
Energy, Mines & Resources Canada

R - 2000

Profile #26, 1992

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Executive Summary

The R-2000 program was initiated by Energy, Mines and Resources (EMR) in 1981 with the goal of affecting the construction of energy-efficient homes in Canada by establishing a new energy performance standard, training builders to construct houses to that standard, and stimulating the demand for such homes. R-2000 has become one of the best known new residential construction programs of its kind. Its homes are as much as 50% more energy-efficient than homes built to Canada's existing codes and the program has proven to be a viable means of stimulating the construction of energy-efficient homes regardless of R-2000 certification.

To date more than 6,000 R-2000 have been built, mostly in Ontario, accounting for less than 1% of all new Canadian homes built since the inception of the program. In addition, many builders incorporate R-2000 standards into their homes even though they do not seek R-2000 certification. EMR estimates that at least an additional 14,000 to 15,000 homes (about 1.5% of the new home construction market) have been built to R-2000 standards since the onset of the program.

In order to be registered as an R-2000 builder, a builder must complete the training program and construct a demonstration home which is inspected during and after construction. Certified builders must submit subsequent plans to their regional office where energy use is evaluated using the HOT-2000 heat loss simulation program. R-2000 certificates are then provided to the homebuyers.

In some regions builders can receive grants for their R-2000 homes. Ontario Hydro, for example, pays C\$2,000 to the homebuyer and gives the same incentive to the builder as long as the home is built in a non-gas supplied area. In New Brunswick, the regional utility pays C\$1,000 to the homebuyer and the Bank of Montreal offers a 1/4 point reduction on mortgage rates for R-2000 homes. Since the inception of the program it has saved Canadians over C\$150 million in energy savings from the R-2000 homes built. However, R-2000 has impacted the entire building industry in Canada. The total program cost spent by EMR and CHBA between the years 1981 and 1991 was about C\$50 million. Program costs in 1991/1992 were C\$1.2 million.

Perhaps more important than the energy savings directly by R-2000 houses has been the program's overall effect on improving energy efficiency in new homes. It is estimated that between 1980 and 1992, the average level of energy efficiency in new homes in Canada has increased by as much as 50%. Much of this improvement is due to the R-2000 program's promotion to consumers and builders and the training provided to builders in constructing energy-efficient homes. Since the program began, over 5,000 builders have been trained, with more than 300 actively participating in the program. Many of the builders who were trained through R-2000 but are not actively participating are still constructing homes that meet or come close to R-2000 standards. EMR has also announced a new program called Advanced Houses. While R-2000 homes use about half the energy of typical Canadian standards, Advanced Houses use about a quarter the energy of typical new homes.

R-2000 Energy Efficiency Home Program

Agency: Energy, Mines and Resources, Canada

Sector: Residential

Measures: Building envelope, ventilation systems and equipment, combustion equipment, appliances, and other energy efficiency improvements.

Mechanism: A federal certification process for energy-efficient home construction. Both builders and homes are certified through the R-2000 program.

History: Started in 1981.

1991 Data

Cost: \$1,254,000

Participation: ~ 1,500 homes certified.

Program Data

R-2000 homes certified: ~6,000

Non-certified R-2000 homes built: ~14,000

R-2000 builders certified: ~5,000

Total EMR costs: ~C\$50 million

Total benefits: ~C\$150 million

Conventions

For the entire 1992 profile series all dollar values have been adjusted to 1990 U.S. dollar levels unless otherwise specified. Inflation and exchange rates were derived from the U.S. Department of Labor's Consumer Price Index and the International Monetary Fund's International Financial Statistics Yearbook: 1991.

The Results Center uses three conventions for presenting program savings. **Annual savings** refer to the annualized value of increments of energy and capacity installed in a given year, or what might be best described as the first full-year effect of the measures installed in a given year. **Cumulative savings** represent the savings in a given year for all measures installed to date. **Lifecycle savings** are calculated by multiplying the annual savings by the assumed average measure lifetime. **Caution:** cumulative and lifecycle savings are theoretical values that usually represent only the technical measure lifetimes and are not adjusted for attrition unless specifically stated.

Agency Overview

The R-2000 Energy Efficiency Home Program is administered by Energy, Mines and Resources (EMR), a federal agency of the Canadian government. In addition, there are several other organizations involved. While the overall impetus and conception of the R-2000 program originated at EMR, it was recognized early in the development stage that a strong link with the house building industry was essential to the success of the program. Such a link was formalized in 1984 when a long term contractual arrangement was negotiated between EMR and the Canadian Home Builders' Association (CHBA) to have CHBA administer and deliver the program nationally.

The delivery of R-2000 reverted back to EMR in 1991. The current approach is to have regional R-2000 programs set up in every province and territory of Canada which will run fairly autonomously with overall direction and coordination from EMR. The typical regional program is supported by a number of partners with electric and gas utilities playing major roles and the provincial home builders' association administering the program. Two of the most successful programs are operated in Ontario and New Brunswick. The success of these two programs is largely due to the key support provided by Ontario Hydro, and New Brunswick Power. [R#10]

The remainder of this section provides an overview of the primary players in the R-2000 program. There are several other organizations which are involved with the R-2000 program in addition to EMR including electric and gas utilities, provincial governments, other federal financial institutions, home builders' associations, and others. Three of the better-known organizations are the Canadian Home Builders' Association, Ontario Hydro, and New Brunswick Power. CHBA's involvement with R-2000 encompasses the entire country, while the involvement of Ontario Hydro and New Brunswick Power has been limited to their respective provinces.

ENERGY, MINES AND RESOURCES

Energy, Mines and Resources Canada (EMR) is a scientific and economic department of the Canadian government concerned with Canada's landmass and the non-renewable resources it contains. EMR is located in Ottawa, Ontario and employs over 4,000 people.

EMR's objective is to advance the development of Canada's economy in a manner consistent with federal environmental and social policies and directions. This objective is carried out through the timely, efficient development, and use of Canada's mineral and energy resources.

The responsibilities of EMR are determined by The Department of Energy, Mines and Resources Act, The Resources and Technical Surveys Act, The Explosives Act, the Energy Efficiency Act, the national Green Plan, and various other acts and regulations. The Minister of EMR is responsible for coordinating, promoting, and recommending national policies concerning energy, mines, minerals, and additional resources, and formulating plans for their conservation, development, and use. In addition, the Minister is authorized to conduct research and technical surveys to assess mineral and energy resources. Other duties that the Minister is authorized to perform include preparing and publishing maps, conducting scientific and economic research relating to the energy, mining, and metallurgical industries, and operating scientific laboratories to perform these duties. [R#5]

In addition to R-2000 activities in Canada, Canada has entered into a licensing agreement with Japan to make the R-2000 home available to that country. The agreement will help to promote Canadian exports in technology, products, and materials. Certain U.S. states and electric utilities have based their new housing programs on R-2000, although there is no formal linkage between EMR and these organizations.

Energy Mines and Resources continues to develop an energy policy framework that meets Canadian needs both nationally and internationally. This includes EMR's commitment to work with Environment Canada to develop a domestic and international policy on global warming.

CANADIAN HOME BUILDERS ASSOCIATION

For seven years between 1984 and 1991, the Canadian Home Builders' Association (CHBA) had principal responsibility for administering R-2000 under contract with EMR. With the growing interest shown by other organizations in R-2000, it was decided in 1991 that EMR would take over the overall direction of the program, with CHBA continuing to supply technical coordination for the program.

CHBA is founded upon the principle that all Canadians have a right to both decent housing and a reasonable opportunity to own their own homes. CHBA realizes that achieving these goals requires a partnership between the housing industry and government. CHBA seeks to strengthen the Association's Provincial Associations so that they may represent the building industry's interests in the face of increasing provincial government involvement with housing. Monitoring and opposing inappropriate regulation and taxation that adversely affects housing affordability is another

Agency Overview (continued)

concern. CHBA also recommends and promotes stable financial options to the changing needs of home buyers and home builders. Providing leadership in implementing Canada's environmental agenda as it relates to the residential construction industry is one more objective of CHBA. [R#6]

ONTARIO HYDRO

To date, most R-2000 homes have been built in the province of Ontario. Ontario Hydro, which is one of the two largest electric utilities in Canada (the other is Hydro Quebec), was one of the first Canadian utilities to embark on a serious DSM program. R-2000 has been a key DSM activity for Ontario Hydro and as a consequence it has made a large investment in the R-2000 program, about C\$10 million. Next to EMR and the CHBA, Ontario Hydro has been the biggest supporter of R-2000 in Canada.

Ontario Hydro was created in 1906 by a provincial statute and operates under the Power Corporation Act to deliver electricity throughout Ontario. Ontario Hydro or "Hydro" provides electric service to nearly 3.7 million customers in the province of Ontario. Besides providing electricity directly and through municipal utilities, Hydro provides steam and hot water as primary products and also has a regulatory role for Ontario's municipal utilities. In conjunction with the Canadian Standards Association, Ontario Hydro is responsible for inspecting and approving electrical equipment and wiring province-wide.

Hydro operates 81 hydroelectric, nuclear, and fossil-fueled generating stations, as well as a major transmission system. Just over half of Ontario Hydro's power generation, in terms of energy, is from nuclear generation (50.8%) Other power sources in 1991 were hydroelectric (24.4%), fossil fuel (21.6%), purchases (1.7%), and non-utility generation (1.5%). In 1991 the utility had a generating capability of 32,333 MW, over 35,000 employees, and had gross revenues of over \$5.97 billion. [R#7]

Ontario Hydro currently has over 40 DSM programs and hopes to make its demand-side management effort the most comprehensive in North America. Hydro's programs are aimed at commercial, industrial, residential, and agricultural customers. Most of the DSM programs are marketed under the name "Power Saver." In 1991, Hydro invested almost \$150 million in DSM. Of that amount, approximately \$40 million was paid directly to customers for energy efficiency measures.

NEW BRUNSWICK POWER

New Brunswick Power (NBP) provided service to over 270,000 customers in FY 1989 with 245,449 customers in the residential sector, and the average residential rate was 5.73 cents/kWh. In 1990, NBP had 2,625 full time employees in its electric department. Electric Sales for 1990 were 19,172 GWh with 3,838 GWh coming from purchased power. Total generating capacity for NBP as of 1/1/91 was 3,221 MW, and peak demand in-province for calendar year 1990 was 2,562 MW. [R#9]

New Brunswick Power has been a key supporter of R-2000 since 1991 when it signed an official agreement with the New Brunswick Home Builders' Association and EMR to support the program in New Brunswick. By October, 1992, nearly 18% of all new houses in New Brunswick are being built as registered R-2000 homes. [R#10]

Program Overview

The R-2000 program, previously known as the Super Energy Efficient Home (SEEH) program, was initiated by EMR in 1981. One of the first new home efficiency programs, R-2000's long-term goal was to effect the construction of energy-efficient homes throughout Canada by educating builders and stimulating demand for such homes. Through the program, builders are trained and registered, homes are certified, and marketing is pursued.

About 6,000 certified R-2000 homes have been built, most of which are located in Ontario. Many builders incorporate R-2000 standards into their homes, even if the home is not eventually certified through the program. EMR estimates that at least another 14,000 to 15,000 homes have been built that meet the R-2000 standard but are not certified.

For seven years between 1984 and 1991, the Canadian Home Builders' Association (CHBA) had principal responsibility for administering R-2000. In 1992, R-2000 began to be administered on a regional basis, with each of the provincial programs accepting responsibility for marketing, administration, and some training. Seven of the provinces had signed agreements with EMR by October, 1992. Most of the regional programs will be run by the provincial home builders' associations, with R-2000 technical standards, quality assurance verification, and training materials production being centrally administered by EMR.

EMR has worked closely with the CHBA in the development of standards and training for builders. By 1991, over 5,000 builders had been certified to construct R-2000 homes. The CHBA provided training which is delivered at the regional and local level. In order to be registered, an R-2000 builder must complete the training program and construct a demonstration home. The demonstration home is inspected during and after construction, and its performance is verified prior to certification of the builder. In the first years of the program, when builder involvement was being cultivated, the first and second R-2000 homes constructed by a particular builder were eligible for a grant. In this manner, builders were compensated for the costs incurred during the development of skills necessary to construct energy-efficient homes. In 1992, the grants are provided in only two of the regional programs.

R-2000 homes may be as much as 50% more energy-efficient than a home built to Canada's existing codes. The basis of R-2000 certification is the compliance with an annual space and domestic water heating energy consumption target level. The target level is determined based on heating degree days, interior heated volume, and type of space and water heating systems. In addition to the energy consumption target level, minimum building envelope requirements are specified, and ventilation systems, combustion equipment, and appliances must meet certain standards. Thus, builders may specify glazing and orientation in any manner that will allow the home to meet the energy consumption target.

With a primary goal of creating a market for energy-efficient homes, the R-2000 focus was meant to be on public information and marketing. However, this focus was not really developed until 1991. In 1992, most of EMR's R-2000 budget is dedicated to marketing. A new promotional brochure was developed, a newsletter designed, and advertising campaigns were launched. Additionally, a comprehensive marketing strategy has been laid out.

R-2000 also ties in with a new program administered by EMR, the Advanced Houses Program. Where R-2000 homes are estimated to use about half the energy of a conventional home, Advanced Houses will use only one quarter. Advanced Houses also include water saving technologies and incorporate environmental impact considerations in building material choices. The Advanced Houses program serves to test new technologies for market acceptance and performance, and those especially effective technologies which are proven through the program will be incorporated into the R-2000 program.

Implementation

MARKETING AND DELIVERY

The focus of R-2000 for 1992 has been to develop regional programs across Canada. Seven provincial agreements have been signed, and EMR is working to gain support in the remaining provinces and territories. The implementation of R-2000 is comprised of three basic components: builder training and certification, home certification, and marketing and promotion.

Training materials are provided by EMR, with builder training and certification being implemented regionally. In order to become registered, builders must attend a training workshop where leading-edge construction techniques are presented and energy-efficient housing design is covered. After the training is completed, the builder constructs an R-2000 Demonstration Home, which is inspected by qualified licensed inspectors during the construction phase and after completion. The second home built by a registered builder is also inspected both during and after construction.

Once a builder is registered they need only submit designs to the regional office where the R-2000 computer program HOT-2000 is used to evaluate the energy usage of the home. HOT-2000 is a heat-loss simulation program that accepts inputs of home size, glazings, insulation, space conditioning, and water heating specifications, and estimates annual energy use based on these inputs. After construction is completed, an airtightness test is performed and the results submitted to the R-2000 office. Most homes are then inspected by the R-2000 inspectors, although inspection procedures vary among the different provinces. If the specifications meet R-2000 standards, the energy use as estimated by HOT-2000 is within the specified target level for the home site, the results of the airtightness test are within the accepted range, and the physical inspection is satisfactory, then the home will be certified. Certificates are provided to the homebuyers by the R-2000 offices.

Some of the provinces offer incentives to builders and/or homebuyers who participate in the program. Ontario Hydro pays \$2,000 (1992\$C) to the homebuyer and \$2,000 to the builder for any R-2000 home built in a non-gas supplied

area. In New Brunswick, \$1000 is paid to homebuyers by the regional utility, New Brunswick Power, and the Bank of Montreal offers a 1/4 point reduction on mortgage rates for R-2000 homes. This same mortgage arrangement is available in several other provinces as well.

National marketing of the program is coordinated by EMR, with the majority of the locally targeted marketing responsibilities on the regions. EMR contracted with Power Smart, Inc. in 1991 to develop a marketing strategy aimed at energy utilities. Additional national marketing is centrally administered through EMR. In 1992, EMR developed a new brochure, a newsletter, and a traveling exhibit. National advertising campaigns were implemented in the summer and fall of 1992 – one aimed at consumers and one aimed at builders. Also, a number of feature articles were prepared for release to newspapers and magazines. With the regionalization of R-2000 in 1992, each region has taken on the responsibility of marketing the program, with some funding provided by EMR. Regional activities have included direct mail campaigns, open houses and special seminars.

MEASURES INSTALLED

The basis for certification of an R-2000 home is the HOT-2000 energy usage analysis. HOT-2000 uses inputs on the home design to determine whether a home will meet a calculated target energy usage level. The formula used for determining target levels is based on heating degree days and interior heated volume, with coefficients dependent upon the type of water and space heating systems. If homes meet the target level of energy usage and other requirements specified below, then they will be certified. The requirements allow the home builder to choose any appropriate combination of insulation, window types, heating appliances, and other design alternatives to meet the energy performance target. In this manner, builders are allowed flexibility and design innovation is encouraged.

ENVELOPE REQUIREMENTS

RSI and R values for wall, ceiling, and attic insulation are specified according to the degree day zone in which the home is built, as shown below. (RSI is a metric unit comparable to R values.)

Heating Degree Days	Minimum Insulation R-values		
	Exterior Walls		Ceilings and Attics
	Above Grade	Below Grade	
up to 3,500	16	10	27
3,501 - 6,000	20	10	32
6,001 - 8,000	24	16	36
over 8,000	27	20	40

Windows must be double glazed with minimum air space thickness of 0.5 inch (12.5 mm). Metal window frames must be thermally broken unless the home is in a warmer area as defined by the January design temperature.

Airtightness must be determined by fan depressurization or some other method approved by the CHBA. The Normalized Leakage Area must not exceed 0.7 cm²/m² (1 in²/100 ft²), or the air change rate at 50 Pascals must not exceed 1.5 air changes per hour (ACH).

VENTILATION SYSTEMS AND EQUIPMENT

Mechanical ventilation systems must be designed and installed by a registered installer in accordance with Canadian standards.

COMBUSTION EQUIPMENT

Gas, propane, and oil-fired space and water heating equipment must have either direct vent (sealed), induced draft, or forced draft venting systems.

Wood-burning fireplaces, woodstoves, and pellet stoves must be certified as meeting applicable Canadian or U.S. standards, and make-up air or envelope air leakage must be provided.

Flue gas extraction fans and a dedicated outdoor source of combustion air are required for pellet-burning appliances.

Only direct vent or power venting gas and propane fireplaces are permitted.

Fireplaces and chimneys on exterior walls must maintain continuity of the house air barrier and must be insulated with noncombustible insulation. Air cooled chimneys are not permitted.

Implementation (continued)

Ducts supplying air to combustion appliances must be insulated with R-2 and have a vapor barrier if they pass through conditioned space.

All combustion appliances must be vented.

Electric domestic water heaters must have a minimum R-10 factory-installed insulation, or have a standby loss maximum of 80 watts for a 60 gallon (270 liter) tank.

Gas-fired domestic water heaters must have a maximum standby loss of 3.5%.

ENERGY PERFORMANCE TARGETS

The target level is determined using the following equation:

$S \times (5 + 55DD/6000) \times V/2.5 + (4745 \times W)$	
S =	4.5 MJ fuel-fired space heating systems
	3.6 MJ electric space heating systems
	1.0 kWh electric space heating systems
W =	7.2 MJ fuel-fired domestic hot water systems
	3.87 MJ electric domestic hot water systems
	1.07 kWh electric domestic hot water systems
DD=	Celsius heating degree days for the locality
V=	Interior heated volume, including basement, in cubic meters

The HOT-2000 computer program is used to determine compliance with the annual energy target.

APPLIANCES

If appliances are included in the sale of a home, the builder must offer the homeowner the option of selecting appliances in the upper 33% of the Energuide rating for the appliance category. (Energuide is a national program which identifies the energy use of various domestic appliance, including refrigerators, stoves, and washing machines.)

STAFFING REQUIREMENTS

For the 7-year period 1983/84 to 1990/91, R-2000 was managed primarily by CHBA. During 1991/92, much of the administration of the program was shifted over to EMR, but full management responsibility was not transferred until the end of that fiscal year. CHBA retains its role as technical advisor. In addition to developing builder training materials, CHBA's role is to ensure that the builder objectives can be met in conjunction with the R-2000 objectives. In order to do this, builders need to construct quality homes that consumers demand, while meeting the energy-efficiency requirements of R-2000. The flexible design of the R-2000 specifications is a direct result of this sensitivity to builder needs.

In 1992/93, the EMR R-2000 team includes 5 people. Jack Cole provides the overall management of the program. Additionally, a technical auditor deals with technical issues and training, the liaison officer maintains contact with the regional operators; there is also a program administrator and a data base operator who issues licenses and certificates.

In addition to the staff at EMR, there is one primary contact person at CHBA, John Broniek, who provides most of the technical assistance to the program. Each regional program also has a small staff, usually based at the provincial home builders' association offices. These staff are responsible for managing the program under direction of the regional program partners.

Monitoring and Evaluation

MONITORING

As part of the builder registration process, the first two homes constructed by a builder are closely inspected by one or more licensed R-2000 inspectors. These inspectors are usually consultants or paid regional staff who have taken an inspector's course. The certification process includes provision for inspections after the first two homes are built, but subsequent inspections are usually less rigorous than the initial two.

Prior to 1992, several monitoring projects of R-2000 homes were undertaken. Selected homes were monitored for energy performance and some air quality measurements were collected. Much of the data generated during these monitoring phases has been compiled and analyzed, however, the results are not readily available. A major monitoring program is underway in which the results of earlier studies will be consolidated, and long-term monitoring data and energy performance data will be generated. Initial results of the study are expected in mid-1993. [R#1,10]

EVALUATION

One program evaluation was conducted in 1986 and 1987, which included surveys and interviews with builders and home buyers, economic and financial analyses, and development and application of various models. The evaluation focussed on analysis of the program rationale, its impacts and effects, and potential changes to the program. The evaluation was generally favorable, although the number of certified R-2000 homes was less than had been anticipated.

DATA QUALITY

Savings information on R-2000 has been estimated by EMR in terms of energy-cost. In the absence of energy savings figures, The Results Center approximated average

energy savings per home as shown in the Program Savings section, based on an estimated average cost of electricity of 7.5 ¢/kWh (Can.) and a 50 year lifetime of the measures. This calculation was performed for the sole purpose of generating some approximation of energy savings realized by the program, and is by no means intended as a precise quantification of the savings. EMR expects to release energy savings approximations due to R-2000 in 1993.

Participation figures were supplied by EMR for the years 1991 and 1992, and for the total number of homes certified through the program. Participation as a percent of the total potential was estimated by EMR to be about 1.5%. About 1,250,000 homes (single family, semi-detached, and row houses) have been built in Canada between 1982 and 1991. About 20,000 of these were R-2000 homes – 6,000 certified and 14,000 not certified.

Program costs for the 1991/92 fiscal year are presented in the 1992 Annual Report [R#1], however, previous years' costs were only available as a total expenditure over the course of the program. Thus, expenditures in the Cost Overview Table in the Cost of the Program section are only shown for the 1991-92 fiscal year. The Results Center estimated the cost of saved energy for the program, based on EMR's total expenditure of C\$50 million, and The Results Center approximation of total annual energy savings achieved (40 GWh). An average conversion rate of \$C1 = US\$0.80 was used.

Program Savings

CALCULATION OF APPROXIMATE ENERGY SAVINGS PER R-2000 HOME

C\$150,000,000 lifecycle savings at 7.5 C¢/kWh = ~2,000,000 MWh lifecycle savings
 assume 50 year lifetime = ~40,000 MWh total annual energy savings
 with 20,000 R-2000 homes being constructed = ~2,000 kWh per home

* Note: The Results Center calculated the above approximation of energy savings based on EMR's estimate of C\$150,000,000 in energy-cost savings generated by R-2000. The approximation should not be interpreted literally.

R-2000 homes are estimated to use about 50% of the energy that conventional homes require. The Results Center approximated energy savings for R-2000 as shown in the calculation table above, and further detailed in the data quality section. The annual energy savings per R-2000 home is estimated to be about 2,000 kWh, which falls in the range of savings reported by other new home construction programs. These savings calculations do not include the savings attributable to the program from the overall increased energy-efficiency of homes built in Canada. EMR estimates that R-2000 significantly influenced construction practices in Canada, and the 50% improvement from 1980 to 1991 in overall energy efficiency of new homes is due in large part to R-2000.

2000 between 1982/83 and 1991/92. Participation increased markedly in 1992, with nearly 1,500 R-2000 homes being inspected.

Perhaps more important than the actual number of homes certified is the success of the program in recruiting builder participation. Since the program began, over 5,000 builders have been trained, with 300 actively participating in the program. Many of the builders who were trained through R-2000 but are not actively participating are still constructing homes that meet or come close to R-2000 standards. It is estimated that at least 14,000 to 15,000 homes have been built to R-2000 standard, even though they were never certified.

PARTICIPATION RATES

Participation in the program was fairly minimal during the early years. R-2000 was not being actively promoted, but almost 800 homes were certified under the program in the

Customer Participation Table	Approximate Number of Certified Homes Constructed
1983 - 1990	3,650
1991	850
1992	1,500
Total	6,000

first 4 years. Participation increased in the subsequent years, and a total of about 6,000 homes were certified through R-

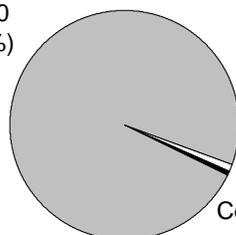
MEASURE LIFETIME

EMR uses 50 years as their average lifetime of the homes built under R-2000. The Results Center thus used 50 years in the approximation of energy savings due to the program, as well as in the presentation of cost of saved energy approximations.

PROJECTED SAVINGS

The R-2000 goal is to continue to influence the construction and purchase of energy-efficient homes. Through the Advanced Houses program, EMR tests and promotes new energy-efficiency building techniques and technologies. As these are shown to be effective, they will be incorporated into R-2000. Similarly, as R-2000 techniques become more widely accepted, they will be incorporated into the building code and dropped from R-2000. Thus, as conventional homes become more efficient, R-2000 homes will still be up to 50% more energy-efficient.

Non-R-2000 homes (98%)



R-2000 homes built but not certified (~1.5%)

Certified R-2000 homes (~0.5%)

Cost of the Program

Costs Overview Table	Contribution to Regional Programs (x 1000)	Marketing Activities (x 1000)	CHBA (x 1000)	General Admin and Technical (x 1000)	Total Program Cost (x1000)	Cost per Participant
FY 91/92	\$334	\$502	\$251	\$167	\$1,254	\$836

[R#1]

Program costs for fiscal year 1991/92 at EMR were \$1.2 million, with the majority being expended on marketing activities. The total program budget spent by EMR between the years 1981, when R-2000 was in the design stage, and 1991, was about C\$50 million. Various other sponsors of R-2000 have financially supported the program. Ontario Hydro, with close to C\$10 million in subsidies and marketing support is the largest of such supporters.

COST EFFECTIVENESS

EMR estimates that the total societal benefit due to R-2000 homes constructed is C\$150 million compared to total

FREE RIDERSHIP

The 1987 survey revealed that 68% of the purchasers of R-2000 homes would have chosen an energy-efficient home even in the absence of the program. However, the evaluation also surveyed home buyers who had purchased energy-efficient homes which had not been certified through R-2000. Of these buyers, 35% said they would not have chosen an energy-efficient home in the absence of the R-2000 program. Thus, though free-ridership may be high for participants in the program, the change in non-participants behavior due to the program, or free-drivership, is also high. [R#2]

Cost of Saved Energy Table (¢/kWh)	Discount Rates						
	3%	4%	5%	6%	7%	8%	9%
1983 - 1992	4	5	5	6	7	8	9

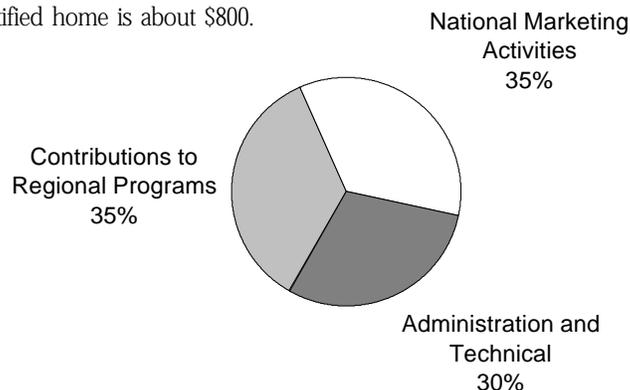
program cost of C\$50 million, resulting in a B/C ratio of 3. The Results Center calculated cost of saved energy based on an approximation of energy savings due to the program, and the total EMR expenditure on the program. The calculation assumes a conversion rate of about C\$1 = US\$0.80. Depending on the discount rate, the cost of saved energy ranges from 4-9 ¢/kWh.

COST PER PARTICIPANT

The Results Center estimated EMR's cost per certified R-2000 home in 1992. With ~1,500 R-2000 homes built in 1992, the estimated cost per certified home is about \$800.

COST COMPONENTS

Fiscal year 1991/92 was a transition year for R-2000. With the renewed governmental support for the program, the regionalization of its implementation, and the shift of administration from CHBA to EMR, the 1991/92 budget is somewhat different from the budget planned for the 1992/93 fiscal year. The pie chart shows cost breakdowns as anticipated by the R-2000 program budget for 1992/93. [R#1]



Environmental Benefit Statement

Marginal Power Plant	Heat Rate BTU/kWh	% Sulfur in Fuel	CO2 (lbs)	SO2 (lbs)	NOx (lbs)	TSP* (lbs)
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Coal Uncontrolled Emissions

A	9,400	2.50%	862,400,000	20,460,000	4,136,000	414,000
B	10,000	1.20%	919,600,000	7,920,000	2,671,000	1,980,000

Controlled Emissions

A	9,400	2.50%	862,400,000	2,046,000	4,136,000	33,000
B	10,000	1.20%	919,600,000	792,000	2,671,000	132,000
C	10,000		919,600,000	5,280,000	2,640,000	132,000

Atmospheric Fluidized Bed Combustion

A	10,000	1.10%	919,600,000	2,420,000	1,320,000	660,000
B	9,400	2.50%	862,400,000	2,046,000	1,654,000	124,000

Integrated Gasification Combined Cycle

A	10,000	0.45%	919,600,000	1,628,000	264,000	660,000
B	9,010		827,200,000	590,000	198,000	40,000

Gas Steam

A	10,400		501,600,000	0	1,144,000	0
B	9,224		435,600,000	0	2,728,000	129,000

Combined Cycle

1. Existing	9,000		435,600,000	0	1,672,000	0
2. NSPS*	9,000		435,600,000	0	792,000	0
3. BACT*	9,000		435,600,000	0	110,000	0

Oil Steam--#6 Oil

A	9,840	2.00%	726,000,000	11,000,000	1,298,000	1,232,000
B	10,400	2.20%	770,000,000	10,912,000	1,632,000	792,000
C	10,400	1.00%	770,000,000	1,558,000	1,311,000	414,000
D	10,400	0.50%	770,000,000	4,576,000	1,632,000	252,000

Combustion Turbine

#2 Diesel	13,600	0.30%	963,600,000	1,918,000	2,979,000	163,000
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Refuse Derived Fuel

Conventional	15,000	0.20%	1,144,000,000	2,948,000	3,881,000	862,000
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Avoided Emissions Based on 400,000,000 kWh Saved (1983-1992)

In addition to the traditional costs and benefits there are several hidden environmental costs of electricity use that are incurred when one considers the whole system of electrical generation from the mine-mouth to the wall outlet. These costs, which to date have been considered externalities, are real and have profound long term effects and are borne by society as a whole. Some environmental costs are beginning to be factored into utility resource planning. Because energy efficiency programs present the opportunity for utilities to avoid environmental damages, environmental considerations can be considered a benefit in addition to the direct dollar savings to customers from reduced electricity use.

The environmental benefits of energy efficiency programs can include avoided pollution of the air, the land, and the water. Because of immediate concerns about urban air quality, acid deposition, and global warming, the first step in calculating the environmental benefit of a particular DSM program focuses on avoided air pollution. Within this domain we have limited our presentation to the emission of carbon dioxide, sulfur dioxide, nitrous oxides, and particulates. (Dollar values for environmental benefits are not presented given the variety of values currently being used in various states.)

HOW TO USE THE TABLE

1. The purpose of the previous page is to allow any user of this profile to apply EMR's level of avoided emissions saved through R-2000 to a particular situation. Simply move down the left-hand column to your marginal power plant type, and then read across the page to determine the values for avoided emissions that you will accrue should you implement this DSM program. Note that several generic power plants (labelled A, B, C,...) are presented which reflect differences in heat rate and fuel sulfur content.

2. All of the values for avoided emissions presented in both tables includes a 10% credit for DSM savings to reflect the avoided transmission and distribution losses associated with supply-side resources.

3. Various forms of power generation create specific pollutants. Coal-fired generation, for example, creates bottom ash (a solid waste issue) and methane, while garbage-burning plants release toxic airborne emissions including dioxin and furans and solid wastes which contain an array of heavy metals. We recommend that when calculating the environmental benefit for a particular program that credit is taken for the air pollutants listed below, plus air pollutants unique to a form of marginal generation, plus key land and water pollutants for a particular form of marginal power generation.

4. All the values presented represent approximations and were drawn largely from "The Environmental Costs of Electricity" (Ottinger et al, Oceana Publications, 1990). The coefficients used in the formulas that determine the values in the tables presented are drawn from a variety of government and independent sources.

EMR AVOIDED EMISSIONS

The number of kilowatt-hours presented in the previous table (400,000,000 kWh) represents one-fifth of the lifecycle energy savings of R-2000 certified homes. The Results Center presents this as a approximation based on the ten year history of the program and its assumed 50-year measure life.

* Acronyms used in the table

TSP = Total Suspended Particulates

NSPS = New Source Performance Standards

BACT = Best Available Control Technology

Lessons Learned / Transferability

LESSONS LEARNED

The R-2000 program has received varying levels of support over the years that it has been implemented. With the cooperation and input of the Canadian Home Builders' Association, EMR has achieved significant success in builder participation levels, and is now shifting focus to building consumer awareness and demand.

With these changes, EMR has realized the need to document some of the successes of R-2000. In order to successfully market R-2000 to consumers, EMR must be able to convince home buyers of the savings that can be achieved by an R-2000 home. While monitoring had occurred in the past, 1992 saw a new emphasis being placed on monitoring and tracking activities, with solid plans to continue to document the achievements of R-2000.

There is no doubt that the program has reached many people. R-2000's biggest success is really in the number of uncertified but highly efficient homes that are now being constructed in Canada. The builder certification process, which has trained over 5,000 builders, has clearly influenced many homebuilders who are now constructing more efficient homes than they were in 1980, when R-2000 was first being conceived. In fact, EMR estimates that the overall level of energy efficiency of new houses in Canada has improved by 50% over the typical new home in 1980. EMR has found success through continued commitment to technical excellence and improvement, emphasis on builder training, education of consumers, and consistent support of the home building industry. The recent addition of various supporting partners has also helped to ensure the future impact of the program. The current emphasis on promotion and marketing is expected to help increase consumer acceptance of homes built to the standard of R-2000.[R#10]

EMR has found that offering incentives to both builders and home buyers, as Ontario Hydro is now doing, clearly affects the number of R-2000 homes that are constructed and certified each year. However, in the absence of funding, many regions can not offer incentives. EMR has chosen to support the regional programs through enhanced marketing activities.

As R-2000 moves into the 1990's, many objectives that were envisioned when the program was initiated are now being pursued. EMR has solidified its relationship with regional groups, encouraging them to implement the program in their own manner, with some financial and marketing support from EMR. The regions have accepted this new role, pushing R-2000 closer toward its goal of a self-sustaining program, in which builders construct energy-efficient homes because home buyers demand them.

TRANSFERABILITY

Many new home construction programs exist in the United States, however R-2000 is the only program of its type in Canada. There are many benefits to administering a program such as R-2000 on the national level, with regional variations, however, without major changes in existing regional programs, such coordination is unlikely to be implemented in the near future in the U.S.

The National Collaborative on Home Energy Rating Systems and Mortgage Incentives for Energy Efficiency is a U.S. Government-sponsored group formed to investigate the linkage of home energy rating systems and energy-efficient mortgages. The Collaborative has examined the possibility of standardizing home energy rating systems in the U.S., finding that the biggest disadvantage would be that most, if not all, existing programs would be ruled out, and political opposition might be a problem.[R#8]

In a country, or region, that does not have any existing home energy rating systems, the R-2000 approach may be attractive. In particular, the flexibility of the program, which allows builders to choose the manner in which they achieve energy-efficiency, has proven popular. Additionally by centrally administering such a program from the start, the potential for confusion among similar programs can be avoided.

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