Overlook
Tree Preservation LLC

Overlook Tree Preservation Industrial Building

The plan for a Portland industrial warehouse on the edge of Forest Park would have made good use of space, accommodating storage, workshop, office and showroom space needs in a 4,000 square foot building. Stormwater would be treated through a permeable paving system, bioswales, rainwater harvesting and an ecoroof around the perimeter of the roof. An energy-producing solar PV laminate system would replace traditional roofing materials on the non-ecoroof portion of the roof. A tilt up-concrete panel system made in part of recycled steel and fly ash would create a thermally massive building envelope, and salvaged fixtures and doors were to be used inside the building. The building would have no sewer hookup and use two composting toilets.

Project Highlights

- **Rainwater collection and reuse**
- **Bioswales**
- **Ecoroof**
- **Solar PV system**
- **Thermally massive building envelope**
- **Composting toilets**

Portfolio Contents

Report

INDUSTRIAL WAREHOUSE

Kevin and Lois MacKenzie
Overlook Tree Preservation Inc
4018 N Colonial Avenue, Portland OR 97227

INTRODUCTION

This project was an industrial warehouse designed to house the four functions of storage, workshop, office and showroom for an innovative tree service company in the outer Northwest Industrial area of Portland. Overlook Tree Preservation will occupy 60% of the space with an adjoining tenant occupying the remaining 40%. The site is located approximately one mile south of the St. John's Bridge on the west side of Highway 30 with the rear of the property abutting Forest Park. The site was chosen for a number of reasons: the close proximity to the owner's home in North Portland for a minimal commute; the nearby location of a biodiesel station; the nearby dump location for tree debris; the centralized location for access to company's client base; and the closeness to nature found in the West Hills.

Our first thought for this site was to place an economically priced prefabricated metal building on it. This is the typical solution for this building type – however, it provides a building that can be a challenge to maintain, has inefficiencies in energy savings and lacks connection to its surrounding natural environment. The site itself also possessed its own challenges: no sewer connection with inadequate space for a septic system, a sloped site with a conservation overlay zone in the rear of the site and a narrow lot. We used these challenges to assist us in re-orienting our thinking to sustainable-based solutions.

Our goal was to design a more durable industrial building that allowed for flexible future use, maintains well and has the ability to welcome the environment indoors to increase the inhabitant's quality of life. The following technologies that we implemented into the final building design are listed in this report.

TECHNOLOGY 1 : COMPOSTING TOILETS

INTRO

Our site is not connected to the sewer system as it stops approximately 300 yards from our site. Due to the steep grade and inadequate space of our site, a septic field was not an option. Therefore, our only option was to place a holding tank on the site and have it pumped out regularly. The size of the holding tank was based upon the number of flushes daily – and we realized that if we minimized the amount of water that accompanied the number of daily flushes, we could utilize a smaller sized holding tank. Also, a larger holding tank meant additional excavation to place it into our site. Our concept was to utilize composting toilets to minimize our water usage. We also wanted to utilize rainwater for the flushing of toilets.

PROCESS

We assumed full time occupancy of 7 people making 5 daily trips to the WC for 21 working days in a month. The average toilet with 1.6 gallons per flush would use 157.64 cubic ft. The composting toilet utilizing 0.625 gallons per flush would use 12.32 cubic ft. The toilets also utilized one pint of water per flush. We found a composting toilet after researching many brands and systems online. We chose the SANCOR Envirolet Composting Toilet primarily for its aesthetic quality as (1) the bowl is porcelain instead of a plastic derivative and (2) the composting unit is separate from the bowl

CHALLENGES

(1) Our designer was a little concerned about fitting the composting unit below the toilet, as it would ideally sit in the basement level for a ground floor toilet application. However, after speaking to the team at Envirolet, we found that we were able to accommodate the composting unit by depressing the floor slab and locating the unit in an accessible location – allowing the necessary "slope" for the organic matter's path.

(2) This was the first commercial application in the City of Portland for the use of a composting toilet. During our first plumbing check sheet, the use of the composting toilets was not approved without any explanation. Further investigation showed that we were not showing the use of a split seat for our composting toilet (which was required by code for commercial application). Since the bulk of these toilets are used by residential projects - Envirolet did not have any commercial seat options. So, we began to research split seat toilet seats with other manufacturers – and found it very challenging to find a split seat that fit this toilet since Envirolet did not have any specification drawings on their unit. We finally received the name of a toilet seat manufacturer with a split seat that possessed the dimensions that would fit our toilet - a very time consuming process.

(3) Our drawings also showed the use of harvested rainwater for the flushing of the toilets. Our plumbing check sheet required that this needed to be approved through a Plumbing Code Appeal. Apparently, commercial buildings can utilize rainwater for irrigation and the flushing of toilets and urinals by appeal only (appeal costs $200) – and they need to be drawn up by an Oregon Registered Engineer.

CONCLUSIONS

We found that this technology had a lot of little issues to work through. It took a lot of time and energy, as there was no precedence to follow. Also, since this technology is primarily used in the residential market, there was not adequate technical information to complete an easy commercial installation. I would foresee that had we moved forward with this technology in our built project, we would have encountered more on site challenges due to this issue (ie. Would the depressed slab really have worked?) Also, by the time we finalized this technology – we were near the end of the construction drawing phase and we

wish we would have anticipated that there would be additional appeal, drawing and coordination costs associated.

TECHNOLOGY 2 : SOLAR PV LAMINATE

INTRO
We wanted to design and utilize a roofing system that would include solar PV laminate as part of the roofing material to eliminate the need for a separate roofing material.

PROCESS
We contacted Solar Roofing Systems Inc. (located in Canada) for info on Solar Save's PV laminate roofing system - and were forwarded to our local dealer - David Parker of Advanced Energy Systems, 2990 Forest Blvd., Eugene OR (541.683.2345).

CHALLENGES
Someone from David's team visited our site and determined that there would not be adequate sunlight available to make it economically feasible as the abundance of tall trees in conjunction with the grade of Forest Park's hillside did not allow for enough solar to reach the roof system.

CONCLUSIONS
We realized that a narrow site like ours with the amount of tall trees would be challenging to utilize this technology. While we were planning to remove numerous trees from our site, which would have opened up the opportunity for sunlight, it was the cost that was difficult to justify.

TECHNOLOGY 3 : VEGETATIVE FILTER STRIP ON ROOF

INTRO
Since our original plan for the solar PV laminate roofing was not feasible - we thought we would investigate the idea of an eco-roof for our entire roof area. With a total roof area of 3200 square feet - this was not economically feasible. Then we decided to implement 18" of eco-roof located on one eave of the building to act as a pre-filtering system to the rainwater harvesting which would equal 112 square feet of eco-roof.

PROCESS
Our landscape architect let the direction for this type of eco-roof application. Traditionally, an eco-roof is utilized for the following reasons (1) to absorb rainwater (2) to provide insulation (3) to create a habitat for wildlife (4) to

help lower urban air temperatures. Our primary reason for our eco-roof strip was to treat the grey water before it was collected in the cistern.

CHALLENGES
The weight of the soil is typically a big challenge for eco-roofs. Additional roof structure needs to be calculated in which typically means additional costs. Also, there is the need to focus on water management and choose ideal roof assemblies that have a watertight membrane.

CONCLUSIONS
Our landscape architect has a proprietary eco-roof mix - Growing Media Mix LANDO-1-1 that is lighter in weight than your typical soil mix. The roofing material, likely a standing seam metal roof - would act as the membrane for the eco-roof.

TECHNOLOGY 4 : STORMWATER MANAGEMENT & BIOSWALE SYSTEM

INTRO
We wanted to design a comprehensive storm water management system to minimize any run off into the city's waste water system. The harvested rainwater was intended to be used for irrigation and for owner's use (for mixing organic fertilizer).

PROCESS
We collaborated with our civil engineer, landscape architect and architect to design a complete system. The code requirement is to treat and dispose of the water collected from the roof and paved parking area so we proposed two treatment systems in conjunction with permeable pavers for the parking area with primary treatment through a bioswale. The first system that we landed on was to treat the rainwater falling onto the roof, filtering the larger debris like twigs via an 18" ecoroof filtering strip located on one eave of the building (equaling 112sf of ecoroof) and allowing the water to collect in a cistern (74,600 cubic ft). The second system takes into account the cisterns' overflow which would go into a large vegetative filter strip, travels 75 feet along the southern edge of the building to the permeable paving and into the bioswales for disposal. Once the bioswale reaches capacity, the system retreats into the sub-base that would allow an additional 8000 gallons (8" x 1600 sq ft paving area) of water to be detained, therefore increasing the total system's efficiency. The entire system exceeds the City's storm water requirements and seeks to maintain a no net loss on-site water resource.

CHALLENGES
(1) From the beginning of the project, we were told that ODOT would be the regulating agency for storm water management. DEQ approved our methodology of on site storm water disposal for the project which meant

that as long as we didn't increase the peak flows in the post-developed state, ODOT would accept runoff to NW St Helen's Road in the same pattern as it flowed during its pre-developed state. During the check sheet process, we found that PDOT actually regulates the small strip between the edge of the pavement and our property line. Therefore BES is the regulating agency for storm water management and they did not agree with our ODOT approved disposal point in a 100-year event.

(2) A large puddle forms and crosses the fog line of our property with the low point of the road with no drainage system for the surrounding area. The City of Portland has expressed great concern regarding the safety issue of this puddle as runoff flows from our site and the road and sits in this low point infiltrating slowly and building up until there's enough hydrostatic pressure for it to drain to the creek approx. 225' from the SE point of our property. We could not find a disposal point that BES would approve.

CONCLUSIONS

There have been a number of misunderstandings about jurisdiction of the drainage during the due diligence and design period. Based on conversations with ODOT, PDOT and BES, this is what we concluded too late in the game.

(1) The area between the property line and the edge of the pavement is regulated by PDOT.
(2) ODOT is the regulating agency beyond the edge of the pavement.
(3) Because PDOT regulates the area where our storm water discharges to, BES is the regulating agency for the storm water management.
(4) Infiltration in the right-of-way is prohibited.
(5) Ponding in front of the property in question is a result of runoff from the Forest Park, private property and the highway.

After extensive discussion, we came up with 3 possible solutions for the disposal point for this project. (1) Add an isolated catch basin to the bottom of the swale on private property to drain private property only. A 6" pipe at 0.5% will convey this runoff to the creek approximately 225' to the northwest in an easement granted by Kinder Morgan, owner of the property between our property and the creek. (2) Add a catch basin at the bottom of the swale that is not isolate and will drain runoff from the road in addition to runoff from the private property. An 8" pipe will convey public and private runoff to the creek in an easement to be granted by Kinder Morgan. (3) Utilize a pumping system that would take the runoff and pump it to the top of our site with the termination next to our property line at the north and allow the water to flow to the creek via gravity. None of these options were feasible for us financially as it meant additional consultant, surveyor's fee to survey and record the easement, county's recording fees and the cost of the installation of the private pipe.

TECHNOLOGY 5 : ENERGY SAVINGS

INTRO
We wanted to reach 50% or better performance beyond the Oregon Energy Code.

PROCESS
We reviewed the building's opportunities and engaged a mechanical engineer's services to document a set of measures for comparison against a baseline code building. Some of the modeling assumptions included (a) using a heat pump (b) providing R25 insulation in lieu of R11 (c) providing R38 insulation in lieu of R19 (d) providing 0.28U and 0.38SC glass in lieu of 0.54U and 0.57U glass.

CHALLENGES
The above assumptions allowed us to arrive at 25% above Oregon Energy Code. The modeling did not take into account our passive cooling measures, which would increase our energy savings.

CONCLUSIONS
We increased the envelope's insulation to mimic the minimum requirement for residential code with R38 ceiling insulation and R19 insulation in the walls - adding it to the outside to leave the mass on the inside. Rigid insulation was also placed on the outside of the wall and under the slab so it was located subgrade. With the energy that we were utilizing, we would use a renewable energy source instead of a fossil fuel - so we planned to purchase green tags from PGE with a renewable energy source like wind power. Due to the high costs of the heat pump, we focused the heating in the office area only - using electric radiant wall panels. A solar hot water tank was considered – and we did not finalize the costs of installing this system. We were not able to re-model with these changes – and therefore did not know the final energy savings with the measures that we planned to implement.

TECHNOLOGY 6 : DAYLIGHTING & SOLAR TRACKING

INTRO
We wanted to minimize the use of electrical lighting through the use of strategically placed windows and skylights for natural light.

PROCESS
We met with John Reynolds, a retired professor from the University of Oregon and author of "Mechanical and Electrical Equipment for Buildings". We spoke about the advantages of skylights vs. vertical glazing. Research shows that skylights only need to be half the size of the vertical glazing to provide the same amount of daylight. He gave us a helpful formula to figure out the depth of usable daylight with vertical windows (2.5 x height of window opening). Therefore, an option would be to eliminate all windows from the walls and use only skylights - placing cloth over the skylights during summer months to avoid

heat gain or utilize automated skylights with louvers if budget allowed. The most effective option for delighting would be to utilize light monitors which faced the SW on the bias, which would capture the winter sun exposure.

We also met with Robert Noose of Solar Tracking Skylights whose company offers patented skylight products and technologies that track the sun throughout the day to capture more of the sun's usable light by reflecting light that would otherwise be lost when the sun is low in the horizon (early and late in the day and throughout the day during winter months). Their products provide greater light levels for a longer duration than any other conventional skylight.

CHALLENGES
Although we liked the idea of daylighting using skylights, we also wanted to preserve the views from the windows. We also had to factor the fact that the cost and installation of skylights was more expensive than windows.

CONCLUSIONS
Our final design combined both skylights and windows – to save some costs as well as to allow views from the offices.

TECHNOLOGY 7 : PASSIVE COOLING

INTRO
The goal was to eliminate the need for air conditioning units while maintaining a comfortable interior temperature during summer months.

PROCESS
We collaborated with 2 green building consultants and reviewed opportunities. GZ Brown from the Energy Studies in Buildings Lab at the University of Oregon campus and John Reynolds. We learned about the "Stack Effect" where a turbine fan is placed at the highest point in the building on an automatic timer set to operate in the middle of the night as a method to exhaust the hot air out of the building. In addition, locate windows in the lowest level of the building as the fan will draw the night air through the building allowing the cool air to pass over the concrete floor slab that would lower the building's overall temperature so that the next morning (called night ventilation of mass), the building's temperature would begin at a lower temperature. For our building, these were the options that we discussed. (1) creating a trellis and/or vine canopy over the parking area to make it cooler (2) increasing the envelope insulation to R38 in the ceiling and R19 in the walls - ideally adding it to the outside and leaving the mass on the inside (3) placing a CMU wall demising wall would be great for thermal mass (4) installing an underground culvert with registers for night ventilation would assist with cooling (5) using shade cloth for shading in the back during summer months (6) installing a trellis of vines using cables for shading in the back during summer months.

CHALLENGES
The only challenge that we saw was that there were many options that we could implement and therefore, we needed to prioritize to see which ones we could afford to implement.

CONCLUSIONS
We placed sliders in the mezzanine offices to allow for natural ventilation from the hillside's cool air. We designed an awning window above the door in the front facade to capture cool night air (while maintaining safety requirements). We planned to place one or two turbine fans in our roof to suck the hot air out in the night – while placing an operable window in our front façade as close to the floor as possible without being a tripping hazard or break-in invitation. Overall, our building system represents a substantial thermal mass that equates to minimal differentiation between hot and cold.

TECHNOLOGY 8 : INSULATED PREFABRICATED TILT UP CONCRETE SANDWICH PANELS

INTRO
We wanted to design a tilt up concrete panel sandwich with insulation that would allow for thermal mass that has the ability to temper the internal temperature variations - requiring less heating and cooling in the interior.

PROCESS
We collaborated with the design team to review and charette details for this type of construction - ensuring the structural engineer chosen had some experience or could bring some creative thinking to the team. This type of sandwich construction with concrete on the interior and exterior, separated by a "filling" of insulation brought up some interesting discussions of if the thermal mass on the interior of the building would be beneficial in our climate – especially since we were not planning to heat the interior of the warehouse space.

CHALLENGES
We realized that our building's typology did not warrant such an elaborate and expensive building system as it did not need concrete on both the interior and exterior walls. Our ideal scenario would be to have the concrete on the exterior of the building with only the rigid insulation on the interior. However, this was not a solution that would work for the interior of a warehouse space so we ended up with a very standard construction of gypboard acting as the other side of the sandwich – primarily due to costs and the unnecessary use of concrete. Our building's size was also on the small size - bordering on the line where tilt up concrete construction was almost cost prohibitive.

CONCLUSIONS

Our final building system was tilt up concrete. However, we utilized more conventional tilt up methods and found another GC that focused only on tilt up buildings and saw our difficult site conditions as a challenge. There was a point in time when we considered a metal prefabricated building (primarily due to cost savings) but we would have to re-draw and re-engineer much of the drawing package and the cost savings would not have warranted it. Also, metal buildings do not maintain well or have a long building life span, therefore we stayed with our concrete construction.

TECHNOLOGY 9 : REUSED & SALVAGED MATERIALS

INTRO
Our goal was to utilize salvaged, refurbished or reused materials for 5% of the building materials.

PROCESS
We collaborated with eM|Zed Design to review opportunities for the reuse of materials.

CHALLENGES
Our primary building system was tilt up concrete. Since the building did not have many components to it, we found it challenging to find reuse opportunities.

CONCLUSIONS
We focused on the one area of the building that we could affect, which was the mezzanine and office level. We visited the Rebuilding Center to see what materials were available for reuse. We decided to reuse doors as there seems to be an abundance of them and cut them down to be used as handrails.

OVERALL CONCLUSIONS

When we began this process, we were excited to add a unique and sustainable building to Portland's urban fabric. During this process, we learned many valuable lessons. We still don't know what we would have done differently with the issue of the stormwater – but did feel that we did everything that we could to bring this issue to a conclusion. Overall, we spent a lot of time in the designing phase – and as many people warned us, we found the price tag for the building increase steadily as we integrated "technologies". Though our final design was relatively simple, we found that our building size was the ultimate challenge as it was not large enough to receive any cost savings from building construction, materials or technologies.

However, we were able to offer a number of technologies that can be utilized in the building industry. We found an industrial building alternative to septic fields for sewer systems by introducing a composting toilet system for commercial use. An industrial building alternative for stormwater management system by introducing a package of solutions for different areas of an industrial building: incorporating a partial green roof; rainwater harvesting strategy; permeable asphalt; and landscape bioswales. And we were able to minimize our energy use by maximizing daylighting and passive cooling techniques.

We also look back to when we began this project almost 4 years ago and many of the technologies that we were looking at are now commonplace in the building industry today. We are grateful for the opportunity to design this sustainable industrial warehouse and regret that we were unable to complete the construction of it. Thank you.

TECHNOLOGY 5

ENERGY SAVINGS REPORT

TABLE OF CONTENTS

TABLE OF CONTENTS 2

EXECUTIVE SUMMARY 3

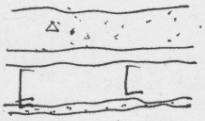
INTRODUCTION 4

MODELING METHODOLOGY 5

Modeling Assumptions and Methodology 5
Modeling Assumptions 6
Results Comparison and LEED Scoring Implications 7

CONCLUSIONS AND RECOMMENDATIONS 8

APPENDIX 1 – Energy Usage – Code Building
APPENDIX 2 – Energy Usage – As Designed Building



- tempering → 15 BTU per SF.
- bump up to 6" studs - R-25 (5½" cavity) - solid insulation vs. batt insulation - polystyrene.
- BETC & Energy Trust Programs - Custom track. 10¢ kwh savings
- 25% for office space only.

EXECUTIVE SUMMARY

This report outlines the energy modeling performed by BEA Consulting on the Overlook Tree Preservation Warehouse Project both for compliance with the Oregon Energy Code. Several models were completed for comparison purposes. The first is a baseline model of the Oregon Energy Code minimum requirements. The second incorporates those baseline Energy Conservation Measures (ECMs) that were determined during the course of the design. Next, each ECM that was to be analyzed was modeled on its own as an addition to the baseline model. Finally, the remaining model is the proposed design, incorporating all the features and ECMs that the design team has added to the building.

The comparisons made are of the baseline code model to the proposed model to determine the net energy reduction of the proposed model. The comparisons have shown the design building to have an energy usage of approximately 25% less than a code-compliant building.

BEA Consulting recommends the adoption of all ECMs included for the project. Current pricing for the ECMs is being completed by the respective parties.

INTRODUCTION

The Overlook Tree Preservation Warehouse Project in Portland, Oregon, is a 4,500 ft^2 1 story building with partial mezzanine comprised of warehouse, storage and office space that will be designed to incorporate several sustainable features.

A set of ECMs was compiled to reflect those additional steps that the design team is taking to improve the building beyond what is conventionally done. A series of energy models is required for the comparison of the impact of each proposed ECM on the baseline code building. In addition, another model that is the code minimum for the State of Oregon compared to all of the ECMs is needed for the total energy savings. This report will outline the methodology and findings of these modeling efforts.

MODELING METHODOLOGY

Modeling Assumptions and Methodology

The models were completed using standard calculation methodologies and eQUEST energy analysis software. As with any computer model, the results are predictions only that may differ from the actual operating experience of the building due to variations in external conditions, maintenance procedures, operating schedules and occupancy levels. The models are based on the October, 17 2006 DD drawing set.

The occupancy schedules for the building were assumed to be those listed by ASHRAE Standard 90.1.

Modeling Assumptions

The following list of assumptions shows the envelope and internal condition assumptions made for the building model:

OVERLOOK TREE PRESERVATION WAREHOUSE
Energy Conservation Measures
Code & Design Comparison

Measure	Oregon Energy Code	Design
HVAC	10 SEER Cooling Electric Resistance Heating	Heat Pump 14 SEER Cooling 8 HSPF Heating
Wall Insulation	R-11	R-25
Roof Insulation	R-19	R-38
Glazing	0.54 U 0.57 SC	0.28 U 0.36 SC

combo hot water - fan coils.
hydro-air heating system. 50 gallon range.

- ECM #1 – HVAC

  Provide 14 SEER and 8 HSPF heat pump in lieu of 10 SEER cooling condenser and Electric resistance heat.

- ECM #2 – Wall Insulation

  Provide R-25 insulation in lieu of R-11 insulation.

- ECM #2 – Roof Insulation

  Provide R-38 insulation in lieu of R-19 insulation.

- ECM #4 – Glazing

  Provide 0.28 U and 0.36 SC glass in lieu of 0.54 U and 0.57 U glass.

solar thermal hot water tan
radiant floor slab.

Overlook Tree Preservation Warehouse
Energy Summary

		Proposed Building		Code Building		
End Use	**Energy Type**	**Energy Use (kW-hr)**	**Energy Use (Therms)**	**Energy Use (kW-hr)**	**Energy Use (Therms)**	**Proposed/ Code (%)**
Heating	Gas	-	-	-	-	-
Heating	Electric	26,880	-	48,700	-	55%
Cooling	Electric	830	-	1,890	-	44%
Fans and Circ. Pumps	Electric	2,370	-	2,190	-	108%
Lighting	Electric	17,840	-	17,840	-	100%
Misc.	Electric	12,760	-	12,760	-	100%
Domestic Water	Electric	5,110	-	5,110	-	100%
Total		65,790	0	88,490	0	74%

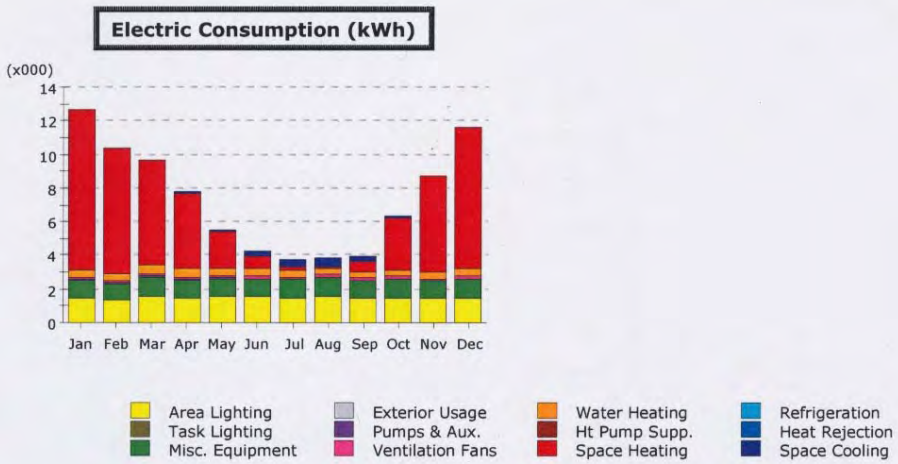
		Proposed Building		Code Building		
End Use	**Energy Type**	**Energy Use (kW-hr)**	**Energy Use (Therms)**	**Energy Use (kW-hr)**	**Energy Use (Therms)**	**Proposed/ Code (%)**
All	Electric	65,790	-	88,490	-	74%
All	Gas	-	0	-	0	-
Total		65,790	0	88,490	0	74%

Proposed Building (kBtu/ft2-yr)	**Code Building (kBtu/ft2-yr)**
5.0	**6.7**

The resulting model showed an energy savings of 25% over the Oregon Energy Code if all ECMs are adopted. This translates into 22,700 kW-hr per year savings.

CONCLUSIONS AND RECOMMENDATIONS

The results of this modelling study show that the building is performing at 25% of the Oregon Energy Code. Of the four (4) Energy Conservation Measures modelled, we recommend that they be implemented.

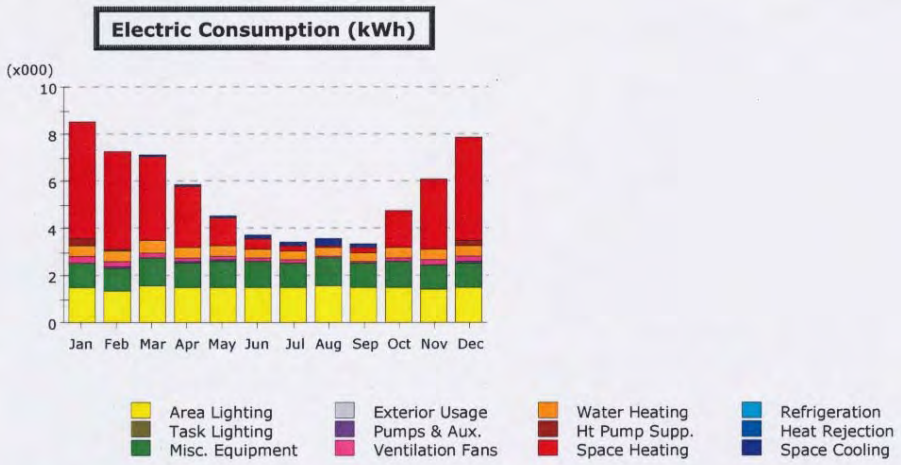


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.00	0.01	0.05	0.08	0.19	0.28	0.39	0.44	0.31	0.12	0.02	0.00	1.89
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	9.52	7.44	6.24	4.50	2.10	0.78	0.24	0.09	0.57	3.09	5.69	8.43	48.70
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.45	0.43	0.48	0.46	0.44	0.42	0.40	0.40	0.38	0.40	0.40	0.45	5.11
Vent. Fans	0.15	0.14	0.16	0.15	0.15	0.15	0.15	0.16	0.15	0.15	0.14	0.15	1.79
Pumps & Aux.	0.07	0.06	0.05	0.04	0.02	0.00	-	-	0.00	0.03	0.05	0.06	0.39
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1.03	0.97	1.15	1.04	1.11	1.10	1.04	1.15	1.03	1.07	1.02	1.04	12.76
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	1.46	1.36	1.56	1.49	1.52	1.50	1.50	1.56	1.46	1.50	1.42	1.50	17.84
Total	12.68	10.40	9.69	7.76	5.54	4.24	3.72	3.80	3.90	6.37	8.75	11.63	88.49

Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	0.01	0.02	0.07	0.11	0.19	0.25	0.14	0.04	0.00	-	0.83
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	4.97	4.17	3.59	2.58	1.22	0.43	0.19	0.08	0.22	1.55	2.98	4.37	26.35
HP Supp.	0.26	0.06	0.01	0.00	-	-	-	-	-	0.00	0.01	0.18	0.53
Hot Water	0.45	0.43	0.48	0.46	0.44	0.42	0.40	0.40	0.38	0.40	0.40	0.45	5.11
Vent. Fans	0.28	0.25	0.24	0.20	0.14	0.11	0.10	0.10	0.09	0.15	0.20	0.26	2.11
Pumps & Aux.	0.04	0.03	0.04	0.03	0.02	0.00	-	-	0.00	0.02	0.03	0.03	0.26
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1.03	0.97	1.15	1.04	1.11	1.10	1.04	1.15	1.03	1.07	1.02	1.04	12.76
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	1.46	1.36	1.56	1.49	1.52	1.50	1.50	1.56	1.46	1.50	1.42	1.50	17.84
Total	8.49	7.27	7.08	5.82	4.52	3.67	3.43	3.53	3.33	4.75	6.07	7.84	65.79

Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

TECHNOLOGY 6

SOLAR TRACKING EXHIBIT

SOLAR TRACKING SKYLIGHTS, INC.
follow the sun...

Solar Tracking Skylights, Inc.
Cost Justification Model
***California -- Sample Site**

Building Information

1.1 watts per sq. ft. for lighting

1,200 sq footage of switchable area

1.32 Switchable kWatts

1 STS units

1,200 sq. ft./STS unit

Financial Information

$0.07 Ave. $/kWhr incl. Peak Demand

2% Annual $/kWhr Increase

$900 STS Installed Unit Cost

35% Inc Tax Rate

$0.60 Effective IRS deduction per sq ft

$648 STS After Tax Unit Cost

$0.00 $/kWhr Subsidy Rate

STS Daylighting Hours

11 Hours at 30 fc Summer

10 Hours at 30 fc Spring/Fall

8 Hours at 30 fc Winter

Site Specific Sun Parameters

68 Peak Summer Sun Angle
38 Ave Summer Sun Angle

42 Peak Spring/Fall Sun Angle
28 Ave Spring/Fall Sun Angle

21 Peak Winter Sun Angle
13 Ave Winter Sun Ang

Site Seasonal Cloudiness Data

0.6 Summer % Clear or PC

0.4 Spring/Fall % Clear or PC

0.2 Winter % Clear or PC

Dimming Parameters

30 fc @ 90% dimming

Breakeven Analysis

6,895	Hrs of Dimming needed to offset Expense
1,312	Annual Dimming hours from STS
5.25	Years to Breakeven

Life Cycle Costing

Years	IRR	Multiple of Orginal Investment
5	-1%	1
10	14%	1.9
15	18%	2.9

Notes:
*Cloudiness Data is the
average of Sacremento and San Diego

Average CA Cloudiness Data

		Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec			Total		
	Yrs	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD	CL	PC	CD
PORTLAND, OR	47	3	4	24	3	4	21	3	5	23	3	6	21	5	7	19	6	8	16	13	8	10	11	10	10	10	8	12	5	8	18	3	4	23	2	3	26	68	74	222
				31			28			31			30			31			30			31			31			30			31			30			31			364
% CL or PC				0.23			0.25			0.26			0.3			0.39			0.47			0.68			0.68			0.6			0.42			0.23			0.16			0.39

Seasonal Averages

Dec	
Jan	
Feb	
Winter Ave	0.21
Mar	
Apr	
May	
Spring Av	0.32
Jun	
July	
Aug	
Summer Ave	0.61
Sep	
Oct	
Nov	
Fall Ave	0.42
SpringFall Ave	0.37

Notes:

a) Source US National Climate Data Center
b) Data is average for two available cities in
c) CL = Clear, PC = Partly Cloudy, CD = Cloudy
d) % CL or PC = Monthly Average # of Days either Clear or Partly Cloudy

Data - US National Climate Data Center