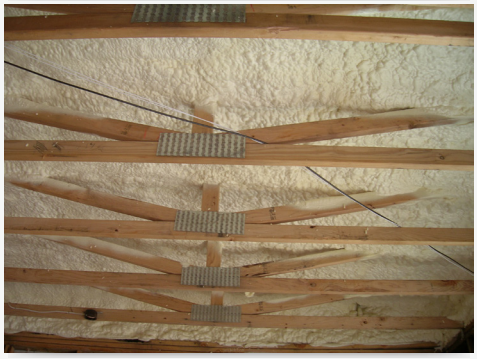


Dolph Creek Townhomes

A new, 14-unit townhome development flanks the restored headwaters of Tryon Creek in Southwest Portland. Very efficient heating and domestic hot water systems and an advanced building design help the project see more than 30% annual energy savings. Storm basins along the creek edge were replaced with ecoroofs, moving water quality and stormwater management from the site to the roof. Other focus areas include indoor air quality, water use efficiency, recycling and use of local and recycled content materials. The project was a LEED for Homes pilot project.

Project Highlights

- **Solar panels**
- **Hydronic heating system**
- **Ecoroofs**
- **Creek area restoration**
- **LEED Silver standard**
- **Energy Star and EarthAdvantage Certifications**
- **Polyfoam insulation and energy efficient windows**
- **100% construction and demolition recycling**

Portfolio Contents

- **Final Report**
- **Monitoring & Verification**
- **Case Study**

EnergyTrust of Oregon
Portland Water Bureau — From Forest to Faucet
Environmental Services
Bureau of Planning and Sustainability — Innovation. Collaboration. Practical Solutions.
City of Portland, Oregon
Sam Adams, Mayor • Susan Anderson, Director

Portland Office of Sustainable Development
G/Rated Green Investment Fund

Grantee Final Report

PROJECT INFORMATION

Name of Primary Contact: Shawn Sullivan
Company or Organization: Dolph Creek LLC
Address: 210 SW Morrison Street, Suite 600
City, State & Zip: Portland, Oregon 97024
Phone: 503-225-1272 Fax: 503-273-8591
E-mail: sarch@europa.com

PROJECT DETAILS

Project Name: The Dolph Creek Townhomes
Project Owner: Dolph Creek LLC
Project Address: 3102~3154 SW Dolph Court
City, State, ZIP: Portland, Oregon
Directions to Site: The intersection of SW 30th and SW Dolph Court
Date Project Started: Fall of 2005
Date of Completion: Winter of 2006

Design and Construction Team
Architect or Designer: Sullivan Architecture LLC
General Contractor: R&H Construction
Landscape Architect: Green Works PC
Structural Engineer: James Pierson Inc,
Civil Engineer: MGH Associates
Mechanical Engineer: Jacobs Heating
Electrical Engineer: Porter Electric
Interior Designer: Sullivan Architecture LLC
Environmental Building Consultant: EarthAdvantage
Energy Modeler: EarthAdvantage

Building Details
Gross Floor Area: 29,962 square feet

Building Type
[ ] Single-family Residential
[√] Multi-family Residential
[ ] Commercial
[ ] Industrial
[ ] Institutional
[ ] Mixed-Use
[ ] Other (describe)

Site Conditions (check all that apply)
[ ] Previously Undeveloped Land
[√] Previously Developed Land
[ ] Brownfield Site
[ ] Preexisting Structure(s)

Project Type
[ ] Renovation
[√] New
[ ] Addition

Green Products & Materials: Must include projected performance, efficiency ratings, equipment ratings or product certifications for all green building products outlined in Exhibit 1, for example, FSC wood, Energy Star Appliances, Green Seal etc..

- Solar Panels
- Regulating on-demand water heating
- HRV's with hydronic forced air system
- Exterior sun screens
- Ecoroofs
- Lowflow toilets (1.1 gpf average)
- Formaldehyde-free cabinets
- Low VOC paints
- Green Label carpets
- Advanced energy windows
- Drip irrigation system, and water quality planting
- Polyfoam insulation
- Exhaust fans in garages
- Restoration of the creek area.
- LEED Silver
- Energy Star Certification
- EarthAdvantage Certification
- 27% energy savings above code
- 100% construction and demolition recycling

Green Venders & Suppliers Used

- EarthAdvantage; LEED and Energy Consultants
- Interfluve, Inc; Applied River and Wetland Restoration
- Mr. Sun Solar: Solar Panels
- Jacobs Heating and Air Conditioning: HRV and forced air system.
- Intergraded Energy Systems; Spray foam applications.
- Tapani Plumbing Inc.: Low flow toilets and On-demand water heaters.
- Bamboo Craftsman Co
- General Electric Co: EnergyStar Appliances
- Lanz Cabinet Shop: Formaldehyde-free cabinets
- Mid-Valley Glass: Jeld-Wen Windows
- Porter Electric: EnergyStar Lighting

PROJECT HIGHLIGHTS

List Innovative Sustainable Technologies & Practices

- Hydronic forced-air heating systems with hot water supplied from on-demands gas water heater, and the domestic supply to the water heaters is pre-heated by passive solar. After the heated water passes through the forced air coils it is returned to the solar storage tank, which supplies the on-demand water heater, forming a closed loop system.
- The restoration of a creek to the surface that previously was flowing into the City of Portland storm sewer system.
- Complete onsite storm water management, including quality and storage from 100% of building and site impervious surfaces.

Project Costs
Land Acquisition: $850,000
Site Clearing/Deconstruction: $28,541
Site Development: $125,919
Public Improvements: $32,000
Design Fees: $152,217
Permits: $19,441
System Development Charges: $79,947
Construction: $2,700,000
Green Technologies: $156,314

Project Cost by measure

Measure: **Solar Panels**
General Contractor Cost: 63,000
Equipment: 49,500
Labor: 13,500

Measure: **Regulating on-demand water heating**
General Contractor Cost:
Equipment: 7,400
Labor:

Measure: **HRV's with hydronic forced air system**
General Contractor Cost:
Equipment: 13,174
Labor:

Measure: **Exterior sun screens**
General Contractor Cost: 26,000
Equipment: 13,900
Labor: 12,100

Measure: **Ecoroofs**
General Contractor Cost: 13,006
Equipment: 3,400
Labor: 9,606

Measure: **Lowflow toilets** (1.1 gpf average)
General Contractor Cost: 3,314
Equipment: 3,314
Labor:

Measure: **Formaldehyde-free cabinets**
General Contractor Cost: 4,462
Equipment: 4,462
Labor:

Measure: **Low VOC paints**
General Contractor Cost: 2,100
Equipment: 2,100
Labor:

Measure: **Green Label carpets**
General Contractor Cost: 26,400
Equipment: 19,800
Labor: 6,600

Measure: **Advanced energy windows**
General Contractor Cost: 37,000
Equipment: 37,000
Labor:

Measure: **Drip irrigation system, and water quality planting**
General Contractor Cost: 13,000
Equipment: 5,590
Labor: 7,410

Measure: **Polyfoam insulation**
General Contractor Cost: 23,514
Equipment: 16,460
Labor: 7,054

Measure: **Exhaust fans in garages**
General Contractor Cost: 6,860
Equipment: 3,500
Labor: 3,360

Measure: **Restoration of the creek area.**
General Contractor Cost: 177,734
Equipment: 80,000
Labor: 97,734

Measure: **LEED Silver, Energy Star Certification, EarthAdvantage Certification**
General Contractor Cost: 6,800
Equipment:
Labor:

Financial Savings & Benefits

Energy:
Hard Cost Savings and/or Cost Tradeoffs: $0.00
Projected or Actual (Circle One) Operational Cost Savings: 45% above code
Incentives: Grants, Tax Credits, Below Market Loans: GIF Grant, BETC for solar, Federal tax credit for solar.

Water:
Hard Cost Savings and/or Cost Tradeoffs: $0.00
Projected or Actual (Circle One) Operational Cost Savings: 1.2 gpf toilets, 2gpm shower heads, drip irrigation
Incentives: Grants, Tax Credits, Below Market Loans: GIF Grant

Stormwater:
Hard Cost Savings and/or Cost Tradeoffs: $0.00
Projected or Actual (Circle One) Operational Cost Savings: Clean River Rewards Program
Incentives: Grants, Tax Credits, Below Market Loans: $0.00

Materials:
Hard Cost Savings and/or Cost Tradeoffs: $0.00
Projected or Actual (Circle One) Operational Cost Savings: $0.00
Incentives: Grants, Tax Credits, Below Market Loans: $0.00

Environmental Benefits

Annual or Modeled Energy Savings (beyond code): 45% (see attached modeling provided by EarthAdvantage.)
Materials Savings: 0%
Annual CO2 Emissions Savings: Unavailable
Annual Water Savings: 2 gpm shower heads, dual 1.2 gpf toilets, drip irrigation system with 100% drought resistant planting.
Construction Waste Diversion: 1.2 pds per building sf transferred to land fill. Remaining waste recycled.
Annual Reduced Rainwater Runoff: 100% onsite stormwater management, quality and retention)
Enhanced Habitat: Stream restoration and water quality features

Community Benefits
The demolition and removal of a deteriorating vacant building with multi-care asphalt parking lot, the removal of over 2,000 tons of contaminated materials, and its replacement with sustainable housing project that included a stream restoration.

DESIGN & CONSTRUCTION

In our initial meetings with Bureau of Environmental Services it was discovered that a former headwater to Tryon creek was buried in a culvert and crossed the site in an encroachment without any easements. Therefore from the onset of the project, restoration and environmental stewardship was established as guidelines. Before design on the Dolph Creek Townhomes began, meetings were meetings were held with EarthAdvantage Engineers to review new energy innovations that could be applied to the design. While major elements were targeted before the design, research and development continued to refine and adapt during the process, even during construction.

Design-build sub-contractors were involved in the development of the innovative energy and sustainable solutions from the start of Design Development.

IMAGES AND GRAPHICS

See attached **LEED for Homes Accountability Form Response**

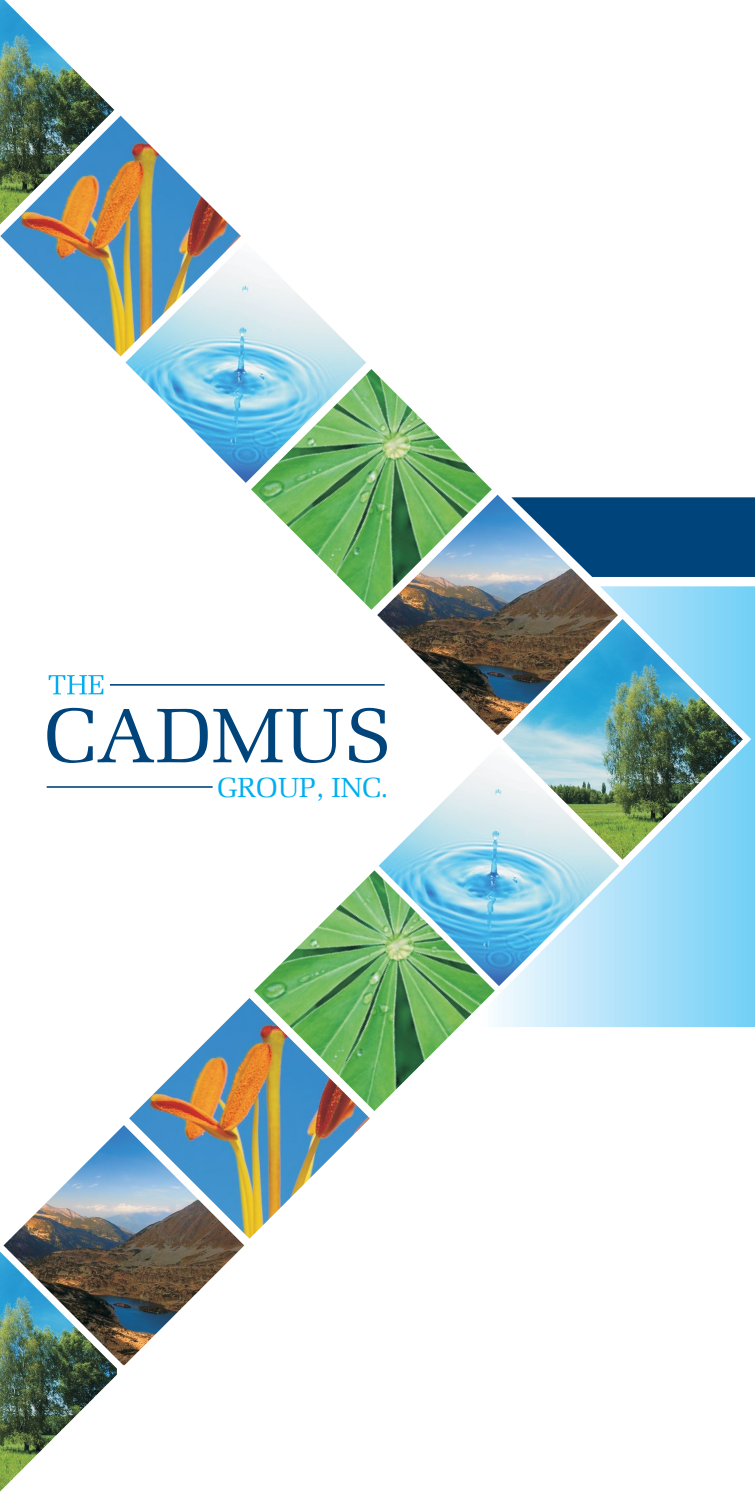
BUILDING CERTIFICATION

LEED Silver
EarthAdvantage

LESSONS LEARNED

The Dolph Creek Townhomes site is located on the outside edge of one of METRO's recognizable inner city urban town centers. The developer therefore hoped that his substantial investment in "green" improvements would help generate value and recognition. While the project received substantial recognition, the Green Building Practices did not develop the perception of value in the potential purchasers at the marketed price point. The cost to provide the extensive sustainable improvements pushed the market price of the Townhomes into a price point where purchasers were more interested in esthetics and location over sustainability.

Commercial construction recycling needs to be controlled by the City of Portland. While projects can achieve responsibility of recycling separation onsite, it cannot be the General Contractors responsibility to monitor the material once it leaves the site. Haulers can represent the material to be recycled, when in fact the containers with 100% separated recyclable material are being delivered to a transfer station and mixed with contaminated material, which is then separated to meet standards set on lower percentages of recycling.



THE CADMUS GROUP, INC.

GIF PROJECT M&V PLAN AND REPORT: DOLPH CREEK TOWNHOMES

REPORT

December 7, 2010

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1. Executive Summary

Dolph Creek, LLC developed the Dolph Creek Townhomes (DCT), a project that received funding from the Portland Bureau of Planning and Sustainability's Green Investment Fund (GIF). The philosophy of this project was to create a "comprehensive, practical, best practices model for townhome development that could be exported and incorporated into other projects," thereby showcasing the compatibility of dense urban growth with sound environmental design.

Green features implemented through this project included a solar water heating system with a variable on-demand water heater for backup, heat recovery ventilation (HRV) with hydronic forced air system, drip irrigation, and ecoroofs on the smaller units. ENERGY STAR appliances and eco-flooring were also installed, and low VOC paints were used.

The energy analysis began with review of a REM/Rate model developed by Earth Advantage for one townhome. The REM/Rate model also included a counterfactual version of the as-built model that used building characteristics based on Oregon Energy Code. Cadmus applied additional savings to the model's estimates for other installed efficiency measures, such as lights and appliances. One year of billing data was used to confirm usage. Cadmus calculated solar water heating energy savings by modeling the system with RETScreen, an Excel-based tool developed by Natural Resources Canada.

The final step was to extrapolate the savings from this one townhome to the other homes, using summary reports from the REM/Rate analysis and accounting for additional savings from the installed efficient measures. Cadmus found the modeled townhome's estimated total energy use was approximately 45% less than a comparable home built to code. Cadmus also determined the average energy savings across all townhomes was 44%.

All GIF projects starting with those funded in 2006 are required to document construction and demolition waste. The program requires recycling 100% of this waste. The developers attempted to meet the 100% construction and demolition waste recycling requirement by hiring Traschco Services to recycle the waste. Insufficient data were available, however, to determine if the goal was actually met.

2. Project Description

General Project Characteristics

Dolph Creek, LLC developed the Dolph Creek Townhomes (DCT). Dolph Creek, LLC was established specifically for this project with Jim Winkler as the overall manager. The project received funding from the Portland Bureau of Planning and Sustainability's Green Investment Fund (GIF). The architect was Shawn Sullivan with Sullivan Architecture. The philosophy of this project was to create a "comprehensive, practical, best practices model for townhome development that could be exported and incorporated into other projects," thereby showcasing the compatibility of dense urban growth with sound environmental design. The developer's underlying goal involved demonstrating development can help restore the environment through design and engineering. The developer experimented with efficient combined heating and domestic hot water systems, rainwater runoff reduction, and an advanced building design.

The townhome project is a part of a larger development that consists of two other buildings: a 100-unit apartment building and a 56-unit affordable senior apartment complex. The development is located on the corner of SW 30th Avenue and SW Dolph Court in Portland. The 14 units for Dolph Creek Townhomes are separated into two rows. The overall development and the townhomes are shown in **Error! Reference source not found.**Figure 1. Each townhome has two bedrooms, 2.5 bathrooms, a den, and a garage, with an area of roughly 1,560 square feet.

Figure 1. Aerial and Side Views of Dolph Creek Development

The project was proposed for completion in fall 2006. It was completed in December 2006 and owners started to move in on April 1, 2007. Not all the units were sold or occupied at the outset; as of mid-2007, eight out of the 14 units had been purchased. At present, approximately 20 people are living in the townhomes.

Proposed Green Features

The green features and practices originally proposed for the units in this project are listed in Table 1. Major green features originally proposed included an efficient heating and domestic hot water system and restoration of the headwaters in the Tryon Creek watershed. The evaluation team also noted where additional green or energy-efficient features were installed, but not

included as part of the Green Investment Fund (GIF) program. Measures that were part of the GIF are indicated in the second column in the table.

Table 1. Proposed and Verified Green Features

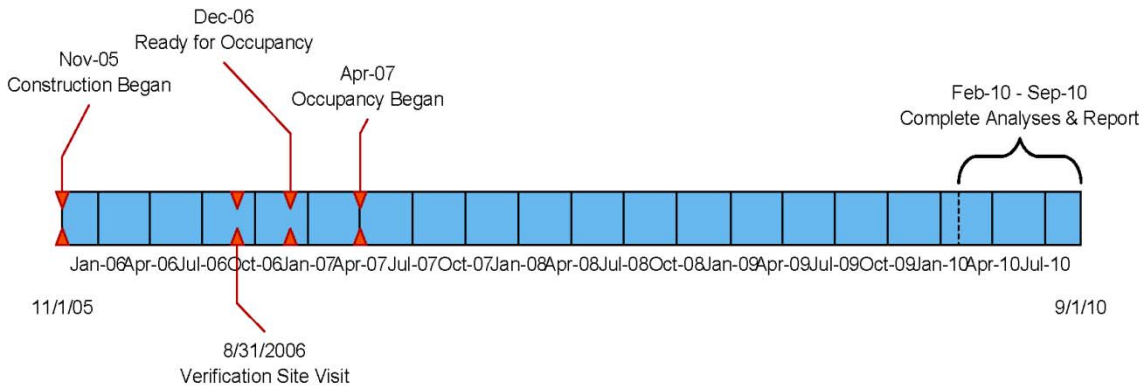
Proposed Measures	GIF Measure?	Installed?	Comments
Exterior			
Drip irrigation system	Yes	Yes	Confirmed by Shawn Sullivan, 1/25/07
Ecoroof on smaller units	Yes	Yes	Confirmed by OSD on 1/29/07
Restoration of the headwaters to the Tryon Creek watershed	Yes	Yes	1,000 lineal feet of subterranean storm line was replaced with a stream and infiltration basin -apart of the storm water management system
Exterior sun screens	Yes	Yes	Metal structure south facing
Building Envelope			
Polyfoam insulation used at all roof decks and mechanicals	Yes	Yes	Confirmed by Shawn Sullivan, 1/25/07
Eco-flooring main floor (type)	No	Yes	Bamboo flooring
Eco-flooring carpet (green label)	Yes	Yes	Confirmed by Shawn Sullivan, 1/25/07
Energy efficient windows	Yes	Yes	Jeld Wen windows: vinyl, U-0.31, SHGC-0.24, visible transmittance-0.45
Low VOC finishes used throughout interior	Yes	Yes	Interior paints: Sherwin Williams Harmony zero VOC
Energy Efficiency			
On-demand water heaters	Yes	Yes	Takagi (T-K20) DWH and Space
Heat Recovery Ventilation (HRV) with hydronic forced air system	Yes	Yes	HRV: Honeywell 208370 REV / Electric furnace: International Comfort Products Mark MV12F 1900A4
Solar thermal collector	Yes [	Yes	Alternative Energy Technologies, AE40 with 80 gallon storage tank and PV module to provide power to pump, GE GEPV 030 MNA 01
ENERGY STAR appliances	No	Yes	Dishwasher (GE PDW7880J) and refrigerator (GE PSW23PSTASS)
Energy efficient air conditioner (optional upgrade)	No	Yes	A/C: International Comfort Products ED 2X2r FA1
Other: Garage Exhaust Fan	Yes	Yes	Confirmed during site visit
Other			
Low-flow showerheads/faucets	Yes	Yes	Confirmed by Shawn Sullivan, 1/25/07
Low-flow toilets	Yes	Yes	Sterling: 1.1 g/flush, dual flush
Formaldehyde-free cabinetry and wood products	Yes	Yes	Confirmed by Shawn Sullivan, 1/25/07
Construction waste and recycling program 100%	Yes	Yes	2,880 lbs hauled by Traschco; had project-wide wood, concrete, cardboard recycling arranged through Waste Management

M&V Scope and Schedule

In accordance with the priorities identified by the Portland Bureau of Planning and Sustainability, the M&V focus was on energy use, rainfall runoff reduction, and construction and development (C&D) waste. Cadmus performed the M&V for this project. Cadmus focused on review of the installed green features and conducted the energy analysis and review.

Our schedule for M&V activities is shown in Figure 2.

Figure 2. Dolph Creek Townhomes Construction and Analysis Timeline



3. Verified Green Features

Cadmus scheduled and performed a detailed site visit to verify the green measures were present and properly installed. Measures were visually verified, when possible, for those involving the use of recycled material or environmentally-friendly products (e.g., bamboo flooring). In other cases the developer, Jim Winkler, or Sullivan Architecture provided documentation or confirmed the use of the material or product. Table 2 shows a summary of the energy-efficiency measures as compared to baseline, code requirements.

Table 2. Comparison of Energy Efficiency Measures

Measure	Code Requirement (Counterfactual)	Project As-Built
Windows	U-value 0.40 (OR Code)	U-value 0.31
Wall Insulation	R-21 (OR Code)	R-21
Floor Insulation	R-25 (OR Code)	R-30
Ceiling Insulation	Flat: R-38 (OR Code) Vault: R-21 (OR Code)	R-38 for flat, and R-30 for vault, with polyurethane expanding foam spray
Space Heating	Gas Furnace, AFUE 78%	HRV with hydronic forced air system, 90% efficient
Infiltration	0.40 ACH	Average 0.325 ACH[1]
Solar Water Heating	None	Alternative Energy Technologies, AE40
Appliances	Standard efficiency	ENERGY STAR refrigerator and dishwasher

The solar water heating system consisted of a 4’ by 10’ solar thermal collector with an 80 gallon storage tank. A 30-watt photovoltaic module operated the pump for the recirculating glycol loop between the panel and the tank's heat exchanger. Domestic supply to the water heating source was then drawn from the storage tank, where the temperature could range from 60 to 140 ºF.

To maximize energy efficiency, the backup water heater needed to adapt to varying supply temperatures from the storage tank. A variable on-demand water heater was selected because of its ability to perform this task. The resulting hot water was available for both domestic supply and a hydronic loop through the forced air electric furnace. Pre-heated water was drawn from the solar tank, through the on-demand water heater, and delivered to the furnace at approximately 160 ºF. Discharge water left the furnace at approximately 80 ºF, where it was returned to the solar storage tank, forming a closed loop supply system.

The forced-air mechanical heat delivery system was designed as a heat recovery ventilator (HRV) with hydronic heating coil. The HRV supplied conditioned air exchanges, acted as a dehumidifier, and was connected to the bathroom exhaust as a heat exchanger.

[1] Earth Advantage blower door test; values ranged from 0.28 to 0.35 ACH

4. Energy Savings

Analysis Approach

Our energy analysis approach began with review and verification of assumptions by Earth Advantage used to estimate initial savings for one townhome. Their analysis applied REM/Rate software to determine a score using the Home Energy Rating System (HERS). The HERS index indicates the relative efficiency of a home as compared to a conventional reference home using a scale from zero (net zero energy home) to 100 (code compliant home). In addition, we reviewed results from the blower door tests conducted by Earth Advantage.

The next step involved taking the REM/Rate model energy usage, applying additional savings estimated for other installed efficiency measures, such as lights and appliances, adjusting for occupancy, and comparing the adjusted usage to billing data collected over one year. If the adjusted model produced yearly consumption estimates (heating, lighting, etc.) consistent with the billing data, then the model and baseline (counterfactual) model could be considered an accurate portrayal of the actual building. The REM/Rate model also included a counterfactual version of the as-built model that used building characteristics based on Oregon Energy Code. The limited scope of this study did not permit detailed analyses of all unique features, but we were able to extract a considerable amount of useful information from the available data.

The final step was to extrapolate the savings from this one townhome to the other homes, using summary reports from the REM/Rate analysis and applying additional savings from the installed efficient measures.

Description of Simulation Model and Other Analysis Tools

The special features of these homes required unique analyses and provided useful insights into energy usage performance. Earth Advantage modeled the townhomes with REM/Rate software to determine savings in gas and electric costs resulting from structural and mechanical improvements over code. A separate model was created for each townhome, after the homes were built, so the actual as-built characteristics were used. The model accounted for all mechanical systems and ventilation, as well as windows, ceilings, roofs, walls, floors and infiltration. Initial analysis used data from one townhome. The primary focus was on energy savings for heating and water heating end-uses, as shown in Table 3.

Table 3. REM/Rate Annual End-Use Consumption (MMBtu) for One Townhome

End Use	Baseline (Code)	As-Built	Savings
Space Heating	39.40	27.50	11.90
Water Heating	19.30	4.60	14.70
Lights and Appliances	20.73	20.68	0.05
Total	**79.43**	**52.78**	**26.65**

The as-built model results were compared to one year of post-occupancy gas and electric bills provided by the owner of one unit. REM/Rate used default values for lighting and appliance

energy usage, which showed little to no savings in these areas. Cadmus calculated additional savings for the dishwasher and refrigerator because they were ENERGY STAR certified. CFLs were installed instead of code incandescent lighting, which contributed to additional energy savings, as shown below in Table 4.

The analysis approach for the efficient appliances was relatively straightforward. Energy savings were estimated from ENERGY STAR calculators by comparing annual usage for the refrigerator and dishwasher to baseline, non-ENERGY STAR appliances with the same specifications. Cadmus estimated annual baseline energy usage for lighting with data from an analysis of Puget Sound new single-family construction. These data were calibrated from billing data in the context of developing end-use energy consumption values on a recent Resource Potential Study for Puget Sound Energy. The townhome lighting fixtures used CFLs, so as-built lighting energy usage was adjusted to 30% of baseline, incandescent fixtures.

Solar Thermal Analysis

Cadmus calculated solar water heating energy savings by modeling the system with RETScreen, an Excel-based tool developed by Natural Resources Canada. The RETScreen inputs include site location, number of occupants, back up water heating fuel, estimates of daily hot water use, and solar collector and storage system characteristics. RETScreen contains a database of product specifications and monthly average solar irradiance characteristics by location. The software uses these values to calculate an annual energy savings estimate.

Results

Earth Advantage calculated the air changes per hour (ACH) from the results of blower door tests for all townhomes. The resulting values indicated the superior construction of these homes. Natural ACH were found to be 0.28 to 0.35 ACH, with an average of 0.325 ACH. The code baseline was 0.4 ACH, so the townhomes' performance represented about a 20% improvement. A number of other factors contributed to REM/Rate estimated savings. As-built windows with a U-factor of 0.31 were reported to achieve 21% savings over baseline windows with a U-factor of 0.40. Frame floors with R-30 insulation were reported to have 26% savings over baseline floors with R-25 insulation. As noted, the lower infiltration in the as-built case contributed significantly to overall savings. The REM/Rate analysis accounted for savings from the on-demand water heater as compared with a standard gas water heater, as well as savings from low flow showerheads and faucets. Earth Advantage also performed a Duct Blaster® test, which indicated a 90% improvement in the duct leakage rate over a standard home built to code.

Total energy usage for the townhome for which we had billing data was calculated using a combination of REM/Rate outputs, as well as data from the as-built appliances, lighting, and solar thermal system. REM/Rate calculated as-built energy usage at 52.78 MMBtu /year. A baseline model was also developed with a REM/Rate energy usage of 79.43 MMBtu/year. The REM/Rate estimated savings were 26.65 MMBtu /year, or 33.6%.

Earth Advantage used these results to calculate a HERS index for each individual unit. Those values ranged from 65 to 67, with an average HERS index of 66. This is an improvement of 33 to 35 points over a reference home with a HERS index of 100, corresponding to 33% to 35% energy savings in the townhomes. In addition, these homes scored considerably better than the required ENERGY STAR HERS index of 85 required when the homes were built.

The refrigerator and dishwasher were ENERGY STAR rated. Effects of all installed measures, including initial REM/Rate estimates and additional savings based on Cadmus calculations are shown in Table 4. The additional savings include adjustments for efficient equipment and solar thermal savings.

Table 4. Energy Use and Savings (MMBtu) for One Townhome

	Baseline (Code)	As-Built	Savings
Heating	39.40	27.50	11.90
Water Heating	19.30	4.6	14.70
• Solar Thermal Savings			2.73
Lights and Appliances	20.73	20.68	0.05
Additional Savings			
• Refrigerator			0.44
• Dishwasher			0.29
• Lighting			5.90
Total	**79.43**	**43.42**	**36.01**

The gas and electric bills from this address totaled 45.1 MMBtu for one year of energy use. Cadmus calculated usage of 43.42 MMBtu. These two values are within 4% of each other, which indicates the modeled results with additional savings calculations provide an accurate representation of the energy consumption. Based on this, we believe the REM/Rate model is sufficiently accurate to use to estimate consumption of the baseline home and savings. The results in Table 4 indicate the townhome's estimated total energy savings are about 45%.

The baseline and as-built usage for the one townhome was extrapolated to calculate savings for all 14 townhomes. Table 5 presents these results and shows 44% average savings across all the townhomes. The heating, water heating, and lights and appliances values were derived from the REM/Rate analysis for each individual townhome, and the additional savings were applied using the same values as for the townhome modeled above.

Table 5. Energy Efficiency Comparison (MMBtu) for All Townhomes

	Baseline (Code)	As-Built	Savings
Heating	576	392.6	183.4
Water Heating	238	64.4	173.6
• Solar Thermal Savings			38.22
Lights and Appliances	297.94	296.53	1.41
Additional Savings			
• Refrigerator			6.12
• Dishwasher			4.04
• Lighting			82.60
Total	**1,111.94**	**622.55**	**489.39**

5. Construction and Demolition Waste

All GIF projects starting with those funded in 2006 are required to document construction and demolition waste. The program requires recycling 100% of this waste.

The complete list of 2005-6 GIF materials requirements are:

- 100% construction & demolition waste recycling
- 30% materials-use reduction
- Design and construction practices that enable deconstructability and reuse of 80% of building materials.
- Use of materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of total value of project materials.
- Use salvaged, refurbished or reused materials, products or furnishings for at least 5% of building materials (by cost).
- Design for easy and accessible garbage and recycling collection for building residents and tenants.

The developers attempted to meet the 100% construction and demolition waste recycling requirement by hiring Traschco Services to recycle the waste. The townhome waste management log was provided to Cadmus for this report, as well as invoices from Trashco Services. In this project, a total of 18 yards and 2,880 pounds of waste were hauled in one 2-yard trip for each of 9 months, at 320 pounds per trip. Unfortunately, the developer was unable to confirm this represented 100% of the construction and demolition waste or if Trashco did in fact recycle the waste after it was hauled away. The developer also noted the drywall was made with recycled content.

DOLPH CREEK HOMES

Big Benefits for the Community, the Environment and Homeowner's Wallets

The 14 new townhomes at Dolph Creek are located in Southwest Portland. The backs of the homes overlook a newly restored portion of a creek which had been directed underground and into the City's stormwater pipe system. Previously devoid of trees, the development now includes a vibrant showcase of new native plants, trees and shrubs. The Dolph Creek townhomes are part of a larger redevelopment that also includes two other buildings – a 100-unit apartment building and a 56-unit affordable senior apartment complex.

This LEED for Homes Gold Certified project transformed a neighborhood eyesore into new housing with a host of energy-saving features for people with a range of incomes. For years, this 2.8-acre site housed a dilapidated vacant building and asphalt parking lot. By the time the project was complete, over 2,000 tons of contaminated materials had been cleared and the nearby stream was restored.

Water, water and less water

Reducing the amount of stormwater that enters a city's stormwater system is a key objective of many sustainable development projects. Managing and filtering stormwater on-site helps reduce the cost of building and maintaining piped systems and reduces impacts on local rivers, streams and wildlife habitats. The Dolph Creek townhomes project set an ambitious goal of managing 100 percent of all stormwater on site. It used several methods to achieve this target:

- Green (vegetated) roofs initially capture, detain and reduce stormwater runoff from each building.
- New trees and drought-tolerant plants help balance stormwater drainage.
- Stormwater detention basins capture remaining stormwater until it is absorbed into the soil.

In addition to making sure that no additional stormwater enters the piped stormwater system, the project helped pull stormwater out of the system by creating a new natural amenity. Consultants from Interfluve worked with the developer to restore the adjacent creek, which is part of the headwaters of Tryon Creek. Some 1,000 lineal feet of subterranean storm line was replaced with a stream and infiltration basin. This restored creek is integrated with the rest of the site's storm water management system.

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The project designers and developer also made sure that less water is used by residents. The homes and landscaping include a mix of water saving features, including low-flow water fixtures, low-flush toilets, drought-tolerant landscaping with drip irrigation, and timers and pressure regulators to further reduce water use. There are no grass beds in the entire development.

State of the Art Energy Efficiency

Residents of the new townhomes (and the environment) benefit from a full range of energy efficient systems incorporated into the design of the homes. These include:

- On-demand, high efficiency water heaters.
- Heat recovery ventilation (HRV) systems that continually exchange tempered air from the interior with exterior fresh air.
- High quality insulation materials.
- Solar Thermal collectors that pre-heat all of the heated domestic water demand.
- Energy Star appliances.
- Energy efficient windows with a U-value of 0.28.
- Exterior solar shades.

In a third-party evaluation of the townhomes conducted by Cadmus Group, where modeled savings were compared to actual performance of the townhomes as they became occupied, found that the townhomes use about 45 percent less total energy than a comparable home. The biggest contributor to the savings was floor, ceiling and wall insulation, solar thermal to pre-heat water and maximizing high efficiency lighting.

Energy Efficiency Comparison (MMBtu) for All Townhomes

	Baseline (Code)	As-Built	Savings	Percent Savings
Heating	576	392.6	183.4	16.5%
Water Heating	238	64.4	173.6	15.6%
▪ Solar Thermal Savings			38.22	3.4%
Lights and Appliances	297.94	296.53	1.41	0.1%
Additional Modeled Savings				
▪ Refrigerator			6.12	0.6%
▪ Dishwasher			4.04	0.4%
▪ Lighting			82.60	7.4%
Total	**1,111.94**	**622.55**	**489.39**	**44.0%**

Lessons Learned

Where is the garbage going? This project was successful in sorting and recycling a significant amount of construction waste. However, the developer later learned that many materials he carefully sorted at the site were recombined once they arrived at recycling transfer stations. Communicate your recycling goals to your hauler and check on the destination of your construction waste. You can ask your hauler to provide transaction receipts especially if you are pursuing the waste credits for LEED certification.

Gauge your market. The Dolph Creek townhomes combined state-of-the-art energy efficiency with community and environmental benefits. Meeting those goals typically increases the cost of construction and can also result in higher sales prices. It is important to explain the long-term savings and expected increased performance in marketing materials so that future owners perceive the added value. For example, efficiency means:

- Increased comfort in the winter and summer.
- Reduced noise due to added insulation.
- Lower costs on their and water bills.

Knowing whether the market will respond to these types of homes in a given location is essential to financial success.

Resources

Earth Advantage Certification Program and Performance Scoring ▪ *www.earthadvantage.org*

Energy Star Appliance Rating Systems ▪ *www.energystar.gov*

City of Portland Bureau of Planning and Sustainability ▪ *www.portlandonline.com/bps*

Energy Trust incentives ▪ *www.energytrust.org*

Project Partners

EnergyTrust of Oregon

Environmental Services City of Portland
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