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Lisa Gelfand
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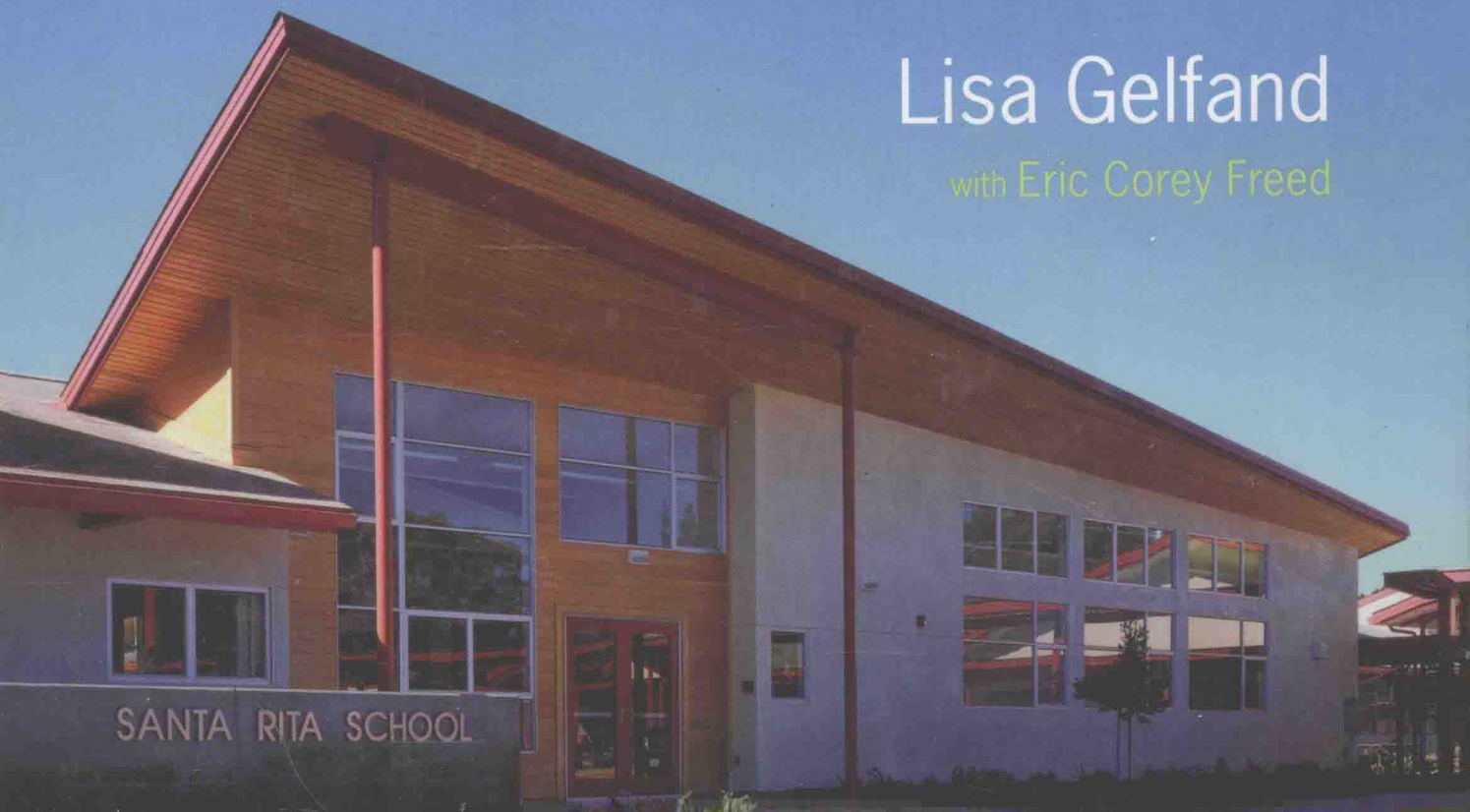

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DESIGN FOR PRIMARY AND SECONDARY SCHOOLS

by
Lisa Gelfand, AIA, LEED-AP
with Eric Corey Freed, LEED-AP

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To Arthur S. Harris
For insight and inspiration

PREFACE

[Jaime Lerner, former mayor of the renowned Brazilian city of Curitiba, has said that there are] a lot of people who are specialists in proving change is not possible. What I try to explain to them when I go to visit is that it takes the same energy to say why something can't be done as to figure out how to do it.

—Bill McKibben, *Hope, Human and Wild: True Stories of Living Lightly on the Earth*

THE GOAL OF THIS BOOK is to help you figure out how to plan, design, build, and run a sustainable school. It can be done. It has been done in some very unlikely places. It needs to be done in many more places.

Another goal of the book is to show you why. With the massive demands our current way of life is making on the resources and fellow creatures of the planet, we need to rethink the way we are doing things and educate our children to rethink our activities some more. Schools are a major activity on their own. Reductions in their energy use and environmental impact would be a good thing to achieve even if they did nothing else. But schools are also where our children first see their society at work, where they watch us act as much as they hear us speak. The example we provide through the design of our schools will grow exponentially.

The book is organized to track sustainable school architecture through all its phases. First we look at the urgency of the need and the benefits that accrue to the sustainable school. Next we look at steps in bringing the community and its team of designers and educators and contractors together to embark on creating the school. The design chapters of the book examine the ideas that give form to schools, the systems that make them run, and the materials that make them real.

The bidding and construction chapters examine how to put the construction team together and then how to manage the significant energy used and site impacts accrued during construction. A large part of sustainable school architecture is sustainable school construction.

This is the point where many architects stop. But sustainability is not about a snapshot or a ribbon cutting at the start of the life of a school. It is about creating a facility that will continue serving kids and communities over many years of change. We look at the roles of maintenance and operations staff in creating the culture of the school and in creating a way of life in the school that is sustainable. We look at how their activities should inform design. And then we look at how schools might be made and run differently in the future.

We hope that the readers of the book include not only other designers but also the educators, maintenance people, businesspeople, contractors, parents, and neighbors who have formed such a vital part of the teams we have been privileged to know while creating sustainable schools. Inevitably there may be too much of one kind of information and not enough of another for each reader. Each chapter offers links to

references that take you deeper into each topic. We include 20 case study schools. The accomplishments of school communities from around the world show that sustainable schools have been built and maintained and can be built on as models for sustainable schools for the future.

Green building organizations, such as the United States Green Building Council (USGBC) and the Collaborative for High Performance Schools (CHPS), have created rating systems aimed specifically at schools. CHPS has a wonderful collection of best practice manuals to assist design teams. LEED and CHPS rating systems can help benchmark a community's accomplishments and ambitions in relation to our current understanding of sustainability. Each chapter lists the relevant credits for the phase in LEED for Schools. CHPS credits are similar.

For us, the benchmark for a sustainable school is the quality of the learning environment. A sustainable school is bright, full of fresh air, comfort, and a happy quiet. Its campus has room for nature, just as nature has the space for us. It is a center for the lives of the children's families as well as a privileged and peaceful place for children to grow and develop. Where design teams have accomplished this in public schools, in old buildings, in cities, and high in the mountains, we salute them and offer their examples in the hope that one day soon all schools will be built sustainably.

ACKNOWLEDGMENTS

MY THANKS to all the educators, school communities, and fellow professionals who have talked about sustainable school ideas, and tried them out in projects, and taught me about the things they do, and helped me see the things I do through their eyes. I bring the experience of architectural practice to the book, so I have needed everybody's help to write this book. I want to thank my friends and contributors who have read and written and sketched and taken pictures of crossing guards and cats and children at play.

Particular thanks to Ken Rackow, for roping in the pictures and the paperwork; to Chris Duncan, for reading and clear thinking and for years of support for sustainable design; to Susan Herrington and Rosanna Lerma and Doree Friedman and Ron Blue, for bringing invaluable insights from their allied fields and for years of fruitful collaboration; to Aaron and Ashley and Ariane and Dan and Nicole for their support of the project even when it interfered with their real work; and to Sandy and Deven and Steve, for helping research and track down photos. I also want to thank the rest of my office for their patience in putting up with the demands on my time as we busily try to keep improving our design.

I have dedicated the book to Arthur Harris, the marvelous principal of Blach School, from whom we really learned about education, and I would like to thank all the rest of the educators we have worked with and their strong grasp of what sustainability could mean in a school environment. In particular, I would like to thank Margaret Gratiot, the former superintendent of the Los Altos School District, for embracing sustainability not as a pilot but as an approach for the entire district, and Randy Kenyon, the business officer, for making it happen. At that time it was an idea but newly reborn, and they were pioneers. I want to thank all the clients and school communities that are helping us make school environments better and more sustainable.

I have had the pleasure to serve on the technical committee of Collaborative for High Performance Schools, as has my partner Chris, and I want to thank the CHPS staff, the PG+E staff, and the Green Advisory Committee to the California Division of the State Architect, for helping to push sustainability ever forward and for talking through many of the ideas in this book.

Thanks to the team at Wiley for their support. And finally, I would like to thank my friends and family and my own sons, who have made me look at education with new eyes. My sons bring a bracingly critical intelligence to schools and architecture and sustainability—after all, for the sake of their generation, we had better start now, and start doing it right.

CONTENTS

chapter 1

AN INTRODUCTION TO SUSTAINABLE SCHOOLS

Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

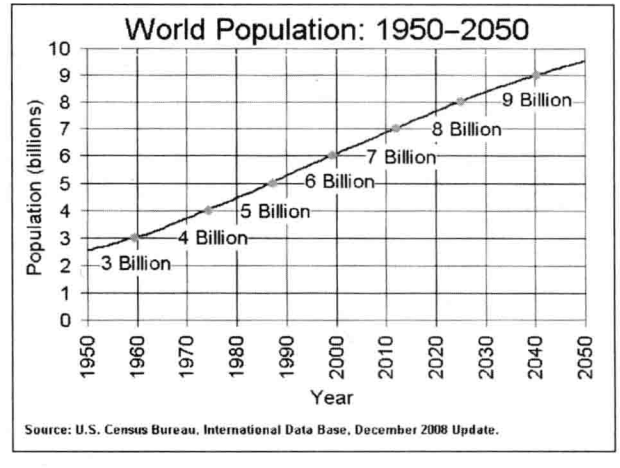
—1987 UN Brundtland Commission Report

INTRODUCTION

SUSTAINABILITY IS ABOUT TIME, the invisible dimension. Although the only sure thing about the future is that it will come, concern for the future is at the basis of concern for sustainability. The world could be in very big trouble right now—facing inundation of coastlines housing tens of millions of people, a die-off of species as large as the mass extinction that made way for mammals. Or maybe not.

But data unarguably show that humanity's activities as builders and farmers and producers and consumers have changed the world, and are changing the world at this moment. Climates are changing. Glaciers are melting. The oceans uptake one-third of the carbon dioxide produced by human activities. Their waters have become measurably more acidic. Due to the relatively small change in ocean chemistry so far, shelled creatures already produce thinner shells. The impact of their demise on the food chain is too complex to predict.

At the time of the Brundtland Commission report, world population was about 5 billion. Almost 25 years later, it is almost 7 billion. If all 7 billion live the lifestyle of Americans, the increased impact of human activities would be exponential. With 5% of the world's population, the United States already produces 25% of the world's greenhouse gas emissions.



The 2008 U.S. government world population projection shows a population of 7 billion by 2011. *Source: U.S. Census Bureau*

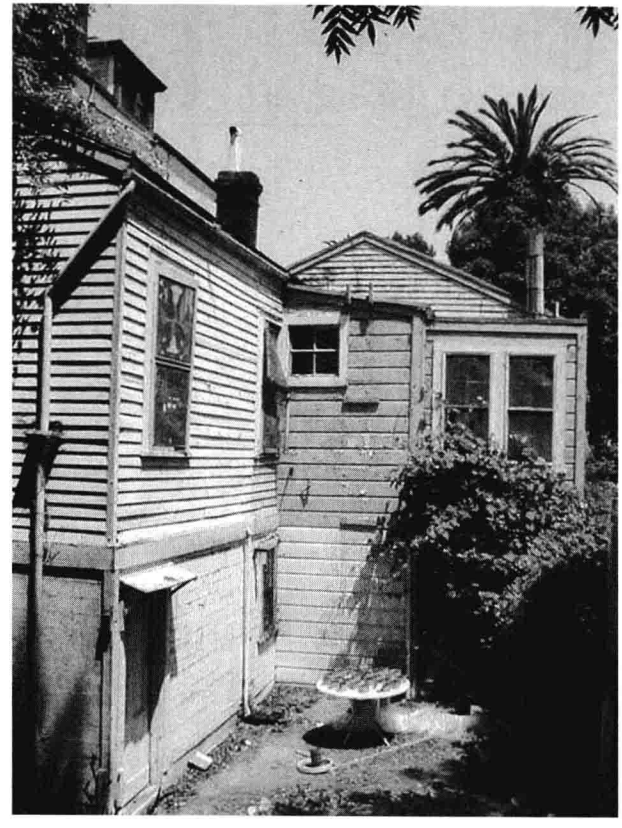
It is about time for sustainability. In the Brundtland Commission definition, the first requirement is meeting the needs of the present. The needs of nations to feed, house, educate, and support fulfilling lives for their growing populations are needs of the present. How can this happen without compromising the future? *Developed, technological nations must reduce, not just hold steady, their impacts on the biosphere.* While it is important to prevent irreversible harm to remaining wild and biologically rich areas such as tropical rain forests, sustainability must start in the over-consuming homes, cities, farms, and forests of temperate zone nations. This book examines how and why schools can lead the way toward sustainability in general.

NEED FOR SUSTAINABLE BUILDINGS

Constructing and operating buildings generate tremendous environmental impacts. In the United States alone, buildings account for:

- 72% of electricity consumption
- 39% of energy use
- 38% of all carbon dioxide (CO2) emissions
- 40% of raw materials use
- 30% of waste output (136 million tons annually)
- 14% of potable water consumption[1]

It is possible to reduce the impacts of buildings drastically with technology, materials, and methods available without any further research. One challenge is that this large reward can be gained only on an incremental, home-by-home, office-by-office basis. Unlike reining in big point source air and water polluters such as factories or power plants, any approach to reducing the impact from the building sector as a whole must include each individual building.



Leaking windows, lack of insulation, and obsolete systems make this building an energy hog. *Source: Gelfand Partners Architects*

New buildings comprise only a small percentage of the building stock in any given year. To substantially reduce the impact of the building sector as a whole, the efficiency of existing buildings needs to be improved. The $5 billion weatherization program adopted as part of the 2009 U.S. stimulus package is an example of the kind of program that can improve energy efficiency on a broad scale by operating at an individual building scale. New buildings with beautiful solar panels may be the face of sustainability in 2010, but the lowly caulk gun is likely to produce more gains in real energy use reduction.

BENEFITS OF SUSTAINABLE SCHOOLS

A compelling moral and educational case exists for demonstrating environmental stewardship in schools where children first learn what it is to be in the world in the society of other people. And as in any other project breaking ground today there is reason to fear that time has run out simply to do less harm. Even doing no harm is not enough. And if neither fear nor virtue motivates, there is also the business case that shows that energy efficiency and healthy environments rapidly pay back their investors.

School construction is a large market on its own, comprising approximately 5% of all construction in the United States in 2007. Sustainable practices in schools would have a measurable impact on energy and resource consumption for society as a whole.

But the benefits of sustainability are not all, or even primarily, to the outside world. A brief look at the advantages to the core mission of the school supports the value of sustainability in design, construction, and operation. Sustainable schools are better environments for learning.

Higher Student Test Scores

An analysis of over 21,000 students in Colorado, California, and Washington by the Heschong Mahone Group showed that the controlled admission of natural light through skylights and windows, "daylighting," in classrooms was strongly associated with higher student performance in reading and standardized testing. Students in the California classrooms with the best daylighting progressed 19% to 20% faster than students in the classrooms with the least.[3] Students in Colorado and Washington similarly showed 7% to 18% higher test scores at the end of the year in daylit classrooms than students in classrooms with the least daylighting.

Studies of classroom acoustics have also supported the connection between better student hearing and better student learning. Global Green, in "Healthier, Wealthier, Wiser: A National Report on Green Schools," cited a study showing students in quiet third-grade classrooms to be 0.4 years ahead of their peers in noisy classrooms in reading, and 0.2 years ahead in math.[4]

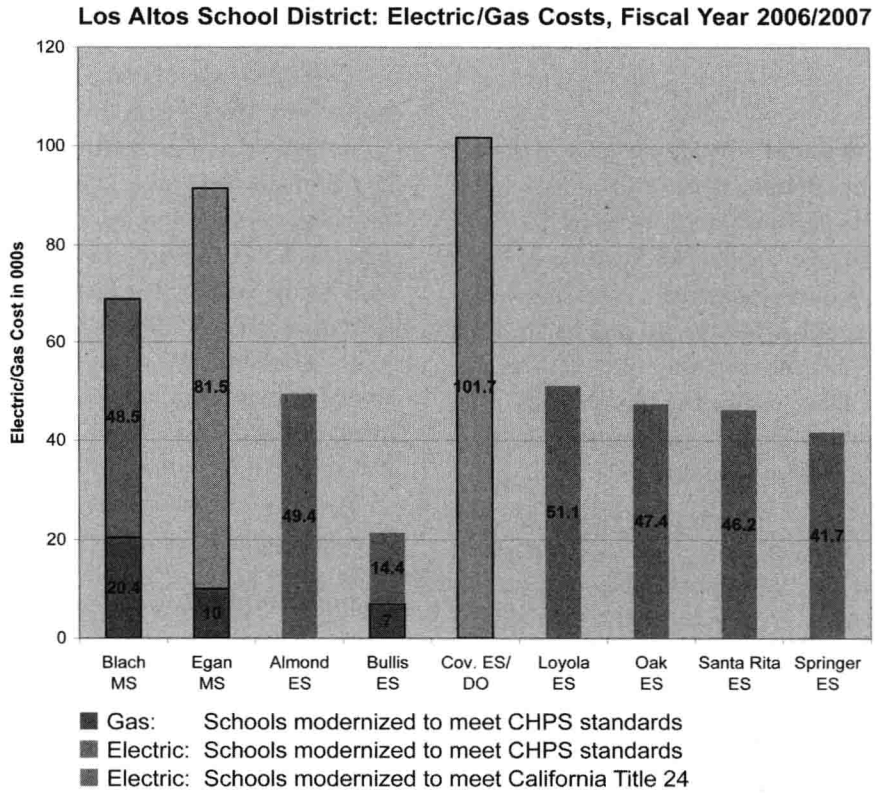
Lower Operating Costs

Energy costs schools money. It comes out of their general fund and thus directly competes with the costs

School and education construction is a major economic activity.
Education construction: The past 10 years

($ Billions)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
School Districts	$17.095	$16.039	$21.567	$26.777	$24.343	$28.638	$29.088	$22.962	$25.325	$20.283
Colleges	$7.330	$13.964	$14.703	$14.732	$16.205	$19.469	$12.186	$14.561	$11.306	$12.656
All Education	$24.425	$30.003	$36.270	$41.509	$40.548	$48.107	$41.274	$37.523	$36.631	$32.939
New Construction	$12.097	$14.431	$19.139	$20.112	$22.505	$31.596	$20.656	$21.220	$19.031	$21.942
Adds/Mods	$12.328	$15.572	$17.131	$21.397	$18.043	$16.511	$20.618	$16.303	$17.600	$10.997

Source: Courtesy *American School & University magazine*[2]



Elementary school energy savings of high-performance schools averaged $50,000 per year, while middle school savings were $23,000 per year. *Los Altos School District*

related to instruction. Saving money on heat and electricity means having more money for student supplies, teachers, and books. In the United States, school energy spending amounts to $8 billion a year, or 2% to 4% of school budgets, more than schools spend on textbooks. Improved operations and maintenance practices could save up to 20% of that in existing facilities, with major additional savings also available in design of new construction and modernization.

In addition to energy, other operating costs include water and landscape maintenance as well as maintenance of equipment and materials. Sustainable strategies lower water use with appropriate plant selection and high-efficiency irrigation; reduce the need for fertilizers and pesticides by appropriate plant selection and uses of on-site compost; and match equipment with its engineering requirements to improve efficiency.

Many of the aspects green schools address also address risks that cost schools money to insure. Benefits in worker health and safety and reduction of mold issues through appropriate waterproofing and ventilation are particularly direct and should be brought to the attention of insurers.

Increased Student Attendance

A healthier environment is reflected in fewer sick days on the part of both employees and students. The emphasis on better indoor air quality in sustainable design is a direct approach to reducing asthma and other respiratory problems in schools. Displacement

ventilation, one of the potential heating, ventilating, and air-conditioning (HVAC) strategies in sustainable schools, is directly linked to reduction of absentee rates. In Howell Township, New Jersey, absentee rates declined 60% after displacement ventilation was installed.[5] Even more limited improvements in indoor air yield measurable results; for example, changes in operations methods at Charles Young Elementary School in Washington, D.C., increased average daily attendance from 89% to 93%.[6]

Enhanced Teacher Performance and Satisfaction

Teacher retention affects both quality and operating costs of education. Gregory Kats, currently managing director of a green investment company, served as the Director of Financing for Energy Efficiency and Renewable Energy at the U.S. Department of Energy (1996-2001). In Kats' cost-benefit analysis of green design, the benefits of teacher retention alone exceed the cost of greening.

Financial Benefits of Green Schools ($/ft²)	
Energy	$9
Emissions	$1
Water and Wastewater	$1
Increased Earnings	$49
Asthma Reduction	$3
Cold and Flu Reduction	$5
Teacher Retention	$4
Employment Impact	$2
Total	**$74**
Cost of Greening	**($3)**
Net Financial Benefits	**$71**

Green schools give positive financial returns. *Source: Courtesy Gregory Kats, Capital E*[7]

Improvements can be made in schools of all ages. *Source: Claire Takacs, © 2009*

Increased Building Life

Beyond new construction, the real challenge in changing the impact of the building sector is in making existing buildings more sustainable. Extending the service life of existing buildings contributes to sustainability, as does construction of new buildings with a goal of permanence. In addition to the choice of durable materials, systems, and assemblies, the commissioning, operations, and maintenance of sustainable buildings keep systems running efficiently. Monitoring of building system performance creates the opportunity to catch problems in filters, balancing, or controls that can shorten system life. Preventive maintenance is built into the sustainable school, along with design and monitoring features that make efficient maintenance easier to accomplish.

Lower Environmental Impact

Schools are a large sector of the building market, which itself is a large contributor to the impacts people have on the planet. But it is salutary to note the direct reduction of impact the operation of each individual green school could accomplish. According to the Kats report,[7] each year one green school could save:

- 1,200 pounds of nitrogen oxides—a principal component of smog
- 1,300 pounds of sulfur dioxide—a principal cause of acid rain
- 585,000 pounds of carbon dioxide—the principal greenhouse gas and the principal product of combustion
- 150 pounds of coarse particulate matter—a principal cause of respiratory illness and an important contributor to smog

In addition, substantial water and wastewater benefits would vary by school and locality. Because of the large physical footprint of school campuses, these benefits could be significant, along with reductions in fertilizer and pesticide use.

Changing Attitudes

Schools have an influence on their community that extends beyond the education that occurs inside the four walls of the classroom. A sustainable school will work with its community to reduce driving, change eating habits, and demonstrate energy saving behavior. These influences can be very strong. Many solar panel installers give good prices for panels they put on a school because they know that seeing the panels will bring business from parents. As students grow up in a sustainably run organization, they will carry those habits and expectations into the workplace and into their own homes as adults.

Changing the mind-set of people who have grown up with a habit of waste, the advantages of the new, and an assumption of unlimited abundance is hard work. But sustainable schools can take part in readjusting these expectations and in resetting the base expectations of the next generation so that its members are much more cognizant of their impact on the world.

Teachers in California have done wonderful work with our children in the elementary grades, instilling in them a deep respect for the environment. By the time the kids reach us, they have really bought into the conservation ethic, intellectually and emotionally. The junior high years for many students mark the start of a phase of intense questioning of parental and societal values. Children at this age develop an exquisite sensitivity to any suggestion of hypocrisy or inauthenticity on the part of their elders. The inclusion of serious energy-conserving technologies at Blach makes a powerful statement to our youth that our commitment to environmentalism comes not only from our hearts, but also from our wallets.

—Arthur Harris, Principal, Georgina Blach Intermediate School[8]
