Roof Options

TARGET CENTER

prepared for

Minneapolis
City of Lakes

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prepared by

Kandiyohi Development Partners, LLC
Renewable Energy, Sustainable Development & Consulting

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1 Executive Summary

The option of installing an extensive green roof system on the Target Center is economically feasible and is recommended by the consultant. The incremental cost difference of $400,000 between the green roof option and the conventional roof option identified by the project architect will be recouped by savings on utility costs and City stormwater fees in about five years. Renewable energy options, including photovoltaic panels and small wind systems, have a payback period of more than 10 years. Unless additional funding can be identified or leveraged for these options, the installation of solar or wind systems is not recommended at this time.

2 Project Scope

The tasks in this project included a survey of the Target Center roof with the architect, engineer and city staff and a review of the July 2005 recommissioning study by Stewart & Associates. A simplified payback model was developed for a potential green roof and wind energy system on the Target Center in December and several meetings were held with the project team. A presentation on green roof systems that are typical on similar kinds of buildings and a tour of the Central Library rooftop was conducted for City and Target Center representatives on January 4, 2007. Since then extensive research has been conducted on vendors and costs that have been used to draft simplified cost-benefit and payback analyses for several roof options:

1.) Solar electrical (photovoltaic) applications for shaving peak summer cooling loads.
2.) Green roof options as an alternative to a conventional roof replacement.
3.) Wind energy options to produce renewable energy on-site at the Target Center.

This final report recommends options for the City and Target Center related to renewable energy systems and a green roof, refines the payback analysis, lays out a contracting strategy, and develops a list of next steps for implementation of the recommendations.

Target Center,
Aerial Minneapolis

3 Recommisioning Study

As anticipated, the July 2005 recommissioning study by Sam Stewart & Associates has already identified the most cost-effective system changes and investments that could be made to reduce energy costs in the Target Center. The study also shows that the month-to-month variability in electrical usage is relatively low---between a range of about $51,000 to $63,000 (2004 $). In addition, the variability of electrical usage appears to be driven by the Target Center's event schedule and not by demands for summer cooling. In fact, the period studied in the report from July to October had the lowest monthly electrical costs.

This is largely due to the fact that the facility's cooling is primarily handled with chilled water through a contract with the downtown NRG district energy system. In 2004, the facility paid $393,187 for chilled water and only $6,382 for electrical power that was used in cooling the building. These costs are for the 70 percent of the facility that is not leased out to other tenants, such as the health club since it is assumed for purposes of this report that these tenants will continue to pay the full pass-through costs of their utilities as part of their leases. For the Target Center as a whole, the reduction in costs for chilled water to cool the building offers some real opportunities for further energy savings in the facility.

Target Center, Minneapolis

4 Solar Energy Opportunities

While Minneapolis overall has about the same solar energy potential as cities such as Jacksonville or Houston, the pattern of that solar energy is different from locations with more southern latitudes. The Twin Cities' solar capacity is a function of our longer summer days and our generally clearer, less-hazy skies in the winter-time than cities in the southeastern U.S. The following chart shows the mean number of hours of sunshine by month for Minneapolis, based on the most recent 30-year average.

Month of the Year	Hours
January	140
February	166
March	200
April	231
May	272
June	302
July	343
August	296
September	237
October	193
November	115
December	112
TOTAL	**2,607**

Downtown Minneapolis skyline on a sunny day (top) and an example of Commercial Solar Panels (bottom)

This seasonal pattern lends itself well to the use of solar electrical systems for summer peak power shaving from April through September when electricity is used for mechanical building cooling systems. Solar as a peak-shaving strategy is particularly effective if solar panels are oriented about 23 degrees west of true south and placed at a 45-degree angle to a flat roof area, maximizing output while shifting the output curve later into the day to match up with the typical demand curve for power during the summer months. However, this general ability to shave peak power usage may not be as good a match with the energy use patterns of the Target Center.

Because there is no summer electrical peak usage at the Target Center, it becomes more difficult to justify the use of solar energy in this project. This is also true because the total costs of solar energy remain high relative to other options. For example, materials and installation of a solar electrical system are likely to average $7,500 per kilowatt, or

$225,000 for a 30-kilowatt system. That system would produce about 80,000 kilowatt hours of electrical power a year at an average value of about $6,400 a year at a value of 8 cents per kilowatt hour. Because solar is generally produced and consumed on-site without any transmission within the power grid, it competes with retail rather than wholesale rates. However even this advantage still gives the solar electrical system a simple payback of 35 years, too long for most applications unless prices for electrical power rise dramatically or solar energy is subsidized.

The costs for installation of a solar electrical system do not include any costs for battery storage. Minnesota has a "retail metering" rule that requires utility companies to buy back any surplus solar or wind power that is generated by systems of 40 kilowatts or less. That means the local grid system acts as the "battery" for any excess power that is being generated beyond what is being consumed on-site.

There are several state and federal programs that provide incentives for the use of solar energy and these incentives can significantly reduce that payback period. At the federal level, there is a 10 percent investment tax credit for solar, equal to $22,500 in the example above. There is also a new $3,000 federal credit for solar, but it is limited to residential users. In Minnesota, the State offers a solar rebate of $2,000 per kilowatt for solar up to four kilowatts or $8,000 and abates the State sales tax on solar equipment. The State's direct solar rebate is nominally limited to residential applications although it has been used for commercial applications and the rebate has been extended to systems larger than four kilowatts. (The Green Institute received $68,000 in State rebates in 2003 for its 34-kilowatt solar energy system.)

While the rebates for solar could potentially be sought and would benefit the project's payback, the federal tax credit requires the applicant to be a Chapter C corporation or otherwise be a taxable entity with passive income. And because the Target Center is owned by a public agency, there is no taxable liability against which to apply the federal tax credit. The same barrier exists to taking a depreciation deduction on the solar equipment itself. There are some creative financial structures that have the solar energy equipment owned by a taxable third party which would then lease the system to the Target Center. If the project was able to access the federal investment credit and the State rebate on the full system, the simple payback period would be reduced to about 18 years.

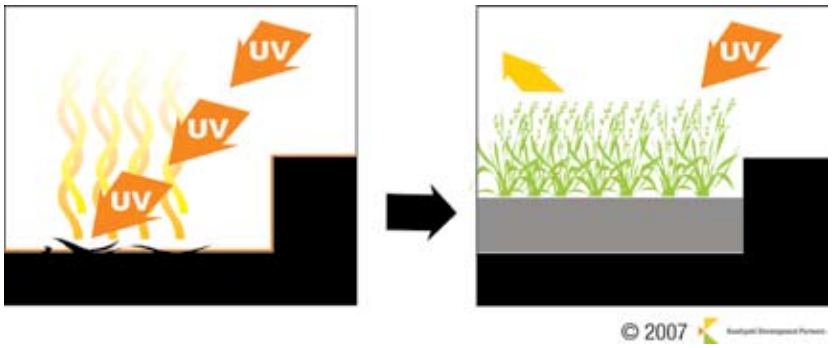
Solar panels on the roof of a public building (top). Downtown Minneapolis skyline at dawn taken from the South(bottom).

Unless the Target Center is able to leverage reduced costs on equipment or labor, or receive some grant funding for a solar energy system, it appears that solar energy is not the most cost-effective option for the facility.

Even if upfront funding could be found for installation of solar energy at the Target Center, another significant barrier exists in the weight-bearing requirements that a solar panel array would add to the rooftop. Even a pan-ballasted solar panel system would add 5-10 pounds per square foot of localized weight to the roof structure, beyond the parameters for this project as set by the project architects.

5 Green Roof Options

Minneapolis has about 50 green roof installations and the number has doubled within the last five years. Green roofs offer a number of public benefits such as management of stormwater, improved air quality and a reduction in the heat island effect that leads to a concentration of air pollution in the downtown area.



Increasing the life span of roof membranes reduces the volume of roofing materials landfilled and can reduce ongoing costs for re-roofing public buildings.

There are also private benefits to green roofs, primarily from the reduction of energy costs by having a cooler roof and increasing the R-value of the roof area to at least 30 to 36. In addition, green roofs have been shown to extend the lifetime of the roof membrane from 15-20 years to 35-50 years. If a high-quality green roof is constructed on the Target Center, it could possibly be the last roof that the facility ever needs.

The Target Center roof lends itself well to an "extensive" green roof system which requires a growing medium layer of no more than six inches. An extensive system may have as little as two inches of growing medium, however in high-wind areas such as the Target Center rooftop, at least four inches is recommended to assure the survivability of green roof vegetation. For this reason, a green roof on the Target Center should have a growing medium layer of no less than four inches.

An extensive system is also one that is typically not accessible to people other than for occasional maintenance or other needs for roof access. If Target Center wishes to make its green rooftop accessible for events or tours, a structural analysis will be required to determine the weight-bearing capacity of the roof in those areas where people would be walking on green roof areas.

An extensive green roof can be expected to reduce heating and cooling costs by at least 20 percent over a roof system such as the one that is currently in place. And an extensive green roof with at least 2.5 inches of growing medium will hold about a one-inch rainfall in a 24 hour period, which will accommodate about 80 percent of all rain events in Minneapolis. And even at its water-saturated weight, an extensive green roof at 15 pound per square foot or less is comparable for load bearing to a standard roof with rock ballast such as the current Target Center roof. This may require the use of engineered soils such as baked shale or other growing media that are specifically designed to be light weight.

Aside from reducing energy costs, reducing peak demand helps the City to achieve its commitments to meet the greenhouse gas reductions in the Kyoto Protocol Treaty.

Several local and national green roof contractors were contacted about this project and the average all-in cost for installation, including design and engineering services as well as plants, was about $15 a square foot. That compares with the architects estimated cost of about $12.5 a square foot for a high-quality EPDM membrane roof with added insulation that would bring the roof R-value to 36. This EPDM system is a more advanced roof system that reflects much of the solar radiant energy and would add significantly to the insulation value of the Target Center roof.

The highly insulated EPDM roof system would provide about 80 percent of the energy savings in cooling over the current roof system, although it has none of the stormwater management benefits. In this particular project, such an EPDM system sets a higher-cost baseline against which the green roof costs are being compared, making the cost differential between the two options much less than it might be between the green roof system and a more conventional roof option.

This pitched garage green roof in the Marcy Holmes neighborhood demonstrates that ultra-lightweight systems can be installed with little or no additional structural support.

It should be noted that the Target Center structure is cantilevered over the sidewalk and thus has a building footprint for purposes of the City stormwater utility of 128,000 square feet but an estimated roof area of 144,000 square feet. In other words, it would be possible to achieve a 100 percent credit on the City stormwater fee with a 128,000 square-foot green roof, which would allow approximately 16,000 square feet, perhaps at the roof edges and around the rooftop mechanical systems, to be re-roofed other than as a green roof.

In calculating the cost differences between a green roof or EPDM roof system, it is assumed that both approaches would encounter relatively expensive costs for tear-off and removal of the existing roof and rock ballast because of the building height and the need to mobilize a crane system for moving roofing materials up to the Target Center rooftop itself. Generally, the green roof contractors we contacted estimated that the costs for tear-off and removal of roof materials and ballast would be $1-2 a square foot and the mobilization of a crane would be $400-600 an hour with a minimum of 60-75 hours required to complete the work if the project was carefully synchronized. Again, the costs for tear-off and a crane for hoisting of new roof materials would be borne by every roof option. For purposes of comparison, the City and Target Center should make certain that any bids include the fully-loaded costs, including these items.

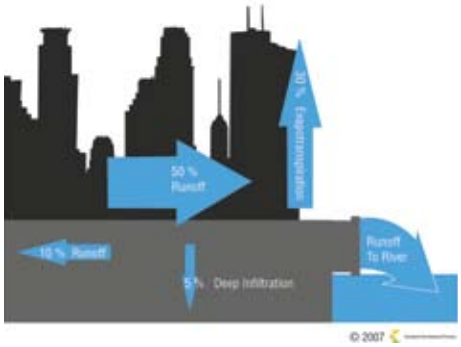
It certainly may be possible to drive down the average costs given by contractors for installation of a green roof system. A recent retrofit roof project in Chicago constructed an extensive green roof system on a similar kind of building for less than $12 a square foot and had weight bearing of less than 15 pounds per square foot. Photos of this roof project are included in the PowerPoint presentation that was shown at the Minneapolis Central Library green roof tour on January 4, 2007 and that is attached as an addendum to this report.

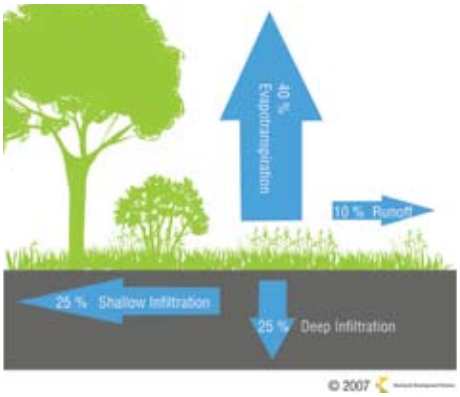
Although the Target Center project is likely to have some higher costs due to the height of the building and other factors, in our conversations with vendors, there appears to be a willingness to aggressively bid this project because of its scale, high-profile and potential marketing benefits for the firms involved. This could offer an opportunity to provide some product or firm branding and visibility in the arena for the green roof company in exchange for a reduced-cost bid on the project.

The semi-intensive green rooftop at the Phillips Eco-Enterprise Center contains many features of an extensive green roof while providing amenity space for 30 people.

6 Energy and Stormwater Fee Paybacks from a Green Roof System

Based on the facility's chilled water usage for 2004, it is estimated that a green roof would reduce cooling loads at the Target Center by at least 20 percent during the peak cooling period from June through September and reduce chilled water costs by 10 percent during other months of the year, resulting in a savings of at least $65,260 a year plus an additional savings of $1,276 in electrical costs for cooling.





Green roofs can reduce the peak volume and overall volume of stormwater in the City's storm sewers and sanitary sewer system.

In addition, the City of Minneapolis abates 100 percent of a property owner's stormwater utility fee for green roof areas that meet or exceed the site's impervious surface area. The City stormwater utility fee is currently based on $9.17 for each Equivalent Stormwater Unit (ESU) or each 1,530 square feet of impervious surface. The Target Center currently pays an annual stormwater fee of $9,206.

The combined annual savings in cooling costs and abatement of the stormwater fee is estimated at $75,742 in 2004 dollars. With a cost difference of $400,800 between the conventional and green roof options, the simple payback on the green roof is about 5.3 years. This estimate does not include any maintenance costs which may be slightly higher in the initial years of a green roof while it is becoming established, or savings in maintenance costs over time due to the much longer useful life of a green roof membrane system. Payback calculations may also be done based on the Net Present Value of the investment today in a green roof system and with some assumption about increases in the costs for energy and stormwater utility fees. However, it has been our experience that these two calculations, one extending the payback period and one reducing it, add complexity to the model while mostly tending to offset each other.

7 Simple Payback Analysis on an Extensive Green Roof System

CAPITAL BUDGET

GREEN ROOF	COST
128,000 SF @ $15	$1,920,000.00
16,000 SF @ $11	176,000.00
Total	$2,096,000.00
5% Contingency	104,800.00
TOTAL	**$2,200,800.00**
Conventional Roof Cost (Estimate)	*$1,800,000.00*
Green Roof Incremental Cost	*$400,800.00*

PAYBACK ANALYSIS

Total Additional Green Roof Investment	$400,800.00	$400,800.00
6-year energy savings	$391,560.00	
Abatement of stormwater fee (6 years)	55,236.00	
Total savings/offsets	$446,796.00	446,796.00
Six-year payback benefit		$45,996.00

8 Wind Energy Options

This analysis was not strictly within the scope of the original project scope of work, however the issue came up with the project team and some very preliminary analysis was done because of the height and unobstructed opening of the Target Center roof area to the prevailing winds from the west and north. While not nearly as well suited as western Minnesota, Minneapolis has moderately good wind resources with an annual average wind speed of 11 miles an hour. This overall capacity for wind energy generation would be enhanced by the elevation of a wind energy installation on the Target Center.

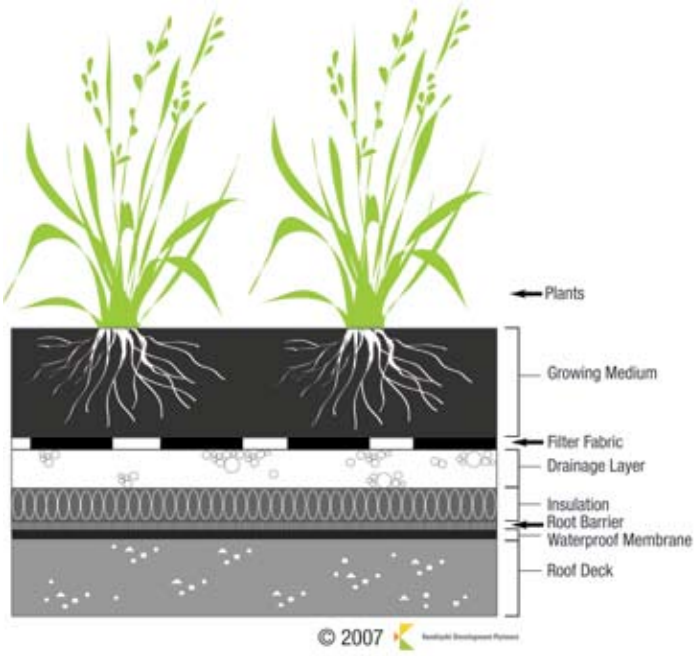
There are a number of new, urban-oriented wind technologies that would be applicable to the facility, including several with local vendors and installers. One of the systems that was analyzed is a swept-blade, one kilowatt generator. Average, all-included costs for equipment and installation is about $5,000 per kilowatt, or $150,000 for a 30 kilowatt system. Based on a capacity rating of 40 percent (e.g., the blades are turning and producing energy 40 percent of the time), the wind energy system would produce 105,120 kilowatt hours of electrical power a year with an average value of about $8,410 a year for a simple payback of about 18 years.

However, as with solar energy, there are extensive 10-year production tax credits and other depreciation and investment credit incentives for wind that could bring this payback down to 10-12 years. Additionally, like solar, there is a challenge in fully utilizing the tax credits and deductions against income because the facility is owned by a non-taxable public entity.

Prairie Technologies,
Rockford MN
ER Systems Green Roof

9 Contracting Strategy

There are a number of components that make up a green roof system that need to be assembled through a project manager, subcontractors and/or a general contractor. A consultant could act as project manager coordinating the design and implementation of a green roof or facilitating an RFP process for contractors as an advisor to the City and Target Center. In developing a green roof system, the City and Target Center need to hire qualified vendors and installers for each of the following components:



Several companies will offer a complete package within their own firm, using technologies owned or licensed to them, or they can assemble a team that includes the separate components. In large scale projects such as the Target Center often design and engineering is handled separately from the other installation contractors. Depending on the scope of work, there are at least five qualified firms locally that can be expected to bid on the project individually or as part of a team.

A **green rooftop** is any vegetated area that is designed as a permanent and integral part of a roofing system and that includes the components generally associated with current green roof technology, including a water-proof membrane, root barrier, drainage system, growing medium and living plant matter.

10 Recommended Next Project Steps

Based on the information and conclusions in this report, KDP recommends that the City and Target Center proceed with installation of a green roof system. If the City and Target Center decide to proceed, the following steps will need to be coordinated:

1. Direct a structural engineer to provide a structural assessment of the Target Center roof that evaluates green roof load factors in conjunction with other load factors and identify roof areas that are above or below average weight baring capacity.

2. Develop a list of possible funding sources, such as grants or corporate contributions, which would reduce the incremental cost differences between the EPDM roof option and a green roof.

3. Assist the City in making the decision on whether to pursue an outside project management "turn key" approach or whether to implement through an RFP process with an internal City project manager.

4. Conduct a pre-bid conference with potential vendors; this can be done following the format of the Green Roofs for Healthy Cities 201 training course.

5. Develop a bid package, solicit proposals and form a project team to review the bids and recommend the firm(s) to be awarded the project.