RENEWABLE ENERGY OPPORTUNITY ASSESSMENT

U. S. Environmental Protection Agency
National Computer Center
Research Triangle Park, NC

A study by the
National Renewable Energy Laboratory
US Department of Energy Federal Energy Management Program

This study funded by:
US EPA Facilities Management and Services Division
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INTRODUCTION

Presently, the US EPA is constructing a new complex at Research Triangle Park, North Carolina to consolidate its research operations in the Raleigh-Durham area. The National Computer Center (NCC) is currently in the design process and is planned for construction as part of this complex. The total floor area for the offices and computer center is approximately 110,000 square feet. The intended occupancy is 280 full-time staff. Integration of renewable technologies in new construction has the potential for realizing much more favorable economic benefits than in a retrofit situation. Implementation of the new technologies can be planned as part of the normal construction process, and full credit for elimination of the conventional technologies can be taken. Several renewable technologies are specified in the current plans for the buildings.

The objective of this study is to identify measures that are likely to be both technically and economically feasible. A Savings-to-Investment Ratio (SIR) of greater than 1.0 indicates cost effectiveness according to 10CFR436. Consistent with 10CFR436, the discount rate and fuel escalation rates used in the analysis are those specified for Federal projects by the National Institute of Standards and Technology [1]. Executive Order 12902 sets a higher hurdle for projects that agencies are required to implement, defining a cost-effective project as one with a payback period of less than 10 years. Since the executive order does not specify simple or discounted payback period, the more conservative (longer) discounted payback period is reported here. In summary, if the SIR for a measure is greater than 1.0, the measure is cost-effective under 10CFR436 and the EPA should consider implementing the measure in facility planning. In addition, if the payback period is less than 10 years, Executive Order 12902 requires the agency to formulate a plan to implement the measure. While perhaps sufficient to inform a go/no-go decision for small projects (<$5000), this opportunity assessment should not be confused with a feasibility study. For larger projects, a full engineering study should be conducted to establish technical and economic feasibility before beginning the project.

Several renewable energy technologies are specified in the current design documents including lighting control for perimeter daylighting, core daylighting from a large central atrium, daylighting with light pipes, and spectrally selective glazing to reduce cooling loads. The analysis indicates that each of these technologies has an SIR greater than 1.0 and a discounted payback less than 10 years, and therefore should be implemented. The NCC has a special requirement for a large uninterruptable power supply to assure reliable operation of the computer facilities. There may be an opportunity to recommend an independent, building-integrated photovoltaic system as part of the UPS system to enhance reliability even though it will not save costs.

In this analysis, the cost-effectiveness of each technology was first considered in the context of the actual rates that the facility pays for electricity, 0.06 $/kWh. Since the EPA includes the external cost of fossil fuel use in its life-cycle costing analysis, this report also presents results that take into account the current monetary cost of emissions from the utilities in North Carolina. In North Carolina the utilities emissions have been characterized as follows [2]:

SO_2 (g/kWh)	NO_x (g/kWh)	CO_2 (kg/kWh)
4.2	2.0	0.59

With a cost of:

SO_2 ($/LB)	NO_x ($/LB)	CO_2 ($/Ton)
0.85	3.75	14

The true cost of electricity for the facility is therefore increased by 0.033 $/kWh, to 0.093 $/kWh.

Under these guidelines for emission cost accounting, the purchasing of utility "green power" could be a cost-effective action for the facility management to make. However, in the state of North Carolina, there are currently no utility green power programs.

The information in this report results from interviews with building design consultants at Architectural Energy Corporation and review of their Design Assistance Report dated January 1998. The EPA design construction documents and plans provided detailed descriptions of the building and its energy systems. Ed Hancock and Carl Mas at the National Renewable Laboratory performed the FRESA analysis and wrote this report. Phil Wirdzek, EPA Headquarters Energy Coordinator, supports this work through an Interagency Agreement with the Department of Energy Federal Energy Management Program (FEMP). NREL support activities to EPA are coordinated by Richard Parish. Federal Energy Management Program (FEMP) Technical Assistance is managed by Anne Crawley of the US Department of Energy.

Individual measures are assessed using the Federal Renewable Energy Screening Assistant Software (FRESA) [3] developed at NREL under DOE sponsorship. Resources and technologies accessed in the screening include: biomass, wind, photovoltaics, daylighting, hydroelectric, ground-source heat pumps, solar ventilation preheating, solar space heating, solar cooling and solar water heating.

A summary of the cost-effective applications of renewable energy at the EPA National Computer Center is presented in Table 1. In this report life cycle-cost is defined as the sum of time-equivalent costs of acquiring, owning, operating and maintaining a building, system, or equipment over a designated study period. The Savings-To-Investment Ratio (SIR) is a ratio of discounted savings to costs for one building design, system, equipment, or strategy versus an alternative, and the discounted payback period is the minimum time it takes to recover the costs of an investment, where the time value of money is taken into account.

Table 1. Cost-effective Renewable Energy Projects at EPA Region 8 Laboratory

Renewable Energy Measure	**Life Cycle Cost ($)**	**Annual Fuel Savings (Mbtu/yr)**	**Annual Electric Savings (kWh/yr)**	**Savings-to-Investment Ratio**	**Discounted Payback Period (years)**
NCC Offices and Computer Center					
Solar apertures	46,000	-	90,700	2.1	12
Solar apertures with emission costing	46,000	-	90,700	*3.2*	*7.7*
Lighting Controls	6,300	-	10,100	1.7	15
Lighting Controls with emission costing	6,300	-	10,100	*2.6*	*9.6*
Window Sun-Screening	12,000	-	30,500	2.1	9
Window Sun-Screening with emission costing	12,000	-	30,500	*3.3*	*5*
Total for All Measures	**64,300**	**-**	**131,300**	**1.7**	**11**
Total for All Measures with Emission Costing	**64,300**	**-**	**131,300**	***2.7***	***7***

MBtu = 1 x 10^6 Btu

PRESENTLY SPECIFIED USE OF RENEWABLE ENERGY AT EPA NATIONAL COMPUTER CENTER

The current design specifications for this facility include several cost-effective renewable energy applications. The renewable technologies include lighting control for perimeter daylighting, core daylighting from a large central atrium, daylighting with light pipes, and spectrally selective glazing to reduce cooling loads. Analysis of the performance of these technologies is included in this report.

GREEN POWER

Presently, the State of North Carolina has no green power programs, and the local utilities do not have net metering programs (therefore grid-connected renewable energy systems are subject to the standards set forth in the Public Utility Regulatory Policies Act of 1978, PL 95-617). However, as the restructuring of the utility industry continues in the next few years, green power purchasing may become a cost-effective option for the facility managers to explore [4].

FACILITY SCALE MEASURES

The EPA National Computer Center is currently in the design process and is planned for construction at the Research Triangle Park in central North Carolina. The total floor area for the offices and computer center is approximately 110,000 square feet. The buildings are expected to be served by a central chiller and boiler plant for the complex. The standard natural gas and electricity rates are relatively inexpensive, and there is no utility net metering program. Therefore, no facility scale renewable technologies are currently recommended.

Wind generation of electricity has been found to be cost effective in locations around the country were a good wind resource is available. However, the Triangle area of North Carolina has relatively low average wind speeds and is not appropriate for wind turbine applications. There may be other locations in North Carolina with a favorable wind resource, which in the future may be harvested by a local utility for sale to consumers.

The use of biomass fuel and refuse energy are resources that were analyzed, but not applicable for this site. The generation of electricity through solar thermal systems and a photovoltaic array were also analyzed. However, the lack of a utility net metering program and the use of inexpensive fuel and electricity precludes the cost-effective use of these measures, where the SIRs were less than 0.2.

This facility, serving as the National Computer Center, may have a special opportunity for implementing building-integrated photovoltaic electricity generation. The computing center utilizes a large battery facility as part of an uninterruptable power supply (UPS) for its critical computer applications. The state of charge of the batteries is maintained with electricity supplied by the standard commercial electrical grid. Although photovoltaic generation does not provide power that is cost-competitive with purchased grid power, it can provide a completely independent power source in case of grid power interruption. Since the main function of the UPS is to provide a highly reliable source of power, PV battery charging may be favorably evaluated as providing enhanced reliability even if its cost for electricity is greater.

BUILDING SCALE MEASURES

The use of many renewable energy technologies is less favorable due to the use of relatively inexpensive fuel. Solar water and space heating systems had SIRs less than 0.5. Solar cooling was even less cost-effective with an SIR of 0.1. Solar preheating of ventilation air in several EPA laboratory buildings has been cost-effective, but is not recommended for the NCC since the heating season is very short and natural gas for heating is relatively inexpensive. Results from the renewable energy opportunity assessments in both the office area and computer center are similar and are therefore presented together.

The building specifications indicated that air infiltration control techniques be implemented throughout the construction of the building. During original construction, it is clearly the most cost-effective time to achieve a "tight" building. FRESA indicates a very quick payback and high SIR for infiltration control during initial construction.

NCC Offices and Computer Center

Solar Apertures

A significant architectural feature of this facility is the two-story atrium in the central portion of the building. It is designed to provide natural daylighting to the interior spaces, reducing the need for electric lighting and reducing the cooling load. In FRESA, the atrium is analyzed as a solar aperture in both the offices and computer center areas. The incremental cost of the atrium skylighting is assumed to be $20 per square foot of aperture area. The SIR is 2.1 and the discounted payback period is 12 years. If utility costs are adjusted for emissions costs, the discounted payback period is 7.7 and the SIR is 3.2.

Light pipes are specified for daylighting in certain areas of the building where relamping is difficult and therefore expensive. When credit for the reduced cost of relamping can be taken in this application, the renewable technology has a favorable SIR and payback.

Lighting Controls

The present plans also specify electric light dimming within 12 feet of the perimeter to facilitate natural daylighting through the perimeter glazing. The specification indicated that this feature is required by the North Carolina Energy Code. The FRESA analysis assumes an incremental wiring cost of $1.80 per foot and a dimming controller cost of $250.00. The overall installed cost of lighting controls is estimated at $7,500. A simple payback period of 15 years and an SIR of 1.7 are calculated using the standard costs for electricity and natural gas. If utility costs are adjusted for emissions costs, the discounted payback period is 2.6 and the SIR is 9.6.

Window Sun-Screening

High performance glazing is specified for reducing solar heat gains and cooling load while maintaining good visible transmission for daylighting. In FRESA, this technology is analyzed as window sun-shading that has a discounted payback period of 9 years and an SIR of 2.1, when the incremental cost of the spectrally selective tinted glass is assumed to be \$5 per ft^2. If utility costs are adjusted for emissions costs, the discounted payback period is 5 years and the SIR is 3.3.

CONCLUSION

At the EPA's National Computer Center in Research Triangle Park there are several opportunities for passive renewable energy systems. The use of daylighting, lighting controls, and high performance glazing is required at this facility. As the local wind resource is not favorable, the cost of fuel and electricity is inexpensive, and there are no net metering programs in the state, other renewable energy systems are not cost-effective for this facility. However, the use of building integrated photovoltaics might provide the facility with high power quality, thus strengthening the uninterupable power supply through increased reliability. It is recommended that the building planners explore the potential use of photovoltaics, considering the special needs of the National Computer Center.

REFERENCES

[1] Energy price Indices and Discount Factors for Life Cycle Cost Analysis 1997, Stephen R. Petersen, NISTIR 85-3273-11 (rev 7/96).

[2] United States Department of the Interior: Denver Service Center Guideline 94-04 (Revised September 1997)[1]

[3] FRESA, Federal Renewable Energy Screening Assistant, Version 2.0 computer software, National Renewable Energy Laboratory, Golden, CO, 1998.

[4] http://www.eren.doe.gov/greenpower

1 Based on: Weisberg, Peter. Green Lights Pollution Prevention Methodology. Washington, DC:ICF, Inc. for the USEPA, 1991

Appendix A: FRESA Analysis Results

Date: 10/21/98

Facility Information for: EPA, NCC, Research Triangle

Facility Address: EPA NAtional Computer Center
Research Triangle Park, NC

Data from the Weather Database	Facility Contact: Chris Long	Agency: Environmental Protection Agency
City Raleigh,NC	Phone Number:	Agency Contact:Phil Wirdzek
Latitude 35.87	Fax Number:	Phone Number:(202) 260-2094
Census Region 3	Email :	Fax Number:(202) 260-8234
		Email : WIRDZEK.PHIL@EPAMAIL>EPA>

Winter Design Temp. (F)	19.94	Winter Length (weeks)	18.98		
Average Winter Temp. (F)	47.49	Summer Length (weeks)	21.36	Zipcode:	27600
Summer Design Temp. (F)	89.60	EIH (MBTU/1000 CFM)	30.83	Total Floor Area (sq ft):	111,000
Average Summer Temp. (F)	77.60	EIC (MBTU/1000 CFM)	52.58	Hydrocarbon Fuels (MBTUs):	2,000
Design Dew Point Temp. (F)	73.04	Solar Offset (months)	-0.80	Electricity Used (kWhs):	10,000,000
Average Dew Point Temp. (F)	64.74	Min 2x Beam (kWh/sq m/day)	3.10	Electricity Price ($s/kWh):	0.093
Min Ave Solar (kWh/sq m/day)	2.20	Max 2x Beam (kWh/sq m/day)	4.90	Coal Price ($/ton):	0.00
Max Ave Solar (kWh/sq m/day)	6.30	Wind Power Class	1.00	Distillate Price ($/gallon):	0.00
Min Ave 1X Beam (kWh/sq m/day)	2.90	Heating Degree Days	3,753	Natural Gas Price ($/ccf):	0.30
Max Ave 1X Beam (kWh/sq m/day)	4.80	Degree Hours above 78	5,559	Propane Price ($/lb):	0.00
				Steam Price ($/MBTU):	0.00

MBtu = 1E6 Btu

EPA, NCC, Offices

Building Type: Offices Number of Similar Bldgs: 1.(

Aspect Ratio: 2.00	Foot Print: 4,000.00	Weekly Hours: 60.00
EER: 9.00	Heating Fuel: Natural Gas	Electricity Demand: 3,000,000.00 kWhr
umber of Floors: 2.00	Heating Plant Efficiency: 0.7!	Fuel Demand: 1,000.00 MBTU

nergy Conservation Measure: Solar Aperatures (RSH)

ser Input	Value
oom Floor Area	200 sq ft
umber of Skylights	2
rea of each Skylight	4 sq ft
kylight Type	2-Translucent Double Dome
kylight Unit Cost	$20 /sq ft
equired Light Level	30 fc
ype of Artificial Lighting	Fluorescent
uilding Floor Area for Skylights	4000 sq ft
ork Days per Week	5
emo	?
utput Name	**Value**
escreen	Yes
R	3.226
iscounted Payback	7.7 years
ectricity Savings	8,863 kWh
el Savings	0 MBtu
el Cost Savings	$0
lectricity Cost Savings	$824
t Present Value	$14,606
fe Cycle Cost	$4,527
nual Hours of Skylighting	2,152 hours
ditional Air Conditioning Load	19 kBtu/yr

End of Information for EPA, NCC, Offices

Date: 10/21/98

Facility Information for: EPA. NCC. Research Triangle

Facility Address: EPA NAtional Computer Center
Research Triangle Park, NC

Data from the Weather Database
City Raleigh,NC
Latitude 35.87
Census Region 3

Facility Contact: Chris Long
Phone Number:
Fax Number:
Email :

Agency: Environmental Protection Agency
Agency Contact:Phil Wirdzek
Phone Number:(202) 260-2094
Fax Number:(202) 260-8234
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Zipcode:	27600
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Hydrocarbon Fuels (MBTUs):	2,000
Electricity Used (kWhs):	10,000,000
Electricity Price ($s/kWh):	0.093
Coal Price ($/ton):	0.00
Distillate Price ($/gallon):	0.00
Natural Gas Price ($/ccf):	0.30
Propane Price ($/lb):	0.00
Steam Price ($/MBTU):	0.00

EPA, NCC, Computer Cer

Building Type: R & D
Number of Similar Bldgs: 1.(

Aspect Ratio: 2.00	Foot Print: 4,000.00	Weekly Hours: 60.00
EER: 9.00	Heating Fuel: Natural Gas	Electricity Demand: 6,000,000.00 kWhr
Number of Floors: 2.00	Heating Plant Efficiency: 0.7	Fuel Demand: 1,000.00 MBTU

Energy Conservation Measure: Solar Aperatures (RSH)

User Input	Value
Room Floor Area	200 sq ft
Number of Skylights	2
Area of each Skylight	4 sq ft
Skylight Type	2-Translucent Double Dome
Skylight Unit Cost	$20 /sq ft
Required Light Level	30 fc
Type of Artificial Lighting	Fluorescent
Building Floor Area for Skylights	4000 sq ft
Work Days per Week	5
Demo	?
Output Name	**Value**
Prescreen	Yes
IR	3.226
Discounted Payback	7.7 years
Electricity Savings	8,863 kWh
Fuel Savings	0 MBtu
Fuel Cost Savings	$0
Electricity Cost Savings	$824
Net Present Value	$14,606
Life Cycle Cost	$4,527
Annual Hours of Skylighting	2,152 hours
Additional Air Conditioning Load	19 kBtu/yr

End of Information for EPA, NCC, Computer Center

Date: 11/ 2/98

Facility Information for: EPA. NCC. Research Triangle

Facility Address: EPA NAtional Computer Center
Research Triangle Park, NC

Data from the Weather Database
City Raleigh,NC
Latitude 35.87
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Min Ave Solar (kWh/sq m/day)	2.20	Max 2x Beam (kWh/sq m/day)	4.90
Max Ave Solar (kWh/sq m/day)	6.30	Wind Power Class	1.00
Min Ave 1X Beam (kWh/sq m/day)	2.90	Heating Degree Days	3,753
Max Ave 1X Beam (kWh/sq m/day)	4.80	Degree Hours above 78	5,559

MBtu = 1E6 Btu

Zipcode:	27600
Total Floor Area (sq ft):	111,000
Hydrocarbon Fuels (MBTUs):	2,000
Electricity Used (kWhs):	10,000,000
Electricity Price ($s/kWh):	0.093
Coal Price ($/ton):	0.00
Distillate Price ($/gallon):	0.00
Natural Gas Price ($/ccf):	0.30
Propane Price ($/lb):	0.00
Steam Price ($/MBTU):	0.00

EPA, NCC, Offices

Building Type: Offices   Number of Similar Bldgs: 1.(

Aspect Ratio: 2.00
EER: 9.00
Number of Floors: 2.00

Foot Print: 36,925.00
Heating Fuel: Natural Gas
Heating Plant Efficiency: 0.7$

Weekly Hours: 60.00
Electricity Demand: 3,000,000.00 kWhr
Fuel Demand: 1,000.00 MBTU

nergy Conservation Measure: Lighting Controls (RSL)

ser Input	Value
Vindow Area Fraction	0.2
lectrical Mods Question	Y
equired Light Level	40 fc
ype of Artificial Lighting	Fluorescent
oom Floor Area of typical room where	200
erimeter Area Fraction	0.3
/ork Days per Week	5
oom Width	15 ft
ost of wiring for Lighting Controls	$1.8 /ft
ost of light controller	$250
emo	?
itput Name	**Value**
escreen	Yes
R	2.609
iscounted Payback	9.6 years
ectricity Savings	8,708 kWh
lel Savings	0 MBtu
iel Cost Savings	$0
ectricity Cost Savings	$810
et Present Value	$14,349
fe Cycle Cost	$5,500
stallation Cost	$5,500

End of Information for EPA, NCC, Offices

Date: 11/2/98

Facility Information for: EPA, NCC, Research Triangle

Facility Address: EPA NAtional Computer Center
Research Triangle Park, NC

Data from the Weather Database
City Raleigh,NC
Latitude 35.87
Census Region 3

Facility Contact: Chris Long
Phone Number:
Fax Number:
Email :

Agency: Environmental Protection Agency
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Average Summer Temp. (F)	77.60	EIC (MBTU/1000 CFM)	52.58
Design Dew Point Temp. (F)	73.04	Solar Offset (months)	-0.80
Average Dew Point Temp. (F)	64.74	Min 2x Beam (kWh/sq m/day)	3.10
Min Ave Solar (kWh/sq m/day)	2.20	Max 2x Beam (kWh/sq m/day)	4.90
Max Ave Solar (kWh/sq m/day)	6.30	Wind Power Class	1.00
Min Ave 1X Beam (kWh/sq m/day)	2.90	Heating Degree Days	3,753
Max Ave 1X Beam (kWh/sq m/day)	4.80	Degree Hours above 78	5,559

MBtu = 1E6 Btu

Zipcode:	27600
Total Floor Area (sq ft):	111,000
Hydrocarbon Fuels (MBTUs):	2,000
Electricity Used (kWhs):	10,000,000
Electricity Price ($s/kWh):	0.093
Coal Price ($/ton):	0.00
Distillate Price ($/gallon):	0.00
Natural Gas Price ($/ccf):	0.30
Propane Price ($/lb):	0.00
Steam Price ($/MBTU):	0.00

EPA, NCC, Computer Cer

Building Type: R & D
Number of Similar Bldgs: 1.(

Aspect Ratio: 2.00
EER: 9.00
Number of Floors: 2.00

Foot Print: 13,200.00
Heating Fuel: Natural Gas
Heating Plant Efficiency: 0.7!

Weekly Hours: 60.00
Electricity Demand: 6,000,000.00 kWhr
Fuel Demand: 1,000.00 MBTU

Energy Conservation Measure: Lighting Controls (RSL)

User Input	Value
Window Area Fraction	0.2
Electrical Mods Question	Y
Required Light Level	40 fc
Type of Artificial Lighting	Fluorescent
Room Floor Area of typical room where	200
Perimeter Area Fraction	0.3
Work Days per Week	5
Room Width	15 ft
Cost of wiring for Lighting Controls	$1.8 /ft
Cost of light controller	$250
Memo	?

Output Name	Value
Prescreen	Yes
IR	2.565
Discounted Payback	9.7 years
Electricity Savings	3,113 kWh
Fuel Savings	0 MBtu
Fuel Cost Savings	$0
Electricity Cost Savings	$289
Net Present Value	$5,129
Life Cycle Cost	$2,000
Installation Cost	$2,000

End of Information for EPA, NCC, Computer Center

Appendix B: BLCC Reports

BLCC Analysis for the use of window screening at the EPA Research Triangle Park Facility in North Carolina. With the actual cost of electricity (0.06 $/kWh)

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******************************************************************************
*    N I S T  B L C C:  COMPARATIVE  ECONOMIC  ANALYSIS (ver. 4.6-98 )      *
******************************************************************************
```

Project: RTP
Base Case: base
Alternative: screen

Principal Study Parameters:

Analysis Type: Federal Analysis--Energy Conservation Projects
Study Period: 25.00 Years (APR 1998 through MAR 2023)
Discount Rate: 4.1% Real (exclusive of general inflation)
Base Case LCC File: RTP.LCC
Alternative LCC File: RTPSOL.LCC

Comparison of Present-Value Costs

	Base Case: base	Alternative: screen	Savings from Alt.
Initial Investment item(s):			
Capital Requirements as of Serv. Date	$0	$12,000	-$12,000
Subtotal	$0	$12,000	-$12,000
Future Cost Items:			
Energy-related Costs	$25,653	$0	$25,653
Subtotal	$25,653	$0	$25,653
Total P.V. Life-Cycle Cost	$25,653	$12,000	$13,653

Net Savings from Alternative 'screen' compared to Base Case 'base'

Net Savings =	P.V. of Non-Investment Savings	$25,653
-	Increased Total Investment	$12,000
	Net savings:	$13,653

Note: the SIR and AIRR computations include differential initial costs, capital replacement costs, and residual value (if any) as investment costs, per NIST Handbook 135 (Federal and MILCON analyses only).

Savings-to-Investment Ratio (SIR)
For Alternative 'screen' compared to Base Case 'base'

$$SIR = \frac{\text{P.V. of non-investment savings}}{\text{Increased total investment}} = 2.14$$

Adjusted Internal Rate of Return (AIRR)
For Alternative 'screen' compared to Base Case 'base'
(Reinvestment Rate = 4.10%; Study Period = 25 years)

AIRR = 7.31%

Estimated Years to Payback

Simple Payback occurs in year 7
Discounted Payback occurs in year 9

ENERGY SAVINGS SUMMARY

Energy type	Units	---- Average Annual Consumption ----- Base Case	Alternative	Savings	Life-Cycle Savings
Electricity	kWh	30,480.0	0.0	30,480.0	762,000.0

BLCC Analysis for the use of window screening at the EPA Research Triangle Park Facility in North Carolina. With the real cost of electricity (0.093 $/kWh)

```
****************************************************************************
*     N I S T  B L C C:  COMPARATIVE  ECONOMIC  ANALYSIS (ver. 4.6-98 )      *
****************************************************************************
```

Project: RTP
Base Case: base
Alternative: screen

Principal Study Parameters:

Analysis Type: Federal Analysis--Energy Conservation Projects
Study Period: 25.00 Years (APR 1998 through MAR 2023)
Discount Rate: 4.1% Real (exclusive of general inflation)
Base Case LCC File: RTP.LCC
Alternative LCC File: RTPSOL.LCC

Comparison of Present-Value Costs

	Base Case: base	Alternative: screen	Savings from Alt.
Initial Investment item(s):			
Capital Requirements as of Serv. Date	$0	$12,000	-$12,000
Subtotal	$0	$12,000	-$12,000
Future Cost Items:			
Energy-related Costs	$39,762	$0	$39,762
Subtotal	$39,762	$0	$39,762
Total P.V. Life-Cycle Cost	$39,762	$12,000	$27,762

Net Savings from Alternative 'screen' compared to Base Case 'base'

Net Savings =	P.V. of Non-Investment Savings	$39,762
-	Increased Total Investment	$12,000
	Net savings:	$27,762

Note: the SIR and AIRR computations include differential initial costs, capital replacement costs, and residual value (if any) as investment costs, per NIST Handbook 135 (Federal and MILCON analyses only).

Savings-to-Investment Ratio (SIR)
For Alternative 'screen' compared to Base Case 'base'

$$SIR = \frac{\text{P.V. of non-investment savings}}{\text{Increased total investment}} = 3.31$$

Adjusted Internal Rate of Return (AIRR)
For Alternative 'screen' compared to Base Case 'base'
(Reinvestment Rate = 4.10%; Study Period = 25 years)

AIRR = 9.21%

Estimated Years to Payback

Simple Payback occurs in year 5
Discounted Payback occurs in year 5

ENERGY SAVINGS SUMMARY

Energy type	Units	---- Average Annual Consumption -----			Life-Cycle
		Base Case	Alternative	Savings	Savings
Electricity	kWh	30,480.0	0.0	30,480.0	762,000.0