Title
U.S. Department of Energy (DOE) Technical Assistance to Beichuan Reconstruction: Creating and Designing Low- to Zero-carbon Communities in New Beichuan, Sichuan Province

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U.S. Department of Energy (DOE) Technical Assistance to Beichuan Reconstruction: Creating and Designing Low- to Zero-carbon Communities in New Beichuan, Sichuan Province

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Introduction

Beichuan county, located in north of Sichuan Province, was the most severely damaged township in last May's Sichuan earthquake. Reconstruction of a new Beichuan is a high-profiled project by the governments. In addition to constructing structurally-sound, quake-safe buildings in the new development, rebuilding Beichuan presents an opportunity for constructing new low- to zero-carbon communities in the region. In fact, building up greener communities in the reconstruction has become a top priority for the county, which, at an estimated 7 square km, is expected to have 50,000 residents in 2015 and 70,000 in 2020.

The recent focus of construction projects is on the east side of the river, while land on its west bank will be reserved for development in the mid- to long-term. In the near term, a number of new public buildings are scheduled to be constructed starting in November 2009. As indicated by the deputy county chief, Mr. He Wang, the construction timeframe is unusually tight. Many buildings, although in various stages of planning and design, will be constructed starting in November 2009. Timely expert advice on design improvement and planning considerations will benefit the integration of energy efficiency and environmental benign elements in Beichuan's reconstruction, and will help promoting integrated development of green communities with low- to zero-carbon emission from the region.

In order to create synergies and provide technical assistance with the support from US Department of Energy, LBNL sets the following goals with the theme of promoting green community development:

1. Help creating healthy and comfortable built environments
2. Advocate efficient use of natural resources in design and operation that would reduce costs and achieve zero-carbon emissions, and
3. Provide guides for integrated environmental planning and green design.

In particular, we advocate an integration approach in planning, design and construction process for energy-efficient buildings, and provide quick recommendations for energy and environmental considerations so that the right decisions for design and construction are made in the process. For example, designing high-performance schools would not only use less energy, cost less to operate, and emit less energy-related pollutants and carbon than conventional buildings, but also would create better thermal environmental conditions conducive to learning for the occupants (e.g., students). Successful implementation of measures for zero-carbon emission may also be duplicative in the region and be a living teaching and learning tool for green development.

In Beichuan where it is cold in winter and sometimes hot in summer, no space heating is required for public buildings under current national building energy codes or design guides for the climate zone. Therefore, designing and delivering buildings that are conducive to people's comfort and health, while being a challenge, presents a unique opportunity to promote development of green communities with low- to zero-carbon emission.

Purpose and Tasks

Our purpose is to provide technical assistance in the building planning, design and construction phases to promote green communities in Beichuan Reconstruction. Specifically, we conducted design reviews, building performance analysis, and developed recommendations for design improvement and/or considerations. The main tasks undertaken include the following:

1) Identify Points of Contacts (POCs) for leading the project

2) Obtain building design information
- Local weather data
- Building designs and their characteristics

3) Outline and carry out a review plan
- Perform local weather analysis
- Review designs
- Obtain and review green building standards in China and the United States

4) Develop recommendations for design/planning
- Draft general recommendations for design and construction
- Perform building simulation to analyze thermal-environmental performance
- Finalize recommendations

5) Interact with POC of Beichuan Reconstruction and deliver summaries of the recommendations
- Provide draft recommendations
- Deliver final recommendations.

Project Outcomes and Accomplishments

1. Project teams were formulated with POCs identified.

The LBNL team was formulated on September 22, 2009. LBNL Point of Contact (POC) to lead the project is Tim Xu, with technical assistance from Chuang Wang and Tianzhen Hong. Supervision was provided by Mark Levine. In addition to emailing to Construction Department of Sichuan Province, phone calls were made to communicate with designers, planners, and/or officials associated with Beichuan Reconstruction. As a result, we have identified Mr. He Wang as the Point of Contacts (POCs) for this Beichuan project. Mr. He is an architect and urban planner, and was appointed Deputy Chief of Beichuan County in charge of high-profiled Beichuan reconstruction. Mr. He leads a local Beichuan team in the planning-design-construction process, and is keen on implementing green planning and designs in the processes.

2. Obtained building designs and weather data

The weather data analysis is critical for reviewing and developing recommendations of local green building design and construction of various types in the Beichuan. LBNL has gathered weather data sets suitable for Beichuan region and developed pre-design analysis. Following phone discussion between the POCs, the Beichuan team has identified four project candidates that can benefit from LBNL's advice. Preliminary designs of four different buildings were then sent to LBNL for review.

3. Outline and carry out a review plan

3.1 Summary of local weather analysis

Predominant wind's directions and speeds in the region change with month and season of the year. Figure 1 shows the aggregated frequencies of wind speed per wind direction in a year. Except for summer months when NW wind becomes more evident, NE wind appears to be most dominant throughout the year with SE wind being secondary. Because the school is normally closed for summer vacation, we have examined ways of optimizing the school design to improve the building's thermal environmental performance when typical occupancies are expected. In hot summer months, SE winds are more common. In addition, based upon the TMY data, we have found that it is common to have natural winds in the region (e.g., over 60% of the time with detectable wind speeds).

The weather is generally mild during spring and fall, and becomes cold in winter and hot in summer (Figure 2). Annual heating-degree days are approximately 1500 HDDs and cooling-degree days up to 55 CDDs. Cooling load is normally not so demanding during occupancy hours in public buildings. Air humidity in the region is generally higher, e.g., 70-80% RH.

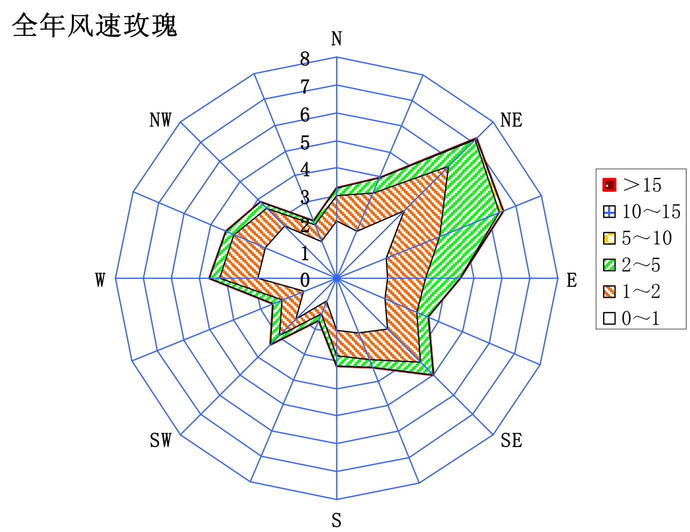

Figure 1 Wind Speed Distribution.

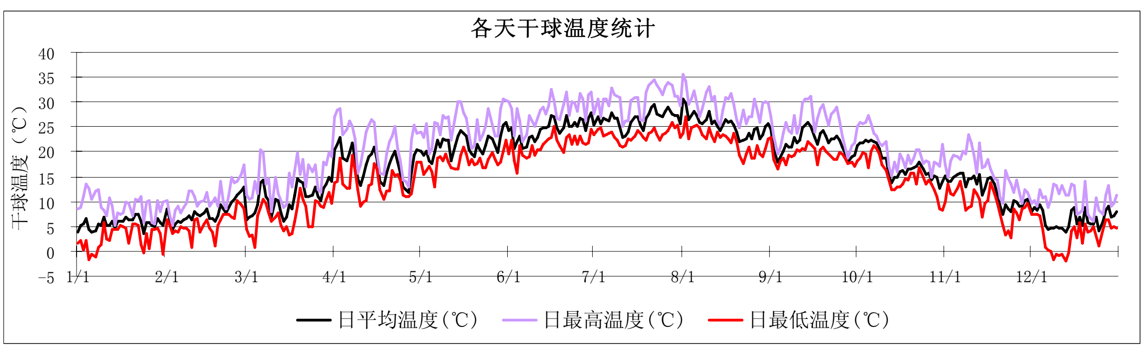

Figure 2 Average Daily Air Temperatures.

3.2 Summary of building characteristics (four building types)

Based upon the design and planning material received from the Beichuan team, Table 1 summarizes the key characteristics of the buildings.

Table 1. Summary of public building information (Locations–all in Beichuan County)

N	Building Name	# of Bldgs	Type	Story	Total Floor Area (m^2)
1	Yong Chang First Elementary	Classrooms Dorm Dining	Education	3	1,0340 5,450 3,350 Total 19,000
2	Sports Center	One outdoor field complex Training facility gymnasium	Public Assembly Sports	- 2-3 high-ceiling	Typical
3	Qiang Cultural Museum	Library Culture exhibition Qiang Museum	Public Assembly	1-4	3,500 3,000 8,000 Total 14,500
4	People's Hospital	Offices + hospital complex	Health Care	3-9	22,546 + 1424

3.3 Review of green building standards in China and the United States

We have reviewed a number of relevant building standards or green building guidelines developed in the United States and in China. No single document provides complete information on design criteria for school buildings. In fact the available standard or green guide typically address a portion, if any, of the many parameters that affects the energy and thermal environmental performance for school buildings. For example, Table 2 summarizes the design criteria from existing green guides and building standards related to schools.

Table 2. Summary of design criteria from green guides and building standard for School

	Indoor temp	**HVAC Vent.**	**Envelop K (W/m^2K)**			**Window**		
	°C		Ext Wall	Roof	Ext. Door	K/SC (W/m^2K)	WF	operable
GB/T 50378-2006 Green bldg	Refer to GB 50189	Refer to GB 50189	-	-	-	-	-	>30%
GB 50189 Public bldg*	Office 16-20 Winter 25 Summer (no school info)	11 ach elementary school	1.0 floor	0.7	-	K2.5-4.7 /SC0.4-0.55 Pending orientation	-	Need shading
JGJ 134-2001/J116-2001 (Residential)	16-18 Winter 26-28 Summer	1 ach	1.0-1.5	0.8-1.0	3	K2.5--4.7 SC pending orientation, WW		-
GBJ99-86 (School)	16-18 classroom 18 library	3 ach 2.5 ach dorm	-	-	-	-	>1:6	-

ASHRAE 90.1-2004 nonresidential			0.857 0.607 floor	0.36 0.19 attic	3.97	K2.67-3.8 /SHGC	-	-
ASHRAE 189.1 green bldg	-	-	-	-	-	-	-	-
ASHRAE handbook	Classroom 22-24 Winter 26 Summer	-	-	-	-	-	-	-

* Assumes central systems only; no space heating enforced for the region; few guidelines applicable to school buildings.

4. Develop recommendations for design/planning

Upon our reviews of the regional weather data and design information provided by Beichuan team, we have developed a list of general recommendations for all buildings, and conducted additional performance analysis of one school building in Beichuan using DOE's EnergyPlus simulation program. The results from simulation analysis allow us to develop further recommendations and guidelines for school design and construction in the region, as compared to existing green design guides or standards in China and in the US.

Critical recommendations related to environmental quality and safety, if any, have been conveyed to the Beichuan team for design improvement and considerations based upon the review and analysis of available designs. Two draft reports on the list of recommendations were developed and delivered on October 9 (English version) and October 28 (Chinese version). The final reports with a refined list of recommendations were completed on October 29, 2009, ahead of the targeted November deadline.

4.1 Summary of Recommendations

In general, building envelop is a main factor in affecting thermal environmental performance of a building, and has significant impact on energy use especially when HVAC is included. Implementing good building envelope technologies available today make buildings more efficient, durable, comfortable, and adaptable. When required, HVAC design should consider interrelated building systems and energy-efficient designs often need smaller HVAC systems. Careful planning and efficient use of natural resources (e.g., water) for various purposes should be integrated. Table 3 enlists the recommendations, when applicable, for all buildings.

Table 3. Design considerations for achieving green planning, design, and construction.

	Measure and Design Considerations	School	Culture center	Sports facilities	Hospital
Indoor Environmental Quality	Operable windows	x	x	x	some
	Non- or low-VOCs from paints and furnishings	x	x	x	x
	Non-lead paints and furnishings	x	x	x	x
Water usage	Irrigation water vs. drinking water Controllable low-flow sprinkler/dripping	x	x	x	x
	Low-flow faucets, toilets	x	x	x	some
	Landscape	-	-	artificial turf	-
Orientation and natural resources	Re-orientation of existing design/layouts to take advantage of NE/SE winds to Maximize natural ventilation	x	x	x	some
	Direct exhaust air, air-borne contaminant dispersion to non-occupied spaces	-	-	-	x
Exterior Material	The cool (e.g., white) roof reflects solar radiation, reducing the heat island effect and internal cooling loads.	x	x	x	x
	Use light exterior colors with higher reflectance and high emittance to reduce solar heat gains	x	x	x	x
Envelope	Apply sufficient insulation to exterior walls, roofs, and floors	x	x	x	x
	Maintain thermal mass	-	x,museum	-	-
	Optimize building shapes to have a smaller shape coefficient	x	x	x	x
	Design window–wall-ratio within 40% or less	class room up to 60%	x	x	x
Fenestration	Avoid large windows facing west without shading device	x	x	x	x
	Design exterior shading for west-facing and south-facing window	x	x	x	x
	Use high-performance double-glazing windows with low-e coatings. The windows have low U-factor, low SHGC, and reasonable visible transmittance for daylighting.	x	x		x
Other Structures	Add shaded corridors	x	x	x	x

	Measure and Design Considerations	School	Culture center	Sports facilities	Hospital
	Vent exhaust from attics	x	when applicable	when applicable	x
Daylighting	Maximize day-lighting and controls to reduce electric lighting while keeping daylight glare under control	x	x	x	x
	Appropriate sky-lighting	x library	x library	no	x
Electric Lighting	Use programmable timing control to reduce electrical lighting	x	x	x	x
	Use occupancy sensor controls to reduce electrical lighting	x, hall ways	x	no	no
	Include dimming control to reduce electrical lighting	maybe	x	X	no
	Use efficient CFL lamps and fixtures such as T8 and T5 lamps (indoor)	x	x	x	x
	Use LED lamps for outdoor and signs lighting	x	x	x	x
HVAC	Variable-speed ceiling fans (safe, low-speed)	x	x	x	-
	Consider demand control mechanical ventilation	x	x	x	x
	Select appropriate HVAC system type (including mechanical vent. only), zoning, and controls	no AC	x	x	x various
	Use radiant cooling and heating systems		x,museum	x, gym	some
	Use air-side and water-side economizers		X	x	x
	Use variable speed drives for fans and(or) pumps		X	x	x
	Use high efficient chillers and variable speed chillers.		-	x	x
	Use multiple chillers instead of a single large one		if necessary	x	x
	Use reset controls to adjust supply air rates and temperatures, fan static pressure set point		x	x	x
	Use reset controls to adjust chilled water temperatures		if necessary	x	x
	Control optimal hot water supply temperature, and condenser water temperature		if necessary	x	x
Boiler	Use high efficient boilers such as condensing boilers.	x	x	x	x
	Use multiple boilers instead of a single large one	x	x	x	x
	Use heat recovery	x	x	x	x

X: applicable; planning and design of the four buildings are illustrated in Figures 3 through 6 in Appendix.

In addition, the following considerations shall be included for planning and designs.

- Bus stops and public transportation integration
- Bicycle parking spaces
- Additional shades and shelters to the parking spaces
- Shaded porches and walkways around the buildings
- South-facing windows with high SHGC ratings to provide a building with heat in the winter
- Properly designed roof overhang or corridors may reduce the solar heat gain from south- or west-facing windows in the summer
- Include easy post-construction addition of window coverings – shades, blinds, mesh screens, and awnings, which will reduce solar heat gain in the summer
- Fire safety and emergency measures and equipment
- Space and facility of battery-chargers for electric vehicles
- User-friendly designs for persons with disability should be advocated and implemented indoors and outdoors for all buildings, e.g., ramps for handicapped access to and within all buildings.

Hospital design should brace for possible outbreaks of diseases like bird flu that leap the species barrier from animals to humans. Lessons learned from SARS, H1N1, mad cow disease, and other illnesses should be integrated for coping with such outbreaks.

Due to the tight schedule and limited resource, it is impossible to develop detail recommendations for the hospital. However, one critical aspect in hospital design and space planning is to avoid potential cross-contamination caused by either improper system control or by improper exhaust or space allocations. For example, infection control and isolation can be compromised when the door from the isolated patient's room is opened. An anteroom maybe recommended as a means of controlling airborne contaminant concentration through containment and air dilution. While proper air handling and ventilation control is necessary in surgical services, airborne infection isolation spaces, protective environment rooms, laboratories, local exhaust systems for hazardous agents, and other special areas, the existing design and layout of infection clinics offices and isolation rooms for treatments may pose risks in cross-contamination to the adjacent spaces with neighboring windows.

The concerns about the existing design of infection clinics and treatment had been conveyed to Beichuan POC earlier. We recommend that design and planning improvement be made to avoid potential risks.

4.2 Additional Guide for School Design though Performance Simulation and Analysis

High-performance schools are comfortable, healthy learning environments that integrate indoor environmental quality, natural and electric lighting, comfort, acoustics, local climates, and safety. In the US, the CHPS (Collaborative for High Performance Schools) organization developed best practices manuals, available for free download at www.CHPS.net, for designing high performance schools. The CHPS design scorecard is attached in the Appendix for reference.

Besides the general recommendations for school buildings, we aim at developing important guidelines based upon energy simulations using EnergyPlus program. Our analysis is focused on thermal environmental performance improvements for school buildings through optimizing building design in the local weather. The goal is to improve student comfort levels in the newly built learning environment, while greatly reducing and even eliminating energy use for space conditioning compared to state-of-the-arts schools in open literatures.

Based upon the weather data analysis of the region and building performance simulations using Energy Plus, we recommend the following guidelines in planning and designing school buildings in Beichuan region:

- Enhance natural ventilation and daylight whenever appropriate for weather and seasonal conditions.
- Implement glare control while maximize natural daylight.
- Increase windows area with proper shading designs, and utilize ceiling fans to avoid overheat in summer.
- Improve enclosure insulations (wall, roof, windows, doors) and minimize infiltrations to avoid heating requirement during winter.

Key measures include:

- Design with larger windows to allow maximal daylight penetration, with window to wall ratio up to 60%. WW ratio should be no less than 40%.
- Double-glass would be recommended when budget permits.
- While single-layer-glass windows for classrooms are acceptable, measures must be taken to obtain and install highest-quality windows that have minimal unintended infiltration or leakage, and avoid condensations.
- Avoid using horizontal sliding windows for classrooms.
- North-facing windows should be no larger than south-facing windows, if not equivalent. External shading should be provided for south-facing and west-facing windows.

In case air conditioning is required for specific applications, central systems shall be avoided.

5. Interact with POC of Beichuan Reconstruction and deliver a summary of the recommendations.

Communications on LBNL recommendations were performed via phone calls and emails. LBNL is interested in learning about the planning-design-construction development and decision-making processes from the Beichuan team. The final reports on recommendations are completed, in both Chinese and English versions. They are delivered to the Beichuan POC by October 29, 2009.

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Appendix A – CHPS Design Scorecard

Collaborative for High Performance Schools (CHPS) Designed Scorecard

Based on the 2009 Edition For New School Construction

COLLABORATIVE FOR HIGH PERFORMANCE CHPS SCHOOLS Better buildings. Better students.

School Name:

Expected Completion:

School District:

School Address: **State:** **Zip:**

School Contact/Principal:

Student Capacity:

Approximate Square Feet:

Verification

Is this the final CHPS scorecard? YES or NO (Please circle)

Registered Principal Architect (Signature)

Name, Title, Date (Please print) **Name, Title, Date** (Please print)

CHPS SECTION	CREDIT NUMBER	TITLE	POSSIBLE POINTS	SUMMARY**	TARGET	POINTS EARNED	FOR SELF CERTIFICATION, PROVIDE NARRATIVE, CALCULATIONS, DOCUMENT/ PLAN REFERENCE HERE. (Use Separate Sheet as Necessary).
LEADERSHIP, EDUCATION AND INNOVATION (1 prerequisite; 13 possible points)							
1. Leadership (4)	LEI1.1	District Level Commitment	1-2	District must maintain CHPS membership and pass a board-level resolution that mandates compliance with CHPS. Two point if resolution incorporates CHPS Maintanence and Operations program.			Add Narrative
	LEI1.2	Integrated Design	1-2	Implement at least two integrated design team workshops to discuss high performance goals. Workshops must be conducted at SD and CD phases of project.			
2. Schools as Learning Tools (1)	LEI2.0	Educational Display	Req	Provide a permanent educational display in prominent school location.	X	X	
	LEI2.1	Demonstration Areas	1	Provide at least three education demonstration			
3. Innovation (8)	LEI3.1	Innovation	1-4	Implement new technologies or strategies that further high performance goals.			
	LEI3.2	Design for Adaptability, Durability and	2-4	Provide a plan and implement strategies that promote material conservation and ease of			
SUSTAINABLE SITES (2 prerequisites; 14 possible points)							
1. Site Selection (6)	SS1.0	Code Compliance	Req	Comply with all requirements of Title 5 and CA Education Code and Public Resource Code sections specified.	X	X	
	SS1.1	Environmentally Sensitive Land	1	No development on sites that are: prime agricultural land, in flood zone, habitat for endangered species, greenfield, near a wetland or considered parkland.			
	SS1.2	Central Location	1	Create centrally located sites within which 50% of students are located within minimum distances of the school.			
	SS1.3	Joint-Use of Facilities	1	Design at least one space for "joint-use" and provide specified security measures.			
	SS1.4	Joint-Use of Parks	1	Share park or recreation space.			
	SS1.5	Reduced Footprint	1	Reduce the building footprint.			
2. Transportation (3)	SS2.1	Public Transportation	1	Locate near public transportation.			
	SS2.2	Human Powered Transportation	1	Provide bike, scooter or skateboard racks & bike lanes for a percentage of the school population.			
	SS2.3	Minimize Parking	1	Minimize parking lot & create preferred parking for carpools.			
3. Stormwater Management (2)	SS3.0	Construction Site Runoff Control	Req	Control erosion & sedimentation to reduce negative impacts on water & air quality.	X	X	
	SS3.1	Limit Stormwater Runoff	1	Minimize runoff.			
	SS3.2	Treat Stormwater Runoff	1	Treat runoff.			
4. Outdoor Surfaces & Spaces (3)	SS4.1	Reduce Heat Islands - Landscaping Issues	1	Shade or lighten impervious areas, or reduce impervious parking.			
	SS4.2	Reduce Heat Islands - Cool Roofs	1	Install cool or green roof.			
	SS4.3	School Garden	1	Provide infrastructure for a school garden with size dependent on student capacity.			
5 Outdoor Lighting (1)	SS5.1	Light Pollution Reduction	1	Minimize outdoor illumination.			

WATER (1 prerequisite; 9 possible points)							
1. Outdoor Systems (4)	WE1.0	Create Water Use Budget	Req	Establish water use budget & conform to the local water efficient landscape ordinance.	X	X	
	WE1.1	Reduce Potable Water for Use for Non-Recreational Landscaping Areas	1-2	Reduce potable water by 50% or 100%, or do not install permanent irrigation systems for landscaping areas.			
	WE1.2	Reduce Potable Water for Recreational Area Landscaping	1	Reduce potable water by 50% and install soil moisture meters or ET Controllers on recreation fields.			
	WE1.3	Irrigation System Testing and Training	1	Create irrigation commissioning plan, test irrigation systems and train staff.			
2. Indoor Systems (4)	WE2.1	Reduce Sewage Conveyance from Toilets and Urinals	2	35% reduction in potable water use for sewage conveyance and provide shut-off capabilities for water supply to all urinals and water closets.			
	WE2.2	Reduce Indoor Potable Water Use	1-2	Decrease water use by and additional 20% or 40% after meeting Energy Policy Act of 1992.			
3. Water Efficiency (1)	WE3.1	Water Management System	1	Install a water management system to monitor usage and reduce consumption.			
ENERGY (2 prerequisites; 29 possible points; minimum 2 points required)							
1. Energy Efficiency (22)	EE1.0	Minimum Energy Performance	Req	Design building to exceed Title 24-2008 by 15%.	X	X	
	EE1.1	Superior Energy Performance	1-15	16% to 44% reduction in total net energy use from Title 24-2008 baseline.			
	EE1.2	Energy Conservation Interlocks	1	Install interlocks to turn off heating and cooling equipment if doors and windows are open.			
	EE1.3	Natural Ventilation	1-4	Comply with Title 24, Part 6, 121b for assembly spaces and/or 90% of typical classrooms.			
	EE1.4	Energy Management Systems	1-2	Install Energy Management System and provide training and manuals for maintenance personnel. Additional point for plug load.			
2. Alternate Energy Sources (6)	EE2.1	On-Site Renewable Energy	1-5	Install web-based performance monitoring system and provide 1-90% of the building's TDV energy use through on-site renewable systems.			
3. Commissioning & Training (2)	EE3.0	Fundamental Commissioning	Req	Third party or district verification of building systems & training.	X	X	
	EE3.1	Enhanced Commissioning	1-2	Additional third party or district verification of building systems, training and best practices.			
CLIMATE (8 possible points)							
1. Greenhouse Gas Emission Reduction (3)	CL1.1	Climate Change Action	1-3	Choose strategies that reduce greenhouse gas emissions and/or measure and report emissions annually.			
2. Greenhouse Gas Emission Reduction (6)	CL2.1	Grid Neutral	2	Create a school that produces at least as much electricity as it uses in a year and uses renewable energy strategies.			
	CL2.2	Zero Net Energy	5	Create a school that produces at least as much electricity as it uses in a year (without using fossil fuel based energy sources produced off-site) and uses renewable energy strategies.			
MATERIALS AND WASTE MANAGEMENT (2 prerequisite; 18 possible points)							
1. Recycling (0)	ME1.0	Storage and Collection of Recyclables	Req	Meet local standards for recycling space & facilitate the separation and collection of materials for	X	X	
2. Construction Waste Management (2)	ME2.0	Minimum Construction Site Waste Management	Req	Recycle, compost and/or salvage at least 50% of non-hazardous construction and demolition debris.	X	X	
	ME2.1	Construction Site Waste Management	1-2	Recycle, compost and/or salvage at least 75% or 90% of non-hazardous construction and demolition			
3. Building Reuse (3)	ME3.1	Building Reuse - Structure and Shell	1-2	Reuse 75% or 95% of existing structure and shell.			
	ME3.2	Building Reuse - Interior Non-structural Elements	1	Use existing on-site non-shell elements in at least 50% of completed building.			
4. Sustainable Materials (7)	ME4.1	Recycled Content	1-2	Follow prescriptive or performance approach.			
	ME4.2	Rapidly Renewable and Organically Grown Materials	1-2	2.5% of materials are rapidly renewable or specify rapidly renewables for 50% of one of the listed major interior finishes or structural materials. Extra point for using organic materials.			
	ME4.3	Certified Wood	1	50% of wood must be certified			
	ME4.4	Salvaged Materials	1-2	Follow prescriptive or performance approach.			
5. Sustainable Materials - Multi Attribute (2)	ME5.1	Environmentally Preferable Products	1-2	Use this credit instead of 4.1-4.4. Interior finishes must meet EQ2.2. Earn a one-half point for each certified EPP Product.			
6. Sustainable Materials - LCIA (4)	ME6.1	Environmental Performance Reporting	1-4	Choose products that have undergone a life cycle impact assessment by national standards.			

INDOOR ENVIRONMENTAL QUALITY (4 prerequisites; 25 possible points)							
1. Lighting and Daylighting (6)	EQ1.1	Daylighting	1-4	Meet minimum requirements and choose one of three options.			
	EQ1.2	View Windows	1	Direct line of site glazing for 90% of classrooms, libraries and administration areas and provide view glazing equal to or greater than 7% of the floor area			
	EQ1.3	Electric Lighting	1	Provide high quality and flexible classroom lighting.			
2. Indoor Air Quality and Thermal Comfort (16)	EQ2.0A	Minimum HVAC and Construction IEQ Requirements	Req	Establish minimum standards for indoor air quality that includes construction ventilation, building flush-out, outside air ventilation and HVAC basic requirements among other things.	X	X	
	EQ2.0B	ASHRAE 55 Thermal Comfort Code Compliance and Moisture Control	Req	Comply with ASHRAE 55-2007 thermal comfort standard and employ moisture control measures to prevent mold growth.	X	X	
	EQ2.0C	Minimum Filtration	Req	Use HVAC with MERV 8 or greater rated filters through the HVAC system.	X	X	
	EQ2.1	Enhanced Filtration	1-2	Use HVAC with minimum MERV 11 or 13 rated filters through the HVAC system.			
	EQ2.2	Low-Emitting Materials	1-4	Earn one-half point for each category of low-emitting products used in all classrooms and staff work			
	EQ2.3	Ducted Returns	1	Install ducted HVAC returns.			
	EQ2.4	Thermal Displacement Ventilation	2	Use thermal displacement ventilation in at least 90% of the classrooms.			
	EQ2.5	Controllability of Systems	1-4	Provide operable windows, dedicated outside air ventilation system and/or separate controls for each classroom.			
	EQ2.6	Chemical and Pollutant Source Control	1-2	Control dust, segregate pollutant sources and local exhaust in kitchens. Install walk-off mats.			
	EQ2.7	Mercury Reduction	1	Create inventory of all devices containing mercury and purchase or replace lamps with low mercury			
3. Acoustics (3)	EQ3.0	Minimum Acoustical Performance	Req	Classrooms must have a maximum (unoccupied) noise level of 45 dBA LAeq, with maximum (unoccupied) reverberation times of 0.6 sec.	X	X	
	EQ3.1	Improved Acoustical Performance	1 or 3	Classrooms must have a maximum (unoccupied) noise level of 40 or 35 dBA LAeq, with maximum (unoccupied) reverberation times of 0.6 sec.			
TOTAL (Minimum points required for CHPS school is 32 of possible 116)					0	0	

** The summary should not be used to determine requirements for a specific credit or prerequisite. Refer to the CHPS Best Practices Manual, Volume III, Criteria available at www.CHPS.net for credit and prerequisite specific requirements.

Appendix B. Pre-design and planning provided by the Beichuan team

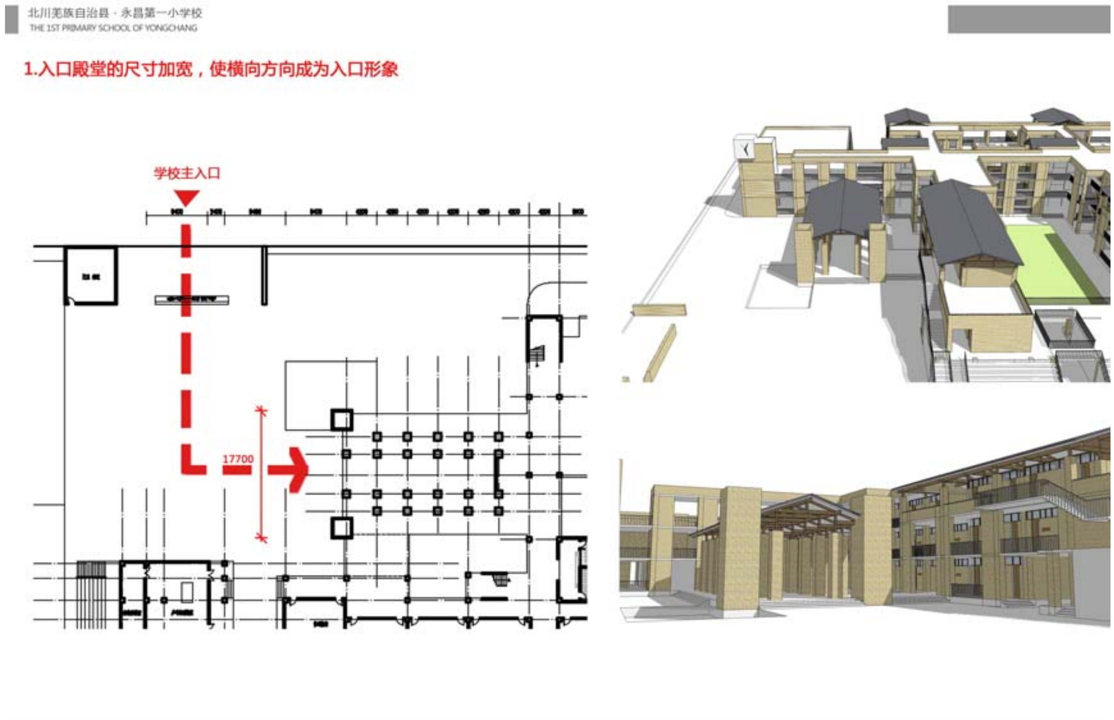

Figure 3 Yong Chang Elementary School

Figure 4 People’s Hospital

Figure 5 Sports Facility (stadium, training facility, and gym)

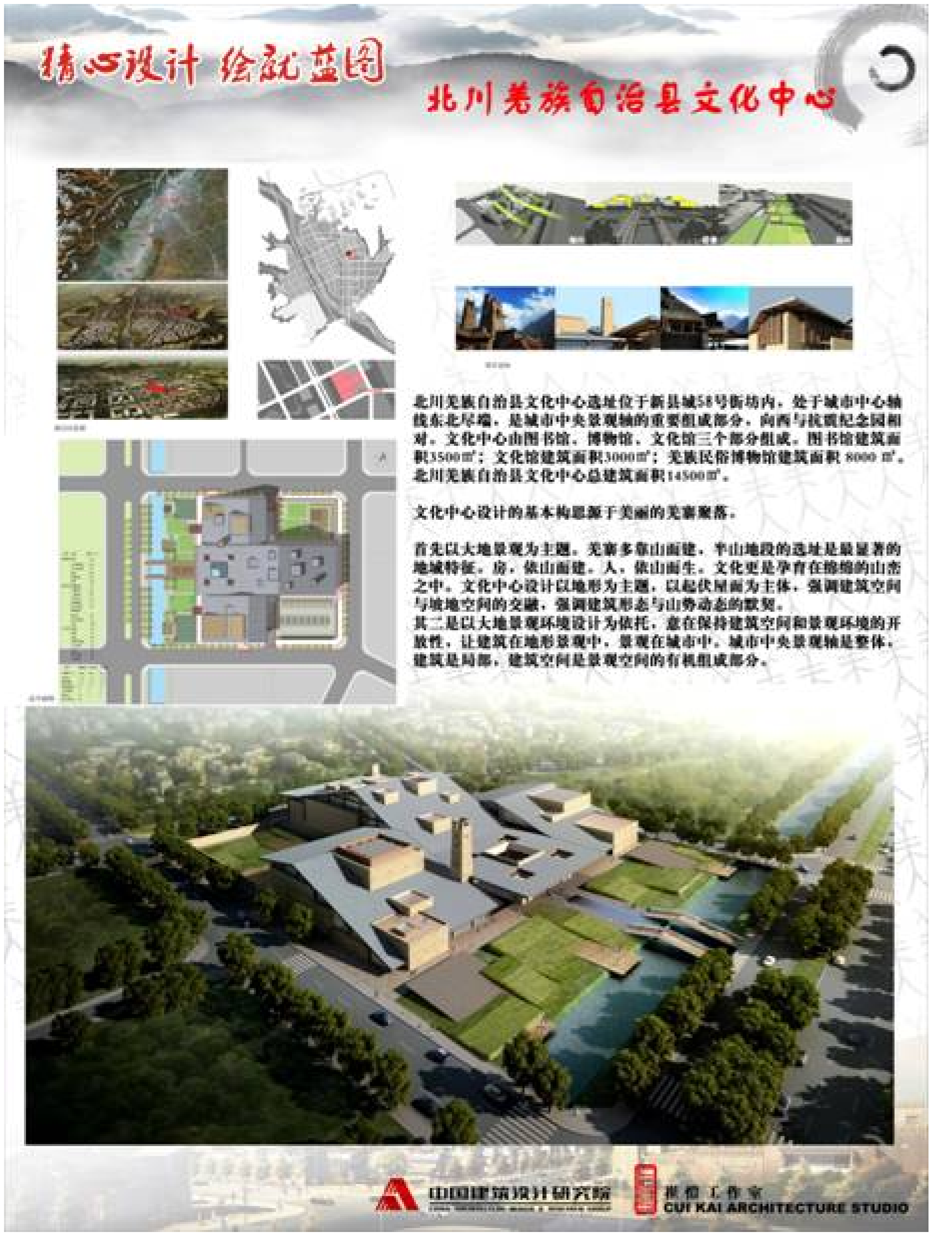

Figure 6 Qiang Culture Center