Division of Buildings and Community Systems

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**ENERGY-✓
CONSERVING
SITE - DESIGN
CASE STUDY
RADISSON, NEW YORK**

FINAL REPORT
DECEMBER, 1979

Program Officer: Mr. Jacob Kaminsky

Prepared for
United States Department of Energy
Assistant Secretary for
Conservation and Solar Energy
Division of Buildings and Community Systems

By
The Reimann Buechner Partnership
503 E. Washington Street Syracuse, NY
Contract No. EM-78-C-01-4212 13202

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EXECUTIVE SUMMARY

CHAPTER 1

Radisson is a 2,950 acre New Community currently being developed by the New York State Urban Development Corporation. The new community is located in Central New York, 12 miles north-west of Syracuse. Case study sites selected for this project are a 95 acre residential site and the 51 acre Town Center of the new community. Development on the Residential Site is a low density (2.8 d.u./acre) mixture of single family, townhouse and multi-family dwelling units. Development on the Town Center site is a mixture of small scale commercial use (144,000 sq. ft.) and 330⁺ multi-family dwelling units.

Energy conserving plans developed for both sites have focused on passive measures to reduce energy use for space heating. Utility systems options have been identified for both sites, but require further study as to feasibility and cost.

This section of the report summarizes energy savings and cost differentials due to passive measures incorporated in both the Residential and Town Center Plans. The future implementation schedule also discussed in this section summarizes the procedures and schedule required for implementation of the passive measures, as well as, further study required for the development of utility system options.

RESIDENTIAL SITE

1. ESTIMATED ENERGY SAVINGS

Two energy conserving plans were developed for the residential study site. Both plans were based on a cluster housing principle which increased the number of dwelling units, as well as, the potential for minimizing winter climate impacts on structures. The first of these plans developed (Energy Plan 1) was a complete cluster scheme. The second of these plans developed (Energy Plan 2) limited the extent of cluster housing due to concerns expressed by the developer.

The design load calculations identified for the conventional and two energy conserving plans are based on the net heating requirements for all proposed single family housing. These calculations were derived from the Carrier Load Information Center Program (CLIC) using existing developer's building plans and specifications. Operating costs are based on the Carrier Air to Air Heat Pump, Model 38 BQ 008 and 40 BA 009.

Identification of estimated energy savings for both of the energy plans is based on the effect of passive measures, such as, the siting and orientation of dwelling units to reduce cold air infiltration and winter heating loads.

Based on use of the CLIC model, the following design loads were developed for the conventional and energy plans.

1. The annual design load for the 201 single family dwelling units on the conventional plan is 6,737 Mbh. This load represents an annual cost of \$77,163 for the total plan, and \$383 per single family dwelling unit.

2. The annual design load for the 259 single family dwelling units on Energy Plan 1 is 9,835 Mbh. This load represents an annual cost of \$95,101 for the total plan and \$367 per single family dwelling unit.
3. The annual design load for the 220 single family dwelling units on Energy Plan 2 is 7,112 Mbh. This load represents an annual cost of \$81,688 for the total plan and \$371 per single family dwelling unit.

Modeling of reduced heating load due to wind protection identified potential annual savings of between 6% to 9% on both energy plans for single family detached units and up to 13% for town house units. This reduction represents a savings in annual operating costs of \$27 annually for single family detached units and \$44 annually for town house units.

When projected on a total plan basis, the annual savings in operating costs for protected dwelling units is \$6,792 for Energy Plan 1 and \$5,454 for Energy Plan 2, respectively, over the conventional plan.

In addition, a comparison of the conventional and the energy conserving plans identified a savings in the energy embodied in site development. Energy Plan 1 saves 25 million BTU's, and Energy Plan 2 saves 15 million BTU's over the conventional plan. These savings represent respective decreases of 22% and 17% over the conventional development plan.

3. FUTURE IMPLEMENTATION SCHEDULE

At the present time, the western portion of Energy Plan 2, as presented in this report, is scheduled for design development and implementation. Design development (i.e., determination of technical feasibility and cost) for site, building, and utility development is scheduled for completion by January 1980. Site construction is scheduled for April 1981.

As part of the plan implementation, a study of heat pump applications on the residential site is being prepared by New York State ERDA and the Niagara Mohawk Power Corporation.

In particular, the study will see if water source heat pumps using individual wells, common wells or river or lake water can supplement fossil fuel.

Standard heat pumps operate using outdoor air. This experiment will attempt to extract heat or cold from water, depending on the season, to demonstrate the commercial feasibility of such pumps.

The researchers also will study other possible methods of increasing the heat content of water circulated by heat pumps by capturing low-grade heat sources within the community. In Radisson's case this could include industrial waste heat, methane gas found on the site, wood, solid waste or other local resources.

The entire utility study is to be phased over a 3 year period, to be coordinated with Radisson's construction schedule. The study will include management and monitoring of systems as built.

TOWN CENTER

1. ESTIMATED ENERGY SAVINGS

PASSIVE MEASURES

Estimated energy savings for passive measures on the Town Center Plan are based on an evaluation of the qualitative differences between the Energy Conserving and Conventional Plans. Factors evaluated are the potential for annual heat gain through south oriented windows and potential winter heat loss reduction.

Studies have indicated that in temperate climates between 20%-50% of the annual heating requirements of a structure can be supplied by direct solar heat controls (Johnston, p. 54). While the exact amount of yearly heat gain varies with climate conditions and building design, potential annual heat gain per square foot of glazing can be identified. Based on comparison to comparable sites, a potential yearly heat gain of 76,517 BTU per square foot of double glazed window is assumed possible at Radisson. A comparison of the Energy Conserving and Conventional Plans indicates that the Energy Conserving Plan doubles the amount of south facing glass while minimizing undesirable east, west, and north glazed surfaces.

In addition to maximizing the potential for annual heat gain, the Energy Conserving Plan reduces the potential winter heat loss through siting structures to protect and minimize windward wall exposure. An overall comparison of the two Town Center Plans indicates that 70% of the north and west surface wall exposure on the Energy Conserving Plan is sheltered from the wind compared to 20% of the north and west wall surface on the Conventional Plan. A comparison of the distribution of surface wall by orientation indicates that the Energy Conserving Plan reduces north and east/west wall exposure by 27% and 37% respectively.

UTILITY SYSTEMS OPTIONS

A conceptual integrated utility system has been proposed for the Town Center. The proposed system would be capable of supplying electric power and fuel utilizing ground water and natural gas on site and would replace a conventional system. Estimates of energy savings due to reduction in line loss and elimination of conventional fuel requirements for this system have not been calculated. However, review of comparable systems (i.e. systems utilizing co-generation techniques with diesel engine driven generation) have identified potential energy savings of up to 46% utilizing an integrated approach.

2. COST DIFFERENTIALS

Cost differentials related to the proposed integrated system are as follows:

- a. The annual cost of a conventional system to serve the Town

Center development is \$400,000. This cost is based on an energy cost of 5¢ per kwh and assumes a fuel requirement of 50 kwh to 55 kwh/sq.ft./year.

- b. The annual cost of the proposed integrated system would be \$380,000 per year. This cost is based on amortizing construction cost over a 20 year period and annual operating and maintenance costs as follows:

<u>Amortization @ 7% over 20 years</u>		
annual cost = \$3,000,000 x .094 =		280,000/year
<u>Operation and Maintenance</u>	=	100,000/year
Total	=	380,000/year

3. FUTURE IMPLEMENTATION SCHEDULE

At the present time, Radisson does not have a definite developer commitment for implementation of the Town Center Energy Conserving Plan. The immediate effort toward implementation will require Radisson to solicit a commercial developer. At the point at which a definite developer commitment is obtained, design development of the passive measures and detailed study of utility options as described in Section 7 would be required.

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CASE STUDY OVERVIEW

CHAPTER 2

STUDY GOALS & OBJECTIVES

The client for this project is the Site and Neighborhood Design branch of the Community Systems Program, U. S. Department of Energy. The client goals to be met by this case study are as follows:

1. To develop and realize possibilities for incorporating both technological and non-technical energy conserving options into community design.
2. To develop and demonstrate methodologies and processes for the evaluation of alternative sets of options for a given site.
3. To derive and demonstrate the implementation of diverse sets of energy conserving options tailored to site specific characteristics.
4. To evaluate the effectiveness of regulatory and design techniques for facilitating and realizing energy conservation in actual developments.

The objectives of the case studies initiated under this contract are as follows:

1. To obtain, through participation in the actual development planning process, a better understanding of how conservation of energy can be factored into the series of trade-off's and decisions in the project planning and design process.
2. To demonstrate how variations in design options, including energy systems and site planning, can meet functional needs while simultaneously minimizing or reducing energy consumption.
3. To evaluate through actual case studies how design/development decisions affect energy demand, how decisions might be modified to achieve greater energy efficiencies, and how the feasibilities of the various options are assessed in specific circumstances.

LIMITS OF RESEARCH

The intent of this study is to incorporate energy conservation considerations into the planning and design of projects scheduled for completion by 1980. For this reason, selected case study projects were required to meet the following guidelines:

1. Immediacy of results and impacts:
 - Projects were to be capable of completion of preliminary design activities within one year.
 - Energy conserving plans developed were to utilize existing technology, demonstrate cost effectiveness and incorporate a realistic strategy for implementation.
2. Size and scale:
 - Projects were to be multi-building complexes of single or mixed use on a scale of 50-500 acres.

SCOPE OF WORK

The preliminary phases of work under this contract entailed project scheduling, collection of site planning data and analysis of the developer's site planning process (Tasks A-C). This data has already been documented in Intermin Report #1.

Major planning, design and evaluation phases of work under this contract (Tasks D-F) are described in depth in this report.

PROJECT DATA

LOCATION

Radisson is a 2850-acre new community currently being developed by the New York State Urban Development Corporation. The site is located in Central New York, twelve miles northwest of Syracuse. The site is approximately twenty-three miles to the southeast of Lake Ontario and 300+ miles to the northwest of New York City. The planning and design considerations relevant to Radisson are representative of the conservative attitudes of upper New York State.

PLATE 1.

The immediate site boundaries of Radisson are formed by the village of Baldwinsville to the southwest. The Town of Lysander, on the western boundary of Radisson, is responsible for all planning approvals. On the west and southwest, the site is bounded by a 3200-acre State game management area. The eastern border is defined by the Seneca River, part of the New York State Barge Canal System. The site's southern border is marked generally by New York State Route 31.

CLIMATOLOGY

The climate of the Syracuse, New York area can be described as humid continental by virtue of its latitude and continental location. The area is near the average track of most of the major low pressure systems that move across the country. The interaction of the warm and cold air masses during the winter and spring season result in a marked increase in cloudiness. Heavy snowfall is associated with outbreaks of arctic air as the cold air becomes saturated by passage over Lake Ontario. Counties to the lee of the lake experience average annual snowfalls in excess of 100 inches.

Wide seasonal swings of temperature are not uncommon. Summers are usually cool with relatively high humidities; winters are cold and sometimes severe. Winter daytime temperatures average about 35°F with nighttime lows about 18°F above zero (U.S.D.C., 1976).

Rainfall is derived primarily from cyclonic storms and thunderstorms which occur on an average of 30 days a year (U.S.D.C., 1976).

The predominant wind direction is from west-northwest at average annual speeds of 9.9 mph, but during the winter months there are many days with higher winds causing blowing and drifting snow (U.S.D.C., 1976).

INTERMEDIATE-SCALE CLIMATIC FACTORS

Imposed upon the macroclimatic conditions are the effects of the intermediate-scale factors such as lakes and uplands. The most evident of these factors in the Syracuse area is the effect of Lake Ontario on snowfall. During the fall and winter months, the temperatures over the lake will normally be much warmer than the cold continental air masses moving over it. The air crossing the lake is warmed from below and much additional moisture is added such that heavy snowfalls occur to the lee of the lake and produce the snowbelt of the region. Cloudiness, fog and light rain can result for the same reasons (U.S.D.C., 1971).

Hills and river valleys can cause a channeling effect of the wind. In hilly areas, local downslope winds develop at night as a result of differential heat loss. The slopes of the hills cool more rapidly than the air over the valley and as a result, the air becomes colder and denser. Downslope drainage of the denser air occurs with the resulting accumulation of cold air in the valley floor. These factors could influence the area around the drumlin and the river within Radisson, and will be discussed in a later section.

LOCAL METEROLOGY

Large and intermediate-scale climatological patterns present the overall picture on climate. Within this overall pattern, however, there are many microscale effects which play an important role in the environment. These will be examined by elements and their variation with site characteristics such as terrain and vegetation.

Solar Radiation

Because of its relationship with so many other climatic elements, solar radiation is the key factor in climatology on any scale. Its variation during the seasons gives rise to differences in temperature, pressure, air masses and other major synoptic phenomena.

Presented in Table 1 is the mean daily solar radiation received in the Syracuse area on a monthly and annual basis.

TABLE 1
MEAN DAILY SOLAR RADIATION

<u>Month</u>	<u>Langleys</u>
January	120
February	170
March	260
April	320
May	410
June	500
July	500
August	440
September	330
October	210
November	110
December	80
Annual	300

Source: U.S.D.C., 1964, Weather Bureau, National Atlas of U.S., Washington, D.C.

*Additional climatic data for the factors discussed in this section can be found in the Appendix under Climate.

On an annual basis, Syracuse receives a mean daily solar radiation of 300 langleys (1 langley = 1 gm cal/cm^2) but there is considerable variation throughout the year. Between the months of November and February the mean daily solar radiation is less than 200 langleys per day, while during June and July, it is as high as 500 langleys per day (U.S.D.C., 1964). The reasons for this variation are evident from the tables of cloud cover and amount of sunshine. During the winter months, the frequency of cloudy days increases significantly, the average cloudiness for the months of November through March is 7.6 and the area receives less than 40% of the possible sunshine. During the summer months, the cloud cover is 5.5 and the amount of possible sunshine increases to 65% (U.S.D.C., 1951).

Plates 3 and 4 provide a basis of comparison of mean sunshine and radiation in the Syracuse area in relation to the rest of the United States. It is evident that this area is among the lowest in the country in terms of the amount of solar radiation received and the total hours of sunshine (U.S.D.C., 1964). Due to the low amounts of solar radiation in the area, one of the key elements to energy conservation is utilizing the optimum housing orientation.

PLATE 3.

PLATE 4.

Precipitation

In the Syracuse area, the mean annual rainfall of 36.4 inches is distributed evenly throughout the year, averaging about 3 inches per month. There are about 168 days a year when precipitation exceeds 0.01 inches.

Snowfall accounts for the winter precipitation and as already indicated Syracuse lies in the snowbelt of Lake Ontario. The mean annual snowfall is 100 inches (U.S.D.C., 1976) and monthly amounts in excess of 24 inches are not uncommon (U.S.D.C., 1972). The maximum monthly snowfall on record is 72.6 inches in January 1925, the same period during which there was a maximum 24 hour snowfall of 27.2 inches (U.S.D.C., 1977).

Plate 5 is a graphical presentation of the mean duration of snow cover (consecutive days of snow depth one inch or more) for the Great Lakes Basin. The mean duration of snow cover in Syracuse is in excess of 100 days (AES, 1972).

MEAN DURATION OF SNOW COVER (CONSECUTIVE DAYS OF SNOW DEPTH ONE INCH OR MORE).

PLATE 5.

Source: Atmospheric Environment, 1972, The Climate of the Great Lakes Basin

Presented in Table 2 is the percent frequency of snow by wind direction derived from marine observations in Lake Ontario during the period 1960-1972. Snow is generally associated with winds blowing from the southwest through north sectors suggesting that these directions of wind be blocked to control drifting (U.S.D.C.,1975).

TABLE 2
PERCENT FREQUENCY OF SNOW
BY WIND DIRECTION

	JAN.	FEB.	MAR.	APR.	MAY	JUNE - SEPT.	OCT.	NOV.	DEC.	ANN.
N	.2	1.5	1.1	.7	.0		*	.9	1.7	.5
NE	.5	.2	1.1	.2	*		*	.4	1.2	.3
E	.7	.4	1.0	.4	*		*	.3	.7	.3
SE	.3	.5	.5	.1	.0		.0	.3	1.0	.2
S	1.3	.6	.5	.0	.0		.0	.5	2.0	.4
SW	2.4	1.7	.3	.1	*		.0	.4	1.5	.5
W	2.3	5.6	.6	.2	*		.0	.6	1.3	.9
NW	1.6	3.2	1.4	.1	.0		.1	.5	.5	.7
VAR	.0	.0	.0	.0	.0		.0	.0	.0	.0
CALM	.0	.0	.0	.0	.1		.0	.0	.0	*

SOURCE: U.S.D.C., 1975, Summary of Synoptic Meteorological Observations for Great Lakes Area, Vol. 1

Large differences in the climatology of precipitation are due to variations in orographic conditions (Critchfield, 1966). However, where the vertical dimensions are small, the wind field is the chief determinant of local precipitation. As a result, precipitation is often found on the lee slopes rather than on the windward slopes, especially in brisk winds and in the case of snow.

Winds

Table 3 presents mean monthly and annual wind speed and direction at Syracuse, New York. The mean annual wind direction is from the west-northwest with a mean speed of 9.9 mph (U.S.D.C., 1977). The winds prevail from the west-southwest to the west-northwest during most months of the year, except in September when the flow is predominantly from the south. Monthly and annual wind direction frequency distributions, in the form of wind roses and average speeds for each direction, are found in the appendix to the report under Climate.

TABLE 3

WIND SPEED & DIRECTION - SYRACUSE, N.Y.

<u>Month</u>	<u>Mean Speed (mph)</u>	<u>Prevailing direction</u>
January	11.0	WSW
February	11.3	WNW
March	11.2	WNW
April	11.0	WNW
May	9.5	WNW
June	8.6	WNW
July	8.4	WNW
August	8.2	WSW
September	8.7	S
October	9.2	WSW
November	10.5	WSW
December	10.6	WSW
Annual	9.9	WNW

Period of Record: 1949 - 1977

SOURCE: U.S.D.C., 1977, Local Climatological Data - Annual Summary
with Comparative Facts: Syracuse, N. Y.

Interpretation of wind related data for study sites indicate areas of possible wind drainage, cold pockets and snow accumulations. A preliminary simplified calculation indicated that wind drainage, if any, will be minimal due to the relatively small gradient of the terrain. This lack of significant topographical differences over the site area makes it impossible to reach definitive conclusions about its micrometeorology.

Wind flow patterns will differ in forested areas that have been thinned or cleared for houses from those in the free air. As the air, at or just above the crown of trees, reaches the clear spot, friction is reduced and the air begins to flow downward along the downwind side of the opening. A flow can be induced in the clearing where the air near the ground is moving opposite to that in the free air above the forest. In the case of thinned forested areas, prevailing wind direction should not differ markedly down to the ground, but the speeds will be noticeably reduced. Wind flow patterns in forested areas are illustrated in Plate 6.

WIND FLOW PATTERNS IN FORESTED AREAS

GROUP

SCREEN

PLATE 6.

Temperature, Heating and Cooling Degree-Days

Syracuse is an area of cool summers and cold winters. The mean annual temperature is 48.1°F: the average of the daily maximum temperature of 57.4°F and the daily minimum temperature of 38.8°F. The diurnal variation is 20°F with temperature minimums occurring near sunrise and maximums just after local noon. Maximum temperatures during the summer are usually in the low 80's and days when temperatures exceed 90°F are rare - for a 14 year period (1954-1977) temperatures above 90°F were recorded on only seven days. Winters, however, show a marked tendency towards extremes. Although mean monthly temperatures are normally below 32°F, there are 51 days a year when the maximum temperature does not exceed freezing and 9 days a year on an average when the minimum temperature is below zero.

The highest and lowest temperatures on record for the Syracuse area are 102°F in July 1936 and -26°F in January 1966 (U.S.D.C., 1972).

Lake Ontario exerts a moderating influence on temperatures especially during the spring and fall seasons. The lake warms slowly during the spring and reduces the warming of the atmosphere over nearby land areas. In the fall, the lake cools more slowly than the land areas and provides a heat source (U.S.D.C., 1972).

Table 4 presents mean monthly and annual heating and cooling degree-days for Syracuse, New York for the period 1941-1970. The average number of heating degree-days is 6678; the average annual number of cooling degree-days is 551.

TABLE 4

MEAN DEGREE DAYS - BASE 65°F

<u>Month</u>	<u>Heating</u>	<u>Cooling</u>
January	1283	0
February	1131	0
March	986	0
April	555	0
May	272	18
June	46	103
July	11	212
August	18	164
September	120	54
October	392	0
November	720	0
December	1144	0
Annual	6678	551

SOURCE: U.S.D.C., 1977, Local Climatological Data Annual Summary with Comparative Facts: Syracuse, N.Y.

Temperature differences existing in the site will depend on such factors as terrain (slope aspect), vegetation, soil and surface covering type. Deciduous vegetation provides shading for cooling purposes; coniferous vegetation is good for warmth and wind control. Surface coverings such as tar, stone and concrete absorb heat and give rise to high afternoon temperatures, while grassy surfaces serve to retain coolness. Soils such as dry sand allow temperatures to rise and fall more quickly than do most loams or clay soils. Moist grassy surfaces have a smaller diurnal and annual range of temperatures than do drier sands or paved surfaces.

Clearings in forests may present heating and cooling problems if they are of the right size. If the dimension is such that the sun's rays can penetrate freely, yet the air flow is reduced, the air within the opening will be heated appreciably, especially if there is a lack of vegetation. At night, the clearing can turn into a "frost-hollow" when radiative cooling is at a maximum and air flow is at a minimum (Griffiths, 1976).

Many of the site selection aspects discussed in the solar radiation section apply to temperature moderation. With the proper foresight, temperatures can be moderated to reduce both the heating and cooling requirements.

DEVELOPMENT PROGRAM

MAJOR LAND USE

The following is a summary of the location of major land uses as shown on the land use plan:

The town center, to be built on high ground slightly to the southwest of the center of the site, will be the focus of the New Community. The center will be the principal location of community services and activities. It will be designed to concentrate the life of the New Community in a small, lively, well defined pedestrian center including shops, offices, community facilities and residences. In addition, it will include the higher density residential development in the New Community, including apartments and townhouses for the elderly and for small families and a central common.

Major school facilities will be adjacent to the town center.

Industrial research and office facilities may also be included in the town center or developed nearby.

A subcenter with minor commercial facilities will be located in the northeast quadrant of the site.

Residential areas will be located to the north, east and south-east of the town center. High rise apartments will be built primarily for the elderly and for families without children. Additional school facilities and natural area parks will be developed as part of the residential area. In general, residential densities will be greatest in the town center and decrease toward the boundaries of the site.

EXISTING DEVELOPMENT

At present, approximately 46% of the new community has been developed (1,319.5 A.) for residential, commercial, industrial and open space/recreation uses, as shown on the accompanying drawing (Land Use, Plate 7). Existing development on site is primarily residential (approximately 500 + d.u.). The major non-residential use on site is the Joseph Schlitz Brewery. The two project study sites are located at the northern and southern limits of the existing residential development.

LEGEND

- RADISSON PROPERTY BOUNDARY
- EXISTING ROAD BY OTHERS
- EXISTING ROAD BY RADISSON
- PROPOSED ROAD BY OTHERS
- PROPOSED ROAD BY RADISSON
- EXISTING RAILROAD
- PROPOSED RAILROAD
- RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- COMMUNITY FACILITY
- OPEN SPACE
- SCHOOL

EXISTING
RESIDENTIAL
DEVELOPMENT

RESIDENTIAL
STUDY
SITE

STATE GAME MANAGEMENT AREA

TOWN
CENTER
SITE

SCHLITZ
BREWERY

LAND
USE
PLAN

RADISSON SITE

PLATE 7.

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PLAN DEVELOPMENT

CHAPTER 3

The following section describes the study site characteristics, conventional and alternative energy plans and a comparison of energy and cost implications for the selected study sites. The first part of this section will deal with the residential study site; the second part will deal with the town center study site. A detailed discussion of technical issues pertaining to plan development for each of the study sites is contained in Section 5, Methodological Considerations.

RESIDENTIAL STUDY SITE

EXISTING CONDITIONS

SITE LOCATION:

The residential study site consists of 92.1 acres located along the Seneca River on the northeast corner of the New Town. The site is bordered by residential development to the south and a golf course to the south, north and west.

EXISTING PHYSICAL FACTORS:

Slope Percentage and Drainage: Existing slope distribution on site is as follows:

60% of site: 0-5% slope
25% of site: 5-10% slope
15% of site: 10%+ slope

Major drainage flow on site is toward existing north/south drainage swales. A drainage easement must be maintained from the outlet of Lake No. 3 to the Seneca River.

Slope Aspect:

25% of slopes: Southern orientation
25% of slopes: Northern orientation
45% of slopes: Eastern orientation
5% of slopes: Western orientation

PLATE 10.

Vegetation: General vegetative cover is mixed deciduous second growth ash, maple and oak with mixed deciduous shrub growth. Existing vegetative cover is as follows:

40% of site: Dense deciduous
30% of site: Sparse deciduous
30% of site: Open

PLATE 11.

Climate: Due to uniform topography, the climate of the site is consistent with macro characteristics already identified for Radisson. More detailed site specific characteristics are as follows:

- Prevailing winter wind ranges over a 60° northwest arc with a mean annual speed of 9.9 mph.
- Due to the prevailing wind patterns, moderating influence of the river is felt to the east side of the river for approximately 100 meters.

PLATE 12.

EXISTING DEVELOPMENT FACTORS

Program Requirements: The site program established by the developer is as follows:

1. Housing
 - 520⁺ Dwelling Units
 - 1/3 Single Family Detached*
 - 1/3 Townhouse
 - 1/3 Multi-Family
2. Marina Development
 - Marina building: 2,400 s.f.
 - Marina basin: 62⁺ boats
 - Marina parking: 80⁺ cars/trailers
 - Picnic area
 - Possible expansion facilities
3. Recreation Complex
 - Parking: 80 cars
 - Swimming pool
 - 4 tennis courts
 - 2 handball courts
 - 1 baseball field
 - 1 playground
 - 3 ballfields

Development Constraints: Existing conditions impose the following development constraints:

- A major north/south connector road bisects the site. Design speeds (45 m.p.h.) on this road limit the area for the intersection of "minor collector" roads to a spacing of 530' (lineal feet).
- The Seneca River flood plain as defined by F.I.A. flood studies limits residential development along the entire eastern border of the study site.
- Existing and planned storm drainage and sanitary facilities impose restrictions on the location of housing units.
- Marketing considerations necessitate maximizing residential frontage and views to golf course and river.
- Town planning standards require a minimum of 1.8 parking spaces per dwelling unit.
- The location and number of multi-family dwelling units are to be fixed elements on all plans developed.

*Note: 1/3 ratio of housing types applies to energy conserving plans only. Conventional plan assumes the more conventional ratio of 1:2 for townhouses to single family detached dwelling units, based on existing development practice.

PLATE 13.

CONVENTIONAL DEVELOPMENT PLAN

The conventional site plan proposed by the developer responds primarily to the program requirements and development constraints outlined above, minimum consideration is given to site planning options to conserve energy, and no consideration is given to site systems options to conserve energy. The major feature of this plan is development of single family detached and townhouse units on fee simple lots, fronting on dedicated public streets.

A summary comparison of the conventional plan and the energy conserving plans is provided in this section after plan descriptions.

DOE CASE STUDY

FOR ENERGY CONSERVATION AND SITE/NEIGHBORHOOD DESIGN

PREPARED FOR:
THE UNITED STATES GOVERNMENT
ENERGY

CONSULTING TEAM:

LENNARD BLOOMER
LANDSCAPE ARCHITECTS
1770 BROADWAY, SUITE 1000
NEW YORK, NY 10019
OSWEN & COBE, ENGINEERS
300 WEST 42ND STREET, SUITE 1000
NEW YORK, NY 10018
DAWES & MOORE, CLIMATE/DOISTS
100 WEST 42ND STREET, SUITE 1000
NEW YORK, NY 10018
KITCHEN, LAMME, BERRY
ARCHITECTS
100 WEST 42ND STREET, SUITE 1000
NEW YORK, NY 10018
NAGATAI, KAWAKAWA, POWER
CONSULTANTS
100 WEST 42ND STREET, SUITE 1000
NEW YORK, NY 10018

DEVELOPER:

RADISSON P/O3

TRADITIONAL PLAN

NORTH

SCALE

DATE

PLATE 14

ENERGY CONSERVING DEVELOPMENT PLANS

Two energy conserving plans for the residential site have been developed based on the following criteria:

1. Selection of building sites should be based on climatological data whenever possible.
2. Structures should be sited and grouped for maximum winter wind protection and solar orientation in order to reduce heating loads.
3. Site roads and utilities should be designed so as to reduce embodied energy costs and financial costs for site development.

These criteria are dependent upon response to existing site factors and analysis of conservation options (for a summary of these considerations, see Section 5, Methodological Considerations).

Since site systems options for the residential site are still in the conceptual phase of development, this section will deal primarily with passive energy conserving plans and their energy and cost analysis. Discussion of site systems options can be found in Section 5 (Methodological Considerations) and Section 3 (Implementation Program).

ENERGY CONSERVING PLAN #1

Major site planning features of the Energy Conserving Plan #1 are as follows:

1. Development of single family detached and townhouse cluster housing along a system of private drives and auto courts in order to provide greater flexibility in unit orientation and wind protection.
2. Increase in site density over the traditional plan in order to reduce site development costs and embodied energy use on a per unit basis.

ENERGY CONSERVING PLAN #2

A second site plan, Energy Plan #2, has also been developed due to the following concerns:

1. Though development character, energy conserving potential and cost benefits are highest in Energy Plan #1, the Urban Development Corporation, as developer, is concerned over the marketability of an extensive cluster housing plan in an untested market area. To date, cluster housing has been built in only one development in the Syracuse area.
2. In light of a residential utility systems option for the residential study site, and in order to provide comparative samples for later field testing of the built project, a mixture of traditional housing and cluster housing patterns on the same site is considered desirable by the project team. The results of comparative field testing could be utilized as an inducement to implementing a greater number of energy efficient developments in the future development of Radisson, and by means of a builder and public awareness program, throughout the Central New York region.

Major site planning features of Energy Conserving Plan #2 are the same as Energy Plan #1 with the following modification:

1. Only single family detached housing is clustered.
2. The number of housing clusters is limited in order to accommodate the developer's concern in regard to an untested market and also to provide a test sampling for later field comparison with traditional housing patterns on site.

DOE CASE STUDY

FOR
ENERGY
CONSERVATION
and
SITE
NEIGHBORHOOD
DESIGN

PREPARED FOR:
THE
UNITED
STATES
DEPARTMENT
OF
ENERGY

CONSULTING TEAM:

THE PERMANI BUSHNIES
LANDSCAPE ARCHITECTS

BYRON BENDER BELL ARCHITECTS

O'BRIEN & GORE ENGINEERS

DAMES & MOORE CLIMATELOGISTS

DE HAVIDY KAISER LAND USE
PLANNERS

MITCHELL LAWRENCE ENERGY
ANALYST

NADARAYA NICHOLSON PRINTER
CONSULTATION ENERGY SYSTEMS
ANALYST

DEVELOPER:

THE NEW YORK STATE URBAN
DEVELOPMENT CORPORATION

RADISSON P10 3

ENERGY PLAN 2

PLATE 16.

NOTES:

ACREAGE	98.2
UNIT COUNT	362
MULTI-FAMILY	186
SINGLE-FAMILY	176
SINGLE-FAMILY CLUSTER	9
TOWNHOUSE	9
DENSITY	2.8 units/acre
ROADS	3800 ft. linear feet
PROTECTED UNITS	162

A summary comparison of the conventional and energy conserving plans is as follows:

DEVELOPMENT CHARACTERISTICS

	<u>Conventional Plan</u>	<u>Energy Plan 1</u>	<u>Energy Plan 2</u>
Total Number of Dwelling Units	201	259	220
Gross Site Density (Units/Acre)	2.57	3.3	2.8
Unit Distribution:			
Single Family Detached	135	---	116
Single Family Cluster	---	132	32
Town House Conventional	66	---	72
Town House Cluster	---	127	---
Total No. of Protected Units	64	193	168
Public Road Length (L.F.)	9,200	7,800	8,700
Private Roadways (L.F.) *	1,750	4,030	2,200

PERCENTAGE OF CHANGE OVER CONVENTIONAL PLAN

	<u>Conventional Plan</u>	<u>Energy Plan 1</u>	<u>Energy Plan 2</u>
Total No. of Dwelling Units	201	+17%	+ 6%
Gross Site Density (Units/Acre)	2.57	+28%	+ 8%
Unit Distribution:			
Multi-Family	142	---	---
Single Family	135	- 2%	+10%
Town House	66	+92%	+ 9%
Total No. of Protected Units	64	+201%	+162%
Public Road Length	9,200	-15%	- 5%
Private Roadways	1,750	+130%	+25%

* Private Roadways include roadway developed for flag lots on conventional plan, as well as cluster housing.

ESTIMATED ENERGY SAVINGS

Two estimates of energy savings have been developed for comparison of the Conventional and Energy Conserving Plans.

The first is a qualitative estimate of anticipated energy savings based on annual energy consumption of existing single family housing at Radisson. This estimate is derived from a comparative analysis of two years of meter reading data, provided by the Niagara Mohawk Power Corporation as well as field identification and air photo analysis of unit siting characteristics. This estimate is limited to single family detached housing. Detailed discussion of this calculation is found in Section 5, Methodological Considerations.

The second estimate of energy savings includes both single family detached and attached townhouse units. This estimate is a comparison of heating load and operating costs for the conventional and energy conserving plans, based on differences in air infiltration due to building siting. This estimate is based on data derived from the Carrier Load Information Center Model (CLIC), which is discussed in greater detail in Section 5, Methodological Considerations.

1. Qualitative Estimate of Energy Savings

Qualitative estimate of energy savings is based on a 25.2% reduction of heating load and operating costs for single family dwelling units which are protected from prevailing winter winds. The 25.2% reduction in heating load is based on a comparative analysis of meter readings for existing single family dwelling units at Radisson, as described in Section 5 of this report. Base heating load and operating costs for single family dwelling units is derived from the Carrier Computer Program (CLIC) analysis.

A summary of the design heating load and operating costs per building type and reduced heating load and operating costs for protected units are as follows:

<u>Building Type</u>	<u>Size</u>	<u>Base Load</u>	<u>Cost</u>
S.F. Colonial	2280 s.f.	41.6 MBH*	\$477
S.F. Contemporary	1446 s.f.	28.5 MBH	\$326

Savings per building type, when projected against the total number of protected dwelling units, results in the following estimate of load and cost savings:

	<u>Traditional Plan</u>	<u>Energy Plan 1</u>	<u>Energy Plan 2</u>
Protected Units:			
S.F. Colonial	13	50	57
S.F. Contemporary	13	50	57
Reduced Load:			
S.F. Colonial	136 MBH	524 MBH	597 MBH
S.F. Contemporary	93 MBH	359 MBH	409 MBH
TOTAL	229 MBH	883 MBH	1006 MBH
Reduced Cost:			
S.F. Colonial	\$ 1,562	\$ 6,010	\$ 6,851
S.F. Contemporary	\$ 1,067	\$ 4,107	\$ 4,682
TOTAL	\$ 2,639	\$ 10,117	\$ 11,534

*MBH = One thousand British thermal unit hours.

2. Quantitative Estimate of Energy Savings

The comparative estimate of energy savings is based on the number of single family detached and townhouse attached dwelling units which are protected from prevailing winter winds.

Design load and operating cost data was developed for residential building types based on the Carrier Air to Air Heat Pump (Model 38 BQ 008 and 40BA 009). Heating cost comparisons were based on infiltration loads for maximum and minimum windows placed on the windward and leeward sides of the structure. Infiltration characteristics were identified as follows:

- a. Maximum when windows occur on the windward side of the structure.
- b. Reduced when windows occur on walls parallel to the wind flow.
- c. Eliminated when windows occur on the leeward side of a structure.

Operating savings summarized per building type on the accompanying chart indicate that optimum wind orientation (minimum windows on windward side) can reduce heating loads. Heating load figures are given in thousand British thermal unit hours (MBH) and reflect 6,678 heating degree days for the Syracuse area (September through May).

The accompanying chart, "Building Type Estimated Savings," identified comparative energy use characteristics attributed to maximum vs. minimum wind exposure for each of the proposed developer's building types. The table identifies building type and comparative operating costs and is the basis for the overall plan comparison presented in this section.

BUILDING TYPE ESTIMATED SAVINGS

<u>Building Characteristics</u>		<u>Maximum Exposure</u>		<u>Minimum Exposure</u>		<u>% Savings</u>
<u>Type</u>	<u>Size</u>	<u>Load</u>	<u>Cost</u>	<u>Load</u>	<u>Cost</u>	
SF Colonial	2280 sf	41.6 MBH	\$477	39.1 MBH	\$ 450	6%
SF Contemporary	1466 sf	28.5 MBH	\$326	26.0 MBH	\$ 299	9%
Townhouse	1374 sf	34.0 MBH	\$385	29.6 MBH	\$ 341	13%

Savings per building type, when projected against the total number of protected dwelling units, results in the following estimate of load and cost savings:

	<u>Traditional Plan</u>	<u>Energy Plan #1</u>	<u>Energy Plan #2</u>
Design Load	6737 Mbh	9835 Mbh	7112 Mbh
Annual Operating Cost	\$77,163	\$95,101	\$81,688
Average Cost Per Dwelling Unit	\$ 383	\$ 367	\$ 371

On a building type basis, operating costs for exposed versus protected units can be summarized as follows:

	<u>Exposed</u>		<u>Protected</u>	
	<u>No. Units</u>	<u>Cost</u>	<u>No. Units</u>	<u>Cost</u>
Traditional Plan				
SF Colonial	54	\$25,758	13	\$ 5,850
SF Contemporary	55	\$17,930	13	\$ 3,887
Town House	28	\$10,780	38	\$12,958
	<u>137</u>	<u>\$54,468</u>	<u>64</u>	<u>\$22,695</u>
Energy Plan 1				
SF Colonial	16	\$ 7,632	50	\$22,500
SF Contemporary	16	\$ 5,216	50	\$14,950
Town House	34	\$13,090	93	\$31,713
	<u>66</u>	<u>\$25,938</u>	<u>193</u>	<u>\$69,163</u>
Energy Plan 2				
SF Colonial	17	\$ 8,109	57	\$25,650
SF Contemporary	17	\$ 5,542	57	\$17,043
Town House	18	\$ 6,930	54	\$18,414
	<u>52</u>	<u>\$20,581</u>	<u>168</u>	<u>\$61,107</u>

COST/BENEFIT ANALYSIS

Cost/benefit analysis of traditional vs. energy conserving plans is based on consideration of the following development and energy factors:

Development Costs:

- Comparison of site development costs for materials and construction
- Comparison of land value increases to the developer

Energy Costs:

- Comparison of embodied energy use and costs for site development
- Comparison of annual operating energy use and costs for space conditioning

1. Development Costs:

Comparison of site costs for construction of site roads, walks and utilities for the three site plans is summarized on the accompanying chart. Comparative figures are provided for each construction item and for total site development. Cost figures for these items are presented for total site and per dwelling unit respectively.

Cost per dwelling unit calculations are based on the number of single family dwelling units, which varies per plan. Multi-family dwelling units, which are constant on all plans, are not included. The table indicates that overall site development costs are 6% higher for Energy Plan #1 and 6% lower for Energy Plan #2, when compared to the developer's traditional plan. However, on a per dwelling unit basis, development costs for Energy Plan #1 are 17% less and development costs for Energy Plan #2 are 8.4% less than for the developer's traditional plan.

DEVELOPMENT COST COMPARISON

	Traditional Plan <u>201 D.U.</u>	Energy Plan 1 <u>259 D.U.</u>	Energy Plan 2 <u>220 D.U.</u>
Roads/Driveways	\$593,000 \$ 2,950	\$530,000 \$ 2,046	\$577,000 \$ 2,622
Water	\$238,000 \$ 1,184	\$236,000 \$ 911	\$231,000 \$ 1,050
San. Sewers	\$425,000 \$ 2,114	\$462,000 \$ 1,784	\$420,000 \$ 1,909
Drainage:			
Piping	\$160,000 \$ 796	\$291,000 \$ 1,124	\$177,000 \$ 804
Ditching	\$ 52,000 \$ 258	\$ 52,000 \$ 258	\$ 52,000* \$ 258
Walkways	\$225,000 \$ 1,119	\$225,000 \$ 1,119	\$225,000 \$ 1,119
Contingencies	\$253,950 \$ 1,263	\$269,000 \$ 1,038	\$252,300 \$ 1,146
Totals	<u>\$1,946,950</u> <u>\$ 9,686</u>	<u>\$2,065,000</u> <u>\$ 7,972</u>	<u>\$1,934,300 TOTAL</u> <u>\$ 8,793 PER D.U.</u>

*NOTE: Difference in cost between piping and ditching operations is due to increased pipe size for energy plans required because of increased density.

In addition to the development cost savings on a per unit basis described above, a comparative evaluation was made of total land value and income per lot affected by Energy Conserving Plans #1 and #2. The following data, as to land investment costs and improved land values, were employed for this analysis:

1. Land investment costs for Radisson for the residential site were calculated at a purchase price of \$500 (1968) per acre and a present value of \$1,000 (1979) per acre. Total land value at present for residential study site, excluding the marina development area (approximately 14 acres) is \$78,000.
2. Sales price per lot for land improved by Radisson (i.e. after site utilities, roads and walks) is calculated at \$12,000 per single family detached lot, and \$6,000 per single family attached lot.
3. Total site income for developed land is based on the sum of the number of single family and townhouse lots developed.
4. Average income per lot is based on total site income divided by the number of dwelling units.
5. Profit increase per lot is based on the increase in total site income over the conventional plan divided by the number of dwelling units.

A summary of the land value comparison for the Traditional and Energy Plans is provided in the accompanying chart:

	<u>Conventional</u> (201 D.U.)	<u>Energy Plan #1</u> (259 D.U.)	<u>Energy #2</u> (220 D.U.)
Income Per Lot Type	\$1,620,000 (135 S.F.) 396,000 (66 TH)	1,584,000 (132 S.F.) 762,000 (127 TH)	1,776,000 (148 S.F.) 432,000 (72 TH)
Total Site Income	2,016,000	2,346,000	2,208,000
Average Income Per Lot	10,029	9,057	10,036
Total Site Income Increase	-0-	330,000	192,000
Profit Per Lot Increase	-0-	1,274	872

2. Embodied Energy Costs:

Estimates of embodied energy savings for site development were calculated based on unit of measurement and conversion factors presented in the following information sources:

1. "Energy in Building Construction, ERDA contract #E-(11-1)-2791, Center for Advanced Computation and R.G. Stein and Assoc.
 - a. Embodied energy (material only) in PVC pipe - 41,634 BTU/lb.
2. "CAC Document No. 228 - Energy Use for Building Construction" Center for Advanced Computation, Feb. 1977
 - a. Embodied energy (material delivered to site) in Carbon Steel Sheets (galvanized) - 27,836 BTU/lb.
3. "Energy Requirements for Roadway Pavements" Asphalt Institute, April 1975.
 - a. Total energy (in place) for asphalt concrete as a construction material - 511,820 BTU/ton.
 - b. Energy equivalent of gasoline used to "generate" power - 125,000 BTU/gal.
 - c. Energy equivalent of diesel fuel used to "generate" power - 139,000 BTU/gal.
 - d. Total energy (in place) for Portland Concrete Cement (P.C.C.) - 2,436,330 BTU/cy.
 - e. Total energy for reinforcing steel used in P.C.C. (in place) - 10,500 BTU/lb.
 - f. Total energy for crushed stone road base (in place) - 236,450 BTU/ton.
 - g. Total energy (in place) for an asphalt spray as a construction material - 49,735 BTU/gal.

A comparison of embodied energy costs for site development is summarized on the accompanying chart. In spite of the increased number of dwelling units on Energy Plans #1 and #2, these plans consume approximately the same amount of embodied energy (.5%) as the base plan. However, on a per dwelling unit basis, Energy Plan #1 saves 25.29 million BTU per unit (22%) and Energy Plan #2 saves 14.58 million BTU per unit (12%) over the Traditional Plan.

EMBODIED ENERGY COMPARISON

	Traditional Plan 201 D.U.	Energy Plan 1 259 D.U.	Energy Plan 2 220 D.U.
Roads/Driveways	7,975.60 39.67	7,550.81 29.15	7,885.60 35.84
Water	4,277.50 22.28	3,700.00 14.28	4,217.70 19.17
San. Sewers	3,435.00 17.09	3,500.00 13.55	3,319.30 15.09
Drainage:			
Piping	3,688.30 18.35	4,700.00 18.14	3,053.60 13.88
Ditching	28.00 .14	28.00 .11	28.00* .13
Walkways	600.00 2.99	600.00 2.12	600.00 2.73
Contingencies	3,000.00 14.92	3,011.00 11.60	2,865.00 13.02
Total Energy	23,004.00 114.44	23,090.00 89.15	21,970.00 TOTAL 99.86 PER UNIT

Note: All quantities shown are given in millions of BTU's.

*NOTE: Difference in cost between piping and ditching operations is due to increased pipe size for energy plans required because of increased density.

3. Annual Operating Costs:

Comparative savings in annual operation costs, based on the number of protected dwelling units; assumes a savings of \$27 annually per single family detached unit and \$44 annually per town house unit.

ANNUAL COST SAVINGS

	<u>Traditional Plan</u>	<u>Energy Plan #1</u>	<u>Energy Plan #2</u>
SF Colonial	\$ 351	\$1,350	\$1,539
SF Contemporary	\$ 351	\$1,350	\$1,539
Town House	<u>\$1,672</u>	<u>\$4,092</u>	<u>\$2,376</u>
TOTAL	\$2,374	\$6,792	\$5,454

TOWN CENTER STUDY SITE

EXISTING CONDITIONS

SITE LOCATION:

The town center study site consists of approximately 51 acres located at the center of Radisson. Major land uses surrounding the town center are high density residential development to the north and south, major educational development to the east, and industrial development to the west. Major areas of low density single family housing exist to the north and are proposed to the east and west.

Immediate boundaries of the site are formed by an existing four-lane divided road (Willett Parkway) to the north and a four-lane expressway to the southeast scheduled for construction in 1985+.

PLATE 17.

1 TOWN CENTER
DEVELOPMENT

2 EDUCATIONAL
FACILITIES

3 HIGH DENSITY
RESIDENTIAL

4 LOW DENSITY
RESIDENTIAL

5 INDUSTRIAL
DEVELOPMENT

EXISTING PHYSICAL FACTORS:

Slope Percentage and Drainage: Existing slope distribution on site is as follows:

70% of site: 5-10% slope range
30% of site: 10% slope range

The major topographic feature on site is a north/south dirt road, to be removed. The major drainage flow is east to seasonally wet areas and drainage swales.

PLATE 19.

Slope Aspect:

35% of slopes: Southern orientation
50% of slopes: Eastern orientation
10% of slopes: Northern orientation
5% of slopes: Western orientation

PLATE 20.

Vegetation: General vegetative cover is mixed deciduous second growth, ash, maple, poplar with mixed deciduous shrub growth. Existing vegetative cover is as follows:

40% of site:	Dense deciduous
35% of site:	Sparse deciduous
25% of site:	Open

PLATE 21.

Climate:

- Prevailing winds range over a northwest 60° arc with a mean speed of 9.9 mph.
- The existing drumlin to the west is likely to alter this wind flow pattern.
- The existing low point at the northern end of the site is likely to create a major frost and snow pocket.

PLATE 22.

EXISTING DEVELOPMENT FACTORS

Program Requirements: The site program established by the developer is as follows:

1. Residential: 350-400 apartment units
2. Commercial: 125,000 + s.f. commercial/retail
19,000 + s.f. office
3. Open Space:
 - Urban Plaza
 - Open space walkway system
 - Public "commons"
4. Parking requirements: 1 car per 100 s.f. commercial

Parking requirements for the Town Center result in land coverage of 13+ acres (i.e. 25% of the total site). Commercial parking standards (10 cars per 1000 square feet) imposed are the same as those required for regional malls. Application of this standard to Radisson does not recognize the following factors:

- The Radisson commercial development is primarily intended to provide convenience services to Radisson residents. Four regional malls within a 10-mile radius of Radisson will serve major shopping needs.
- Due to the nature of the facility, parking will be primarily short-term with high turnover.
- Due to the mixed commercial/office/residential uses, shared parking is a viable approach to reduce parking.
- Based on national studies by the Urban Land Institute, a parking ratio of 5.5 cars per 1000 square feet would be adequate for this facility and would reduce parking by one-half. (De Chiara & Koppleman pp 442-43).
- Reduction of parking requirements would permit greater development flexibility, increased residential density, increased open space and reduced site development costs.

Development Constraints: Existing conditions impose the following development constraints:

- The existing major four-lane road borders site to the north and creates major traffic flow to the site.
- Vehicular access to site is limited to two points north and south due to gradient and sight lines.
- Proposed four-lane expressway to southeast creates potential noise intrusion.
- Location of proposed pedestrian overpass fixed due to existing gradient establishes the major pedestrian access point.

CONVENTIONAL DEVELOPMENT PLAN

The conventional site plan proposed by the developer responds primarily to the program requirements and development constraints outlined above, minimal consideration is given to site planning options to conserve energy, and no consideration is given to site systems options to conserve energy. Major features of this plan are as follows:

1. Concentration of residential units in crescent-shaped highrise structure to provide an architectural edge to the commons area and create a visual highpoint.
2. Development of all commercial/retail uses in an enclosed pedestrian mall focusing on the commons area.
3. Site coverage, resulting from this plan is as follows:

- Building area

Commercial/Retail:	125,350 sq. ft.
Office:	19,200 sq. ft.
High-rise residential:	378 dwelling units

- Parking Area

	<u>Total</u>	<u>% Shaded</u>
Commercial/Office	9 Acres	7%
Residential:	6 Acres	16%

- Open Space: 4 acres

4. Existing vegetation preserved: 9% of gross site.

ENERGY CONSERVING DEVELOPMENT PLAN

The energy conserving plan for the town center site has been developed in response to the same climate-related site planning criteria as the residential plan. In addition to the site planning criteria for site selection and building orientation, extensive consideration was given to the selection and planning of residential building types which would permit optimum orientation for sun and wind for the greatest number of dwelling units.

Major site planning features of the energy conserving plan are as follows:

1. Residential and commercial structures are sited in open pockets where vegetation or topography offers potential for building protection.
2. Three-story garden apartments comprise approximately 60+% of the residential units. Due to its reduced height, this building type is less susceptible to wind eddying and turbulence and eliminates the need for vertical transportation systems. In addition, this building type offers the potential for optimum solar orientation and wind protection for a greater total number of dwelling units than do high-rise structures.
3. High-rise residential structures are used due to space limitations on site, but are oriented so as to reduce wall surface exposure to prevailing winds.
4. Commercial structures are planned with a seasonally enclosed pedestrian access and walkway system to provide an air lock and sun shade as required.
5. Site coverage resulting from this plan is as follows:

- Building Area:

Commercial/Retail	126,500 sq. ft.
Office	19,800 sq. ft.
High-rise Residential	126 dwelling units
Garden Apartments	204 dwelling units

- Parking Area:

	Total	% Shaded
Commercial / Office	10 Acres	43%
Residential	5 Acres	38%

6. Existing Vegetation Preserved: 30% of Gross Site

PLATE 26.

DOE CASE STUDY

FOR ENERGY CONSERVATION and SITE/NEIGHBORHOOD DESIGN

PREPARED FOR:
THE UNITED STATES DEPARTMENT OF ENERGY

CONSULTING TEAM:

THE BERMAN BLECHNER
LANDSCAPE ARCHITECTS
FOR SUNKER BELL ARCHITECTS &
ASSOCIATES
O'BRIEN & O'BRIEN ENGINEERS
DAVIS & MOORE CLIMATE/URBANS
ROBERT KARRER LAND USE
MITCHELL LARSEN ENERGY
ANALYST
NADARA MOKHAW POWER
CORPORATION ENERGY SYSTEMS
ANALYST

DEVELOPER:

THE NEW YORK STATE URBAN
DEVELOPMENT CORPORATION

RADISSON TOWN CENTER: ENERGY PLAN

ESTIMATED ENERGY SAVINGS

Estimated energy savings for the Town Center Site are based on the comparison and evaluation of qualitative differences between the Energy Conserving and Traditional Plans. Plan characteristics evaluated are the differences in the siting and orientation of structures in relation to their impact on maximizing winter heat gain and minimizing winter heat loss.

The Radisson Study Team does recognize that this method of modeling energy savings is more tentative than the modeling techniques employed for the residential study site. However, the Radisson team feels that evaluation of qualitative differences is appropriate to the Town Center Site due to the following considerations:

1. Plan development for the Town Center is dependent upon the use of schematic building types, which identify building massing, surface window area and building entry points. Data of this type is sufficient for the siting and orientation of structures and the development of circulation and parking systems. However, in the absence of specific data on building configuration and structural and window design and material types, insulation and HVAC systems it is difficult to provide a detailed assessment of the impact of passive design features such as building siting and orientation on reduced load requirements. Potential energy savings for various passive design features can be evaluated in a qualitative manner, as discussed in this section, but are difficult to quantify.
2. Comparative analysis of the Town Center Plans to existing development at Radisson was not possible due to the absence of existing commercial and apartment structures at Radisson.
3. Use of the Carrier Load Information Center (CLIC) Model was limited to commercial structures only as the model is not suited for analysis of multi-family dwellings.

Following is a comparative analysis of the Energy Conserving and Traditional Plans in terms of potential energy savings due to direct solar heat gain and winter heat loss reduction.

1. Annual heat gain through South oriented windows:

Studies have indicated that in temperate climates between 20%-50% of the annual heating requirements of a structure can be supplied by direct solar heat gain through south oriented windows with insulating controls. (Johnston, p54)

In northern climates, the south facing side of a building is ideal for solar windows. During cold winter months, the southside of a building gains more heat than a horizontal roof; while during summer months, glass surfaces can be shaded from high sun angles. (Johnston, p. 55).

The exact amount of yearly heat gain varies with climatic conditions and building design. However, the potential annual heat gain per square foot of window can be identified. Yearly heat gain data compiled for the City of Concord, New Hampshire - which is at the same latitude (43°) and has the same mean annual radiation (300 Langleys) as the Radisson Site - indicate that the potential direct annual solar heat gain for south facing windows is 2.54 times greater than that for north facing windows.

Following is a summary of potential yearly heat gain per square foot of single and double glazing assumed to be possible at the Radisson site.

HEAT GAIN THROUGH WINDOW BTU/FT.² YEAR

NORTH		EAST & WEST		SOUTH	
SINGLE	DOUBLE	SINGLE	DOUBLE	SINGLE	DOUBLE
33,481	30,080	91,684	82,263	88,609	76,517

Analysis of window area orientation for the Traditional and Energy Conserving Town Center Plaza indicates that the Energy Conserving plan does result in an appreciable increase in south window area. Following is a summary comparison of square footage of glazed surfaces related to orientation for commercial and residential building types.

SURFACE GLASS AREA

BUILDING TYPE	TOTAL GLAZED SURFACE (sq. ft.)	DISTRIBUTION BY ORIENTATION (sq. ft.)		
		NORTH	EAST & WEST	SOUTH
Commercial/Office				
Traditional Plan	8,316	1,944	4,320	2,052
Energy Plan	20,952	1,296	4,752	14,904
High-Rise Apartments				
Traditional Plan	106,080	17,280	49,200	39,600
Energy Plan	57,600	8,820	10,080	38,700
Garden Apartments				
Traditional Plan	—	—	—	—
Energy Plan	59,625	16,500	11,750	31,375
Total All Types				
Traditional Plan	114,396	19,224	53,520	41,652
Energy Plan	138,177	26,616	26,582	84,979

As the above summary indicates the Energy Conserving Plan doubles the amount of south facing glass over the Conventional Plan while minimizing undesirable east, west and north glazed surfaces. Based on previous data which identifies that the potential annual heat gain for south facing windows is triple that for north facing windows, the potential for increasing direct annual heat gain is significantly greater on the energy conserving plan.

In order to identify potential reduction in heating requirements due to direct solar gain a more detailed analysis of the winter energy requirements of structures is required. Such an analysis requires more detailed building design data such as heat loss rate for average 5° increments of winter temperature; calculation of internal heat generation; evaluation of the efficiency of the heating plant and night-time setback of thermostats. In the absence of specific building design data detailed calculation of winter energy requirements was restricted. In addition, use of the Carrier Land Information Center Model (CLIC) was not possible due to the fact that the program does not recognize direct solar gain for calculation of winter heating requirements.

Upon review and discussion with the Department of Energy more detailed analysis of the cost/benefit and feasibility of utilizing direct solar gain is recommended as a follow up phase to this project.

2. WINTER HEAT LOSS REDUCTION

A major consideration in development of the Energy Conserving Plan was the siting of structures to minimize cold air infiltration and to reduce winter heat loss. Passive design strategies for minimizing cold air infiltration integrated into the Town Center Plan include reduction of north and west surface wall area and the wind sheltering of surface wall exposure.

Following is a comparison of the distribution of surface wall area by orientation for the Conventional and Energy Conserving Plans. As the summary indicates, the Energy Conserving Plan reduces the percentage of north, east and west wall exposure over the Conventional Plan for each building type.

SURFACE WALL EXPOSURE

BUILDING TYPE	TOTAL WALL SURFACE	DISTRIBUTION BY ORIENTATION		
	(sq. ft.)	NORTH	EAST & WEST	SOUTH
Commercial/Office				
Traditional Plan	37,600	9,384	16,080	11,532
Energy Plan	46,000	12,576	15,552	19,224
High Rise Aparts.				
Traditional Plan	278,400	86,400	126,000	66,000
Energy Plan	121,860	17,640	50,400	53,820
Garden Apartments				
Energy Plan	111,000	41,250	23,500	46,250
Total All Building Types				
Traditional Plan	316,000	96,388	142,080	77,532
Energy Plan	278,860	70,114	89,452	119,294

On a total plan basis, undesirable wall surface exposure are reduced on the Energy Conserving Plan as follows:

	CONVENTIONAL PLAN	ENERGY CONSERVING PLAN	
	SURFACE WALL AREA	SURFACE WALL AREA	CHANGE
	(sq. ft)	(sq. ft)	
Total Wall	316,000	278,000	- 38,000
North Wall	96,388	70,114	- 26,274
East & West Wall	142,080	89,452	- 52,628
South Wall	77,532	119,294	+ 41,762

As the above summary indicates the Energy Conserving Plan significantly reduces total wall surface exposure and undesirable north, east and west wall exposure in comparison to the Conventional Plan.

By reducing north, east and west wall surface area, as well as reducing the percentage of window glazing on these surfaces, the Energy Conserving Plan minimizes potential cold air infiltration.

In addition to siting structures to reduce north, east and west surface wall area, the Energy Conserving Plan utilizes existing vegetation and building spacing to provide wind sheltering on north and west wall surfaces. An overall comparison of the two plans indicates that 70% of the north and west wall surface on the Energy Conserving Plan is sheltered from the wind compared to 20% of the north and west wall surface on the Conventional Plan.

Use of the Carrier Commercial Load Program did permit modeling of heat load for commercial/office structures. Due to the fact that the Carrier Program does not take solar gain or wind buffering into account, the program was used on a limited basis to identify the basic heating load and rate of air infiltration ($3/4$ of an air change per hour) on a medium/tight commercial structure. This information was used with surface wall characteristics data (wall and glass area) to identify the amount of heat loss through square foot of window and wall area and the resulting building heating load. Heat load estimates derived from this calculation indicate a 5% increase in heat load for the Energy Conserving Plan (5,965,486 BTUH) over the Traditional Plan (5,613,994 BTUH). This increase in load, should be considered in relation to the following factors:

1. In spite of the fact that the energy plan optimizes building orientation to reduce infiltration loads, the use of several buildings to incorporate approximately the same square footage necessitates more wall area to be exposed. A comparison of exposed wall area for each plan identifies a 8,300 square foot difference in wall area between the two plans. The energy plan has a 18% increase in wall area over the Conventional plan. This increased wall area accounts for the higher heat loss on the energy plan.
2. In spite of the fact that the Energy Plan maximizes potential solar gain through window orientation, the plan increases the total glazed surface for commercial/office space by 12,000 square feet (25%) over the Conventional Plan. This increase in surface glass area results in an increase in air infiltration and heat loss.

As the differences in wall and glass surface identified above indicate, the increased heating load on the energy plan is due primarily to differences in the character of building surface with no account made for solar gain or wind buffering. As previously stated, town center building types are conceptual in nature and require more detailed development of solar gain factors, building design and climate impacts in order to quantify the potential benefits of heat gain and winter heat loss reduction identified in this section.

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TEAM STRUCTURE & ORGANIZATION

CHAPTER 4

The following section describes the roles and project input of the decision-making team and technical team.

DECISION MAKING TEAM

The New York State Urban Development Corporation and the Town of Lysander Planning Board were the major decision-makers for this project. Both groups served in an advisory and approval capacity and provided review, critique and suggested revision of preliminary and final plans. The project roles and approval authority of the decision-making team is described below.

1. New York State Urban Development Corporation: As primary developer at Radisson, the Urban Development Corporation is responsible for major planning and program decisions affecting present and future development at Radisson. Major land planning decisions, such as land use, development program and circulation systems, have been determined by the Radisson Master Plan. Any proposal affecting major land planning issues is subject to approval by the Urban Development Corporation. During the course of plan development, the following project proposals have been subject to U.D.C. approval:
 - a. The introduction of cluster housing and increased site density on the residential study site.
 - b. The use of cluster housing for a study of community based energy systems, and individual heating and cooling systems.
 - c. Investigation of on-site natural gas for incorporation into community based energy systems.

In addition to the major decision-making authority of the Urban Development Corporation imposed upon the project, the Radisson Development Office has the authority to administer design controls and to decide when variances are acceptable. These design controls affect use of materials and colors, building size, facade alignment, setback, use of site fencing and outbuildings, and preservation of vegetation. During the course of plan development, the following proposals have been subject to approval by the Radisson Development Office:

- a. Varying building setbacks and deviation from facade alignment.
- b. Development of private roadways.

2. Town of Lysander Planning Board: The Town of Lysander Planning Board has ultimate authority for review and approval of proposed development plans, according to town zoning by-laws. In addition, the Planning Board is responsible for ensuring that development plans meet requirements for N.Y.S. Environmental Quality Review (SEQR), Environmental Impact Assessment (E.I.A.) and Statement (E.I.S.) as necessary. Meetings with the Planning Board have been held to solicit their input and schematic approval. Planning Board regulations affect the following development issues:

- Building setbacks
- Minimum building site and use classification
- Roadway specifications
- Building/parking ratios

Planning Board administered SEQR regulations affect the following anticipated effects of development:

- Effect of development of physical setting, terrain features, cultural features, social and economic features.
- Growth inducing aspects of the development.
- Energy budget and commitment of resources
- Short and long-term impacts.
- Unavoidable adverse effects and mitigating measures.
- Alternatives to the proposed development.

RELATIONSHIP TO TECHNICAL TEAM

In addition to their approval roles, the decision-making team has served in a review and advisory capacity. In its advisory capacity, the Urban Development Corporation has provided planning, site and program data for the case study sites as well as technical review of marketing implications, energy systems and architectural systems. The planning consultant to the Town of Lysander Planning Board has served in a review capacity during development of site plans, inputting as to plan compliance with subdivision and development regulations and general evaluation as to marketability.

A third group, private builders currently developing housing at Radisson, has also served in an advisory capacity and reviewed residential energy plans from the point of view of marketability and developer acceptability. Developers also reviewed energy performance analysis of units which they are currently building and preliminary builder guidelines.

The relationship between decision makers and the technical team is illustrated on the accompanying chart. Primary differences are seen in terms of role and criteria.

TEAM RELATIONSHIPS

A major factor affecting the decision-making process in this project was the limited direct input of administrative and policy making personnel from the New York State Urban Development Corporation. In effect, the prime decision making role has been assumed by the Radisson Development Office, represented by the General Manager. The Development Office and General Manager have had direct control over project presentation to and review by the Urban Development Corporation, the Town of Lysander Planning Board, developers at Radisson, and the residents of the New Community.

Presentations to these groups have been restricted to final project plans and have thus limited the potential for team interaction with a range of public and private decision-makers during the course of options evaluation and plan development. Acceptance or rejection of technical team proposals was, therefore, determined by the Radisson Development Office.

Due to its direct responsibility for financial and construction management and marketing and its accountability to the Urban Development Corporation administrative staff, the Radisson Development Office tended to apply conservative criteria to the project, emphasizing a minimum change approach to development. The primary criteria applied to development were that proposals not affect the existing visual or social character of the community or require any changes in developer practices or building models.

Additional consideration should be given to administrative changes in the Radisson Development Office. During the course of the case study, there were a total of three different individuals serving in the capacity of General Manager at Radisson. The personal judgment of these individuals did affect the degree to which the project was advanced with Urban Development Corporation personnel.

In terms of the decision making process, the major factor affecting the case study was the developer's perception of energy conservation. From the onset of the case study, the basic attitude on the part of the developer was that minimum options for energy conservation were possible at Radisson. This attitude was based on previous studies, such as the American Hydrotherm Corporation's study of districting heating (December 1972), as well as the general lack of proven alternative fuel sources at Radisson. The first level of acceptability for energy options at Radisson was the use of passive techniques of site planning and design, with later acceptance of an individual systems approach. As this attitude was also shared by the technical team, as discussed later, this did limit the technical scope of the Radisson project.

TECHNICAL TEAM

The technical team for this project was selected based on their technical expertise and previous consulting experience at Radisson. Team members' working familiarity with the regulatory constraints, development practices, physical characteristics and planning objectives of the New Community and the Syracuse area was considered to facilitate project development and lend a credibility to proposals developed for the case study project. This credibility was considered desirable in order to facilitate review and acceptance by the Urban Development Corporation, the Town of Lysander Planning Board and private builders and developers at Radisson.

The following is a list of the technical team, identifying consulting members and areas of expertise:

<u>Consultant</u>	<u>Expertise</u>
Reimann-Buechner Partnership	Land Planning and Design
Beyer Blinder Belle	Architectural Design Land Use Planning
O'Brien & Gere	Electrical and Civil Engineering
Dames & Moore	Climatology and Geology
Dr. Harvey Kaiser	Land Use Planning
Mitchell J. Lavine	Energy Use Analysis
Niagara Mohawk Power Corporation	Energy Systems: Alternative Energy Sources Alternative Distribution Systems Integrated Site Utilities Systems

Project responsibilities for team members are as follows:

Reimann-Buechner Partnership was responsible for contract administration and team coordination. In this capacity, the firm developed task assignments and project schedule, coordinated information exchange among team members, reviewed and compiled all consultants' reports, initiated all client contact and was responsible for all project presentations.

Special project responsibility for Reimann-Buechner Partnership dealt primarily with passive site planning and included collection of project data, analysis of site development suitability, analysis of energy use characteristics in housing at Radisson and concept and plan development for passive energy plans.

Beyer Blinder Belle: As architectural consultant, Beyer Blinder Belle was responsible for a "State of the Art Review" of building design data which included identification and evaluation of design criteria and energy systems, structural systems and HVAC systems for energy conserving building design, as well as identification of personnel contacts and references on energy conserving building design. In addition, Beyer Blinder Belle was responsible for energy evaluation of existing building types at Radisson and identification, review and analysis of regulatory requirements (i.e. New York State Energy Conservation Code, 1979; BOCA Energy Conservation Construction Code, 1977; and the New York State Construction Code) affecting development at Radisson.

O'Brien & Gere: As consulting engineers, O'Brien & Gere was responsible for identification of engineering constraints imposed on development, review of construction feasibility, calculation of all materials' quantities and construction costs for plan implementation. In addition, O'Brien & Gere was responsible for development of base line energy use data for the conventional and energy conserving plans. Base line data included identification of embodied energy costs and financial costs for plan development; identification of base heating and cooling load and annual operating costs for all structures; analysis of energy savings due to reduction of air infiltration and identification of conceptual integrated utility systems for the Town Center study site.

Dames & Moore: The major project responsibility for Dames & Moore was collection and analysis of climatological data. In this capacity, Dames and Moore compiled macroclimatological data for the Syracuse area and developed a qualitative estimate of climatic characteristics affecting the study sites. Factors analyzed included solar radiation, precipitation, wind, temperature and heating and cooling degree days. The firm also compiled data on site energy resources which would potentially affect the development of utility systems at Radisson.

Land Use Planner & Energy Analyst: These consultants have primarily served in a review and critique role. Areas of particular focus for these consultants were the review of methodology for data collection, options evaluation and plan development for the entire project.

The Niagara Mohawk Power Corporation: The Research and Development branch of the Niagara Mohawk Power Corporation has provided consulting and review services in regard to utility systems. The power company has identified utility attitudes toward the feasibility of developing alternative energy sources and load management programs. It has also reviewed plans in order to identify the most efficient methods for utility distribution and has made data available for development of the energy consumption baseline. In addition, the Niagara Mohawk Power Corporation has identified options for development of total energy recovery systems at Radisson.

Project assignments for members of the technical team, based on areas of expertise, are summarized on the accompanying matrix.

	Reimann-Buechner	Beyer Blinder Belle	O'Brien & Gere	Dames & Moore	H. Kaiser	M. Lavine	Niagara Mohawk Power Corporation
SITE OPTIONS:							
Siting	x	x					
Orientation	x	x					
Use of natural and man-made elements	x						
Climate modification		x		x			
SYSTEM OPTIONS:							
Buildings		x					
Utilities			x	x			x
PROGRAM REQUIREMENTS:							
Market	x				x		
Development Program	x				x		
Budget and Schedule	x						
ENERGY USE:							
Existing Housing	x					x	x
Prototypical Building Load	x		x				
SITE ANALYSIS:							
Energy Sources			x	x			x
Climate				x			
Development Suitability	x		x				
Existing On Site Factors	x						
Site Options Evaluation	x	x	x	x			
Energy Use Analysis	x	x	x			x	
System Options Evaluation			x				x
PLAN DEVELOPMENT:							
Passive Site Plan	x	x					
Utility System							
Options	x		x	x			x
Plan Comparison	x	x		x	x		
Regulatory Analysis	x	x		x	x		x

ANALYSIS

Project assignments were made by the Reimann.Buechner Partnership. These assignments were based on areas of expertise. In each of these areas, team members were instructed to conduct a state of the art review in order to identify energy conserving options for the Radisson project. Consultants were requested to summarize these findings in reports which were to be reviewed and evaluated during collaborative team work sessions. Coordination and synthesis of final evaluation options was the responsibility of the Reimann.Buechner Partnership.

A major problem inherent in the Radisson project team approach was the fact that team members were examining areas of potential conservation options exclusive of one another. Therefore, the opportunity for a community based energy approach was virtually excluded by the team's working relationship. In addition, requesting the team to conduct a state of the art review was too "broad-brushed" an approach for a special project and study and resulted in identification of extremely broad recommendations and, in some instances, a lack of options. A more directed approach was required to define tasks and project scope for the consulting team.

In order to provide the more specific project direction required, the project managers should have placed preliminary project emphasis on development of the energy baseline for the proposed conventional development and used this analysis as the basis for identification and evaluation of options. Had this strategy been used for project management and definition of consultant tasks, it is highly probable that the following improvements to the case study would have occurred.

1. The case study would have provided a more objective and quantifiable identification of energy conserving options.
2. Preliminary feasibility data (i.e. ground water conditions, soils, etc.) required for the 0/3 utility options would have been documented.
3. The weakness of available quantification techniques would have been identified, and alternative techniques could have been selected.

In addition, the weighting of the team toward traditional project planning skills further limited the potential of the team to address community scale utility system options. In general, the Radisson project team was strong in the area of project work but required additional members with more sophisticated analytical skills.

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METHODOLOGICAL CONSIDERATIONS

CHAPTER 5

The purpose of this section is to describe the sequence of technical and decision-making points for the project. The following considerations are discussed in this section:

Approach to Project

Program Plan as Executed

Technical Issues

- Data Gathering
- Energy Evaluation

Conservation Options

APPROACH TO PROJECT

Following is a discussion of the initial project approach taken by the Radisson Study Team. Contract prerequisites for the case study required that the study teams perform the following scope of work:

1. Inventory energy conserving options.
2. Develop energy conserving plans incorporating site planning options and energy systems options.
3. Evaluate and compare energy conserving plans and conventional developer plans.
4. Evaluate regulatory and legal constraints affecting implementation of energy conserving plans.

The major work item of these prerequisites was development of energy conserving plans. During the initial phases of investigation, project data on Radisson's past development studies, existing program requirements and existing site conditions, was reviewed by the technical team. The purpose of this review was to determine the best strategy for development of energy conserving plans for the residential and Town Center study sites. Based on analysis of this data, factors were identified which indicate that the potential for development of integrated systems options at Radisson is limited, but the potential for development of passive energy conserving plans is both realistic and could result in significant energy savings. The factors identified are as follows:

1. A 1972 cost/feasibility study of district heating for Radisson had identified that low density residential areas of single family attached and detached housing were not cost feasible for development of central systems due to the relatively high initial cost of a distribution system in areas of low density. Though a central system was considered cost feasible for the Town Center, that determination was based on a building program of 282,000 gross square feet which is twice the size of the present program of 140,000 gross square feet. (American Hydrotherm Corporation, p. 4).
2. A 1978 performance study of solar heating and cooling systems undertaken for the Niagara Mohawk Power Corporation had indicated that solar collectors were likely to perform badly during the prime heating season (December - February) due to the high incidence of cloudiness during that period. (Arthur D. Little, Inc., p. C-1).
3. An informal evaluation of potential energy sources available to the study sites was conducted by the technical team during project work sessions. Potential site energy sources reviewed for the development of heating and cooling systems included natural gas, ground water, waste incineration and hydro power. The general conclusion reached by the study team was that the cost for development of these sources would not be merited due to the low density and limited building program on both study sites. In addition, the time required for detailed study of the availability of these sources and for analysis of the feasibility and cost effectiveness of utilizing these sources for development of energy systems could not be met within the project time frame.

In light of the indication that utility systems options had limited potential for the Radisson study sites, the project team determined that development of energy conserving plans utilizing passive conservation techniques was a suitable project approach. Selection of a passive approach was based on the following considerations:

1. Previous "State of the Art" review by the Reimann Buechner Partnership had indicated that significant energy savings could be realized through site planning, based on passive techniques.
2. Quantification available at the outset of this project indicated that reduction of base load energy consumption in a range of 6-14% was possible through the use of passive site planning options.
3. Passive conservation strategies could be incorporated into the Radisson development within the project time frame and would result in immediate energy savings. In addition, they would require minimal cost for operation without requiring a long-term write-off period.

Based on these considerations, the initial project approach of the Radisson study team emphasized reduction of end use energy consumption through the use of passive conservation measures. The two primary areas identified for energy conservation were the reduction of energy consumption for the heating of structures and the reduction of embodied energy consumption for site development. These two areas of conservation provided the basic project criteria for the identification and evaluation of energy conservation options and the development and evaluation of energy conserving plans.

Due to the focus on conservation of energy for space heating and site development, members of the project team undertook "State of the Art" reviews in their area of technical expertise to identify energy conserving options. Because major expertise of team members was in the areas of project design, emphasis was placed on identifying options for the planning and design of structural groupings, roadways, site utilities and individual structures which could potentially reduce heating demand and site construction operations.

Because of the extreme winter climate and high winter heating demand associated with the project location, emphasis was placed on identification of climate related options. These options were considered to include any technique for modifying air infiltration and heat loss associated with winter winds and for capitalizing on available solar radiation and heat gain during the peak winter heating season. All options identified were evaluated in terms of their potential to either reduce winter heat loss or increase winter heat gain.

Subsequent to identification of conservation options, a preliminary analysis was made of existing single family housing at Radisson to identify variation in winter heating requirements associated with wind protection or solar orientation. The purpose of this analysis was to provide a preliminary project baseline. The results of this analysis indicated that the sheltering of buildings from winter winds and the reduction of cold air infiltration resulted in the most significant reduction of winter heating requirements.

During the following phase of plan development, options which would result in wind sheltering and reduced air infiltration were weighed more favorably than options for increased solar orientations. The energy conserving plans for the residential and Town Center study sites described in Section 2 of this report were developed based on this approach. Estimates of energy savings for heating of structures and estimates of embodied energy savings for site development were calculated after plans were completed.

Study findings developed under this approach were presented at the second Case Study Workshop held in Washington, D.C. on September 14 and 15, 1978. The following section, "Program Plan As Executed" will identify changes in study approach resulting from the Department of Energy review at the workshop and the project team's evaluation of the study approach.

PROGRAM PLAN AS EXECUTED

The purpose of this discussion is to provide a retrospective view of the case study in terms of modifications to the project and the study team's evaluation of the project.

Modifications to Project

During the course of project review at the second Department of Energy Workshop, concern was expressed regarding the degree to which emphasis was placed on space conditioning requirements. Case study participants were informed that building consumption and space conditioning constitute only a small portion (approximately 20%) of total community energy requirements. (Argonne, pp. 95-96).

For the remaining portion of work, case study participants were directed to expand their focus from end-use service demand to include a more generalized view of systems requirements.

Based on this directive, the Radisson Study Team undertook a further investigation of utility systems options applicable to the residential and Town Center study sites.

Investigation of utility options for the Town Center was undertaken by the firms of O'Brien & Gere Engineers and Dames & Moore; investigation of the residential site was undertaken by the Research and Development Branch of the Niagara Mohawk Power Corporation. Both studies were developed in cooperation with the Urban Development Corporation.

The purpose of these studies was to evaluate and recommend utility systems options which merited further investigation. Evaluation and selection of options for further study was based on the following factors:

1. Appropriateness of the option to the scale of development at Radisson.
2. Applicability of the option to other developments.
3. Preliminary justification as to the potential energy savings and cost/benefit of an option.
4. Further studies required for evaluation of energy sources' availability; development of systems' design and implementation.

Utility systems options derived from these studies are described later in this section of the report.

Project Evaluation

Upon review of the case study project, the Radisson Team offers the following evaluation of the case study.

1. Technical Team Composition

Under the initial contract proposal, the technical team was envisioned as primarily responsible for development of the energy conserving plans. The Niagara Mohawk Power Corporation's role was seen as primarily advisory. During the course of project development, however, the utility began to play more active roles. As increased emphasis was placed on energy systems, the technical expertise of the utility company became essential. In terms of both an exhaustive knowledge of the "State of the Art" of utility systems design and a thorough knowledge of load demand factors in the Central New York area, Niagara Mohawk was uniquely qualified to offer services to the project. In addition, the utility company could offer a working knowledge of the Radisson New Community in terms of its physical characteristics and existing utility infrastructure. During the course of project development, as an increased emphasis was placed on energy systems, the utility company began to assume an active role in identification of utility systems options. By the time of project completion, the Niagara Mohawk Power Corporation had assumed full responsibility for identification and analysis of utility systems options for the residential study site. During this period of time, the Research and Development branch of the utility company had assigned one individual as project coordinator, made company staff available to the project and independently financed a preliminary proposal for further study. In retrospect, based on the changes in project emphasis and the expertise offered by the Niagara Mohawk Power corporation, the Radisson Study Team would have initiated the project with the power corporation as a key technical team member with major responsibility for the identification and analysis of utility systems options.

2. Energy Simulation Techniques

Due to the limited capacity of computer models to account for the effects of climate modification on space conditioning requirements, the Radisson Study Team would place greater reliance on hand calculation techniques and qualitative analysis.

Based on discussions with other project teams during the Department of Energy Workshop, the Radisson Study Team feels that identification of a simulation model for evaluation of the climate impacts would have been desirable. A joint endeavor by all case study participants to develop a simulation model would have facilitated quantification of plans and eliminated duplication of efforts.

3. Project Review

The second Department of Energy Workshop resulted in changes in project approach for many of the study teams. While this workshop was valuable for all participants in terms of project clarification, the timing of this workshop, at a midpoint in the case study project, did restrict the ability of study participants to undertake further investigations of site energy sources and systems options. This restriction was primarily due to factors of time and budget.

In retrospect, the Radisson Study Team feels that earlier clarification of these issues, as well as a more constant exchange of information among the five study teams, would have benefited all case study participants.

TECHNICAL ISSUES

Technical issues discussed in this section are data gathering and energy consumption and simulation models. Task assignments in both areas were based on technical expertise of team members.

DATA GATHERING

The major focus of data collection was to inventory the following data:

1. Climatological data
2. Site and project planning data
3. Building design data
4. Site energy resources data

The following discussion will identify methodology for data gathering and analysis in the areas listed above. Options considerations related to this data will be presented later in this section of the report; existing characteristics data is documented in Sections 1 & 2.

I. Climatological Data

The study team's climatological consultants were requested to examine and evaluate the climatological and topographic aspects of the area to determine their potential impact on land planning and design. The consultants also identified options for modification of climatological factors and potential energy sources related to on site and micro meteorological conditions.

Initial methodology proposed for gathering climate data required the use of portable monitoring stations with strip chart recording for a twelve month period. Due to project schedule limitations, a qualitative assessment technique was employed whereby micro meteorological data for the case study sites was deduced from historical records of meteorological conditions in the Syracuse, New York area. Procedures for data collection analysis were as follows:

- a. Data Collection: Climatological studies were based on long term data recorded at Syracuse, New York for the following parameters: wind, speed and direction, solar radiation, cloud cover, sunshine, precipitation, snowfall and snow cover. These records were compiled mainly by the Environmental Data Service and the National Weather Service and are available through the National Climatic Center in Asheville, N.C..

Background for climatological applications to site planning was obtained from various sources pertaining to applied climatology and microclimatology. Information related to the onsite subsurface conditions was obtained from data presented by Reimann.Buechner Partner-

ship, and O'Brien & Gere Engineers, as well as onsite evaluations. A complete listing of sources is compiled in the bibliography.

- b. Analysis: The approach taken toward presentation and analysis of climate data was based on the following parameters: (1) The climate of an area is dependent on a number of factors. These include latitude, elevation and proximity to large bodies of water; (2) within an area local differences in climate can also result from changes in topography and vegetation.

To derive a site specific climatology for the O3 and P areas within Radisson, the large-scale or macro-meteorological factors were examined first. In the absence of onsite measurements, micrometeorological principles were then applied to qualitatively estimate the smaller scale characteristics, as identified on the accompanying outline.

CLIMATE AND SITE

Macrometeorology (dominant)	Micrometeorology (modified)
<u>Elements</u>	<u>Modifications</u>
1. Wind speed and direction- prevailing monthly and annual wind speed and direction and frequency of occurrence.	a) Topographical effects - cold air drainage into valleys; seasonal slope exposure. b) Vegetation Effects - reduction of wind speed; change of direc- tion; alteration of flow by cre- ation of pressure and suction zones.
2. Snowfall - Great Lakes effect and increase in elevation from the lake inland.	a) Topographical Effects - increase in accumulation on lee side of slope; duration of snow cover depending on insulation of slope. b) Wind direction and vegetation- determination of areas where snow will likely drift and accu- mulate; modifications of vegeta- tion to control drifting and pile up of snow.

3. Sunshine -
Cloudiness
Solar Radiation

- a) Topographical Effects - orographic clouds; * differences in insolation on slopes depending on location and season.
- b) Vegetation - shading; differences in absorption and reflection properties.
- c) Surface Cover - color of soils and type of covering determine amount of radiation absorption; tar, concrete, stone result in high afternoon temperatures; woods and grassland moderate afternoon temperatures but can cause colder night-time minima.
- d) Lakes Effect - increase moisture available for cloud formation and reduction of radiation transmittance.

4. Temperature

- a) Topographical Effects - cooling effect of higher elevations and rivers; cold air drainage into valleys; definition of "cold-pocket" areas.
- b) Vegetation - shading; cooling through evapotranspiration.

5. Heating Degree Days

and

Cooling Degree Days

- a) may be underestimations due to winds and draughts.
- b) may be overestimations on sunny days due to increased absorption of radiation by buildings.

6. Precipitation

- a) differences due to type of vegetative canopy.

*Orthographic Cloud: "Any cloud whose existence or form are largely controlled by the disturbed flow of air over and around mountains, as the banner cloud." (Random House Dictionary of the English Language, 1966).

II. Site and Project Planning Data

Site and project data inventory included collection of the following data, employing both literature search and direct contact.

Planning Reports and Studies:

1. Final New Community Master Plan, 1971.
2. Revised New Community Master Plan, 1978-1979.
3. Housing Market Analysis for Radisson, 1977.
4. Comprehensive Soils and Engineering Reports, 1971.
5. Engineering Study and Report District Heating System, 1972.
6. Radisson Development Guidelines, Site Vocabulary

Codes and Regulations:

1. Town of Lysander Zoning Regulations.
2. New York State Environmental Quality Regulations.

Design Base Data:

1. Existing Conditions Maps, Surveys and Air Photos
2. Site Development Programs
3. Building Types

Ongoing Projects:

1. Schlitz Brewery Waste Disposal Systems
2. Radisson Gas Well Studies

III. Building Design Data

A "State of the Art" inventory of building design was compiled by means of literature survey and personal contact. In addition, building design data identified by the project manager and at the Department of Energy Sand Workshops was reviewed. The data resources compiled through this procedure are described below. This data provided the major architectural input into site planning and energy and cost analysis.

1. Building type concept and design criteria inventory: a summary analysis of architectural planning and design concepts for residential and retail building types.
2. Energy conservation criteria and systems list:
An architectural inventory categorized according to the following components:

- Solar energy systems
- Siting criteria
- Interior space planning criteria
- Insulatory systems
- Wall systems
- Floor and ceiling systems
- Roof and attic systems
- Lighting systems
- HVAC and other life support systems
- Vertical transportation systems

And evaluated according to the following system:

- ○ Low suitability
- ● Medium Suitability
- ● High suitability
- NA Not applicable
- * Active system

3. Technical supplement to energy conservation systems in building design: A detailed supplement describing and evaluating conservation systems in building design.
4. Bibliography of relevant sources and materials: A reference bibliography on building design and systems, subject referenced to all building options data documented for the project.
5. Summary of key sources and personal contacts: A representative sampling of building design data is contained in the appendix to this report.

In addition to the "State of the Art" data identified above, architectural consultants were also requested to compile site specific building data to be utilized for conceptual design. The following data sources were compiled through this procedure:

1. Developer Guidelines: Analysis of existing developer building types in use at Radisson to identify architectural systems, space planning or building modifications to increase the energy efficiency of building types. Considerations included wall, ceiling and roof insulation, fenestration, location of garages, etc..
2. Conceptual Building Types: Conceptual multi-family and commercial building plans were developed based on program requirements, existing development character and existing climatic conditions.

IV. Site Energy Resources Data

The following data on site energy resources was gathered through literature search and personal contact, and was used for both identification and evaluation of site energy systems options.

- a. Wind Power: Niagara Mohawk, in an energy conservation re-search program, concluded that the wind power capabilities for large scale usage was limited by the availability of relatively constant winds with speeds greater than 20 mph. The accompanying figure provides estimates of available wind power throughout the U.S.. The patterns do not show how much power can be extracted from the wind, but provide useful information in determining where wind power projects could be useful. The actual amount of power extracted will depend on system design.

AVAILABLE WIND POWER - ANNUAL AVERAGE

SOURCE: WEATHERWISE, DECEMBER 1974

PLATE 27.

- b. Solar Heating Systems: Solar heating systems are becoming of increasing interest as an alternative energy source because of the "unlimited" supply and low operating cost after the initial capital investment. The question has been raised whether this would be a viable alternative to energy usage in the Radisson area.

According to the National Solar Heating and Cooling Information Center, both active and passive solar heating systems can be set up almost anywhere in the country provided that a good southern exposure is available and that protective landscaping be set up to guard against cold winds, especially for passive systems.

However, as previously discussed, Syracuse receives only about one-third of possible sunshine during the winter months and approximately two-thirds during the warm months (U.S.D.C., 1976). Studies done in this area by Niagara Mohawk for load forecasting reflect these facts in their conclusions: "The climate in the area is among the most unfavorable in the country for the application of solar heating. Persistent cloudiness through much of the heating season limits the amount of solar energy available for conversion. The lack of sunshine seriously damages the economics of solar energy." Solar energy is available in limited quantities, but its extraction will depend on systems design.

- c. Ground Water: Background data gathered to date indicates that Radisson is generally flat to gently rolling with a total relief of 150 feet across the site.

The area receives approximately 37 inches of rain a year, approximately half of which is lost to surface runoff. In addition, snowfalls in excess of 100 inches a year can be expected to add to the total hydrologic cycle.

The bedrock immediately beneath the site consists of Silurian shales and dolomites at depths ranging from 15 feet to an excess of 40 feet. The bedrock itself has historically yielded groundwater from joints and fractures and the yields on the average have been very low.

The material overlying the bedrock of the Radisson area consists in ascending order (older to younger) of: 1) glacial till, 2) glacio-lacustrine deposits, 3) shoreline deposits, and 4) organic soils. Based on information collected during earlier site evaluations, the glacial till and glacio-lacustrine deposits were shown to yield very low quantities of water. However, along the rivers and other areas where relatively permeable sands and gravels occur, yields of 50 to 100 gpm from individual wells have been recorded (Onondaga Soils Testing, Inc., 1973). The lateral extent and capacity of these aquifers are, however, unknown at this time.

- d. Natural Gas: Radisson is located within an abandoned natural gas field. Around the year 1900, a number of gas wells were drilled within this gas field but are presently not in service. Location of some of these abandoned wells is illustrated on the accompanying drawing. The exact number, location, physical condition and potential production capacities of these wells are not fully understood at this time.

These wells were developed prior to, or very early in, 1900 and before the time that hydrofracturing (increasing of bedrock permeabilities by fracturing the bedrock with high fluid pressures) was widely utilized. In western New York, hydrofracturing of the bedrock has been shown to be successful for significantly increasing the amount of gas which can be extracted from a rejuvenated well. In some cases, doubling of the well production has been observed.

In light of the recent advances in the gas industry, it would seem reasonable to assess the potential of utilizing onsite gas as an alternate energy source. Additionally, the current guidelines for the deregulation of natural gas prices by the U.S. Government may increase the value of the gas on the Radisson site and make this an even more economic proposal.

If sufficient quantities and qualities needed for commercial production of a natural gas field are not identified, it may still prove economic to utilize onsite gas supplies to provide an on-site integrated energy system.

The following considerations should be identified in relationship to any study pertaining to development of these gas wells.

1. The wells in the site may constitute potential hazards to life and property from gas explosions that could occur either during or subsequent to construction activities in Radisson.
2. It is also possible, as with any exploration venture, that the risk of not obtaining sufficient information to reasonably assess the economic attractiveness of the wells is very large.

**GAS
WELL
LOCATOR**
RADISSON SITE

B. ENERGY ESTIMATION

Estimates of energy consumption were calculated by comparative analysis to existing development at Radisson, and by use of a load estimate model. Both types of calculations were used for the residential study site, however, due to the absence of existing commercial development at Radisson, comparative analysis could not be made for the Town Center site.

The purpose of both types of energy estimation was to identify the potential reduced load demand which could be attributed to building siting characteristics. Methodology and findings of estimates are described below.

1. Comparative Analysis

For the purpose of this analysis, the team examined approximately 186 existing single family dwelling units, developed in a 13-acre area to the south of the residential study site. The development pattern for this area, as shown on the accompanying drawing, is characterized by low density single family housing with an infrastructure of cul-de-sacs and collector streets. Units are sited to directly front on public streets. Average spacing between units is 100' side to side and 75'-100' back to back. Spacing between housing fronts is between 100'-180'. Housing in this area is heated by electricity, gas or oil with the predominate number utilizing electricity.

In an effort to establish a correlation between unit siting characteristics and heating energy consumption, the study team obtained meter reading data for existing development at Radisson. The data, made available by the Niagara Mohawk Power Corporation, identified the following data per unit:

- a. House address
- b. Heating source
- c. Bi-monthly energy use for a two-year period (October 1976-October 1978)

This data was sorted by the consulting team according to heating source and street. Average summer and winter fuel consumption was then calculated and recorded for each residence.* In reviewing this data, the decision was made to limit the analysis to 75 electrically served units for the following reasons:

- a. The greatest number of building units utilized electricity.
- b. The incidence of blocks of housing units was greatest for electricity.
- c. Comparison of consumption characteristics between different fuel sources would require conversion factors which were considered undesirable.

*Note: A copy of the meter summary is found in the "Energy Simulation Data" section of the Appendix.

Following the decision, a separate listing of housing siting characteristics was then developed identifying the following elements on a street-by-street basis:

- a. Unit location, by number
- b. Type and quality of vegetative protection (i.e. dense mature tree cover, intermediate tree cover, dense understory, vegetative cover, open site)
- c. Solar orientation (north/south, east/west)

These characteristics were identified through analysis of aerial photographs (Spring 1978) and site visits.

A comparative summary of meter reading and site characteristics data was then developed as shown on the accompanying chart. The chart identifies the following components:

- a. Street location
- b. Solar orientation aggregated according to protected vs. unprotected siting conditions
- c. Average electrical use for November through March according to kilowatt hours.

No attempt was made to eliminate high or low readings since specific data on user characteristics was not available.

Conclusions:

Analysis of mean averages for heating consumption in the sample indicate the following conclusions:

- a. Existing protected units with either north/south or east/west orientations consume 28% - 33% less energy than unprotected existing units.
- b. Statistical analysis of data verifies that wind protection is a significant factor in reduction of winter heating load, and that study data is reliable, independent of the fact that analysis of user characteristics was not a study parameter. A summary memo of the statistical analysis is contained in the Appendix to this report.
- c. Percentages of energy savings due to wind protection are comparable with State-of-the-Art data on the effects of wind sheltering on reduction of air infiltration (Princeton University; Hastings & Crenshaw; Olgyay).
- d. Field data on energy consumption has been found to have high acceptability with developers, builders, and the lay public during the project review process. Field testing should be included during the implementation phases of the project.

2. Load Estimation Model

The CLIC program, developed by the Carrier Load Information Center, was used for estimating building loads on both study sites. Separate CLIC programs are available and were used for residential and commercial structures respectively. Both programs entail use of software packages with data input to a computer by telephone. Descriptive literature and data sheets for both packages are included in the Appendix to this report. Basic features common to both programs are described below:

- a. Data Base: Both programs contain climatic data and design factors for the Syracuse region. Criteria for acceptable design parameters for building latitude, room humidity, dry and wet bulb temperatures, etc. are based on the Ashrae handbook or Carrier System Design Manual. Factor data for window, wall, roof and ceiling insulation; people and appliance loads; outdoor air and ventilation; equipment selection and heating and cooling estimates is provided in the Carrier User Instructions Handbook.
- b. Input Data: Data input to the program includes design data, unit data, building data and fuel rates, and calculated energy operational expenses.
- c. Output Data: Data output by this program is annual operating costs for heating and cooling.

Building data, as to size, construction, fenestration, was derived from the following sources:

- a. Residential building data was based on construction drawings for existing single family and townhouse units at Radisson. Buildings were selected based on the size of the unit and quality of construction which were felt to be most representative of the building types which would be constructed on the site.
- b. Commercial building data was based on schematic commercial building types developed for the Town Center. Maximum insulation factors and standard building construction were assumed. Fenestration, circulation and entranceways were provided by architectural consultants based on standard practice.

Load and operating costs obtained from this program were the basis for developing the estimates of energy savings, previously identified in this report.

Consideration should be given to the following characteristics of the CLIC program relevant to its application to this project.

1. The program is designed to identify peak load heating and cooling requirements. For this reason, the program primarily responds to factors which can optimize building design, such as changes in building insulation, orientation and glass area in new buildings, or the effect of the addition of exterior awnings or partition insulation in existing buildings.
2. The climate base for the program is derived from regional climate data. For this reason, site specific modifications of climate impacts, such as the use of windbreaks or the location of structures for wind sheltering, cannot be directly input into the program. Impacts of this nature must be related to air infiltration factors. In addition, the program does not account for the year-round effects of solar heat gain. While the program does recognize increases in summer cooling load due to solar heat gain, it does not recognize reductions in winter heating load due to solar heat gain.

After review with the Carrier Corporation's research staff and experimentation with the CLIC program, the Radisson team determined that the program should be used for identification of reduced air infiltration and winter heating load.

CONSERVATION OPTIONS

Following is a description of options considered and the methodology employed for evaluating options. Description of options includes criteria as well as technique.

Conservation options discussed are grouped according to the following categories:

1. Passive Site Options
2. Building Options
3. Utility Systems Options

PASSIVE SITE OPTIONS

Passive site options include techniques for modification of seasonal climate impacts on structures which do not require the use of hardware technology. Data gathering in this area was the responsibility of the team's architects, landscape architects and climatologists.

Major criteria for identification of passive site options was response to winter design conditions (6.678 heating degree days) affecting heating requirements and natural site features. More limited consideration was given to summer design conditions (551 cooling degree days) affecting cooling requirements. Discussion of site options is structured so as to identify the following:

1. Climatic factor: the major site factor to which an option responds.
2. Significance: the major impact which a climatic factor has on heating or cooling load.
3. Option: recommended design technique response to the climatic factor identified and its anticipated impact on heating or cooling load.

Climatic Factor: Wind

Radisson site data identifies average wind speeds of 9.9 mph ranging over a 60° arc north/northwest.

Significance:

Ashrae has identified the following significance of wind in the calculation of air infiltration:

1. Wind movement increases the infiltration of cold air through the cracks around doors and windows and even through the building materials themselves. (American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), p. 379).
2. Heat loss due to infiltration is significant because it results in both sensible heat loss (i.e., increased heat required to warm outdoor air entering by infiltration) as well as latent heat loss (i.e., heat equivalent of any moisture which must be added). (ASHRAE, p. 379).

ASHRAE also identifies the following benefits to be obtained by wind sheltering:

1. Sheltering of one building by another results in significant reductions in effective wind velocities. (ASHRAE, p. 334).
2. In low buildings, the nature of the terrain and shielding provided by adjacent structures will have a major effect on wind velocity and therefore on the relative importance of wind and temperature difference. (ASHRAE, p. 334).

Option: Orientation

Preferred wind orientation utilizes a 90° angle to prevailing winds, minimizes wall exposure to wind, creates parallel air flow, and reduces air infiltration by 59% over orientations at a 45° angle to the wind. (Maitingly & Peters, p. 36).

Option: Buffering

Studies on townhouse units indicate that buffering of the end unit by a single row of evergreen vegetation of equal height to the units and located at a distance of $1\frac{1}{2}$ -2 x the height of the unit on the windward side will almost negate the air infiltration impact. (Maitingly and Peters, p. 37).

The same buffering effect can be provided by using unit clusters to buffer one another, again siting units at a distance of $1\frac{1}{2}$ -2 times the height of the unit. (Maitingly and Peters, p. 38).

With the additional location of solid fences on the north side of attached units, reduced air infiltration rates for combined orientation and buffering in this manner has been measured up to 96% for townhouse units. Fences recommended by this study were 5.5 feet in height and 6 inches from the ground and attached to the dwelling unit. (Maitingly and Peters, p. 38).

PLATE 31.

In addition, comparative meter readings of energy consumption in single family detached residences in Syracuse have identified reduced winter heating consumption in dwelling units protected from the wind by deciduous vegetation (Center For Landscape Architectural Education & Research, pp. 1-11).

PLATE 32.

Another experiment was conducted by the Lake State Forest Experimental Station in Nebraska on two identical houses. One was fully exposed to the wind, and the other was protected by dense shrubbery. The exact fuel consumption for maintaining an indoor temperature of 70°F in each house was measured. A savings of 23% was recorded for the protected house (Olgyay, p.99).

Similar results are reported in a study conducted in South Dakota. A fully exposed electrically heated house required 443 Kwh to maintain an inside temperature of 70°F from January 17 to February 17. An identical house sheltered by a windbreak required only 270 kWh. The difference in average energy requirements for the whole winter was 33.92% (Hastings and Crenshaw 1-5).

Option: Berming

Studies done at 25° F. indicate that heat loss through a wall with eight inches of insulation is 6.5 times greater than heat loss through an uninsulated underground wall.

Studies indicate that earth berming to window sill level can reduce energy consumption by 6.6% for a rectangular house and 13.1% for a square house. Earth berming to a level of 2 feet below the roof eave resulted in a 31.7% reduction in energy use (Kroner & Haviland, pp. 4-3 and 4-4).

4.2 Earth Berming to Window Sills:
Standard Practice

Energy Savings..... 6.6%

4.3 Earth Berming to Window
Square Plan House

Energy Savings.....13.1%*

*Source: "Passive Design For
The Energy Conscious Architect",
p. 4-3.

Climatic Factor: Solar Radiation

On an annual basis, mean daily solar radiation is 300 langley's with extreme seasonal variation. Due to the significant increase of cloud cover during winter months (7.6 for the months of November-March) the area receives less than 40% of the possible sunshine. During the summer months, the cloud cover is 5.5 and the amount of possible sunshine increases to 65% (U.S.D.C., 1951). As Plate 4, Page 14 indicates, this area is among the lowest in the country in terms of the amount of solar radiation received and the total hours of sunshine (U.S.D.C., 1964).

Significance:

Syracuse receives only about one-third of possible sunshine during the winter months and approximately two-thirds during the warm months (U.S.D.C., 1976). Studies done in the area by Niagara Mohawk for load forecasting reflect these facts in their conclusions: "The climate in the area is among the most unfavorable in the country for the application of solar heating. Persistent cloudiness through much of the heating season limits the amount

of solar energy available for conversion. The lack of sunshine seriously damages the economics of solar energy." Solar energy is available in limited quantities, but its extraction will depend on systems design.

Due to the low amounts of solar radiation in the area, one of the key elements to energy conservation is utilizing the optimum housing orientation.

Option: Site Selection

The degree and the direction of terrain slopes play an important role in choosing the orientation. The least desirable slope is the northern slope because it receives the least amount of radiation in the winter. Eastern and western slopes receive maximum sunshine during the summer months and would increase cooling requirements. Southern slopes are desirable due to maximum winter sun and an early arrival of spring and a late departure of fall. In a temperate climate such as Syracuse has, the southeastern slope is the most desirable for maximum natural heating in winter and requirements for cooling in summer.

Comparative meter reading of energy consumption in single family detached residences in Syracuse have identified reduced winter energy consumption (10-14%) in dwelling units sited on southern and southeastern slopes.

TYPICAL CROSS SECTION OF WOODLAND RESERVOIR

MEASURE OF ENERGY EFFICIENCY - ORIENTATION
Woodland Reservoir

Option: Orientation

Structures should be oriented to provide the largest window area on the side of the structure where the sun exposure minimizes combined mechanical heating and cooling needs. Sunlight transmission through windows will be a net benefit on an annual basis if winter solar heat gain exceeds winter window heat loss and summer solar heat gain (Hastings and Crenshaw, p.1-21).

The average daily Btu gain per square foot of window at a latitude of 42° north dependent upon orientation is as follows:

<u>Orientation:</u>	<u>S</u>	<u>E or W</u>	<u>N</u>	
June 22	786	1026	638	BTU/sq.ft. daily
December 22	757	286	143	BTU/sq.ft. daily

(Hastings & Crenshaw, pp.1-24)

Studies on orientation have identified the following energy savings for winter heating.

Boston: (42° N latitude)

A conventional test house was calculated to require 92 million Btu per year from the heating system. By merely shifting 80 square feet of windows from the north to the south sides of the house, the heating requirement was reduced to 83 million Btu for a net savings of 9 million Btu (9.8%) (Hastings and Crenshaw, 1-27).

Based on analysis of the single factors site options available, consultants attempted to identify options for building groupings which would have the potential for incorporating the greatest number of climate response techniques. The advantages identified for this approach are as follows:

1. Development of building grouping prototypes to minimize climate impact would provide a replicable model for Radisson and other developments.
2. Prototypical building groupings would provide builders with a set plan for development with inherent potential for energy conservation.

Options developed for building groupings are as follows:

Single Family Cluster Housing:

Single family cluster housing patterns were identified as an option for energy conservation based on an analysis of the existing single family housing pattern at Radisson. This pattern which is characterized by fee simple lots on dedicated public streets, presents the following restrictions to maximum sun and wind response:

1. Siting and orientation of dwelling units is determined by street orientation, as is placement of garage and fencing. Potential for optimizing solar orientation and wind protection through manipulation of the unit is negligible.
2. Existing streetscape pattern of single family housing creates a housing pattern with unit spacing averaging 100-180' front to front on units and 75-100' back to back on units. As a result, the opportunity for creating unit to unit wind buffering is lost.
3. In spite of the fact that 90% of the existing housing at Radisson is sited in areas of heavy vegetation, only 5% of the existing housing receives wind protection from existing vegetation.

Additional support for deviation from standard subdivision layout is found in the following quotation from Sunworld:

Subdivisions are usually not designed to provide sites that are properly sun-oriented: cul de sacs of pie-shaped lots and curved streets with lots on a gridiron pattern present varied orientations, which only by accident will be south-facing. Ideally, lots should be laid out along an east-west axis. Where the topography demands otherwise, the best solution will probably be to break with the traditional lot

layout pattern and allow clustering of lots. This would permit proper orientation while also making possible the arrangement of buildings to enhance their thermal efficiency and to protect them from winter winds. (Sunworld, 1979 p.14)

The option for clustering single family detached housing has the following characteristics:

1. Clustering of houses around private auto courts off private drives permits units to be oriented for maximum solar orientation and wind protection.
2. Clustering creates a housing pattern with unit spacing averaging 40' front to front and 15'-50' side to side, so that unit to unit wind protection can be achieved.
3. On sites with areas of heavy vegetative cover, an average of 75% of the units can be buffered by existing vegetation.
4. Since increased site density is possible with clustering, costs and energy embodied in site development is reduced on a per lot basis.

The option for clustering single family attached housing has the following characteristics:

1. Clustering of attached houses along private drives permits units to be oriented for maximum solar orientation.
2. Clustering of attached houses creates a housing pattern with unit spacing averaging 40' front to front. Since housing type already has a built-in efficiency due to common walls, at least 50% of all units can achieve wind protection, even on a non-vegetated site.

PLATE 36.

DOE CASE STUDY

FOR ENERGY CONSERVATION and SITE/NEIGHBORHOOD DESIGN

PREPARED FOR:
THE UNITED STATES DEPT. OF ENERGY

CONSULTING TEAM:
THE REMAIN BUCKLEB
LANDSCAPE ARCHITECTS
BYRON BUCKLEB ARCHITECTS &
O'BRIEN & O'BRIEN ENGINEERS
DAVIS & MOORE CLIMATELOGISTS
DE HARVEY KAISER LAND USE
PLANNER
MITCHELL LIVING ENERGY
ANALYST
NAGATA KOSHIKI POWER
CONVERSION ENERGY SYSTEMS
ANALYST

DEVELOPER:
THE NEW YORK STATE URBAN
DEVELOPMENT CORPORATION

PROPOSED
SINGLE FAMILY
DETACHED
CLUSTER

BUILDING OPTIONS

Building options were considered to include techniques for modification of seasonal climatic impacts on structures, including design of buildings, insulatory and structural systems, and mechanical and HVAC systems as described below:

RESIDENTIAL BUILDING OPTIONS

Residential building options were developed in order to identify developer options for improvements to existing residential building types. These options were based on an evaluation of the strengths and weaknesses of prototypical developers' building types with respect to energy conservation criteria and a determination of optimum building orientation based on physical configuration, floor layout, and construction details.

A comparative analysis of buildings was made using an energy conservation performance matrix for each building type in relation to its orientation and siting. Four general front (or entry) elevations were assumed: north, south, east and west. Performance ratings were given for all evaluation criteria based on building and climatological data. Samples of the matrices employed and written and graphic performance summaries and recommendations for residential building types are found in Section 2, Building Design Data, Appendix.

The general conclusion indicated by the energy performance matrix evaluation was that in many instances the optimum climatic orientation of a conventional developer house would necessitate placement of a unit with front facade facing the side yard or rear yard of a lot. Such siting would not be acceptable to either the Radisson Development Office, the private developer, or the potential buyer. Such considerations enforced the option for clustering residential units and lead to the compilation of developers' guidelines. These guidelines contained in Section 2 of the Appendix provide specific recommendations to developers for improvement of the energy performance of their units.

TOWN CENTER BUILDING OPTIONS

Building design options for the Town Center include optional building modules and groupings for apartments and commercial/retail building types described below.

Building Type: Highrise Residential

Option: Double Loaded Corridor Building

Use of double vs. single loaded corridor buildings was evaluated from the point of view of efficiency and climatic fit. Summary of critical analysis of the relative advantages and disadvantages of the double loaded building type is as follows:

Pros: - Double loaded circulation is more efficient than single loaded scheme - 7 linear feet of public corridor per dwelling unit.

- 57% of all dwelling units have favorable orientations; 14% have acceptable orientations.

Cons: - Does not generally promote natural dwelling unit cross-ventilation.

- Centrally located corridor does not act as buffer to dwelling units from wind chill.
- Fewer dwelling units have optimum orientation than single loaded scheme.
- Dwelling units facing northwest winds require triple glazing and/or minimum glazing surfaces.

CONCEPT PLAN
DOUBLE LOADED CORRIDOR - HIGH RISE

To minimize negative features of double load plan, modification of floor plan is recommended, as shown below:

**MODIFIED FLOOR PLAN
DOUBLE LOADED CORRIDOR - HIGH RISE**

Option: Single Loaded Corridor Building

Critical analysis summary of single loaded corridor building with duplex dwelling units is as follows:

Pros: - Provides for natural cross-ventilation.

- Public corridor buffers wind chill.
- Minimizes potential air infiltration if oriented as shown on prototypical plan.
- Skip-stop elevator eliminates 50% of floor stops, reducing energy consumption.
- Prototypical plan minimizes or eliminates glazing surface on cold or northwest side vulnerable to wind chill.
- All active living favorably oriented to south.

Cons: - Single loaded corridor is less efficient than double loaded scheme - 16.5 linear feet of public corridor per dwelling unit; however, a duplex dwelling unit configuration, coupled with a single loaded scheme, reduces total corridor length.

- Skip-stop elevator requires duplex configuration.
- Long circulation corridor required.

Recommended modifications to counteract negative features and improve climatic advantages of building type entail modification of floor plan, fenestration and building wall as shown on the accompanying sketches.

SECTION
SINGLE LOADED CORRIDOR - HIGH RISE

**CONCEPT PLAN
SINGLE LOADED CORRIDOR - HIGH RISE**

Building Type: Commercial/Retail

General design options identified to increase the efficiency of traffic flow and climatic response of commercial/retail structures are as follows:

Traffic Systems:

- Consider utilization of energy efficient High Pressure Sodium lighting with color correction in parking areas and other site lighting applications.
- Consider energy incentive parking plan, which follows. This plan gives priority to compact and generally energy efficient automobiles.
- Utilize grass-block overflow parking to minimize need for additional asphalt paved areas.
- Consider programming of space so as to share parking wherever possible.

CONSIDER PARKING CONFIGURATION IN WHICH PRIORITY
IS GIVEN TO COMPACT AND MID-SIZE VEHICLES AS AN
EMERGENCY INCENTIVE

ENERGY - CONSERVING PARKING PLAN NOT TO SCALE

PLATE 42.

Mall Enclosure Systems:

Four systems for enclosure of pedestrian shopping mall were identified, each based on a building mass along a 30' double loading pedestrian corridor. The systems vary in terms of type and degree of overhead enclosure, from permanent overhead structure to mobile canopy systems modulated on a seasonal basis. The following recommendations were made relative to all systems:

- Incorporate double door entry vestibules which create an air lock but still provide an opportunity to utilize natural ventilation during non-severe climatic conditions.
- Orient all glazing and appropriate shading to south, southeast or southwest.
- Design service access in such a way as to avoid direct north-west winter winds.
- Utilize service and storage areas as buffers to wind chill.
- Reduce standard 18, 14 and 12 foot commercial ceiling heights to 10 feet.
- Utilize double loaded pedestrian systems.
- Provide a market flexibility for second floor office or retail use.

Critical analysis of the mall enclosure systems is as follows:

Concept #1: Enclosed Mall with Clerestory

- Pros:
- Incorporates use of natural light.
 - Second level has view to both mall and outdoors.

- Cons: - Due to site plan, passive solar heat gain would be limited to morning hours.
- Second level view is of first floor roofing, mechanical equipment and parking lot.

Concept #2: Enclosed Green House Mall

- Pros: - Maximizes use of natural light.
- Second level has view to both mall and outdoors.
- Cons: - Unwanted heat gain or loss through "Greenhouse Effect" is more difficult to control.
- Second level view is of first floor rooftop, mechanical equipment and parking lot.
- May not be cost-effective - further detailed analysis required.

Concept #3: Enclosed Mall with Skylights

- Pros: - Allows natural light to penetrate into enclosed pedestrian way.
- Minimized heat gain and loss.
- More cost-effective than Concept #2.
- Cons: - Added second level volume of enclosed space needs to be heated and cooled and serves no purpose other than physical and visual tie to upper level from lower floor.

Concept #4: Seasonally Enclosed Mall

- Pros: - Maximizes natural light and winter heat gain.
- Permits natural ventilation in summer.
- Minimizes the requirement of space conditioning of pedestrian corridor.
- Cons: - May present undesirable interior hot or cold air pocket.
- May cause uncontrollable drafts within and into the space.
- Mechanical life support systems within each retail space may be subject to additional strain.

UTILITY SYSTEMS OPTIONS

Utility systems options were identified by team climatologists, engineers and the Niagara Mohawk Power Corporation. Identification of utility systems options was based on the following factors:

1. Potential to incorporate site energy resources, as discussed in Section 5.
2. Ability of system to utilize existing hardware and technology.
3. Time frame required for implementation of the system.
4. Potential energy savings, cost/benefit and acceptability to developer.

The following discussion summarizes the scope and findings related to utility systems options for the residential and town center sites.

RESIDENTIAL SITE

Utility systems options for the residential study site were identified by the Niagara Mohawk Power Corporation. The methodology employed for this study was as follows:

1. To identify potential fuel sources for the residential study site.
2. To identify the various heating and cooling systems which could utilize these fuel sources.
3. To evaluate the respective viabilities of the various systems in order to make a determination as to which system would be most applicable to the Radisson site.

The following is an analysis of various energy systems that will produce energy recovery benefits in the Radisson New Town Development, prepared by the Niagara Mohawk Power Corporation. The energy recovery systems described are built upon, and integrated into, the energy systems hardware located in individual homes, apartments, commercial and industrial units. Recovery and reuse of energy is accomplished through the use of alternate natural sources of heating and cooling available on the New Town site and recovery of excess energy within dwelling units.

Energy recovery systems have been selected to cover the full range of possibilities, starting with recovery within individual dwelling units, cluster systems providing recovery options for several units of individual houses or apartment and commercial buildings; and central recovery systems providing benefits to every structure within the New Town Development. The systems described are based upon the use of hardware currently available in the market place. Systems have been developed from engineering practices that are now in use or that can be adapted for use in energy recovery systems.

Future study of the systems will define the economic benefits of each system and develop information that can be used to make choices between the systems that are based on sound, technical and economic feasibility.

Alternate Energy Sources

All of the systems: individual, cluster and central plant can be designed to utilize alternate energy sources. The central plant system and cluster systems offer the best opportunity for alternate energy uses. They also have significant load management potential. Alternate energy sources will allow a flexibility for the reduction of primary fuel demands. These alternate sources can also serve the project during a shortage of primary fuel. Utilization of on-site energy sources, such as the lake, river, water wells and gas wells, can be incorporated into the equipment design to reduce demand on off-site sources. An economic study is necessary to assess the impact of on-site energy sources on the financing structure of the various systems.

Central Energy Recovery Systems

The following pages describe various systems to heat-cool and provide the domestic hot water requirements of the project.

The systems have been divided into three specific categories, as follows:

Individual System	- Individual buildings will house independent heating/cooling and domestic hot water systems.

Cluster Systems

- A number of individual buildings consisting of either residential, commercial or a mixture, will have all heating/cooling and domestic water requirements provided from a centralized source located as near the center of the cluster as practical.

Central Plant Systems

- All buildings located in the community project will have their heating/cooling and domestic hot water requirements generated from a centralized source.

It is also possible to use any number of the various schemes in combination, such as a centralized plant with individual or cluster systems.

A basic heating/cooling and hot water generation system for individual buildings, consisting of separate electric, oil or gas-fired equipment has not been included. These particular systems vary widely in design and were not considered effective in terms of heat recovery.

Individual Systems

1. Heat Pump System (gas or electric fuel) for the building heating/cooling system. A supplemental electric heating coil is required to produce sufficient heating capacity whenever the outdoor temperature reaches or is lower than 30°F. Domestic hot water requirements can be partially generated using the hot gas energy normally discharged to the atmosphere. Additional domestic hot water requirements will be met using conventionally fueled hot water heaters.
2. Heat Pump System (gas or electric fuel) for the building heating/cooling system. A thermal storage tank in conjunction with solar heating panels and the heat pump hot gas discharge will provide for supplemental heating using a water coil, whenever the outdoor temperature reaches or is lower than 30°F. Domestic hot water requirements will also be generated from the heat pump hot gas and solar panels. Supplemental electric heating coils may be required in the thermal storage tank to provide sufficient energy in cases where the heating and hot water requirements exceed thermal storage capacity.
3. Heat Pump System (electric fuel) heating and cooling system. The water source heat pump would utilize well or lake water at temperatures of 50°F + as a source of thermal energy. Depending on the type of equipment utilized, recoverable heat would be used for domestic hot water heating or returned to the thermal energy source.

4. Heat Pump System, similar to that described for system type #3. However, this system would utilize solar heat panels to assist in providing energy for the domestic hot water requirements.

Cluster Systems

5. Hydronic heating/cooling system can be gas, oil or electric fueled generators. The heating system would also provide the energy necessary to generate the absorption cooling system and provide domestic hot water. Whenever the absorption cooling equipment is in operation, domestic hot water could be generated using the thermal energy normally discharged to the atmosphere.
6. Hydronic heating/cooling system as defined for system type #5, with the exception that this is an all electric system and will utilize off-peak electric to generate sufficient thermal storage capacity at temperatures sufficient to operate the absorption cooling equipment.
7. Hydronic heating/cooling system as defined for system #5, except that the system will utilize thermal storage with solar unit to defray the fueled energy requirements necessary to provide domestic hot water and/or the cooling load if sufficient temperatures can be generated to operate the absorption cooling equipment.

Variations of the cluster type system, using central heating and individual building cooling with heat pumps, is defined in System Fuel Requirements as Type 7a and 7b.

Central Heating Systems

8. Waste Incineration: These systems would minimize fuel energy requirements and may provide a possible solution to the community problem of trash disposal. In addition to an electric, gas or oil system required to ignite the trash, it may also be feasible to utilize on-site natural gas deposits or develop a source of methane gas from a sewage plant.

The basic heating system would be a high pressure steam distribution or hot water heating loop to each building in the community. Cooling and domestic hot water would be generated at each building or generated at a cluster system. Cluster systems in conjunction with centralized high pressure steam or hot water distribution would provide the maximum use of available energy.

9. Waste Incineration System is essentially the same as described for type #8 with the exception that this system would utilize thermal storage to maximize the energy recovery possible.
10. Waste Incineration System would be an extension of type #9, but would include a solar heating system to add to the thermal storage possible.

FUEL ECONOMIES THROUGH ENERGY RECOVERY

The following tabulation of fuel requirements for the various systems described earlier indicate the approximate energy savings that would accrue through the use of various energy recovery systems.

The use of water source heat pumps for individual unit systems indicates a significant reduction of energy requirements through the use of available site ground water. Hydronic heating and cooling systems, analyzed on the basis of a cluster of ten units, indicate the possibility of energy recovery through the use of absorption machines to generate partial domestic hot water requirements. Further reductions are possible by using natural ground water to reduce the power requirements of cluster systems. The recoverable energy benefits of a central plant system are shown for an assumed community size of approximately 1200 persons.

The following calculations indicate the energy reduction benefits that could result from the incorporation of an energy recovery program, within the overall design for the new community. No attempt has been made to analyze the trade-offs associated with the various systems other than energy. Future detailed studies can identify the most efficient energy recovery systems that make economic sense and could serve as a model for development of similar systems throughout the country.

FUEL REQUIREMENTS

Individual Systems

1. Heat Pump (Air to Air)

Energy required for heating	15,500 Kwh
Energy recoverable using hot gas for domestic water heating	<u>375 Kwh</u>
Total nonrecoverable heating energy required	15,125 Kwh

2. Heat Pump (Air to Air)

Energy required for heating	15,500 Kwh
Energy recoverable using hot gas for domestic water heating	375 Kwh
Energy recoverable using solar panel and thermal energy storage (90 ft ² panel area)	<u>1,200 Kwh</u>
Total nonrecoverable heating energy required	13,925 Kwh

3. Heat Pump (Ground Water)

Energy required for heating	9,500 Kwh
Thermal storage system using domestic hot water heater to increase C.O.P. No recoverable energy	<u>-</u>
Total heating energy required	9,500 Kwh

4. Heat Pump (Ground Water)

Energy required for heating	9,500 Kwh
Thermal storage system using domestic hot water heater and solar panels to increase C.O.P. Recoverable energy	<u>1,200 Kwh</u>
Total nonrecoverable heating energy required	8,300 Kwh

Cluster Systems (Assumed at 10 Individual Units)

5. Hydronic Heating/Cooling System

Energy Totals
Per Dwelling Unit

Energy required for heating:

Electric	200,000 Kwh	(20,000 Kwh)
Gas	1,330,000 FT ³	(133,000 FT ³)
Oil	10,550 Gal.	(1,055 Gal.)

Energy recoverable from using
absorption machine to ge-
nerate partial domestic hot
water requirements.

22,800 Kwh
77,780 FT ³ Gas
540 Gal. Oil

Total nonrecoverable
heating energy required.

177,200 Kwh	(17,720 Kwh)
1,252,220 FT ³ Gas	(125,222 FT ³)
9,495 Gal.	(950 Gal.)

6. Hydronic Heating/Cooling System

Energy required for heating	200,000 Kwh	(20,000 Kwh)
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Energy recoverable from
using absorption machine (or
centrifugal chiller) to ge-
nerate partial domestic hot
water requirements.

22,800 Kwh	(2,280 Kwh)
------------	-------------

Thermal storage to shift de-
mand peak will not reduce
energy requirement.

—

—

Total nonrecoverable
heating energy required.

177,200 Kwh	(17,720 Kwh)
-------------	--------------

7. Hydronic Heating/Cooling System

Energy required for heating:

Electric	200,000 Kwh	(20,000 Kwh)
Gas	1,330,000 FT ³	(133,000 FT ³)
Oil	10,550 Gal.	(1,055 Gal.)

Energy recoverable from using
absorption machine to ge-
nerate partial domestic hot
water requirements.

22,800 Kwh
77,780 FT ³ Gas
540 Gal. Oil

Energy recoverable using
solar panels & thermal
energy storage(1800' ² panel)

25,300 Kwh
86,000 FT ³ Gas
600 Gal. Oil

(Cont'd)

Energy Totals
Per Dwelling Unit

Total nonrecoverable heating energy required.	151,900 Kwh	(15,190 Kwh)
	1,166,220 FT ³ Gas	(116,622 FT ³)
	9,410 Gal. Oil	(941 Gal. Oil)

7a. Central Hydronic Heating - Individual Heat Pump Units (Water to Air):
90° Water.

Energy required for heating:

Electric	200,000 Kwh
Gas	1,330,000 FT ³ Gas
Oil	10,550 Gal. Oil

Energy recoverable from
compressor operation
of individual units.

30,000 Kwh
200,000 FT ³ Gas
1,580 Gal. Oil

Energy recoverable using
solar panels and thermal
storage. (1800' ² panel)

25,300 Kwh
86,000 FT ³ Gas
600 Gal. Oil

Total nonrecoverable
heating energy
required.

144,700 Kwh	(14,470 Kwh)
1,044,000 FT ³ Gas	(104,400 FT ³ Gas)
8,370 Gal. Oil	(837 Gal. Oil)

Multiple Cluster System

7b. Central Hydronic Heating

Individual Heat Pumps (Water Source)
Water loop temperature maintained at 50° F₊.

Energy requirement per dwelling. 20,000 Kwh/yr.

Heat pump energy required per dwelling heating system. 9,500 Kwh/yr.

Required energy make-up per dwelling. 10,500 Kwh/yr.

Additional community energy requirements for heating using 50 dwelling units as a base = 10,500 x 50 = 525,000 Kwh/yr.

Recovery Options

1. Recoverable energy from waste incineration plant:
(Refer to Item #8) = 6.3 Kwh/day/person.

50 Dwelling units at 4 persons/dwelling unit = 200 people.
200 people x 6.3 Kwh/day x 365 = 459,900 Kwh/year.

Total community heating requirements = 20,000 x 50 = 1,000,000 Kwh/year.

Recoverable Heat = 459,000 Kwh/year
(9,000 Kwh/yr./dwelling unit)

Assuming no thermal losses, possible energy recovery using water source heat pump with waste incineration is 46% of total community requirements.

2. Waste water
3. Solar
4. Ground water
5. Transformer losses

Central Plant System Options

8. Waste Incineration:

Assumed Planned Community of

142 Multi-family units x 4 persons	568
124 Single Family units x 4 persons	496
100 Townhouses x 2 persons	<u>200</u>

Total assumed community population 1,264 persons

Average waste generation per person per day = 6#

Average fuel value per pound waste = 6500 Btu/#

Total Refuse Available for Incineration (1264 x 6) = 7584#/day

Gross heat generation (7584 x 6500) = 49,296,000 Btu/day

Net heat recoverable = Gross - 10% loss x 60%

efficiency = 27,220,000 Btu/day

Recoverable energy with waste incineration plant = (27,220,000/1,264) =
21,535 Btu/day/person
6.3 Kwh/day person
21.5 FT³ Gas/day/person
.15 Gal fuel oil/day/person

9. Waste Incineration - With Thermal Storage

Based on community size indicated above, and assuming a cooling requirement of .86 ton/hour/person, cooling requirements = $(.86 \times 1264) = 1,087$ tons

Heat requirements for cooling = $18\#/hr/steam \text{ per ton} = (18 \times 1087) = 19,566\#/Hr.$

$19,566\#/hr \times 960 \text{ Btu}\# = 18,783,360 \text{ Btu/hour}.$

Actual operating hours will vary depending on load. However, assuming 24-hour operation, total requirements = $18,783,360 \times 24 = 450,800,640 \text{ Btu/day}.$

Recoverable energy = $49,296,000 \text{ Btu/day} = 11\%$ of requirements.

Assumed recoverable heat with thermal storage would approach 27% of requirements for cooling. Recoverable energy for the heating system would vary with system design.

10. Waste Incineration with Thermal Storage and Solar Panels

Would be as indicated in #8 and #9 above. Heat recovery from solar panels would vary with panel area but could reasonably provide an additional 8% of total heating/cooling and domestic water requirements.

11. Several other options can be considered, such as local gas wells, industrial waste heat, etc..

TOWN CENTER SITE

A conceptual utility system capable of replacing a conventional system has been developed for the Town Center. The system as illustrated on the accompanying diagram utilizes existing natural gas and ground water on site to supply heating and cooling and electrical needs.

Estimated construction costs for the integrated system are as follows:

Gas Engine Driven Generators	\$ 900,000
Exhaust Heat Exchanger	5,000
Storage Heat	100,000
H.W. Pump	25,000
Grd Water Wells (2)	10,000
Grd Water Pump	25,000
Chilled Water Ht. Exchanger	5,000
Chilled Water Pump	25,000
Gas Well	5,000
System Pump	50,000
Piping	50,000
Controls	200,000
Paralleling Equipment (Elect)	200,000
Building 7500ft ² x \$24/ft ²	200,000
Gas Well Development	1,000,000
Gas Compression Station	200,000
	<hr/>
	\$3,000,000

The annual cost of operating this system based on amortizing the construction costs identified above and annual operating and maintenance is as follows:

Amortization @ 7% over 20 years

Annual cost = \$3,000,000 x .094 = 280,000/year

Operation & Maintenance = 100,000/year
TOTAL = 380,000/year

The annual cost of a conventional system to serve the Town Center development is \$400,000. This cost is based on energy costs of 5¢ per kwh and assumes a fuel requirement of 50 kwh to 55 kwh /sq.ft./year.

Investigations to date indicate it is unlikely, with the cost of energy today, that anything but the conventional energy system would be designated and installed in the 144,000 sq. ft. Town Center. However, residential facilities including 350 dwelling units are also planned for the

**RADISSON TOWN CENTER
INTEGRATED UTILITY SYSTEM
SCHEMATIC DIAGRAM**

Town Center area which have the potential to make it cost effective even in view of the low cost of today's energy to provide an integrated utility system for this section of Radisson.

Although estimates of energy savings have not been prepared for the proposed integrated system, a preliminary literature search has found numerous studies, final designs and demonstration projects in all areas of the country, each indicating an integrated utility system has the potential for substantial cost savings over conventional design techniques. One study reviewed identified the potential for a 46% energy savings utilizing an integrated utility approach. This particular approach utilized co-generation techniques with diesel engine driven generators.

IMPEDIMENTS TO IMPLEMENTATION

CHAPTER 6

The following section summarizes impediments which effect implementation of passive energy plans which have been developed, and the utility systems options which have been identified for the residential and town center study sites.

RESIDENTIAL SITE

Passive Plan

Impediments to the implementation of the residential energy plan primarily pertain to single family clustering and are as follows:

1. Ownership and maintenance of roads and utilities:

Under the proposed clustering scheme, all utilities would be located in a Right-of-Way easement. Repair of utilities, which is the responsibility of individual home owners in conventional development, would now become the joint responsibility of all residents on a cluster. Snow plowing and road maintenance, which is ordinarily the responsibility of the Town of Lysander, would also become the joint responsibility of all residents on a cluster.

Comparison of road surface and length of utility to be maintained on a four-house cluster indicates that it is comparable to overall maintenance of four conventional single family houses on fee simple lots.

Impediments identified through meetings with U.D.C., the Town of Lysander Planning Board and Radisson residents and builders are as follows:

- a. Residents in cluster developments would still be assessed for taxes for road repair and maintenance in the same manner as owners of housing fronting on dedicated public streets.
- b. Residents in cluster housing would be required to enter into a maintenance agreement at the time of purchase of their home.

2. Development Guidelines and Controls:

At present, builders at Radisson purchase land developed by U.D.C. and are subject to guidelines restricting building setback, materials, color, facade alignment, site fencing and planting. These guidelines were established primarily for visual control. If the energy conserving benefits of cluster planning, in terms of climate response, are to be achieved, Radisson must develop builder guidelines to ensure that buildings are sited for sun and wind response as planned.

Since Radisson desires to apply principles of passive site planning to future residential development, guidelines developed would be utilized for future development.

In addition to guidelines, a method of control must be established in order to guarantee that units as built can achieve the potential energy savings indicated. This type of control is particularly necessary to provide potential purchasers of new homes with a means of assessing claims of energy efficiency.

3. Public Awareness and Marketability:

Due to the fact that cluster housing patterns are not currently used in the Central New York area, an educational effort must be made to inform consumers of the advantages of the benefits (cost, environmental and energy) to be realized by cluster housing.

Sampling of Radisson residents indicates that data as to actual energy savings of housing units is required before cluster housing can be marketed as energy conserving. It is assumed that a one-year monitoring use, relative to siting conditions, would be required to obtain this data.

4. Efficient of Conventional Utility Distribution

Under existing regulatory constraints, utilities are required to be placed in public right-of-way. Under standard electrical design for single family residences, (see Plate 50) primary electrical line follows the public right-of-way and drops off at transformers which feed across the road to houses in a secondary system. When applied to eight prototypical residences, this system would require 400 lineal feet of primary distribution (156 ft/d.u.) and 540 feet of secondary (67 ft/d.u.). Extending this to 48 houses, which is what one feeder would normally supply in an electrically heated development of 76 to 80 amps, the line losses amount to 23.5 Kwh/year, or \$940/year based on 4¢/Kwh electricity. This averages out to \$19.60 per house. The customer does not see this cost except as indirectly reflected on all utility bills. However, it is a real energy cost to the system.

PLATE 44.

In order to service cluster housing under existing constraints, the utility company has identified the need to loop in and out of each cluster group—increasing the length of primary line to 850 feet or 106 feet per dwelling unit (see Plate 45). The line losses in this system amount to 48 Mwh/yr. which is approximately \$1,920 or \$40 per dwelling unit. The additional energy used annually under this distribution system would be sufficient to produce free service to one of the forty-eight conventionally served houses.

PLATE 45.

In light of the undesirable line loss entailed in the servicing scheme identified above, an alternative servicing scheme for cluster housing using utility easements has been proposed (see Plate 46). This scheme results in the same distribution pattern and line requirements as the conventional pattern. In fact, tightening of clusters is likely to reduce line requirements over conventional patterns.

CLUSTER HOUSING WITH
SPECIAL EASEMENT

Plate 46

The following steps are required to insure that cluster housing can be implemented with efficient distribution patterns.

1. Meetings with the Public Service Commission and Niagara Mohawk Power Corporation are required in order to establish special utility easements.
2. Design development of cluster housing is required in order to produce the tightest pattern possible for reduction of line loss and to insure year round service accessibility to transformers.

Utility Systems Options:

The Niagara Mohawk Power Corporation has provided the services of its Research and Development Department since the inception of this project. At present, Niagara Mohawk has proposed a two-phased assessment of a community based energy system for space heating and cooling equipment, as well as selected individual heating and cooling systems.

This assessment would entail detailed investigation of the options for individual, cluster and central plant systems identified in Section 5 of this report. The assessment would build on-site and design data developed under the case study and would include detailed on-site investigation of energy sources.

Niagara Mohawk's attitude toward development of energy systems at Radisson is expressed as follows:

"Utilities have in recent years become increasingly attracted to the load management potential of certain customer loads. Time of Day or Time of Use rates are emerging in several parts of the country. Real time control is felt by most to be essential to meaningful implementation of customer load management. Hardware is now offered by several manufacturers for providing this type of control, however there are implementation problems. There are not enough controllable loads to make broad based installation attractive, consequently, the coordinating effort necessary for installing the control hardware, and insuring that there would be enough load to be attractive would be monumental."

"Community based thermal plants could provide a very attractive load management tool while still offering the customer an attractive energy conserving tool."

At present, the major impediment to development of community utility systems for the residential site is the need for further study of the cost benefit and feasibility of systems options identified to date.

TOWN CENTER

Passive Plan

Impediments to the implementation of the Town Center Energy Plan pertain primarily to the following marketing and development concerns:

1. Developer Commitment and Guidelines:

At the present time, Radisson does not have the commitment of a commercial developer for the entire Town Center site. Due to the flexibility

for phasing which has been incorporated into commercial development, it is most likely that commercial development will be implemented in stages by a group of developers. In order to ensure that the objectives of climate response incorporated into the energy plan are implemented, Radisson must develop building guidelines for the Town Center. Such guidelines would control building orientation, spacing and facade controls so as to insure that wind sheltering, solar access and shading would be incorporated into the plan as built.

2, Parking Requirements:

Under present zoning, the Town Center must conform to parking requirements of a regional shopping center (1 car per 100 sq. ft.). The increased surface parking area required by these standards increases development and maintenance costs and associated energy use.

Modification of parking requirements to meet the following standards could offer an inducement to potential developers through cost savings and reduce energy use for site maintenance:

- a. In operational practice and hence for development planning purposes, where there is virtually no walk-in trade nor public transit usage, the provision of 5.5 car parking spaces per thousand square feet of gross leasable area is adequate as a standard to meet the demand for parking space at shopping centers. This standard accommodates the need for parking spaces at shopping centers for all but the ten high hours of demand during an entire year. These ten highest hours occur during the three peak days of the year. It is uneconomic to provide parking spaces for such limited peak demands.
- b. As found in zoning ordinances at present, most of the regulations for shopping center parking call for a substantially greater amount of parking spaces than are found to be necessary in actual practice.

The findings lead to the following general conclusions: off-street parking needs have been overestimated by shopping center developers, lenders, and tenants; similarly, off-street parking requirements being asked for are excessive in many zoning ordinances.

Accordingly, for shopping centers of all sizes it is recommended that a standard of 5.5 parking spaces per thousand square feet of gross leasable area be established generally.

Integrated System Option

Project engineers have identified an integrated utility system concept for the Town Center. As indicated earlier, the proposed system would utilize existing natural gas and industrial waste heat sources on site.

Major impediments to the implementation of the utility system are as follows:

1. Investigations to date indicate that it is unlikely with the cost of energy today that anything but a conventional energy system would be designed and installed to serve the proposed commercial development of 144,000 square feet. While inclusion of a 350-unit residential development proposed for the Town Center would make an integrated system cost effective, it is unlikely that these units would be built earlier than 1985.

In addition, further engineering studies are required for the following:

- a. Investigation of the availability, quality and cost of development of natural gas, waste heat and other potential energy sources.
- b. Analysis of the feasibility and cost of energy storage systems and the potential environmental impact of such storage systems.

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IMPLEMENTATION PROGRAM

CHAPTER 7

RESIDENTIAL STUDY SITE

Radisson is currently in the process of implementing the portion of Energy Plan 2 developed for the 0/3 Parcel of the Residential Study Site. The site will be developed as shown on Plate 47 and will include 55 single family detached dwelling units on fee simple lots, with a total of 33 single family dwelling units in 5 cluster arrangements.

Radisson's designs and construction schedule for plan implementation is as follows:

November 1979	Site Design	Conceptual
February 1980	Site Design	Profiles and Soils
May 1980	Site Design	Final
June 1980	Construction	Bidding
July 1980	Construction	Buildings
July 1980	Construction	Utilities
August 1980	Construction	Completion

As part of their implementation program, the Radisson Development Office has undertaken the following activities.

1. Radisson has held extensive meetings and discussions with the mortgage bankers in Onondaga County in regard to the proposed cluster housing. To date, the cluster housing concept has been resisted by the local banking community. Indications are that resistance is based on the novelty of the concept and a basic conservatism in the Syracuse area. However, based on previous experience, Radisson is confident that the concept will gain local acceptance.
2. Lot descriptions have been developed for all building sites; however, the issue of maintenance of and responsibility for utilities and private drives in housing clusters has yet to be resolved. This issue is currently under study by Radisson's attorneys.
3. Radisson is recommending that private developers utilize the guidelines for building orientation and siting recommended in this report. However, no controls will be exercised by Radisson during construction.

In addition to implementation of the Residential Energy Plan 2, Radisson is participating in a study with the Niagara Mohawk Power Corporation of utility system alternatives for the 0/3 Site.

This study was conceived and proposed during the Case Study Project. The purpose of this study is to evaluate the cost feasibility for employing an advanced heat pump system at Radisson, augmented by waste heat and other energy sources locally available.

The resulting energy use would be at least 30 percent less than air-to-air heat pumps would require, 55 percent less than electric baseboard heating, and 50 percent less than conventional oil-fired boilers.

Alternative solutions will be analyzed and the most promising incorporated in a controlled experiment at Radisson. Later phases of the three-year project will enable several homes to take advantage not only of a cheaper heat source but larger, shared mechanical equipment.

In particular, the study will see if water source heat pumps using individual wells, common wells or river or lake water can supplement fossil fuel.

Standard heat pumps operate using outdoor air. This experiment will attempt to extract heat or cold from water, depending on the season, to demonstrate the commercial feasibility of such pumps. Water generally is warmer than air in winter and colder than air in summer.

The researchers also will study other possible methods of increasing the heat content of water circulated by heat pumps by capturing low-grade heat sources within the community. In Radisson's case this could include industrial waste heat, methane gas found on the site, wood, solid waste, or other local resources.

The Radisson/Niagara Mohawk study will be completed and implemented within Radisson's construction schedule identified previously.

Data which has already been compiled by study participants is currently under review and analysis by Arthur D. Little Incorporated and is as follows:

Niagara Mohawk Power Corporation:

1. Energy consumption by building type, size, design loads, and system type.
2. Electrical, natural gas, and oil costs.
3. Available rates.
4. Escalation factors for electric and gas.

New York State ERDA:

1. Escalation factors for oil.
2. General hydro-geological data (regional).

New York State Urban Development Corporation:

1. House Plans and site design.
2. Model homes with full design criteria.
3. Available - subsurface data (local vicinity), well data, maps and profiles.
4. Available hydro-geological data (geological, piezometric and aquifer identification).

Carrier Corporation and Argonne National Laboratory

1. Weather tapes.

The Radisson Development Office does intend to market the 0/3 Residential parcel as an energy conserving community in terms of its passive and utility system options. Marketing data and energy savings data will be prepared during the 1980 construction period. Project updates and further information on implementation will be available through the Radisson Development Office and the Niagara Mohawk Power Corporation.

TOWN CENTER STUDY SITE

Although immediate implementation of the Town Center Plan is not anticipated, the following implementation program is identified for the time at which a developer commitment is obtained. The discussion deals with the development of both the passive energy plan and utility systems options.

PASSIVE PLAN

1. Design Development of All Building Types

As identified earlier, conceptual building types have been used in all plan development to date. In light of the extensive effort made to maximize potential direct solar gain in all building types, detailed architectural design studies would be required to ensure that placement and insulation of glazing and building design (e.g. form, overhangs, height, material and insulation) would permit maximum direct heat gain and minimum heat loss. In addition, more detailed design studies would be required to reduce the amount of surface wall exposure in the commercial/retail complex. The purpose of these studies would be to insure maximum reduction of winter heating load. Load data based on improved passive building design would be used to determine if sizing of HVAC systems could be reduced.

In addition, more detailed studies would be made of the energy implications and cost/benefit of the reduction of vertical transportation systems through the use of garden apartments and the use of skip stop elevators and single loaded corridor buildings in high rise residential structures.

2. Design Development of Site Plan

Site planning features of the "Energy Conserving Plan" capitalize on existing site topography and vegetation for insulation and wind sheltering of structures and for shading of paved surfaces. The following detailed studies are required to insure that the plan as built incorporates these features.

a. Detailed Grading:

The "Energy Conserving Plan" utilizes existing topography to insulate the northwest surface wall of the first story commercial development. "State of the Art" data has identified potential reduction of heating loads of up to 13% for first story berming (Reimann.Buechner Partnership, p. 89). More detailed studies of topographic relations and soil characteristics are required to determine the feasibility of this approach.

b. Preservation of Vegetation:

The Energy Conserving Plan preserves 80% of the existing vegetation on site. Shading studies indicate that preservation of existing vegetation, which is primarily deciduous, permits shading of 43% of the total commercial surface parking area (ten acres) and 30% of the total residential surface parking area (5 acres). Due to the fact that the majority of parking is on the south side of structures and in close proximity to building surface wall and glazing, shading of paved surfaces should substantially reduce summer heat gain. More detailed studies of the location and grade elevation of existing vegetation in relation to proposed building and parking grade elevations are required in order to ensure that vegetation is preserved.

3. Monitoring and Cost/Benefit Analysis.

Due to the difficulties encountered to date in quantifying the potential load reduction due to climatic response monitoring of the project as built is considered desirable. Base load data would be derived from calculation of load requirements based on building design, mechanical systems and internal heat gain factors. This data would be compared against actual building performance over a one year period.

In addition detailed cost data for site and building construction would be developed as to the actual cost savings or increase for passive design versus conventional development. Cost data would be evaluated in relation to operating costs to establish cost/benefit.

INTEGRATED UTILITY OPTION

As identified previously in this report, an integrated utility system can be developed at Radisson utilizing on site waste heat and natural gas. The following discussion identifies factors which are likely to effect the implementation of such a system and procedures required to develop the system at Radisson.

1. Factors Effecting Implementation

The proposed integrated system relies on the use of industrial waste heat and existing natural gas on site as fuel sources. Identification of the quality and availability of these sources and the time and cost required for utilizing them directly effect the feasibility of developing an integrated system.

2. Procedures Required for Implementation

The following procedures have been identified as necessary for development of an integrated system for the Town Center at Radisson.

- a. Investigation of sources of energy paying particular attention to industrial waste heat, solar and on-site natural gas. Estimate load capabilities of available sources, compare sources on a cost effective basis.
- b. Investigation of seasonal or long term energy storage techniques, such as Aquifer, man-made and chemical, develop costs for storage and transmission facilities and compare alternatives on cost effective basis.
- c. Development of control system and strategies to maximize efficiency of the overall system including math modeling, micro processing and metering.
- d. Preparation of basis of system design and provision of preliminary design in sufficient detail to form the basis for the final design and financing for the recommended facilities.