SUSTAINABLE SCHOOLS

Roots for a New Generation:
How Manitoba Schools are Reaping the Benefits of LEED

Prairie Architects Inc.

Dudley Thompson

Presentation to the
Manitoba Building Envelope Council
Winnipeg November 17, 2014

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SUSTAINABLE SCHOOLS

Roots for a New Generation:

How Manitoba Schools are Reaping the Benefits of LEED

Part One: Climate Change & Sustainability
Part Two: Why Green Schools
Part Three: Early Costs and Benefits
Part Four: International Case Studies
Part Five: Manitoba Approach
Part Six: Conclusions and Next Steps

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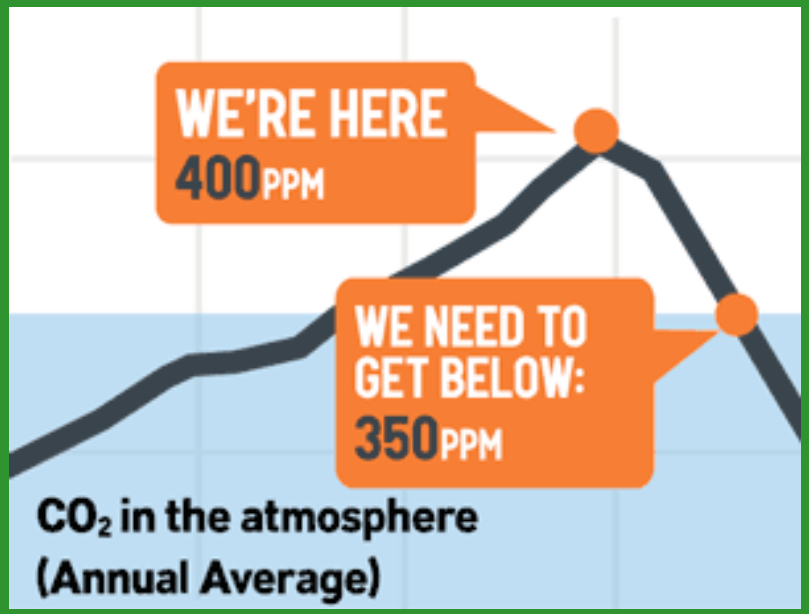
Part One – Climate Change & Sustainability

1.1 CO2 Emissions



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Part One – Climate Change & Sustainability

1.2 Water

IPCC report paints bleak picture of war, famine and pestilence: 'Climate change is happening and no one in the world is immune'

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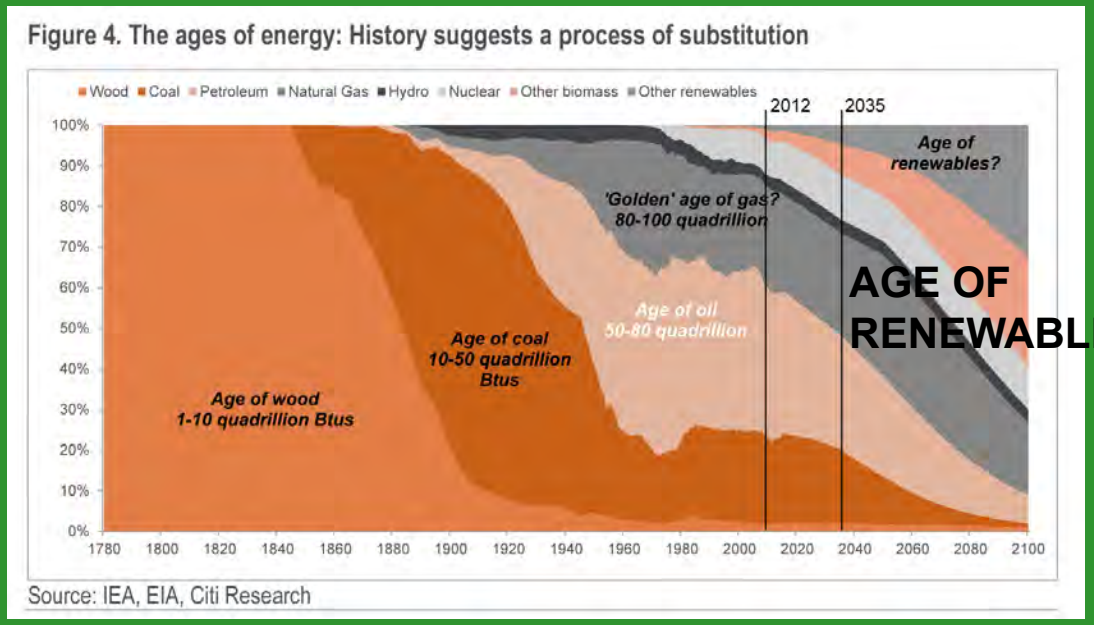
Part One – Climate Change & Sustainability

1.3 Energy

IPCC Report: "Nobody on this planet is going to be untouched by the impacts of climate change."



AGE OF RENEWABLES

PARADIGM SHIFT

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Part Two – Why Green Schools

GreenSchools

- Schools are wonderful laboratories for sustainability
- Children as teachers and practitioners for our sustainable future
- Good prototypes to demonstrate shift in paradigms
- Early LEED schools demonstrate metrics for change
- Centralized administration of large numbers of similar buildings
- Pressure on operating budgets to conserve $$

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Part Three – Early Costs & Benefits

3.1 – Overall estimate

TABLE A

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**

- Study by Gregory Kats for USGBC
- Compares financial costs and benefits of conventional vs 30 green schools based over a 20 year period
- Green schools cost $200/sf and are only 2% more than conventional ($3/sf)
- Intangibles above these savings
- Net cost for green school = $200-$71 = $129/sf

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Part Three – Early Costs & Benefits

3.2 – Direct Savings to School Division

	Component	Saving	NPV $/sf
1	Energy Reduction	33% or $. 38/sf	$9
2.	Water	32% or $ .06/sf	$1
3.	Teacher Retentlon	4% better	$4
4.	Less Cost of Greening	2% of total construction costs	($3)
	NET BENEFIT TO DIVISIONS		$11

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Part Three – Early Costs and Benefits

3.3 –Savings to Society

	Component	Saving	NPV $/sf
	INDOOR AIR QUALITY	41% productivity gains	
	TEMPERATURE CONTROL	3 - 15% productivity gains	
	HIGH PERFORMANCE LIGHTING	3-15% productivity gains	
	EMISSIONS REDUCTIONS	Less pollutants in classroom	
1	Increased Earnings	3-5% + in scores 1.4% lifetime earnings	$49
2.	Asthma Reduction	25% in green schools	$3
3.	Cold & Flu Reduction	51% in green schools	$5
4.	Employment Impact	More jobs in green economy	$2
	NET BENEFIT TO SOCIETY		$59

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Part Three – Early Costs and Benefits

3.4 – Non-Quantified Benefits

	Component	Saving	
1	Reduced Teacher sick days	7% better attendance	
2.	Reduced O and M costs	$8/sf reduction	
3.	Reductions in demo & waste	74% reduction	
4.	Insurance Benefits	Mold reductions/lower risks	
5.	Improving Equity	Improves health for poor	
6.	Generating System Reliability	Reduces overall power needs	
7.	Heat Island	Lower ambient temps in area	

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Part Four – International Case Studies

	PROJECT	LEED	E kWh/sm
1	Bethke Elementary, Colorado	Platinum	132.4
2.	Kensington High, Chicago	Platinum	125.1
3.	Kiowa County, Kansas	Platinum	92.0
4.	David Suzuki, Windsor	Platinum	78.8
5.	Hood River Middle, Portland	Platinum	75.6

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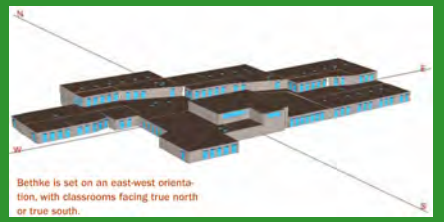
Part Four – International Case Studies

4.1 Bethke Elementary School – Colorado USA LEED PLATINUM 132kWh/sm

GROUND SOURCE HEAT PUMP ONLY

NATURAL DAYLIGHTING

EAST-WEST ORIENTATION FOR SOLAR



Bethke is set on an east-west orientation, with classrooms facing true north or true south.

TABLE 1 **METRICS FOR NEW PSD BUILDINGS**

The Poudre School District's seven newest buildings, constructed according to the district's sustainability design guidelines, all achieve high efficiency and high ENERGY STAR ratings.

Building	Year Constructed	Floor Area (ft^2)	Max Peak Demand (W/ft^2)	Energy Cost ($/ft^2$·yr)	Energy Use ($kBtu/ft^2$·yr)	ENERGY STAR Rating
Operations Office	2002	8,753	3.4	0.44	19.0	99
Zach Elementary*	2002	67,412	1.7	0.54	42.6	96
Bacon Elementary	2003	65,299	1.6	0.54	45.7	97
Fossil Ridge High School	2004	296,375	2.3	0.56	40.9	94
Kinard Middle	2006	112,735	2.6	0.39	21.6	98
Rice Elementary	2007	62,691	1.4	0.75	41.5	99
Bethke Elementary	2008	62,691	1.5	0.58	41.7	99

*Includes 7,200 ft^2 of modular classrooms

DISPLACEMENT VENTILATION

GREEN POWER

ARCHITECT: RB + B Architects

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Part Four – International Case Studies

4.2 Kensington High School – Chicago USA LEED PLATINUM 125 kWh/sm

RAINWATER HARVESTING SAVES 65%

Site Design
1. Native Landscaping Requires No Watering
2. Reflect Solar Heat

Storm Water Mitigation
3. Green Roofs Cover 45% of Roof Area
4. Porous Paving at Parking
5. Rain Gardens
6. Reinforced Turf at Emergency Access Area
7. Rainwater Cisterns

Resource Conservation
8. Geothermal Heating and Cooling
9. Super Insulated Exterior Building Shell

Other Green Features
10. Outdoor Classroom and Organic Garden
11. Recycled Landscape Paving from Original Site
12. Field Turf Requiring No Watering or Mowing

Building Elements
13. Auditorium
14. Music Classrooms
15. Cafeteria and Kitchen
16. Gymnasium and Athletic Offices
17. Dance Studio
18. Art Studio

ENERGY AT A GLANCE

Annual Energy Use Intensity (EUI) (Site)
39.74 kBtu/ft²
Natural Gas 1.62 kBtu/ft²
Electricity 38.12 kBtu/ft²

Annual Source Energy 129 kBtu/ft²

Annual Energy Cost Index (ECI) $1.10/ft²

Savings vs. Standard 90.1-2004 Design Building 46%

ENERGY STAR Rating 75

Heating Degree Days (base 65°F) 4,082

Cooling Degree Days (base 65°F) 1,423

Average Operating Hours per Week
55, plus community functions in the theater and gymnasium

WATER AT A GLANCE

Predicted Annual Water Use
367,750 gallons

Note: Actual annual water use is not available because a water meter was not installed until summer 2012.

96% OF SPACES MEET LEED DAYLIGHTING

4 YEAR GEOTHERMAL PAYBACK

35% RECYCLED MATERIALS

ARCHITECT: SMP Architects

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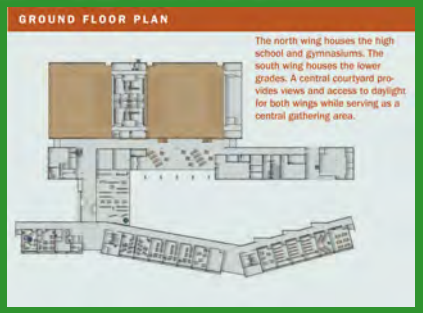
Part Four – International Case Studies

4.3 Kiowa County School – Kansas USA LEED PLATINUM 92 kWh/sm



INTEGRATED DESIGN PROCESS

125,000 WATER CISTERN

NO ELECTRIC LIGHT DURING DAY

50KW WIND TURBINE FOR 8%

PASSIVE DESIGN FOCUS

ARCHITECT: BNIM Architects

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Part Four – International Case Studies

4.4 David Suzuki School – Windsor CAN LEED PLATINUM 79 kWh/sm

WATER AT A GLANCE	
Annual Water Use	94,822 gallons

ENERGY AT A GLANCE	
Annual Energy Use Intensity (EUI) (Site)	25 kBtu/ft²
Electricity (From Grid)	25 kBtu/ft²*
Annual Source Energy	84 kBtu/ft²
Annual Energy Cost Index (ECI)	$0.94/ft²
Predicted Annual On-Site Solar Energy Exported	2.9 kBtu/ft²**
Savings vs. Canada's Model National Energy Code for Buildings 1997 Reference Building	63% as compared to calibrated baseline model
ENERGY STAR Rating	82
Heating Degree Days (base 65°F)	5,199
Cooling Degree Days (base 65°F)	1,120

* Includes a small amount of electricity from on-site wind turbines. The amount of electricity from the wind turbines is unknown because they are not separately metered.
** Based on RETScreen model.

36kW PV
SOLAR HOT WATER

SOLAR WALL FOR PRE-HEAT

GREEN ROOF & LIVING WALL

64% ENERGY SAVINGS OR $80,000/YR

SCHOOL AS A TEACHING TOOL

ARCHITECT: McLean & Associates

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Part Four – International Case Studies

4.5 Hood River Middle School – Portland USA LEED PLATINUM 75 kWh/sm

95% WASTE RECYCLED ON SITE

101% CO2 REDUCTION

95% AREAS HAVE FULL DAYLIGHT

35KW SOLAR PV PROVIDES 100% OF ENERGY

88% WATER SAVED WITH RAINWATER CISTERNS

ARCHITECT:OPSIS Architects

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Part Five – Manitoba Approach

5.1 – PSFB Mandate

Manitoba

PSFB Design Principles
- Liveability
- Energy Efficiency
- Durability

PSFB Directives:
- LEED Gold
- Energy 33% better than mNEBC
- Integrated Design Process
- Efficient Planning
- Exceed Green Building Policy
- Commissioning

11 new schools in process following PSFB principles

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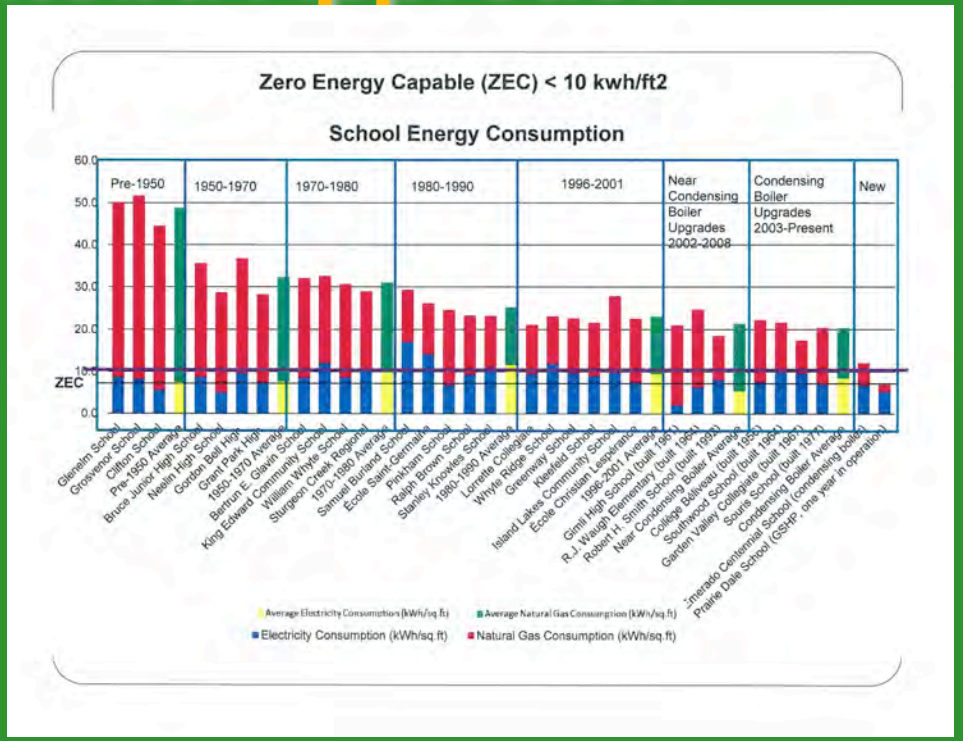
Part Five – Manitoba Approach

5.1 – PSFB Mandate

Manitoba



	PROJECT	LEED	E KBtu/sf	E kWh/sm
	CANADIAN AVERAGE		88.7	279.0
	ZERO ENERGY CAPABLE (NBI)		34.0	107.0
	MANITOBA HYDRO PLACE		27.9	88.0

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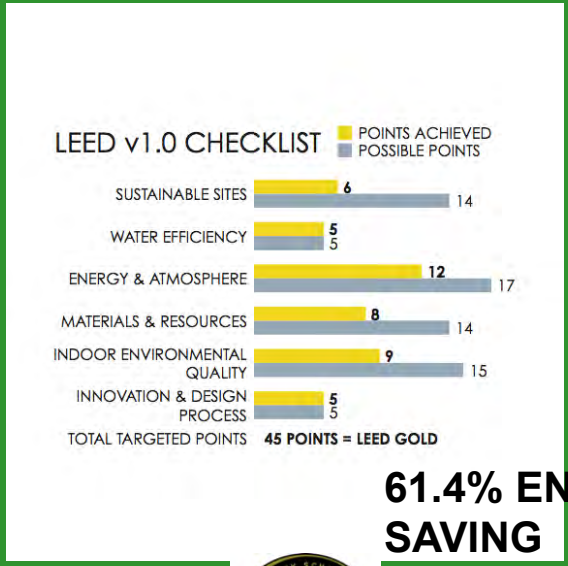
Part Five – Manitoba Approach

5.2 Manitoba Case Study 1: Northlands Parkway Collegiate, Winkler Prairie Architects Inc. LEED GOLD (t) 86 kWh/sm

54% FSC WOOD

95% ROOMS NATURAL DAYLIGHT

75% WASTE DIVERSION



35% LOCAL MATERIALS

61.4% ENERGY COST SAVING

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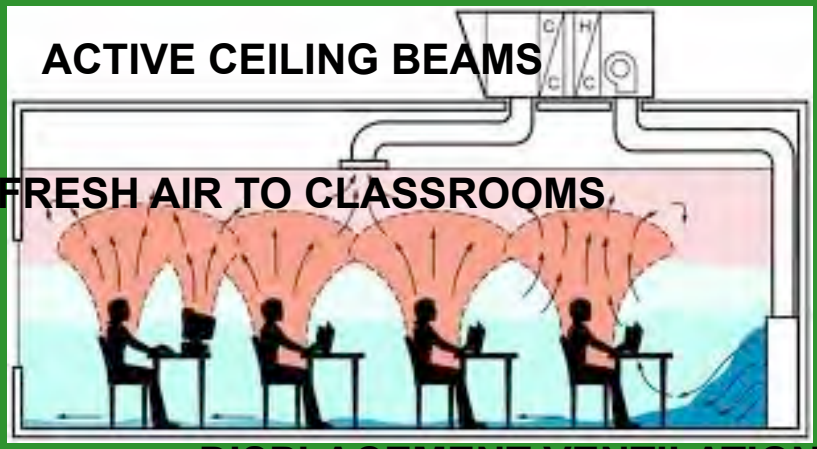
Part Five – Manitoba Approach

5.3 Manitoba Case Study 1: Northlands Parkway Collegiate, Winkler Prairie Architects Inc. LEED GOLD (t) 86 kWh/sm

49% WATER REDUCTION

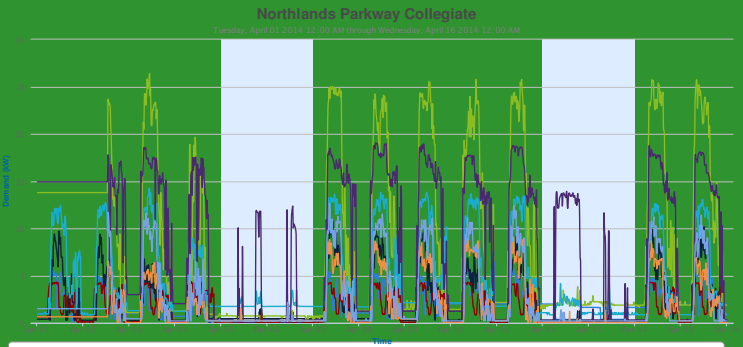
TRIPLE GLAZED WINDOWS
LOWER PLANT COSTS

ACTIVE CEILING BEAMS



100% FRESH AIR TO CLASSROOMS

DISPLACEMENT VENTILATION



Building	Meter	Consumption
Northlands Parkway Collegiate	E002M01 – Pnl_LP1A fed from panel DP1A(E2.1)	631.31 kWh
Northlands Parkway Collegiate	E002M02 – Pnl_LP1B fed from panel DP1A(E2.2)	764.50 kWh
Northlands Parkway Collegiate	E003M01 – Pnl_LP1C fed from panel DP2A(E3.1)	2980.23 kWh
Northlands Parkway Collegiate	E002M04 – Pnl_LP1D fed from panel DP1A(E2.4)	495.49 kWh
Northlands Parkway Collegiate	E002M03 – Pnl_LP1E fed from panel DP1A(E2.3)	1639.15 kWh
Northlands Parkway Collegiate	E003M02 – Pnl_LP2A fed from panel DP2A(E3.2)	3109.41 kWh
Northlands Parkway Collegiate	E003M03 – Pnl_LP2B fed from panel DP2A(E3.3)	602.09 kWh
Northlands Parkway Collegiate	E003M04 – Pnl_LP2C fed from panel DP2A(E3.4)	849.32 kWh

REAL TIME DIGITAL MONITORING

GARDEN VALLEY SCHOOL DIVISION GVSD

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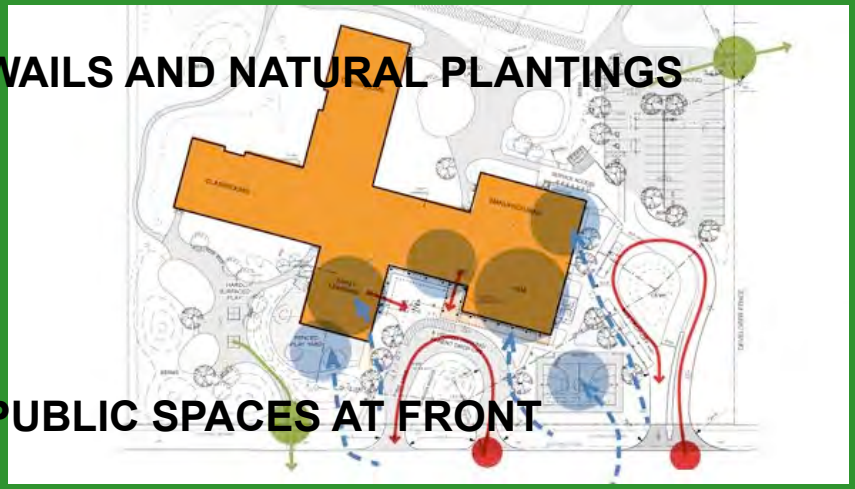
Part Five – Manitoba Approach

5.4 Manitoba Case Study 2: Amber Trails Community School, Winnipeg
Prairie Architects Inc. LEED GOLD (t) 95 kWh/sm

BIOSWAILS AND NATURAL PLANTINGS

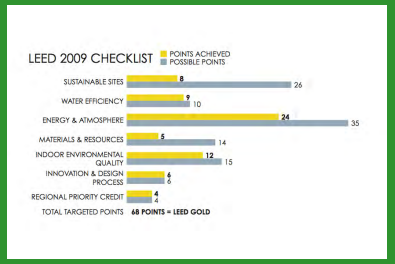


PUBLIC SPACES AT FRONT

ELECTRIC VEHICLE CHARGING

THERMAL MASS INTERIORS

LARGE WINDOWS FOR 95% NATURAL DAYLIGHTING



52% ENERGY SAVINGS

SEVEN OAKS SCHOOL DIVISION
community begins here

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Part Five – Manitoba Approach

5.5 Manitoba Case Study 2: Amber Trails Community School, Winnipeg
Prairie Architects Inc. LEED GOLD (t) 95 kWh/sm

GEOTHERMAL HEAT/COOL

40% WATER REDUCTION
RAINWATER COLLECTION

95% MATERIALS RECYCLED

FULL RADIANT FLOOR
FOR EVEN HEAT

SEVEN OAKS SCHOOL DIVISION
community begins here

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Part Six – Next Steps

6.1 – Results so Far

- Meeting PSFB targets
- Manitoba Schools some of the best energy savings in the world

	PROJECT	LEED	E KBtu/sf	E kWh/sm
	CANADIAN AVERAGE		88.7	279.0
	ZERO ENERGY CAPABLE (NBI)		34.0	107.0
	MANITOBA HYDRO PLACE		27.9	88.0
1	Bethke Elementary, Colorado	Platinum	42.0	132.4
2.	Kensington High, Chicago	Platinum	39.7	125.1
3.	Kiowa County, Kansas	Platinum	29.2	92.0
4.	David Suzuki, Windsor	Platinum	25.0	78.8
5.	Hood River Middle, Portland	Platinum	24.0	75.6
	Amber Trails, Winnipeg	Gold (t)	30.5	95.0
	Northlands Parkway, Winkler	Gold (t)	27.4	86.5
	NZE Prototype, Los Angeles	Platinum	14.2	44.7

Confirmation of health benefits.

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Part Six – Next Steps

6.2 – Lessons Learned

- Owners committed to making a difference
- Owners also want systems to work
- Complexity of interface of systems
- Takes time and patience for full operation
- Ownership when client & students involved
- Commissioning is key
- Interface of mechanical systems and BMS
- Measurement and Verification essential
- Geothermal / heat pump fine tuning
- Rainwater cistern collection works
- Triple glazing – savings from plant size reduction
- Exterior blinds – education of local authorities

- Moved so far in such a short time
- Emerging formula for design components
- Plateau in energy/water savings- new challenge

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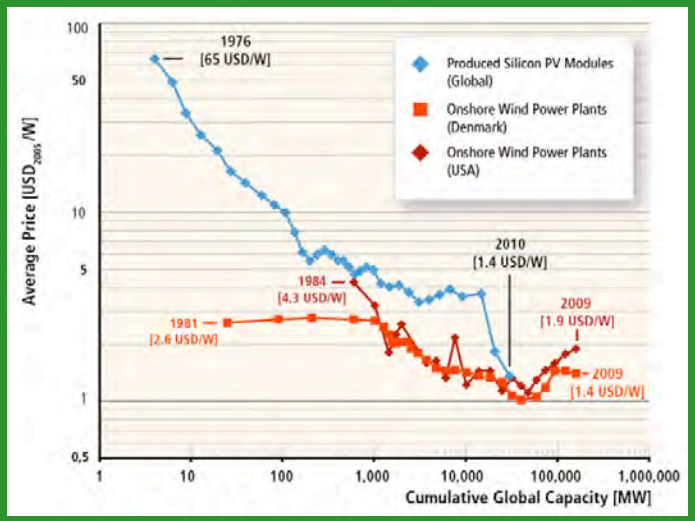
Part Six – Next Steps

6.3 – Where are we going?

Emerging Realism

Future Communities: "we will be living in denser communities, driving smaller cars, living more frugally and locally. Get ready for a smaller world. Soon, your food is going to come from a field much closer to home...your neighbours and neighbourhood are about to get a lot more important in a smaller world in the not-too-distant future...and don't be surprised if the new smaller world that emerges isn't a lot more enjoyable and liveable than the one we are about to leave behind".(WHY 22-24)



Dropping costs of renewables

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Part Six – Next Steps

6.4 – What can we do better?

RECOMMENDATION 1: Benchmark Performance

- Benchmarking is law in NYC buildings
- Energy Labels - mandatory in all European buildings
- Energy Star Portfolio Manager – 40% US offices
- Benchmark Energy intensity of all Manitoba Schools

Performance Report Card

Grading Period 2011-2012

Teacher: CCG Energy Solutions

Standard Comparison: EPA's Portfolio Manager

Facility Name	Baseline Rating (1-100)	Current Rating (1-100)	Total Floor Space (Sq. Ft.)	Baseline Site Energy Intensity (kBtu/Sq. Ft.)	Current Site Energy Intensity (kBtu/Sq. Ft.)
Firelands Local - Firelands Elementary	55	93	77,770	76.2	36.1
Hudson City - Ellsworth Hill Elementary	97	99	64,411	48.4	35.9
Hudson City - Hudson High School	90	100	360,000	47.1	24
Mapleton Elementary School	10	95	60,743	136.2	39
Mount Vernon Middle School	1	94	136,750	138.1	36.1
North Royalton High School	71	92	260,900	77.8	49.5
Polaris Career Center	14	87	240,000	114	50.8
Twinsburg High School & Sports Complex	1	92	367,295	152.7	54.5
West Holmes High School	40	87	187,000	79.1	44.1

Excellent with Distinction

Manitoba concentrating on new schools
What about existing schools? 95% of inventory?

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Part Six – Next Steps

6.5 – What can we do better?

RECOMMENDATION 2: Transparent Post-Occupancy Review

- Tell the truth about our buildings
- Share lessons learned - transparency
- Learn from our mistakes
- Allow failure and vulnerability
- Celebrate success together

Post-Occupancy Evaluation Opportunities

Why?	How?	What?
Evaluating healthcare facility design & outcomes (patient, staff, and organizational) is a key part of the POE process.	Most POEs use some form of survey, onsite observation, and interviews to better understand the occupant experience.	A toolkit for a systematic review of healthcare facilities
Yet there exists: • no accepted standard; • very few good ways to access and make information available to the industry to inform future projects; and • a lack of follow through due to lack of time, resources, or other factors.	Data can be collected through multiple resources such as: • occupant surveys; • onsite observations; • interviews and focus groups; and • metrics to evaluate outcomes against established targets.	A standardized POE-focused Post Occupancy Evaluation (POE) is envisioned resulting in: • feedback about performance for the organization; • the entry of metrics into an accessible database; and • an ability to more effectively share lessons learned.

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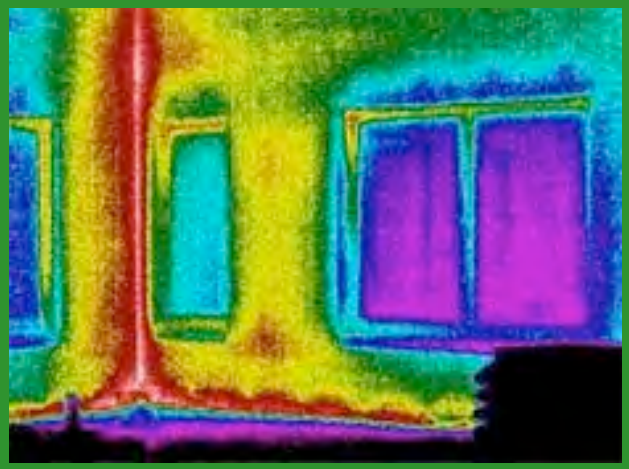
Part Six – Next Steps

6.6 – What can we do better?

RECOMMENDATION 3: Troubleshoot & Quantify Innovation



- Innovation has risks
- Longer start-up period
- Owners want performance
- Metrics to confirm sustainability
- Third Party to monitor innovation

- Manitoba Hydro Power Smart swat team to troubleshoot, calibrate and quantify long-term metrics of sustainability for Manitoba schools
- Example of MH Place evolution

Manitoba Hydro POWER SMART

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Part Six – Next Steps

6.7 – What can we do better?

RECOMMENDATION 4: Develop Environmentally Responsive Prototype

- Design based on environmental thermodynamics – like M Hydro Place
- Holistic and resilient
- Focus on passive and regerative designs
- Net zero water/ net zero energy
- Biodiversity and biophillia
- Living Building Challenge

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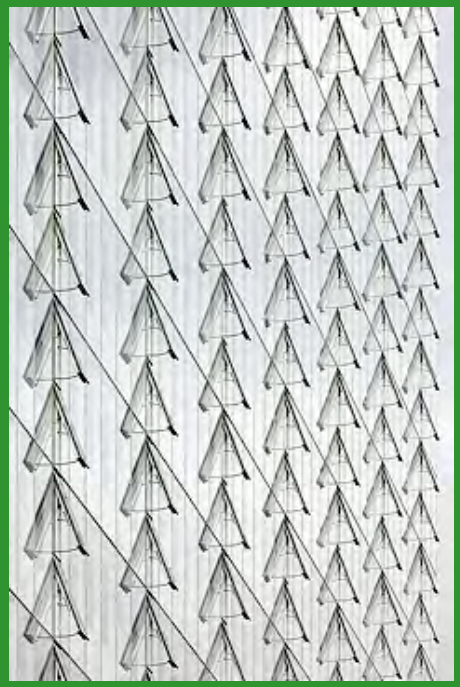
Part Six – Next Steps

6.8 – What can we do better?

RECOMMENDATION 4: Develop Environmentally Responsive Prototype



Manitoba Hydro Place, Wpg
LEED PLATINUM 88 kWh/sm

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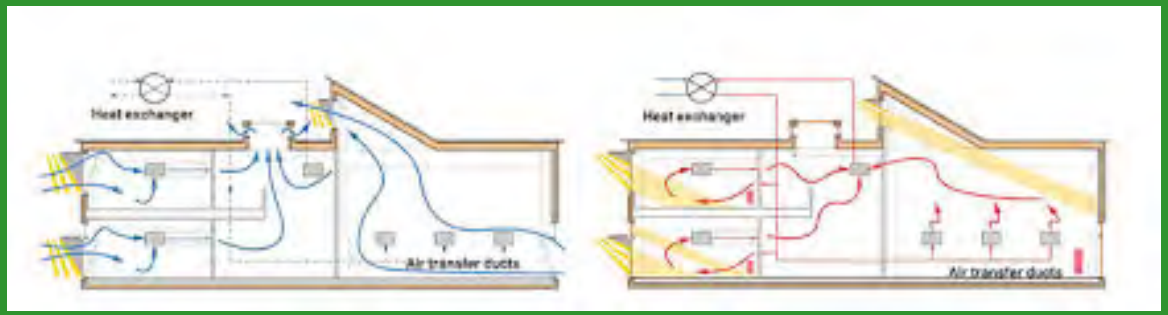
Part Six – Next Steps

6.8 – What can we do better?

RECOMMENDATION 4: Develop Environmentally Responsive Prototype

0.6 Air changes/hr
120 kWh/sm



Oakmeadow Primary
Wolverhampton UK
Passivhaus Certified

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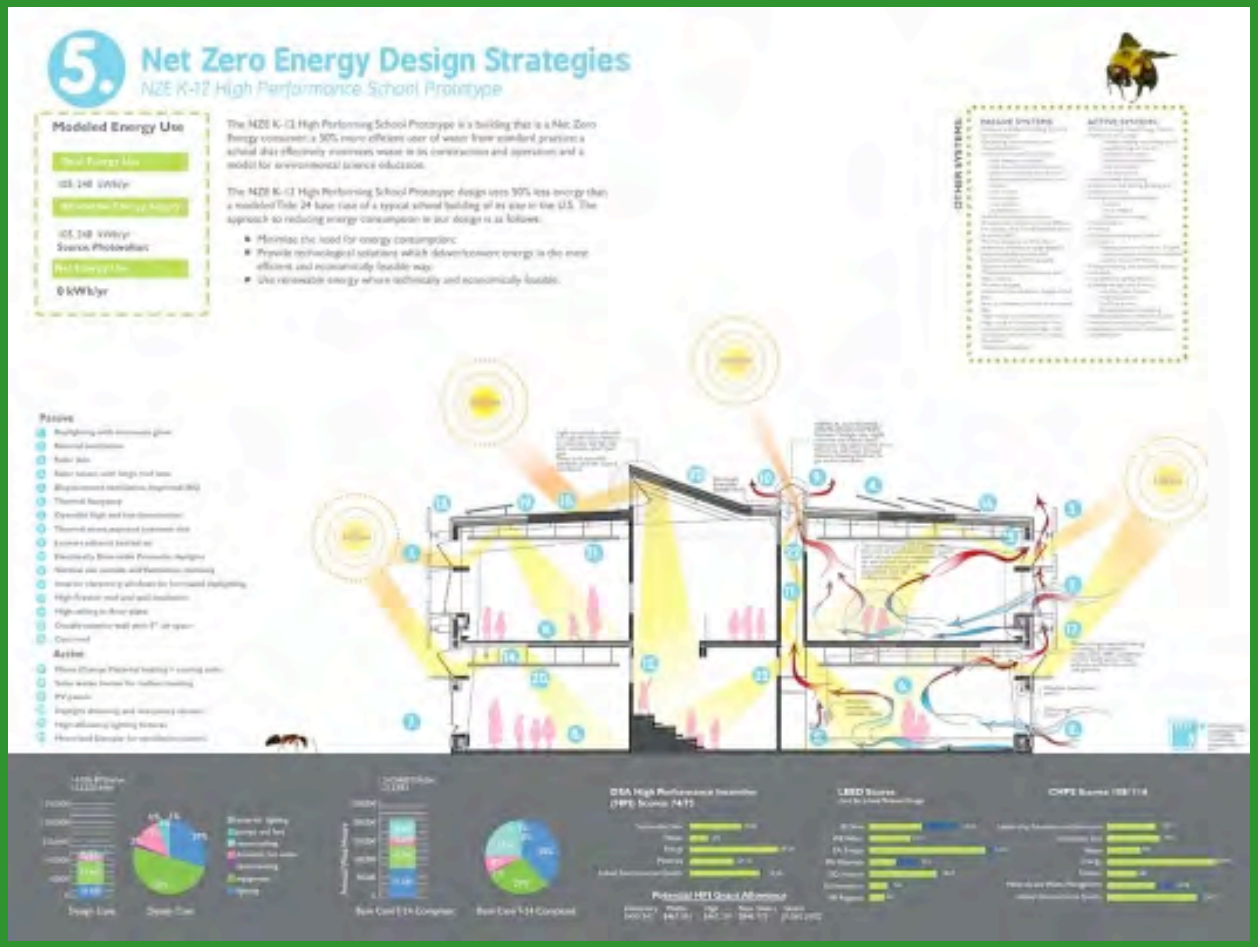
Part Six – Next Steps

6.8 – What can we do better?

RECOMMENDATION 4: Develop Environmentally Responsive Prototype



NZE K-12 Prototype, LA
LEED PLATINUM
44 kWh/sm

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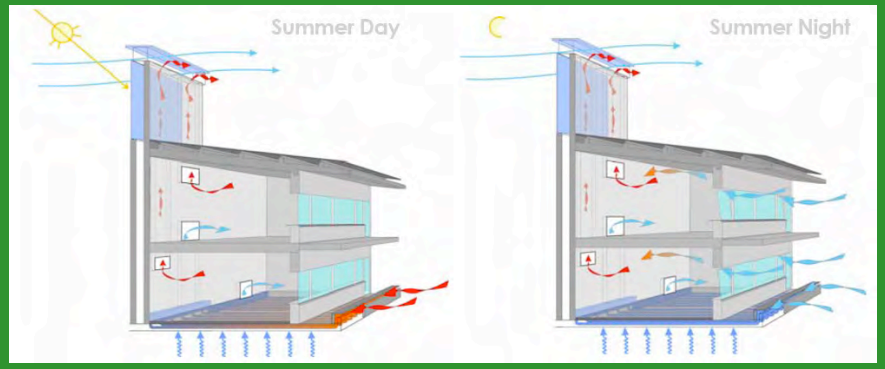
Part Six – Next Steps

6.8 – What can we do better?

RECOMMENDATION 4: Develop Environmentally Responsive Prototype

Regenerative
Passive



Charles de Gaulle School
Damascus Lebanon
Transsolar

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Part Six – Next Steps

6.9 – Vision for the Future - Conclusions

Health Beauty Passive Design Regeneration

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