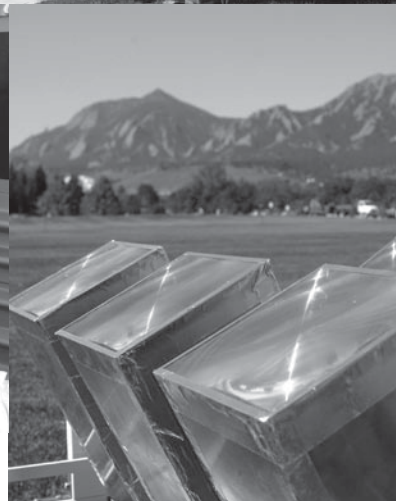


# COLORADO BUSINESS REVIEW

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## This issue:

**Photonics and the Energy Solution** on this page. **The Renewable Energy Industry in Jefferson County** on page 2. **On page 4, Residential Solar Buyers. Renewable Energy in the Tourism Industry** on page 7.



## Photonics—Part of the Energy Solution

Barb Ihde

Harnessing the power of light has always been a quest for mankind. In the hundreds of years since the invention of the microscope, the telescope, and the electric light bulb, using light has been key to enabling scientific breakthroughs, as well as changing the way we live our daily lives.

Just over one hundred years ago, Einstein discovered the quantum effect of light—how it behaves like a wave and a particle. With the invention of the laser, this area of technology, which is known as *photonics*, became a field in the early 1960s. Colorado has been on the forefront of this field, with both research

and industry beginning to build at that same time.

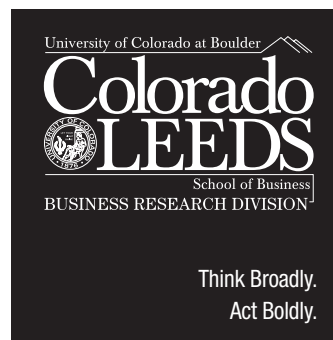
In the recent past, photonics made a name as the science behind the telecommunications boom. We all heard “fiber optics is the future”—that is, until the telecom bubble burst. Yet, it did have an effect. Now 90% of our communications systems use fiber-optic cables.

Photonics has always worked with more than one industry. Here in Colorado, companies collaborate with more than 11 different industries, and the industries keep changing as the technology matures. Colorado’s satellite imaging companies, for example, have gone from having aerospace and defense as major

customers to sending images to our desktops and cell phones.

Today the focus is on energy. Part of the draw to photonics is its ability to help do things faster and better. Think about

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# Powering Our Future: Jefferson County

Michelle Claymore

## From the Editor

With higher energy costs affecting nearly every aspect of our lives, and traditional and alternative energy one of the four targeted areas of Governor Ritter's economic development policy, we focus on the renewable energy industry in this issue.

On page 1, Barb Ihde, executive director of the Colorado Photonics Industry Association, examines the role of photonics in addressing challenges in the renewable energy industry. With the highest concentration of renewable energy and energy research companies and employment in Colorado, Jefferson County is a center for innovation in the research and development of new energy technologies. Michelle Claymore, vice president of the Jefferson Economic Council, details recent business activities in this industry on this page. On page 5 environmental studies PhD candidate Keith Stockton highlights results of a research study that examined the demographics and motivating factors of residential purchasers within the first year of Xcel's Solar\*Rewards program.

CONTINUED ON PAGE 3

At a time when the United States is highly focused on national security and looking at ways to eliminate its dependence on foreign oil, Jefferson County's energy industry is developing a hot commodity—new energy technologies. The county draws on its strong history in mining and oil and gas while bringing together academia, researchers, and business to lead the country in developing energy technologies for the future, such as biomass, wind, thin-film, fuel cell, and hybrid.

At the center of local activity is the **National Renewable Energy Laboratory** (NREL), the U.S. Department of Energy's only federal laboratory whose primary mission is to conduct research and develop renewable fuels and energy sources that fundamentally change the way we power our homes, businesses, and cars. Established in 1974, NREL has more than 1,200 employees and houses the National Centers for Photovoltaics, Bioenergy, and Wind Technology.

The **Colorado School of Mines** (CSM) also plays an important role in the research and development of new energy technologies. It houses the following organizations:

- Colorado Energy Research Institute—Established by the Colorado Legislature to develop energy-related research and educational programs for Colorado
- Colorado Fuel Cell Center—A \$3 million laboratory established to advance fuel-cell research, development, and commercialization, and to promote business opportunities in Colorado

In 2007, CSM and NREL joined the University of Colorado at Boulder (CU) and Colorado State University (CSU) to form a research partnership called the **Colorado Renewable Energy Collaboratory** (<http://www.coloradocollaboratory.org/>).

Research and commercialization of new energy technologies has been active in Jefferson County for more than 30 years. However, it wasn't until the recent attention on homeland security issues and rising fuel prices that national and statewide focus shifted to renewable energy. Colorado became the first state to adopt a renewable electricity standard (RES) by ballot initiative in 2004 (Amendment 37). The current RES requires 20% of Colorado's electric portfolio to be from renewable sources of energy by 2020. (See related article on page 4.)

Adopting a RES and adding a state department called the Governor's Energy Office has helped foster additional business activity in Colorado. ConocoPhillips located its Global Technology and

Corporate Learning Center in Louisville, and Vestas's North American manufacturing facilities will be located in Windsor and Brighton. Xcel Energy is working on a SmartGridCity pilot project, which is the next-generation electricity grid, in Boulder. The company is hoping the project becomes a national model for other communities. These and other recently announced projects help bring international attention to Colorado as a preferred business location for companies within this industry.

The Jefferson Economic Council (JEC) is trying to do its part in growing the renewable energy industry in Colorado. Established in 1955, JEC is the oldest economic development organization in the state of Colorado. JEC staff work closely with companies and industry partners to assist with start-up, retention, and/or expansion projects.

Renewable energy was identified as a target market for business growth in Jefferson County about 10 years ago. Since then, JEC has developed several industry-specific marketing pieces, including an industry-focused marketing video that appeared on Frontier Airlines earlier this year, a four-color *Renewable Energy* marketing brochure, business articles in *Images of Jefferson County* magazine, and an industry-specific website at [www.jeffcoenergy.org](http://www.jeffcoenergy.org). JEC also hosts a group called the Energizing Tomorrow Task Force that brings companies and industry partners together for networking and information sharing.

These marketing efforts must be working! Jefferson County has the highest concentration of renewable energy and energy research companies and employment in Colorado. Our most recent business activity includes:

- Abengoa Solar, a world-leading Spanish concentrated solar power company, established its U.S. headquarters in Lakewood in 2007.
- Ascent Solar Technologies began production of its thin-film photovoltaic modules. The company spun-out from ITN Energy, which is headquartered in Jefferson County.
- Blue Sun Biodiesel recently moved its corporate headquarters to the Signature Centre in Jefferson County, making it the first energy company in the world headquartered in a LEED Platinum-certified office building. Blue Sun is an integrated agriculture-energy company and marketer of premium renewable fuel products.
- Community Power Corporation (CPC), headquartered in Jefferson County, continues to grow by developing, commercializing, and marketing renewable energy-related products, such as biomass conversion technologies.


# 's Renewable Energy Industry

- CoorsTek recently opened a state-of-the-art multimillion dollar New Specialty Materials Center in Golden. The center focuses on developing next-generation ceramic materials for applications in high-tech markets, including fuel cells, semiconductors, electronics, laser, advanced armor, medical, and several others.
- Infinite Power Solutions, a developer of thin-film batteries for micro-electronic applications, such as smart cards, built out a 40,000-square-foot facility in South Jeffco for its headquarter and manufacturing operations.
- Power Ecalene Fuels, Inc. is commercializing technology that produces the alternative fuel Ecalene.
- PrimeStar Solar, headquartered in Wheat Ridge, is beginning production of its thin-film photovoltaic modules and recently leased additional industrial space in Arvada.
- Proterra (formerly Mobile Energy Solutions) established its headquarters in Golden and is developing hybrid electric, battery-powered, and fuel cell vehicles.
- SunEdison recently established a Western regional headquarters for regulatory and government affairs in Westminster and is working with the Denver Federal Center and NREL to establish and/or maintain a solar park for each entity.
- U.S. Department of Energy recently consolidated its Seattle and Chicago regional operations to its Golden Field Office in Denver West, increasing local employment to about 200 people.
- Versa Power Systems, Inc. established its headquarters in Jefferson County and is developing solid oxide fuel cells.

Preparing a future workforce with the appropriate knowledge base is also at the forefront of activities in Jefferson County. **Red Rocks Community College (RRCC)**, in addition to its new Process Technology Program, has started a Renewable Energy Technology Program that offers students an Associate Degree of Applied Science with a Solar Thermal or Solar Photovoltaic Specialty. **WarrenTech**, a career and technical high school serving Jefferson County, recently created a two-semester program in Alternative Fuels. Courses include biofuels, wind power, solar power, fuel cells, and hybrid drive, among others.

The Metro Denver WIRED Initiative awarded a \$500,000 grant to Lakewood-based **International Center for Appropriate and Sustainable Technology (iCAST)** to develop training courses for energy efficiency work areas, including energy audits; solar

panel installation; insulation technicians; energy modeling of buildings for residential, commercial, and industrial; HVAC installation and technicians; and sales training for energy efficiency companies.

Jefferson County will continue to be an epicenter for innovation in the research and development of new energy technologies that power our future! For more information on this growing industry in Jefferson County, please feel free to contact Michelle Claymore at [mclaymore@jeffco.org](mailto:mclaymore@jeffco.org). 

**Michelle Claymore is vice president of the Jefferson Economic Council.**

## FROM THE EDITOR,

CONTINUED FROM PAGE 2

Recognizing that the growing tourism industry is one of the largest consumers of a rapidly diminishing energy source, a not-for-profit project was created to help with the study, commercialization, and ongoing improvement of “best practices” in renewable energy throughout the tourism industry. Wendy Kerr, project manager, discusses the project on page 7.

### *Save the date!*

The Forty-Fourth Annual Colorado Business Economic Outlook Forum will be held Monday, December 8, at the Grand Hyatt Hotel, 1750 Welton Street, in downtown Denver. This half-day event gives a general forecast for the Colorado economy and offers detailed information on industry sectors. The forecast begins at 1:00 p.m., followed by industry discussion sessions and a networking reception. This event is sponsored by the Leeds School of Business and Compass Bank. There is no charge, and no RSVP is necessary.

Join us on December 8!

—Richard Wobbekind

# Demographics and Motivators of Residential Solar Buyers in Colorado

Keith Stockton

In November 2004, Colorado voters passed Amendment 37, the first renewable portfolio standard in the United States approved directly by citizen initiative. The amendment called for Xcel Energy to increase its share of renewable electricity sales to 10% by 2015. House Bill 07-1281, signed by Governor Ritter in March 2007, effectively doubled that requirement to 20% by 2020.

Included in the amendment and the house bill were solar electric power set-asides. The set-asides require that 4% of the new renewable electricity come

from solar electric systems (solar hot water systems are excluded). The remaining 96% of the new renewable electricity can come from a number of renewable sources, such as wind, geothermal, biomass, and small hydroelectric plants or even additional solar.

To broaden solar electric implementation and prevent just a few large, utility-scale projects from meeting the requirement, one-half of the new solar electric power must come from on-site installations. These installations range from small residential rooftop systems to the large two-megawatt system recently installed on the south side of DIA's main terminal.

Although the 2% on-site solar requirement may seem small, it represents a significant investment in solar electric power technology. By 2020, the solar electric power requirements call for approximately \$560 million in new on-site solar capital investment.

Financial rebates are a vital element to achieving the solar requirements. Xcel customers fund the rebates through a 2% surcharge on their electric bills. Residential and small business purchasers may obtain rebates equaling \$4.50 per installed watt, or approximately 60% of the cost of their systems. This makes the Xcel Solar\*Rewards program one of the most beneficial solar energy programs in the country. Xcel paid solar system purchasers \$38.6 million in rebates from March 2006 through June 2008.

The combination of Solar\*Rewards rebates and a federal tax credit provide residential purchasers with a significant economic incentive. Instead of \$32,000, the average 4,000-watt solar photovoltaic system has an out-of-pocket cost of \$12,000. The cost of electricity from this system over 20 years is approximately \$0.20/kWh. This cost is about double the price Xcel charges for renewable electricity from wind power through its Windsource program. Therefore, even with abundant

solar resources and one of the highest rebate programs in the country, residential solar electric systems in Colorado still provide modest economic returns and are significantly less economically efficient than wind power. In light of these economic perspectives, a research study was conducted to identify these purchasers and what motivated them to install solar systems.

Our research examined the demographics and motivating factors of residential purchasers within the first year of Xcel's Solar\*Rewards program. We utilized survey research to gather information about these purchasers and gain an understanding of just who they are and what motivated them to purchase a residential solar electric system.

## Survey Administration

Solar system purchasers began receiving surveys in August 2006. Through February 2007, Xcel mailed a combined 300 surveys to the subject population. By May 2007, the end of the research period, respondents submitted 193 surveys for a response rate of 64%.

## Survey Results

### PV System Decision Process

The first set of parameters examined were those associated with the system purchasing decision process. The most interesting question asked buyers to rank the factors most important to them when they made their purchase.

The primary drivers were environmental and immediate financial returns. The immediate economic motivators included the rebates, federal tax credit, and lower electric bills factors. A long-term financial consideration, increasing their home's resale value, was near the bottom of the list.

Environmental factors were also high motivations for purchasers, with "doing what's right for the environment" and "combat global warming" ranking second and third. Lesser factors, including "satisfaction level with Xcel Energy" and "have power in case of a power outage (battery equipped systems)," were at the very bottom of the list.

### Demographics

Purchasers were asked several demographic questions, ranging from age, gender, and race to education level and income. Purchasers tended to be older than the adult population. Two-thirds were in their 40s and 50s, a moderately greater concentration than the 40% of the general population of these age groups combined.

While two-thirds of the general population is white, 93% of the purchasers identified themselves as white. Just 1% of respondents identified themselves as Hispanic or African American.

**XCEL PAID SOLAR SYSTEM PURCHASERS  
\$38.6 MILLION IN REBATES FROM MARCH  
2006 THROUGH JUNE 2008.**

Purchasers were substantially more highly educated than the general population. Eighty-nine percent had a bachelor's degree or above, compared to 26% of the general population. Even more notable, 58% of purchasers had a post-graduate degree, whereas just 13% of the general population has such a degree.

Household income was weighted toward the higher end of the economic spectrum. Seventy-eight percent of the purchasers had a household income greater than \$75,000 per year. That compares to 40% of the general population. The largest percentage of purchasers was in the \$100,000 to \$200,000 per year income range.

We identified the geographic location of the new solar systems by asking survey participants to identify their ZIP code. Boulder County dominates the geographic distribution. Purchasers who reside in Boulder County were 55% of the total purchasers, whereas Boulder County residents represent 10% of the general population of the study area. Weld County, with a similar size population, had one-thirtieth the number of system installations as Boulder County.

#### Political Parameters

Purchasers were asked several questions relative to their political affiliation and views on Amendment 37. A slight majority of purchasers were members of environmental and/or renewable energy advocacy groups. These groups included the Colorado Renewable Energy Society, the American Solar Energy Society, the Sierra Club, and Greenpeace.

Political party affiliation tilted toward Democrats and away from Republicans and Independents. General political position leaned strongly toward progressive and very progressive positions.

#### Overall Program Conclusions

Colorado's Amendment 37 and House Bill 07-1281 solar electric provisions have been successful in promoting the installation of residential systems in the state. More than 1,700 new systems have been installed under Xcel's Solar\*Rewards program. Based on the research, financial incentives were major motivating factors for the purchasers within the study population. However, the financial incentive was not the only motivation as solar electric systems are currently relatively poor economic investments. Concern for the environment in general and climate change in particular were also strong motivations for these early purchasers.

Perhaps the most surprising finding from the research is the large disparity in demographic distribution of the purchasers versus the general population. Before we began our research, we expected that purchasers would come primarily from higher rungs of the socio-economic ladder. However, we did not expect such lopsided distributions in some factors, especially in education level and income.

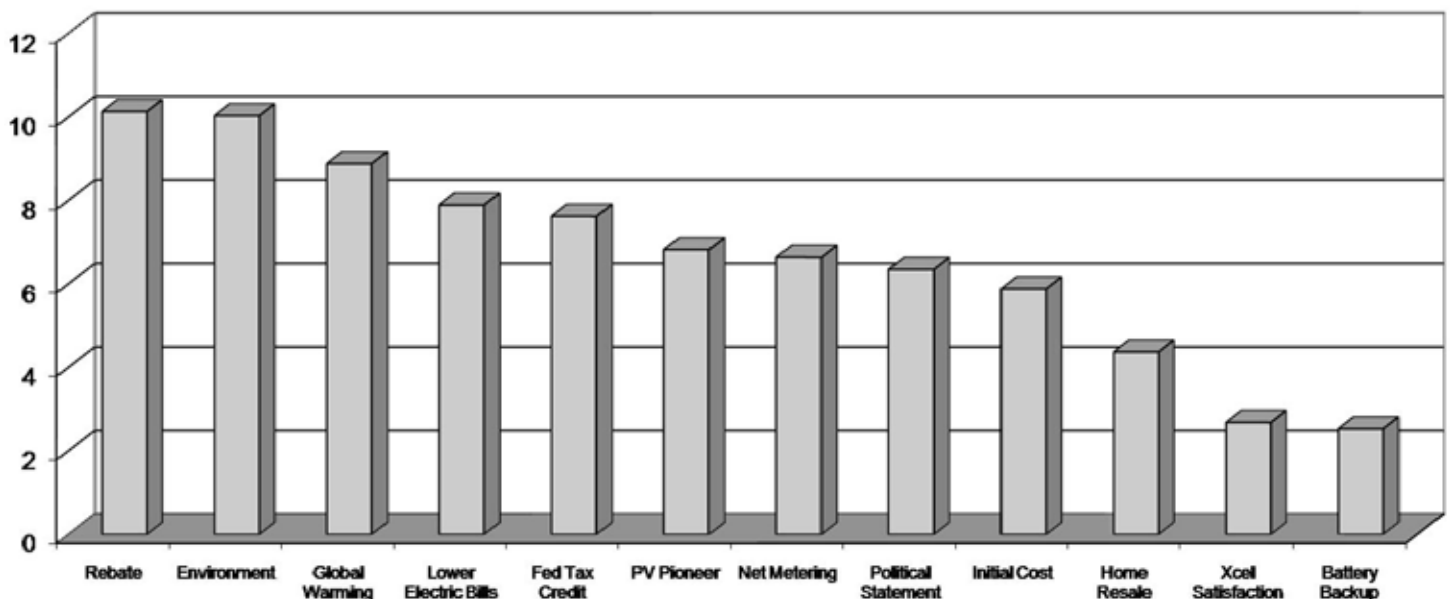
We find two broad conclusions that future policymakers should consider when developing their own solar electric incentive programs. First, even with significant financial incentives, residential solar electric systems are still a luxury good that appeal primarily to those

purchasers at the higher end of the socioeconomic scale. This may be problematic and pose fairness questions if all taxpayers or utility rate-payers publically fund the incentive program. We suggest that future policymakers consider the economic fairness of any incentive program in regard to all citizens, perhaps by designating a portion of funds for low- and middle-income purchasers.

Second, it remains to be determined if a program of this type will be successful for the residential segment in the long term. The incentives were successful in 2006 while purchasers consisted predominantly of environmentally motivated and wealthier early adopters. Eventually this market segment will be satisfied. Another risk to the program is that Xcel sees that it will meet its 2017 solar target early, thus putting the \$2.50 renewable energy credit portion of the rebate at risk. Xcel forecasts that sales for on-site solar electric systems in Colorado will peak in 2008 and then decrease significantly by 2010. At that point, unless solar electric system costs decrease substantially, the solar industry will need to react to a market with more financially pragmatic customer attitudes and significantly higher net system costs. One potential program along these lines is to imbed the cost of solar electric systems into newly constructed homes. The inclusion into the home purchase price may soften the purchaser's perspective of the financial impact of the solar electric system. ☐

**Keith Stockton is an environmental studies PhD candidate in the Leeds School of Business. He may be reached at [kestock@msn.com](mailto:kestock@msn.com).**

## Motivating Factors



it—nothing travels faster than light. This higher productivity inherently means energy savings. Lasers and vision systems assist manufacturers with making assemblies to go faster and with less waste. Laser cutting and welding eliminates pollution and the need for chemicals.

Our daily lives use less energy because of photonics. Light sensors are everywhere—they turn our faucets on and off and keep rooms dark when not in use. Barcode readers save time and energy as they speed us through checkout at stores. LCD screens have improved in size, clarity, and energy efficiency to the point they are in almost everyone's office and home. Soon, we will transition from compact fluorescent lighting to LEDs—a case where an improved photonics technology replaces another photonics technology.

Within the energy industry, photonics is also behind the scenes. Precise sensors play a big role in the sophisticated “downhole” measurements needed to make the most out of gas and oil wells and well drilling. Zolo Technologies, located in Boulder, uses technology developed for the telecommunications industry to create equipment that helps coal-fired power plants burn cleaner and more efficiently.

Photonics shines the most, however, when we look at renewable energy. Sunlight has always been a source of heat and lighting. We are now starting to use it for electricity. Photovoltaics—the science of turning sunlight into electricity—has seen the most incredible leaps in efficiency and cost reduction over the past two decades. Thin-film photovoltaics will become more prevalent as products are designed to be flexible and coated onto a vast number of surfaces. Thanks to the National Renewal Energy Laboratory, Colorado is a hub of emerging photovoltaic companies.

The future is bright for photonics and for Colorado. Companies here will continue to grow, using the technology to address old, new, and now renewable challenges. The breakthroughs that help us live better, which have been coming in this area for centuries, show no signs of stopping. And that's great for you and me, for Colorado, and for the entire planet. ☺

**Barb Ihde is the executive director of the Colorado Photonics Industry Association. She may be contacted at [exec@coloradophotonics.org](mailto:exec@coloradophotonics.org).**

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# Renewable Energy in Tourism Initiative

Wendy Kerr

Recognizing that the rapidly growing global tourism industry is also one of the largest consumers of a rapidly diminishing energy source, the University of Colorado's Energy Initiative and Leeds School of Business joined forces with the North Carolina Center for Sustainable Tourism at East Carolina University (ECU) and the National Renewable Energy Laboratory (NREL) to create the Renewable Energy in Tourism Initiative (RETI). RETI is a not-for-profit project designed to help with the study, commercialization, and ongoing improvement of "best practices" in renewable energy throughout the travel and tourism industry.


In June 2008, RETI published a set of *Best Practices in Renewable Energy for the Tourism Industry*, and they can be downloaded at *no charge* at <http://reti.colorado.edu>. Through the use of case studies, these manuals outline renewable energy adoption strategies that maximize energy efficiency, minimize environmental impacts, and result in cost savings or increased profitability across six tourism sectors: Accommodations, Airlines, Cruise Lines, Public Lands Agencies, Ski Resorts, and Tour Operators. Thirty-four companies are highlighted, including several based in Colorado and others from across the United States and around the globe.

According to the lead authors at Sustainable Travel International, the RETI best-practice manuals "are intended to serve as an inspiration and guide to tourism businesses of all sizes interested in realizing the benefits of adopting renewable energy initiatives and supporting a healthy planet." Large companies, such as Vail Resorts, Xanterra Parks & Resorts, and Virgin Atlantic Airlines, are included for their innovative large-scale projects, such as Vail's new LEED-certified resort villages; Xanterra's Death Valley photovoltaic energy system, which is the largest nonutility PV system in the United States; and Virgin's research on biodiesel fuel for airplanes. Energy efficiency practices among smaller organizations are also analyzed, including Utah's Escape Adventures, which illustrates that commissioning an energy audit and finding ways to reduce overall energy needs before investing in renewable energy technologies can result in a significant reduction in capital costs. Examples of ways to go completely off-grid are illustrated by Tiamo Resorts and Inn Serendipity, as well as the *Solar Sailor* at Captain Cook Cruises.

RETI was made possible thanks to a 2007 CU Energy Initiative seed grant awarded to Principal

Investigator, Dr. Patrick Long, who at the time was the director of CU's Center for Sustainable Tourism at the Leeds School of Business. Chris Adams of Miles Media, Inc. provided much of the ongoing direction of the project as part of an advisory committee. Other members of the committee included representatives

**A SET OF *BEST PRACTICES IN RENEWABLE ENERGY FOR THE TOURISM INDUSTRY* CAN BE DOWNLOADED AT NO CHARGE.**

from NREL, Colorado State Parks, and Eco Tourism International. Sustainable Travel International conducted the background research and case study interviews. Gary Horvath and Wendy Kerr with the CU Leeds Business Research Division provided project management and administrative support. 

**Formerly with the Business Research Division, Wendy Kerr is currently the e-commerce and development coordinator with the International Mountain Biking Association. She may be reached at [wendy.kerr@imba.com](mailto:wendy.kerr@imba.com).**

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