for a few years. The three units are constructed in slightly different manners in order to compare the performance of the different configurations. Their paper compares the embodied energy and purchased energy over the lifetime of five different configurations using data from the three actual units. The characteristics of these houses include super insulation, 4 pane windows with 3 low emissivity coatings and argon filling, ventilation air heat recovery, a heat pump using a sunspace and ground coupling as sources, transparent insulation in the sunspace, and PV panels. The main comparisons that they attempt to make are between a "green" unit, where particular attention is paid to material selection, a standard unit, built to the current Norwegian building standard practice, and a unit with a large amount of technical equipment (all of the features described above).

Slide 4



The Rest of the World (Cont'd)

- Norwegian Row House (Cont'd)
 - Conclude that energy used in operation is more important than embodied energy
 - Best approach is a design that includes low embodied energy materials, solar and low energy design

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 4

They state, "the results clearly show that in the long run, the energy used for operation is more important than the energy embodied in the materials used to construct and maintain the building." (Winther and Hestnes, 1999). They don't leave it here, however, as their final conclusion is that, "the best buildings may be those that combine the two approaches, i.e. that are both solar, low energy, and 'green'." (Winther and Hestnes, 1999).

Winther, B. N., A. G. Hestnes, "Solar Versus Green: The Analysis of a Norwegian Row House," *Solar Energy*, v 66, p 387-393, 1999.

Slide 5

The Rest of the World (Cont'd)

- Thermal Test Facility in Denver, CO
 - Features include:
 - Daylighting
 - Occupancy sensors
 - Temperature setback
 - Thermal bread reduction during construction
 - Evaporative cooling
 - Overhangs
 - Building uses 63% less energy than base case model prediction

Strategies for Alternative Energy Use and Reductions at the Building Envelope - Prairie Region Slide 5

The Thermal Test Facility in Denver, CO has been described by Torcellini, et. al. (1999) The features included in this facility were daylighting, including occupancy sensors, to reduce cooling load and electrical consumption, heat load reduction by setting the temperature back during unused periods, and paying particular attention to reducing thermal breaks in the building envelope, the employment of an evaporative cooling system, and the use of overhangs to reduce direct solar gain. The resulting building uses 63% less than the base case model prediction.

Torcellini, Paul A.; Hayter, Sheila J.; Judkoff, Ron, "Low-Energy Building Design - The Process and a Case Study," ASHRAE Transactions, v 105 (part 2), p 802-810, 1999.

Slide 6

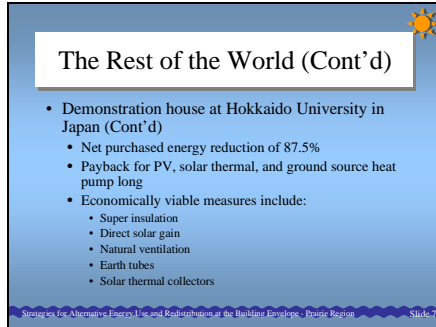
The Rest of the World (Cont'd)

- Demonstration house at Hokkaido University in Japan
 - Features include:
 - Prefabricated extruded polystyrene/oriented strand board structural panels
 - Low-e coated windows with awnings
 - Passive solar heat
 - Natural ventilation
 - Large thermal mass, including PCMs
 - Roof integrated PV
 - Ground source heat pump
 - Solar thermal collectors
 - Exhaust air heat pump
 - Earth coupled ventilation air supply

Strategies for Alternative Energy Use and Reductions at the Building Envelope - Prairie Region Slide 6

Yasuhiro Hamada, et. al. (2001) describe a demonstration house built on the campus of Hokkaido University in Japan. This house incorporates prefabricated extruded polystyrene/oriented strand board wall and roof panels, double glazed, argon filled, low emissivity coated windows, with awnings for shading, passive direct solar heat and natural ventilation, large thermal mass, including phase change materials with a melting temperature of 20°C, roof integrated PV panels, a ground source heat pump, flat plate solar collectors, exhaust air heat pump, earth coupled ventilation supply air pre-heating/cooling, and a few long term heat storage strategies.

Slide 7



The Rest of the World (Cont'd)

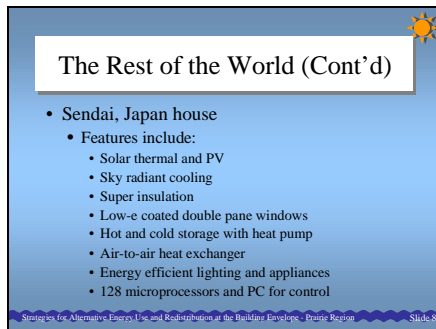
- Demonstration house at Hokkaido University in Japan (Cont'd)
- Net purchased energy reduction of 87.5%
- Payback for PV, solar thermal, and ground source heat pump long
- Economically viable measures include:
 - Super insulation
 - Direct solar gain
 - Natural ventilation
 - Earth tubes
 - Solar thermal collectors

Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region Slide 7

The net purchased energy reductions from all of these measures is 87.5%, but the payback periods for the PV (28 years), solar thermal (15 years), and ground source heat pump (8-25 years) were rather large. The authors conclude that “super thermal insulation, direct solar gain, natural ventilation, earth tubes, solar collectors, and so forth, improve energy efficiency of homes without too much cost.” (Hamada, et. al., 2001)

Hamada, Yasuhiro, Makoto Nakamura, Kiyoshi Ochifuji, Katsunori Nagano, Shintaro Yokoyama, “Field Performance of a Japanese Low Energy Home Relying on Renewable Energy,” Energy and Buildings, v 33, p805-814, 2001.

Slide 8



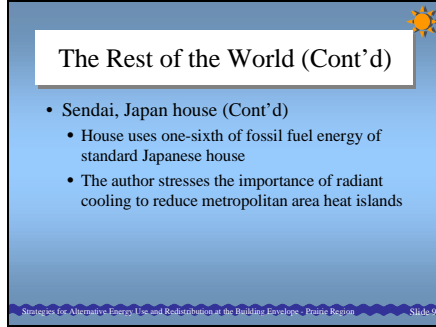
The Rest of the World (Cont'd)

- Sendai, Japan house
- Features include:
 - Solar thermal and PV
 - Sky radiant cooling
 - Super insulation
 - Low-e coated double pane windows
 - Hot and cold storage with heat pump
 - Air-to-air heat exchanger
 - Energy efficient lighting and appliances
 - 128 microprocessors and PC for control

Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region Slide 8

Another Japanese house, located in Sendai, is described by Saitoh and Fujino (2001). This house incorporates solar collectors, photovoltaics, sky radiators, super insulation, double pane, low emissivity windows, auxiliary thermal storage with a heat pump used for cool storage in the summer and heat in the winter, a rainwater collection tank, flat plate ventilation air heat exchanger, energy-efficient lighting and appliances, and 128 microprocessors along with a personal computer for control.

Slide 9



The Rest of the World (Cont'd)

- Sendai, Japan house (Cont'd)
 - House uses one-sixth of fossil fuel energy of standard Japanese house
 - The author stresses the importance of radiant cooling to reduce metropolitan area heat islands

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 9

The resulting house uses one-sixth of the fossil fuel energy of a standard, comparable Japanese house. The most unique feature of this house (besides the number of MIPS (Millions of Instructions Per Second) is the sky radiation cooling. Of this feature, the authors say, “this would be particularly effective in metropolitan areas including Tokyo where it is estimated that the ambient temperature in the summer evening around 2030 will exceed 40°C.” (Saitoh and Fujino, 2001)

Saitoh, Takeo S., and Tetsuji Fujino, “Advanced Energy-Efficient House (Harbeman House) with Solar Thermal, Photovoltaic, and Sky Radiation Energies (Experimental Results),” *Solar Energy*, v 70, n 1, p 63-77, 2001.

The Rest of the World (Cont'd)

- Building Integrated Photovoltaic (BIPV) projects
 - Rappenecker Hof in Germany
 - 100 roof integrated modules
 - Generates three-quarters of its electricity
 - Switzerland
 - PV panels integrated into sun shades on south façade
 - Others in Europe
 - Facade panels
 - Semi-transparent façade materials
 - Shading systems
 - Roofing materials
 - Skylights
- "Photovoltaic technology is ready for the building market." (Hagemann, 2001)

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 10

There have been many Building Integrated Photovoltaic (BIPV) projects around the world to date. Rappenecker Hof, a mountain inn in Germany, collects three-quarters of its electricity from an array of 100 modules mounted to the sloped roof surface of the building (Boyle, 1996). Boyle also gives an example of a building in Switzerland which has PV panels integrated into the facade, acting as sun shades over windows on the south facade. Ingo Hagemann describes numerous BIPV projects in Europe including techniques such as facade panels, semi-transparent facade materials, shading systems, roofing materials, and skylights. His final conclusion is that "photovoltaic technology is ready for the building market." (Hagemann, 2001).

Boyle, Godfrey (ed.), Renewable Energy: Power for a Sustainable Future, Oxford University Press, Oxford, 1996.

Hagemann, Ingo, "Building Integrated Photovoltaics: New Developments and Trends in Europe," Building Energy 2001, Northeast Sustainable Energy Association Conference, Tufts University, Medford, MA, USA, March 21-24, 2001.

Slide 11

The Rest of the World (Cont'd)

- Swedish houses without heating systems
 - Set of 20 row houses near Göteborg, Sweden
- Features include:
 - No conventional heating systems
 - Careful passive solar design
 - Tight, well insulated envelope
 - Heat recovery ventilator
 - Active solar hot water heat
 - Operable windows for summer ventilation
- Estimated cost of construction is normal

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 11

Hans Eek (2001) describes a set of twenty row houses near Göteborg, (Gothenberg) Sweden, which have been constructed without heating systems. Heat is captured from the sun by careful passive solar design, and from the appliances and occupants. The envelope is tight and well insulated, and a heat recovery ventilator is used. Active solar collectors are used to heat hot water, which is supplemented by electricity. Operable windows are used to provide ventilation in the summer. The cost of these houses is estimated to be normal.

Eek, Hans, "Houses Without Heating Systems - In Real Life," Swedish Research for Sustainability, n 2, p 13, 2001.

Slide 12

Prairie Region Weather

- Continental climate
- Design temperatures:
 - -35°C in winter
 - +30°C in summer
- Good sunshine
 - 2400 hours annually (55% of possible hours) in Saskatoon
- Latitude 50°N (Winnipeg) to 53°N (Edmonton)
- Annual heating degree days (base 18°C) 5200°Cd to 5950°Cd
- Annual cooling degree days (base 18°C) less than 200°Cd

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 12

The prairie region of Canada experiences a continental climate, with outdoor design temperatures in the larger cities in the southern Prairies that range from approximately -35°C in winter to +30°C in summer. The prairie climate is also characterized by good sunshine conditions, with annual average bright sunshine of 2400 hours (55% of possible hours), for instance, in Saskatoon. The latitude of the major cities ranges from 50°N (Winnipeg) to 53°N (Edmonton). Annual average heating degree days (base 18°C) amount to 5200°C-d in Calgary, 5400°C-d in Edmonton, 5950°C-d in Saskatoon, and 5900°C-d in Winnipeg. Annual average cooling degree days (base 18°C) amount to less than 200°C-d throughout the major prairie cities, ranging from a high of 178°C-d in Winnipeg to a low of 38°C-d in Calgary. Details of the climate statistics for Calgary are listed in Table 1.

In summary, the temperatures on the prairies show very large extremes compared with coastal regions, and regions further south.

Slide 13

Calgary Weather					
Month	Monthly average daily radiation on horizontal surface (kWh/m ² /d)	Monthly average daily radiation on vertical, south facing surface (kWh/m ² /d)	Monthly average temperature (°C)	Monthly average relative humidity (%)	Monthly average wind speed (m/s)
January	1.34	4.37	-9.6	63.0	4.4
February	2.31	5.18	-6.3	62.5	4.2
March	3.59	4.76	-2.5	64.0	4.4
April	4.96	3.73	4.1	57.5	4.7
May	5.68	3.17	9.7	56.5	5.0
June	6.38	3.14	14.0	58.0	4.7
July	6.34	3.28	16.4	60.0	4.2
August	5.36	3.51	15.7	60.5	3.9
September	4.02	3.95	10.6	61.0	4.2
October	2.70	4.60	5.7	56.0	4.2
November	1.54	4.34	-3.0	63.5	4.2
December	1.06	3.81	-8.3	64.0	4.4
Annual	1.38 MWh/m ²	1.45 MWh/m ²	3.9		4.4

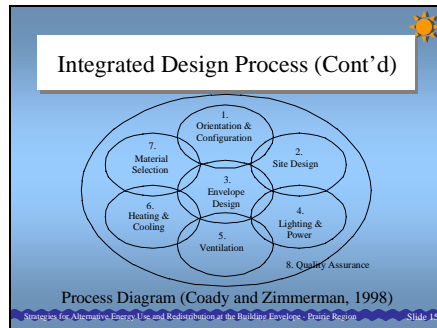
Slide 14

Integrated Design Process

- Integrated Design Process is necessary
- C-2000 program considers it critical
- Participants are rewarded to create optimal overall design
 - Lower operating and maintenance costs
 - Improved comfort
 - Improved financial performance for the owner

To develop buildings that successfully reduce energy consumption requires an integrated design process. Nils Larsson (1998) describes how the C-2000 program for advanced commercial buildings considers the integrated design process critical to the development of truly advanced, energy efficient buildings. An Integrated Design Process rewards all participants in the project in a way that promotes optimizing the design and construction of building systems to improve comfort, lower operating and maintenance costs, and improve the financial performance for the owner.

Slide 15



Coady and Zimmerman (1998), in "It's the Process, Not the Gadgets!" include the process diagram, shown here as Figure 1, in their paper. The diagram indicates how the building envelope becomes central, with every other part of the design interacting with the envelope design.

Coady, Teresa, and Alex Zimmerman, "It's the Process, Not the Gadgets!" Green Building Challenge '98 Conference Proceedings, Vancouver, Canada, v 1, p 95-103, October 26-28, 1998.

Slide 16



**Advanced Multi-unit Residential
Concept Building Description**

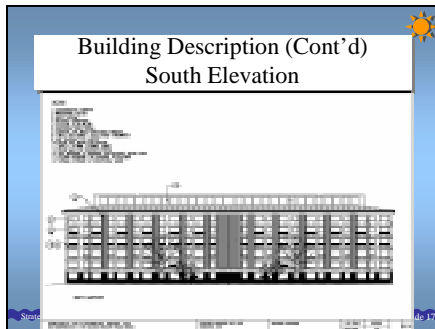
What might an advanced multi-unit residential building designed for the prairies look like?

- Use sunshine in winter, but reject in summer
- Keep heat in
- Pleasant, comfortable place to reside
- Good financial returns for owners

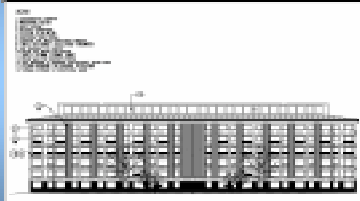
Strategies for Alternative Energy Use and Realization in the Building Envelope - Prairie Region Slide 16

So, what might an advanced multi-unit residential building designed for the prairies look like? It must take advantage of the bountiful sunshine that we receive during our cold prairie winters for light and heat, but still reject the unwanted heat in the hot, dry summers. It must have the ability to keep heat inside in the cold winter season, letting it escape as slowly as possible. It must be a pleasant, comfortable place for people to reside. It must provide good financial returns for its owners.

Slide 17

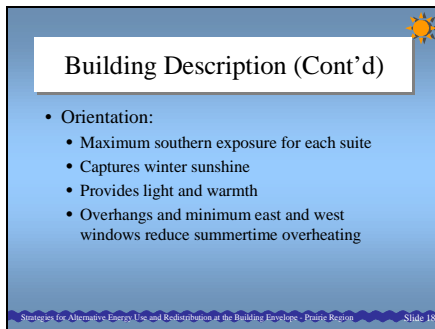


**Building Description (Cont'd)
South Elevation**



Slide 17

Slide 18



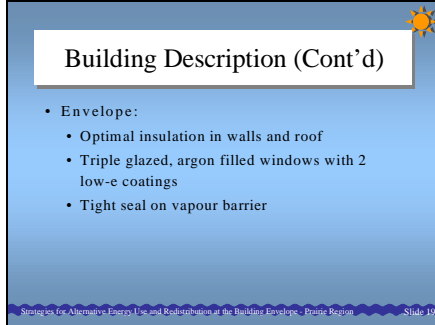
Building Description (Cont'd)

- Orientation:
 - Maximum southern exposure for each suite
 - Captures winter sunshine
 - Provides light and warmth
 - Overhangs and minimum east and west windows reduce summertime overheating

Strategies for Alternative Energy Use and Realization in the Building Envelope - Prairie Region Slide 18

The maximal southern exposure for each suite captures the wintertime sunshine, providing light and warmth to the living areas.

Slide 19



Slide 19 features a blue background with a white title box at the top containing the text "Building Description (Cont'd)". Below the title box, a bulleted list is presented. The first bullet point is "Envelope:", followed by three sub-bullets: "Optimal insulation in walls and roof", "Triple glazed, argon filled windows with 2 low-e coatings", and "Tight seal on vapour barrier". A small sun icon is located in the top right corner of the slide. At the bottom, a thin blue bar contains the text "Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region" on the left and "Slide 19" on the right.

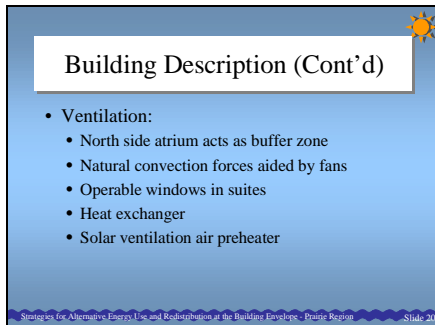
Building Description (Cont'd)

- Envelope:
 - Optimal insulation in walls and roof
 - Triple glazed, argon filled windows with 2 low-e coatings
 - Tight seal on vapour barrier

Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region Slide 19

Overhangs above the south windows and the avoidance of east and west facing windows limit the summertime sun penetration to reduce overheating. The use of operable, triple glazed, spectrally selective, Argon filled windows with two low-e coatings improves the insulation value of the windows. This, along with optimal wall and roof insulation, minimal thermal bridging, and careful attention paid to air-vapour barrier installation during construction, substantially reduces heat losses through the building envelope.

Slide 20



Slide 20 features a blue background with a white title box at the top containing the text "Building Description (Cont'd)". Below the title box, a bulleted list is presented. The first bullet point is "Ventilation:", followed by five sub-bullets: "North side atrium acts as buffer zone", "Natural convection forces aided by fans", "Operable windows in suites", "Heat exchanger", and "Solar ventilation air preheater". A small sun icon is located in the top right corner of the slide. At the bottom, a thin blue bar contains the text "Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region" on the left and "Slide 20" on the right.

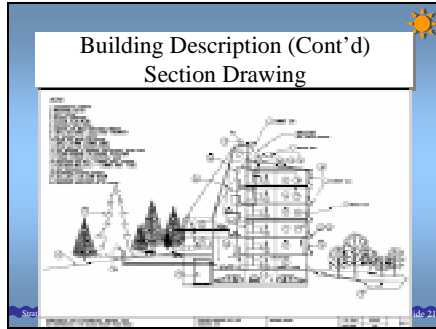
Building Description (Cont'd)

- Ventilation:
 - North side atrium acts as buffer zone
 - Natural convection forces aided by fans
 - Operable windows in suites
 - Heat exchanger
 - Solar ventilation air preheater

Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region Slide 20

In addition to heat energy in the wintertime, buildings use energy for ventilation, cooling, and lighting. The atrium on the north side of the building provides a buffer zone for ventilation air. Natural forces of convection are aided by fans drawing air from the atrium into individual suites and up through a heat exchanger on the top of the building. In the wintertime, air is drawn from a solar ventilation air pre-heater mounted on the south wall and delivered into the atrium as fresh warm air, rather than a cold draft. In the summertime, the atrium area is purged at night, allowing it to act as a thermal buffer to help cool the building during the day. Once again, natural convection and wind forces are used to move the air, with some assistance from fans.

Slide 21



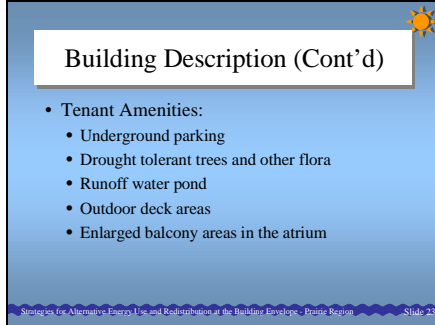
Slide 22

Building Description (Cont'd)

- Heating and Cooling:
 - In-floor pipes
 - Large surface area means lower temperatures
 - More comfortable heat
 - Less energy intensive
 - Cooling uses building service water and seasonal ice storage tank

Heating and cooling are provided by in-floor pipes. The large surface area of the slab allows heating and cooling to be done at temperatures much closer to the desired room temperature, providing a more comfortable heat for the occupants that is also less energy intensive. Cooling can in fact be done with the building service water from the water mains, with assistance from an ice storage tank, rather than window or wall mounted air conditioning units. The benefit for the occupants is a quieter, more comfortable thermally conditioned living space. The benefits to the owner are lower installation, maintenance, and energy costs for cooling and heating since the building uses more natural, free energy sources with reduced reliance on fossil fuels.

Slide 23



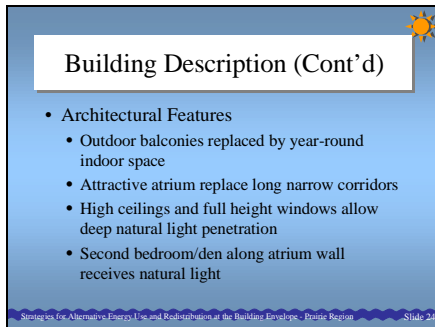
Building Description (Cont'd)

- Tenant Amenities:
 - Underground parking
 - Drought tolerant trees and other flora
 - Runoff water pond
 - Outdoor deck areas
 - Enlarged balcony areas in the atrium

Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region Slide 23

The building is designed to be occupant friendly. Underground parking provides a warmer, snow-free place for parking. Parking space is replaced by drought tolerant trees and other natural flora, a pond to capture rainwater runoff, and outdoor deck areas for socializing. These features have the added benefit of reducing the local heating caused by large expanses of black asphalt or concrete in the summertime, and reducing the need to shovel snow from the parking lot in the winter. Runoff from precipitation into municipal storm sewers is reduced by minimizing the hard surface areas on the site and creating a local collection area. For cool summer nights and cold winter days, the enlarged balcony areas in the atrium provide additional space for occupant interactions.

Slide 24



Building Description (Cont'd)

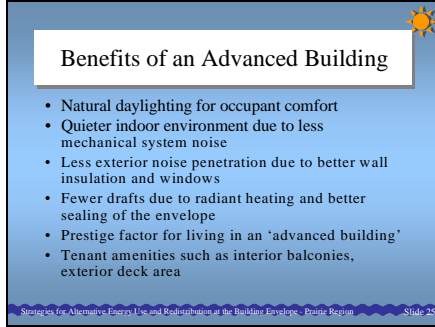
- Architectural Features
 - Outdoor balconies replaced by year-round indoor space
 - Attractive atrium replace long narrow corridors
 - High ceilings and full height windows allow deep natural light penetration
 - Second bedroom/den along atrium wall receives natural light

Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region Slide 24

The elimination of balconies and the thermal bridging problems they pose for the building envelope is an important feature of the design. The private seasonal outdoor amenity area usually provided by balconies is instead created through enlarged balcony areas in the atrium area on the north side of the building, resulting in a year-round space. The atrium replaces the typical empty, long, narrow corridors with balconies, decks, plants, and daylighting – a sort of internal mall or “street” where residents can interact.

Each suite has high ceilings (over 9 feet) and full height south facing windows to allow deeper daylight penetration and the opportunity to use borrowed natural light for a second raised bedroom or den without locating it in an outside wall. These “back” bedrooms/dens can also borrow daylight from the naturally illuminated atrium area.

Slide 25



Slide 25 features a blue background with a white title box at the top left containing the text "Benefits of an Advanced Building". To the right of the title box is a small yellow sun icon. Below the title box is a bulleted list of seven items. At the bottom of the slide, there is a small blue banner with white text that reads "Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region" and "Slide 25" on the right.

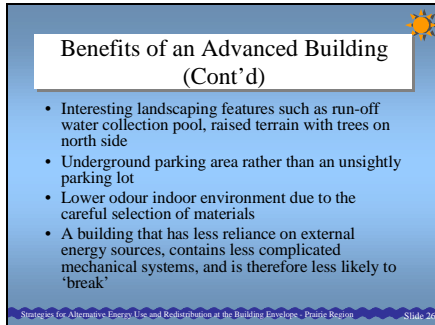
Benefits of an Advanced Building

- Natural daylighting for occupant comfort
- Quieter indoor environment due to less mechanical system noise
- Less exterior noise penetration due to better wall insulation and windows
- Fewer drafts due to radiant heating and better sealing of the envelope
- Prestige factor for living in an 'advanced building'
- Tenant amenities such as interior balconies, exterior deck area

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 25

The emphasis in much of this presentation has been on the energy saving benefits of an integrated design process. Some of the other advantages of a building with the features included in this concept are:

Slide 26



Slide 26 features a blue background with a white title box at the top left containing the text "Benefits of an Advanced Building (Cont'd)". To the right of the title box is a small yellow sun icon. Below the title box is a bulleted list of four items. At the bottom of the slide, there is a small blue banner with white text that reads "Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region" and "Slide 26" on the right.

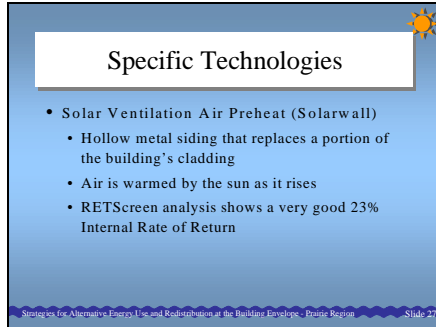
Benefits of an Advanced Building (Cont'd)

- Interesting landscaping features such as run-off water collection pool, raised terrain with trees on north side
- Underground parking area rather than an unsightly parking lot
- Lower odour indoor environment due to the careful selection of materials
- A building that has less reliance on external energy sources, contains less complicated mechanical systems, and is therefore less likely to 'break'

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 26

The nature of the integrated design process provides for the inclusion of these and other marketable features of the advanced building to be included along with the energy saving features. The beauty of many of the energy saving features is that they also create a more advantageous indoor and outdoor environment – the challenge is to sell these features to potential tenants and developers.

Slide 27



Slide 27 features a blue background with a white title box at the top containing the text "Specific Technologies". To the right of the title box is a small yellow sun icon. Below the title box, there is a bulleted list of four items. At the bottom of the slide, there is a small blue banner with white text that reads "Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region" and "Slide 27" on the right.

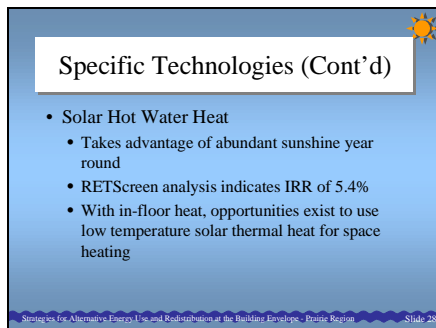
Specific Technologies

- Solar Ventilation Air Preheat (Solarwall)
 - Hollow metal siding that replaces a portion of the building's cladding
 - Air is warmed by the sun as it rises
 - RETScreen analysis shows a very good 23% Internal Rate of Return

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 27

A Canadian firm called Conservall manufactures a ventilation air pre-heater known as Solarwall that mounts on the exterior of a building, replacing the cladding. The material consists of perforated metal ducts and looks much like vertical metal cladding. Ventilation air for the building is drawn in along the material's length, being heated by the sun as it rises to the top of the building. A disadvantage of this product is that it is useful for only the heating season, when ventilation air must be heated. An advantage is that the capital cost is only slightly more than the cladding it replaces. Our analysis showed a 23% Internal Rate of Return (IRR), assuming a product cost double the cladding it replaces. Available Renewable Energy Deployment Initiative (REDI) grants were excluded from the analysis.

Slide 28



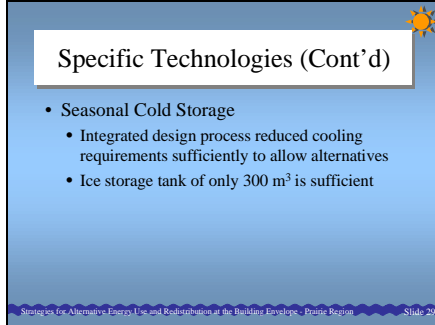
Slide 28 features a blue background with a white title box at the top containing the text "Specific Technologies (Cont'd)". To the right of the title box is a small yellow sun icon. Below the title box, there is a bulleted list of four items. At the bottom of the slide, there is a small blue banner with white text that reads "Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region" and "Slide 28" on the right.

Specific Technologies (Cont'd)

- Solar Hot Water Heat
 - Takes advantage of abundant sunshine year round
 - RETScreen analysis indicates IRR of 5.4%
 - With in-floor heat, opportunities exist to use low temperature solar thermal heat for space heating

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 28

Since sunshine is so prevalent on the prairies, another analysis using this resource to heat water was performed. This analysis produced an IRR of 5.4% using the heat solely for heating domestic hot water. This is a conservative estimate since building heat with low temperature water is very feasible with additional hot water storage incorporated into the building, and REDI grants are excluded from this analysis.

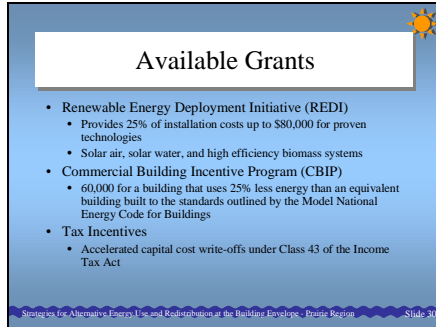


Specific Technologies (Cont'd)

- Seasonal Cold Storage
 - Integrated design process reduced cooling requirements sufficiently to allow alternatives
 - Ice storage tank of only 300 m³ is sufficient

Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region Slide 29

The most unique and possibly the most beneficial technology that was explored for this advanced building concept is the long-term storage of cold. The cooling requirement on the prairies is typically quite small since overnight temperatures usually drop below 20°C. Winter temperatures always drop well below freezing for a substantial period. These two facts prompted an investigation into the feasibility of storing some of the cold from wintertime and using it to cool the building in the summertime. Building energy modeling showed a cooling requirement of 100 GJ that was not met by the service water cooling previously described. Storing this much energy in the phase change of ice to water requires about 300 m³ of ice, a volume approximately equivalent to the space occupied by 5 parking stalls under the building.



Available Grants

- Renewable Energy Deployment Initiative (REDI)
 - Provides 25% of installation costs up to \$80,000 for proven technologies
 - Solar air, solar water, and high efficiency biomass systems
- Commercial Building Incentive Program (CBIP)
 - 60,000 for a building that uses 25% less energy than an equivalent building built to the standards outlined by the Model National Energy Code for Buildings
- Tax Incentives
 - Accelerated capital cost write-offs under Class 43 of the Income Tax Act

Strategies for Alternative Energy Use and Rehabilitation at the Building Envelope - Prairie Region Slide 30

Government of Canada programs include the Renewable Energy Deployment Initiative (REDI), which provides 25% of the installation costs up to \$80,000 to businesses installing solar air, solar water, and high efficiency biomass systems (REDI,2002). The Commercial Building Incentive Program (CBIP) encourages energy efficient design of new and retrofit commercial buildings through a financial incentive of up to \$60,000 for a building that uses 25% less energy than an equivalent building built to the standards outlined by the Model National Energy Code for Buildings (CBIP, 2002). There are tax incentives for accelerated capital cost write-offs under Class 43 of the Income Tax Act available to businesses investing in renewable energy equipment such as photovoltaic systems. These are described in a brochure published by the Government of Canada called “Tax Incentives for Business Investment in Energy Conservation and Renewable Energy” (GoC, 1998).

Commercial Building Incentive Program,
<<http://cbip.nrcan.gc.ca/cbip.htm>>,
accessed 2002-Sep-20.

Government of Canada, “Tax Incentives for Business Investments in Energy Conservation and Renewable Energy,” 1998.

Renewable Energy Deployment Initiative,
<http://www.nrcan.gc.ca/es/erb/reed/redi_e.htm>,
accessed 2002-Sep-20.

Slide 31



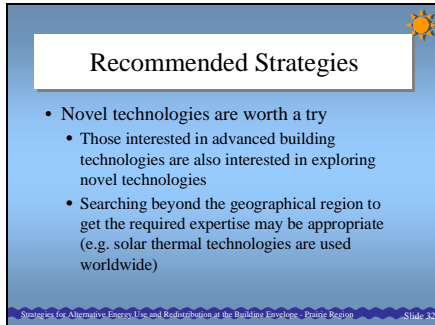
Slide 31 features a blue background with a white title box at the top containing the text "Recommended Strategies". To the right of the title box is a small yellow sun icon. Below the title box, there is a bulleted list. At the bottom of the slide, there is a small blue banner with white text that reads "Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region" and "Slide 31" on the right.

Recommended Strategies

- Integrated Design Process
 - Need to have the whole picture in mind – environment, occupants, construction, operation, and maintenance
 - Specific technologies cannot be labelled good or bad
 - Appropriate technologies for the building and site will come from the integrated design process

An integrated design approach is necessary for the development of advanced buildings. Without looking at the whole picture of how a building interacts with its environment and the people that occupy it, both in its construction and operation, no specific technology can be labeled as good or bad. Technologies that are appropriate for the building that has been presented in this study may not work on the actual site of a real building, but the integrated design approach used to arrive at this concept building will.

Slide 32



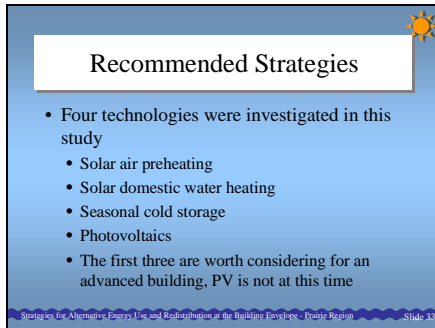
Slide 32 features a blue background with a white title box at the top containing the text "Recommended Strategies". To the right of the title box is a small yellow sun icon. Below the title box, there is a bulleted list. At the bottom of the slide, there is a small blue banner with white text that reads "Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region" and "Slide 32" on the right.

Recommended Strategies

- Novel technologies are worth a try
 - Those interested in advanced building technologies are also interested in exploring novel technologies
 - Searching beyond the geographical region to get the required expertise may be appropriate (e.g. solar thermal technologies are used worldwide)

Familiar technologies are more acceptable to industry in general, but within the subset of industry that is interested in using the integrated design process to develop an advanced building, there is interest in exploring novel approaches to energy use. It may be necessary to go outside of the region or even overseas to get the expertise to implement a novel technology, but if it is appropriate and cost effective, it is worthwhile.

Slide 33



Slide 33 features a blue background with a white title box at the top containing the text "Recommended Strategies". To the right of the title box is a small yellow sun icon. Below the title box, there is a bulleted list. At the bottom of the slide, there is a small blue banner with white text that reads "Strategies for Alternative Energy Use and Redistribution at the Building Envelope - Prairie Region" and "Slide 33" on the right.

Recommended Strategies

- Four technologies were investigated in this study
 - Solar air preheating
 - Solar domestic water heating
 - Seasonal cold storage
 - Photovoltaics
 - The first three are worth considering for an advanced building, PV is not at this time

Of the four specific technologies that were investigated, solar air preheating, solar domestic water heating, and seasonal cold storage are worth considering in the design of an advanced building. Photovoltaics are not currently an economically viable technology in this region.

Slide 34

A presentation slide with a blue background and a sun icon in the top right corner. The title "Recommended Strategies" is in a white box at the top. Below it is a bulleted list. At the bottom, there is a small text line and a slide number.

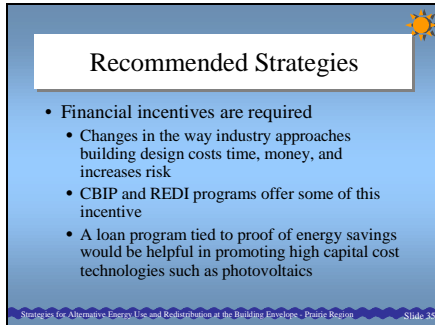
Recommended Strategies

- Passive solar design is a must
 - Benefits are free, but real
 - Principles have been largely ignored by industry of late
- Passive solar design starts with the design of subdivisions, and continues through building design to occupant education

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 34

A return to the basic principles of passive solar design is required. This is an absolutely free approach to reducing energy consumption in buildings that has been largely ignored by industry of late. The need for passive solar design starts with the design of subdivisions to include sites that are appropriate for solar capture. The provision of such sites may in fact produce buildings that are more solar oriented by their very nature. Beyond this, continued promotion of simple, passive solar principles is required.

Slide 35

A presentation slide with a blue background and a sun icon in the top right corner. The title "Recommended Strategies" is in a white box at the top. Below it is a bulleted list. At the bottom, there is a small text line and a slide number.

Recommended Strategies

- Financial incentives are required
 - Changes in the way industry approaches building design costs time, money, and increases risk
 - CBIP and REDI programs offer some of this incentive
 - A loan program tied to proof of energy savings would be helpful in promoting high capital cost technologies such as photovoltaics

Strategies for Alternative Energy Use and Realization at the Building Envelope - Prairie Region Slide 35

Changing the way industry develops buildings costs money, time, and increases risk. These must be offset by some sort of incentive. The CBIP and REDI programs provide some of the required incentive. Some sort of loan program tied to proof of energy savings in addition to the grants may also be helpful in promoting high capital cost technologies such as photovoltaics.

Appendix 9


Affordable Advanced Housing – A Case Study – The Dumont Residence presentation by Rob Dumont

Slide 1

Affordable, Advanced Housing—A Case Study

The Dumont Residence Saskatoon

Rob Dumont, Ph.D.
Saskatchewan Research Council



Slide 4


South Elevation




Slide 2

Affordable



- Afford: “to manage to bear without serious detriment” Webster’s Ninth New Collegiate Dictionary
- Total Cost of Housing Energy Use =
- Initial Cost plus Annual Energy Cost plus Maintenance Cost



Slide 5

Design Philosophy

- Energy efficient
- Environmentally sound
- Eye-pleasing
- Effective from a cost standpoint
- Integrated Design

Slide 3

The Dumont House



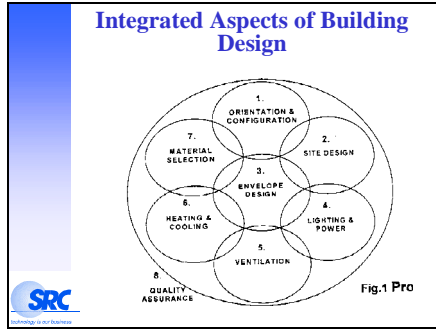

Slide 6

Integrated Design

- “An Integrated Design is a design in which all major component of the building are considered and designed as a totality. Components are *not* designed in isolation of their effects on other components and systems.”



Slide 7



Slide 10

Benefits

- 1. Reduced annual space heating requirement because of passive solar gains—approximately 30% of annual heat requirements of house are from passive solar.
- 2. Reduction in unwanted solar gains in summer as minimal east or west windows used.
- 3. No need for central air conditioning; capital cost saving of approximately \$2k

Slide 8

- *Example of Integrated Design*
- Building orientation with long side of the building facing south was chosen to:
- A. Allow passive solar gain through south windows in winter
- B. Minimize unwanted solar gains through east and west facing windows in summer – avoid air conditioning system
- C. Allow the use of roof overhangs to provide summer shading of the second floor windows
- D. Facilitate the use of a solar water heater

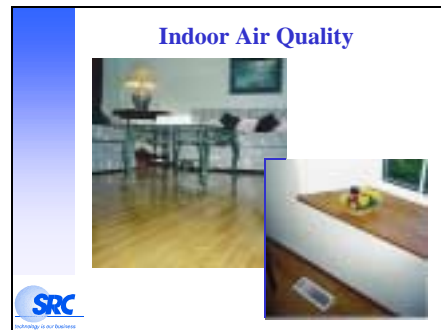
Slide 11

- Second example of the Integrated Design
 - Pre-finished oak hardwood floor was chosen rather than wall-to-wall carpet to
 - A. Minimize organic compound emissions and odours from new carpet
 - B. Increase the working life of the finished floor
 - C. Reduce the capture of dirt particles in the floor
 - D. Facilitate thorough cleaning
 - E. Reduce the need for extra ventilation when the house was new
 - F. Reduce room overheating because of extra thermal capacity and thermal conductance of the hardwood compared with the carpet

Slide 9





Slide 12



Slide 13

Insulation Levels



- R80 Attic
- R60 Walls
- R60 Basement Walls
- R35 Basement Floor
- R5 Windows

Slide 16

Window Type

- Triple Pane
- Argon Gas Fill
- Two Low E Coatings
- Nonmetallic Spacers
- Wood Frame
- Casement Design

Slide 14

Wall Framing




Slide 17

Windows




Slide 15



Cellulose Insulation



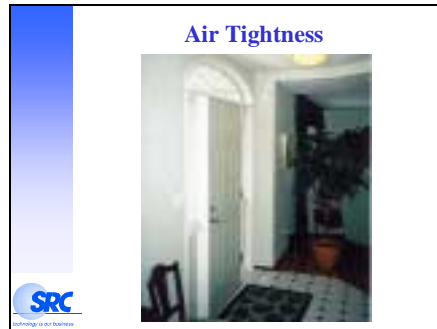

Slide 18

Air Tightness

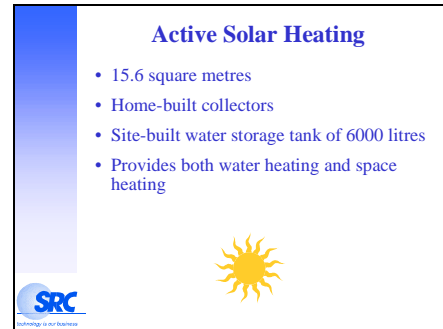
- Third tightest in Saskatchewan
- 0.47 air changes per hour at 50 pascals
- Blown cellulose insulation in walls added to air tightness

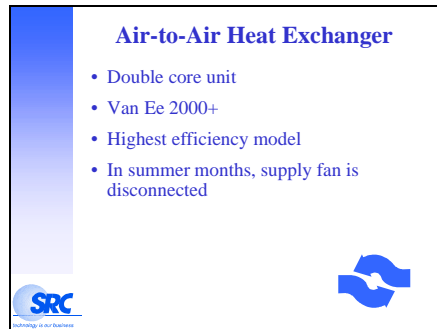
Slide 19



Slide 22



Slide 20



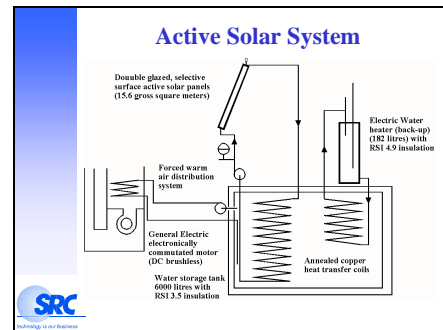
Slide 23



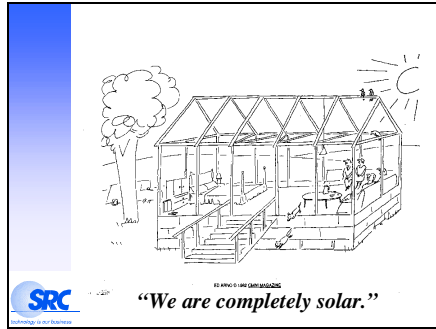
Slide 21



Slide 24





Slide 25



Slide 28

Lighting



- Use of compact fluorescent lamps in majority of light fixtures
- Use of T8 lamps, silver reflector and electronic ballast in kitchen
- Outdoor lamp at back controlled by motion sensor
- Excellent experience with lamps -- only two compact fluorescent lamps replaced after 9.5 years

Slide 26

Appliances

- Most efficient Canadian refrigerator (Woods unit) at a measured consumption of 25 kWh per month
- Use of Green Plug on the freezer and refrigerator
- Use of a built-in wall oven with superior insulation
- Washing machine with variable water level

Slide 29

Lighting




Slide 27

Appliances




Slide 30



Lighting




Slide 31

Water Conservation

- Toilets retrofitted with dams to reduce water use
- Aerating faucets
- Plumbing installed so that a grey water heat exchanger can be installed at a later date (to recover heat from the bathtub water and the clothes washer)
- No lawn in front of house (rock garden with evergreens)

Slide 34

Use of Recycled and Low Embodied Energy Materials





Slide 32

Water Conservation




Slide 35



Indoor Air Quality

- No combustion sources inside home
- No smoking policy during construction
- No smoking allowed
- Dry basement
- No particle board or wafer board used inside
- Solid hem-fir joists
- Douglas fir plywood sub-floors






Slide 33

Use of Recycled and Low Embodied Energy Materials

Slide 36

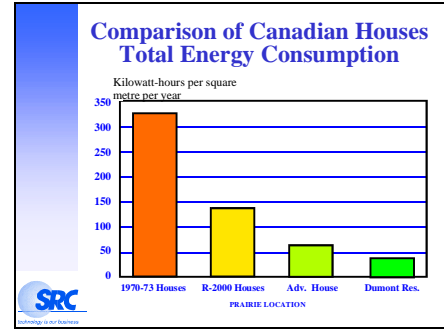
Indoor Air Quality

Slide 37



Slide 40



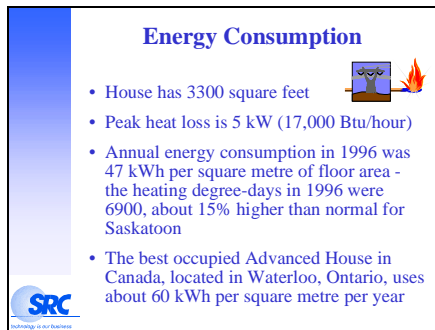
Slide 38



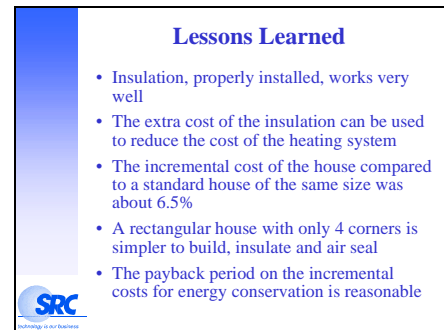
Slide 41



Slide 39





Slide 42



Slide 43

Lessons Learned (cont)

- Water conservation measures are very cost-effective
- Lighting and appliance conservation are generally very cost-effective
- The house has a measured energy consumption about 80% less than the measured energy consumption of conventional houses
- This house is probably the best insulated in the world





Slide 44

Acknowledgements

- Carroll Homes
Contractor
- Philippine Schaan-Dumont
Interior Design

... And all the workers who helped build us
a very satisfying home



Slide 45

The Dumont House



Appendix 10

An Advanced Multi-Unit Residential Concept Building for the Prairie Climate report highlight

Produced by:
CMHC
Integrated Controls
SRC



An Advanced Multi-unit Residential Concept Building for the Prairie Climate

Canadian society is changing. We are an increasingly urban population, living in higher density neighbourhoods, and yet we appreciate our space. We are increasingly aware of the effects of pollution and energy use on our environment, with the Kyoto protocol for greenhouse gas reductions being brought to our attention almost daily. We want comfortable living spaces protecting us from our harsh climate, yet how do we improve the sustainability of our society?

Is there a way that we can address these concerns, making a residence that is more comfortable to live in, uses less energy, and maybe even costs less? By looking at the needs of owners, developers, and tenants more carefully at the beginning of a building project, and using an Integrated Design Process, it is possible to achieve many of these seemingly contradictory requirements.

The building proposed here requires 34% less energy than a similar building built to Model National Energy Code for Buildings (MNECB) guidelines. Free renewable energy sources provide 13% of the remaining energy, making the net energy costs for this concept building 44% lower than the best buildings currently built.

Study Description

The Policy and Research Division of the Canada Mortgage and Housing Corporation (CMHC) commissioned various groups across the country to investigate regional strategies for alternative energy use and redistribution related to the envelopes of multi-family buildings. Integrated Controls, along with the Saskatchewan Research Council and Monty Samson, Architect, developed a concept building that we believe makes excellent use of the natural resources available and provides a more comfortable and attractive building for its residents. For the next part of the study, we wish to solicit feedback from multi-unit residential building owners and developers to determine the feasibility of this concept building.

Integrated Design Process

The development of this concept building started by bringing professionals from as many building development disciplines as possible together into the same room. We looked at

the problem in front of us and said, “How can we make this better, without making it cost more?” By simply asking this question, rather than doing the same thing that has always been done, opportunities opened before us. We found that building enhancements offered opportunities to reduce or even eliminate other systems. For example, by making a better envelope and orienting the building to reduce summer solar heat gains, conventional cooling systems are not required. This process is known as an Integrated Design Process.

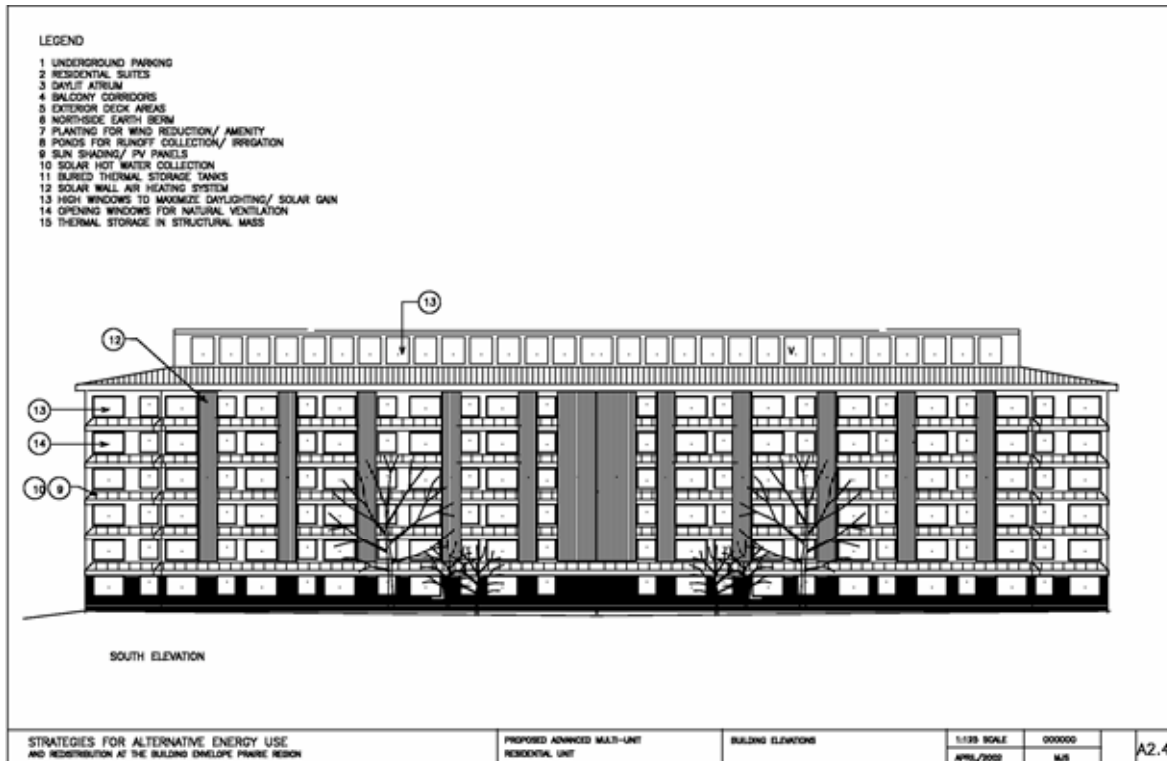
An Integrated Design Process is a design procedure in which all major components of the building are considered and designed as a totality, right from the concept stage. Components are not designed in isolation. Nils Larsson, in describing the C-2000 program for advanced commercial buildings, states that the integrated design process is critical to the development of truly advanced, energy efficient buildings. An Integrated Design Process rewards all participants in the project in a way that promotes optimizing the design and construction of building systems to improve comfort, lower operating and maintenance costs, and improve the financial performance for the owner.

Advanced Multi-unit Residential Concept Building Description

So, what might an advanced multi-unit residential building designed for the prairies look like? It must take advantage of the bountiful sunshine that we receive during our cold prairie winters for light and heat, but still reject the unwanted heat in the hot, dry summers. It must have the ability to keep heat inside in the cold winter season, letting it escape as slowly as possible. It must be a pleasant, comfortable place for people to reside. It also must provide good financial returns for its owners.

Section and plan sketches of the concept building produced by our integrated design team are shown below. A southern exposure for each suite captures the wintertime sunshine, providing light and warmth to the living areas. Overhangs above the south windows and the avoidance of east and west facing windows limit the summertime sun penetration to reduce overheating. The use of operable, triple glazed, spectrally selective, Argon filled windows with two low-e coatings improves the insulation value of the windows. This, along with optimal wall and roof insulation, minimal thermal bridging, and careful attention paid to air-vapour barrier installation during construction, substantially reduces heat losses through the building envelope.

In addition to heat energy requirements in the wintertime, buildings use energy for ventilation, cooling, and lighting. The atrium on the north side of the building provides a buffer zone that preheats ventilation air during the heating season. Natural forces of convection are aided by fans drawing air from the atrium into individual suites and up through a heat exchanger on the top of the building. In the wintertime, ventilation air is drawn from a solar air pre-heating system mounted on the south wall. This air is delivered to the atrium as fresh warm air, rather than a cold draft. In the summertime, the atrium area is purged at night, allowing it to act as a thermal buffer to help cool the building during the day. Once again, natural convection and wind forces are used to move the air, with some assistance from fans.



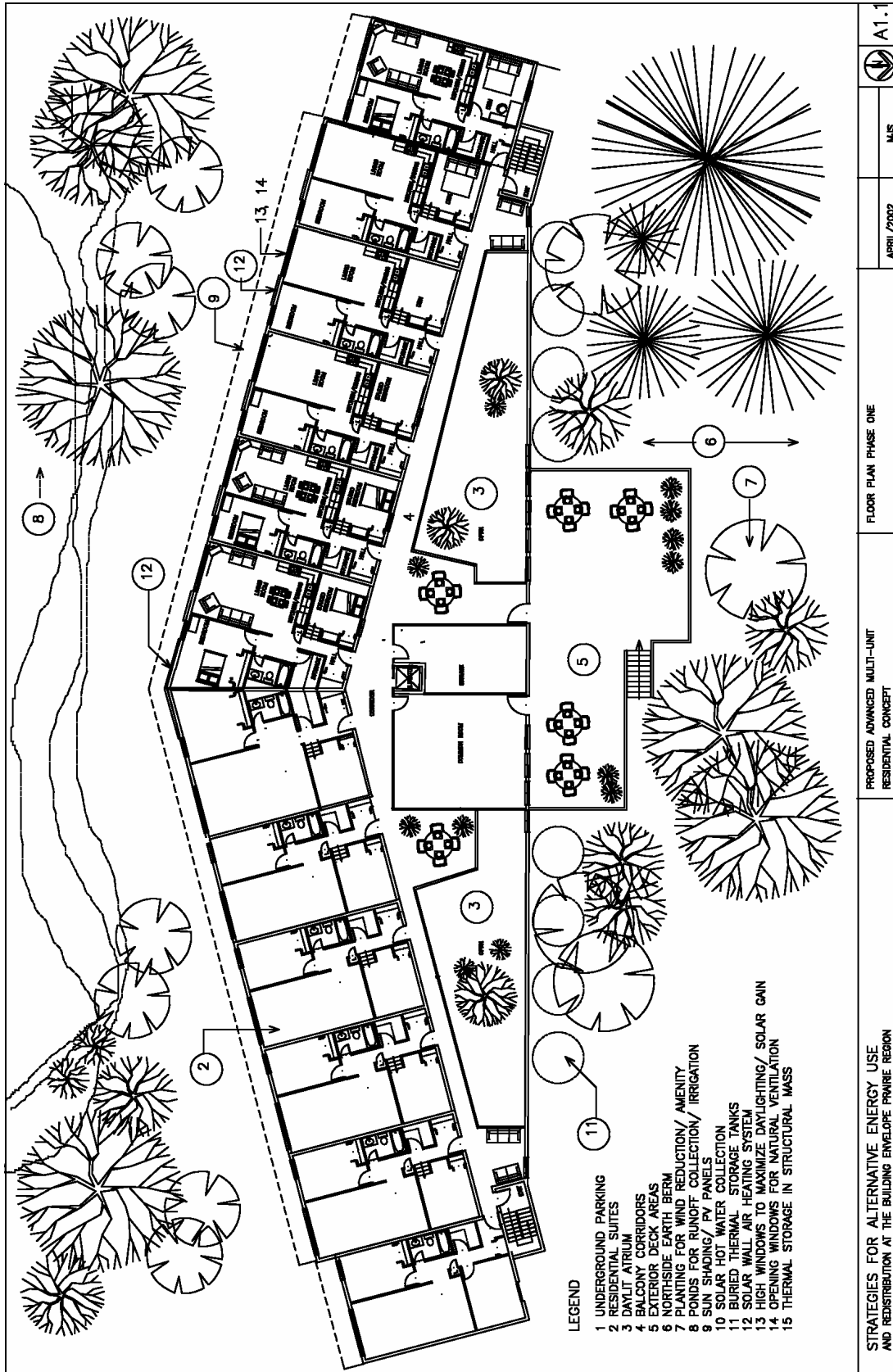
Heating and cooling are provided by in-floor pipes. The large surface area of the slab allows heating and cooling to be done at temperatures much closer to the desired room temperature, providing a more comfortable heat for the occupants that is also less energy intensive. Summer cooling can in fact be done with the building service water from the water mains, with assistance from an ice storage tank, rather than window or wall mounted air conditioning units. The benefit for the occupants is a quieter, more comfortable thermally conditioned living space. The benefits to the owner are lower installation, maintenance, and energy costs for cooling and heating since the building uses more natural, free energy sources with reduced reliance on fossil fuels.

Tenant amenities are bountiful in this building design. Underground parking provides a warmer, snow-free place for parking while at the same time eliminating the unsightly, high maintenance, and heat sink effect of a large expanse of pavement. Above ground parking space is replaced by drought tolerant trees and other natural flora, a pond to capture rainwater runoff, and outdoor deck areas for socializing. For cool summer nights and cold winter days, the enlarged balcony areas in the atrium provide additional space for occupant interactions. These features have the added benefit of reducing the local heating caused by large expanses of black asphalt or concrete in the summertime, and reducing the need to shovel snow from the parking lot in the winter. Furthermore, limiting the hard surface areas on the site and creating a collection area reduces runoff from precipitation into municipal storm sewers.

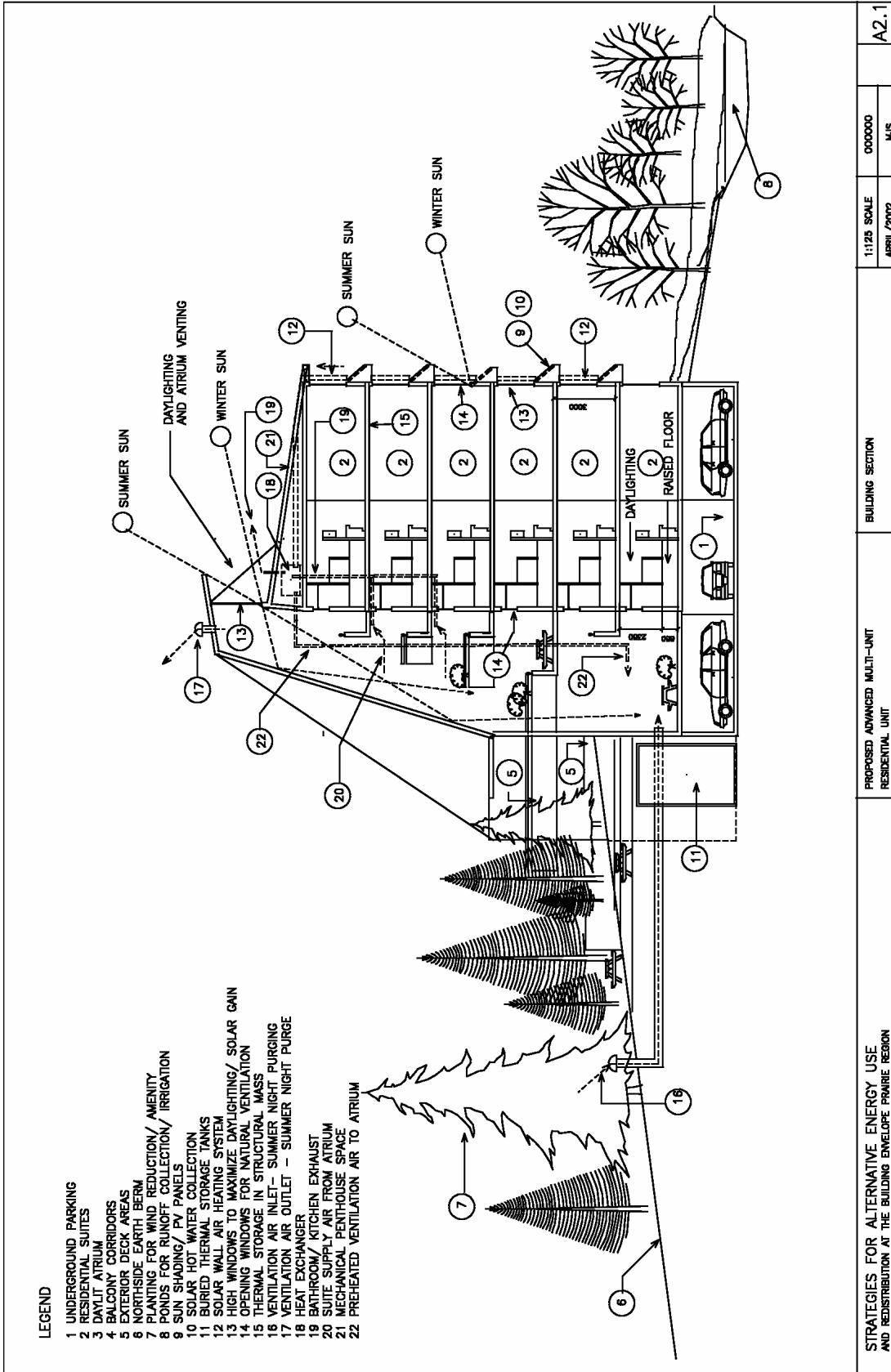
Architectural Features

The elimination of balconies and the thermal bridging problems they pose for the building envelope is an important feature of the design. The private seasonal outdoor amenity area usually provided by balconies is instead provided in a communal way both in and adjacent to the atrium area on the north side of the building and is available 12 months of the year. The atrium replaces the typical empty long narrow corridors with balconies, decks, planting, and daylighting – a sort of internal mall or “street” where residents can interact.

Each suite has high ceilings (over 9 feet) and full height south facing windows to allow deeper daylight penetration and the opportunity for using borrowed natural light for a second raised bedroom or den without locating it in an outside wall. These “back” bedrooms/dens also have the opportunity to borrow daylight from the naturally illuminated atrium area.



STRATEGIES FOR ALTERNATIVE ENERGY USE AND REDISTRIBUTION AT THE BUILDING ENVELOPE PHASE REGION	PROPOSED ADVANCED MULTI-UNIT RESIDENTIAL CONCEPT	FLOOR PLAN PHASE ONE	APRIL/2002	A1.1
--	--	----------------------	------------	------



Specific Technologies

As part of the study, we investigated some specific technologies more thoroughly to determine the economic feasibility of each. In most cases, there are government grants or tax incentives available for these emerging technologies, but these have not been included in the analyses.

Solar ventilation air preheat (Solarwall)

A Canadian firm called Conservall manufactures a ventilation air pre-heater known as Solarwall that mounts on the exterior of a building, replacing the cladding. The material consists of perforated metal ducts and looks much like vertical metal cladding. Ventilation air for the building is drawn in along the material's length, being heated by the sun as it rises to the top of the building. A disadvantage of this product is that it is useful only during the heating season, when ventilation air must be heated. An advantage is that the capital cost is only slightly more than the cladding it replaces. Our analysis showed a 23% Internal Rate of Return (IRR), assuming a product cost double the cladding it replaces. Available Renewable Energy Deployment Initiative (REDI) grants could help reduce the cost further, but were excluded from the analysis.

Solar hot water heat

Since sunshine is so prevalent on the prairies, another analysis using solar hot water heating was performed. This analysis produced an IRR of 5.4% using the heat solely for heating domestic hot water. This is a conservative estimate since building heat with low temperature water is very feasible with additional hot water storage incorporated into the building, and REDI grants could improve the savings.

Seasonal cold storage

The most unique and possibly the most beneficial technology that was explored for this advanced building concept is the long-term storage of cold. Cooling requirements for prairie buildings are typically quite small since overnight temperatures usually drop below 20°C. Winter temperatures always drop well below freezing for a substantial period. These two facts prompted an investigation into the feasibility of storing some of the cold from wintertime and using it to cool the building in the summertime. Building energy modeling showed a cooling requirement of 100 GJ that was not met by the service water cooling previously described. Storing this much energy in the phase change of ice to water requires about 300 m³ of ice, a volume approximately equivalent to the space occupied by 5 parking stalls under the building.

Photovoltaics

Building Integrated Photovoltaics (BIPV) is a technology that proponents consider an ideal technology. It takes a resource that is abundant, free, and natural, and turns it directly into electricity with no moving parts. The problem with PV is that the initial capital expenditure is still very high. An analysis performed on this building situated in Calgary showed an Internal Rate of Return of -2.3%, assuming electricity cost of \$0.079/kWh, and solar panel costs of \$7/W. We do not recommend the inclusion of BIPV at this time, however, we have included design features that allow PV installation to occur when future economic conditions make them more feasible. If solar panel costs

are reduced by 50% and electricity prices increase by 50%, the IRR for BIPV becomes 4.3%. Both of these analyses exclude government tax incentives available for photovoltaic installations.

Benefits of the Building

The advanced building resulting from the Integrated Design Process has many advantages for the occupants and owner, including:

- Reduced energy consumption;
- Government grants are available to implement emerging technologies;
- In the near future, government incentives for reduced greenhouse gas emissions will apply to buildings using less energy;
- Natural daylighting for occupant comfort;
- Quieter indoor environment due to less mechanical system noise;
- Less exterior noise penetration due to better insulation and windows;
- Fewer drafts due to radiant heating and better sealing of the envelope;
- Prestige factor for living in an 'advanced building';
- Tenant amenities such as interior balconies, exterior deck area;
- Interesting landscaping features such as run-off water collection pool, raised terrain with trees on north side;
- Underground parking area rather than an unsightly parking lot;
- A building that has less reliance on external energy sources, contains less complicated mechanical systems, and is therefore less likely to 'break'.

The nature of the Integrated Design Process provides for the consideration of these and other marketable features into an advanced building. The beauty of many of the energy saving features is that they also create a more comfortable indoor and outdoor environment. Sustainable buildings are economically, environmentally, and socially beneficial.

Visit our home page at www.cmhc.ca