



# Conceptual Study

Translating Wing Power Generation System

**Prepared For | Cleancore Energy Inc.**

Renewable Energy & Business Development





CH2M HILL  
4599 Tillicum Street  
Burnaby, BC V5J 3J9  
Tel 604.659.3335  
Fax 604.659.3345  
www.ch2mhill.com

24 December 2008

Mr. Hans Dysarsz  
President  
Cleancore Energy Inc.

**Subject: Concept Study Leading to Cost Estimates for a Novel Translating Wing Power  
Generation System**

Dear Mr. Dysarsz,

There are many challenges involved with the development of a wind power project in a low wind speed regime in Canada. The low wind speed does not lend itself to traditional wind capture technologies and the cold weather operation poses unique requirements. Your design concept using ground-based translating wings is a unique approach that offers some potential benefits.

CH2M HILL is excited to respond to this challenge and is proposing a concept-level study and economic evaluation of Cleancore's innovative translating wing power generation concept. The following attributes illustrate why our approach will benefit Cleancore:

**An Experienced Team**

CH2M HILL and our subsidiary construction company Commonwealth Construction have considerable experience working on numerous power projects, and enables us to meet the design and construction challenges. Commonwealth's extensive experience in modular design will allow us to minimize onsite fabrication and maximize offsite fabrication to reduce the high cost of local construction.

**Wind Power and Transportation Expertise**

CH2M HILL's combined expertise in the areas of wind power and transportation will allow us to develop Cleancore's unique ground level design and incorporate conventional technology from these existing technology areas and to minimize the need for high reach lifting equipment and expensive local construction.

**Outstanding Reputation for Delivering Sustainable Solutions**

CH2M HILL has been an active leader in the worldwide movement toward sustainability and is currently ranked as the #1 Overall Environmental Firm and the #1 Firm in Environmental Consulting/Studies by Engineering News Record Magazine. Our direct experience in the design and implementation of a wide range of renewable energy applications will allow us to complete the study in a time and cost effective manner, enabling Cleancore to better evaluate the potential of your translating wing power generation system.

### **Resource Availability**

With over 25,000 employees worldwide we have the resources available and ready to support this study and any development, procurement, and construction required for future projects. This project will be executed from our Burnaby office where we have all of the major engineering and project services disciplines required to support this project. The project team will be supported by our numerous technology experts throughout the CH2M HILL organization and outside consultants on an as-needed basis.

CH2M HILL remains committed to providing Cleancore with successful projects. We have studied this potential wind power project and have developed an approach for the conceptual study. We have a skilled and experienced team ready to begin work on this study and we will engage technical experts who will translate these recommendations into the best technical solutions at the lowest cost.

We appreciate the opportunity that Cleancore has provided in considering funding this study and future development work. If you have any questions or require additional information, please do not hesitate to contact me. We look forward to discussing the next steps with you at your earliest convenience.

Regards,

Ross Lewis, P.Eng.  
General Manager, BC Operations

# Contents

---

# Contents

<b>Project Description .....</b>	<b>1</b>
<b>Scope of Services .....</b>	<b>2</b>
<b>Methodology.....</b>	<b>3</b>
<b>Proof of Concept Design.....</b>	<b>4</b>
<b>Schedule &amp; Key Milestones .....</b>	<b>5</b>
<b>Project Team .....</b>	<b>6</b>
<b>Commercial .....</b>	<b>7</b>
<b>Relevant Experience.....</b>	<b>Appendix</b>



## Project Description

Cleancore Energy have been in discussion with potential investors for more than a year regarding development funding for Cleancore's innovative Translating Wing Power Generation Technology. Some investors have indicated to Cleancore that before they will commit any significant financial resources towards developing the Cleancore technology they need to understand, in a broad sense, the potential for the economic feasibility of the technology.

CH2M HILL proposes to provide Cleancore with a "reality check" of the potential economics of the Cleancore technology by completing a Conceptual Study of the Translating Wing Power Generation System that will estimate the potential range of capital and operating costs and power generation based on a simple "proof of concept" design.

CH2M HILL will minimize new conceptual design work and the associated cost of the study by utilizing as many commercially-available components from the transportation and power generation industries as possible for the concept design.

Cost and performance data should be available for this equipment that can be utilized in the study (with some judgment) for simply estimating power generation potential and capital and operating costs. CH2M HILL will utilize our understanding of wind power generation and the costs of construction and the difficulties of operating equipment in the Canadian climate to provide the balance of the study requirements.

An outline for the "proof of concept" system design is included in the Concept Design Section.

The Scope of the study will include the following main elements:

- Conceptual design for a "proof of concept" system
- Estimate for power generation potential
- Estimate for system capital costs
- Estimates for operating and maintenance costs
- Project schedule with milestones for engineering and construction
- Economic assessment for the system
- Summary report

A more detailed scope of work for the study is included in the Scope of Services Section.

Detailed cost estimates and a schedule for completing the study is included in the Commercial Section.



*CH2M HILL is consistently ranked as an overall leader by industry publications including Engineering News Record. The most recent ENR ranking of the top 200 environmental firms ranked CH2M HILL as:*

*#1 – Overall Environmental Firm  
#1 – Consulting / Studies  
#1 – Design / Engineering*

*This industry recognized expertise will allow us to provide an accurate and cost effective assessment of the potential of this new wind capture technology.*



## Scope of Services

Within this proposal, we have identified a proposed scope of work, methodology and specific resources that meet the anticipated requirements of the conceptual study. Our team has a diverse background including the core technologies required for this study: Wind Power and Transportation Technology with supporting engineering disciplines, cost estimating and economic evaluation skills. Our wealth of diverse experience working with clients to commercialize and scale-up first-of-a-kind technologies allows us to deliver an innovative and cost-effective approach that is unmatched in the industry.

Conceptual engineering will be required to develop a design basis for the Translating Wing Power Generation System and enable Class 5 (concept evaluation) capital and operating cost estimates and project economics to be prepared. The timeline for this study is anticipated to take 14 weeks from proposal acceptance and can be broken down into the following study phases.

Phase 1:	Define Design Basis	3 weeks
Phase 2:	Engineering Concept Development	7 weeks
Phase 3:	Cost Estimate, Economics and Report	4 weeks

### Phase 1: Define Design Basis

1. Mobilization.
2. Kick-Off Meeting will be held to define project and phase goals and deliverables.
3. Data Collection to establish typical external design requirements and operating parameters for available sites in a Northern Canadian low wind regime area:
  - Wind data and map(s) for typical locations
  - Electrical costs, utilities costs, property purchase costs, taxes and other cost data for typical area
  - Power interconnection location and requirements to supply power to electrical utilities
  - Other site data from government sources
4. Concept design selection / definition using team-based brainstorming and conceptualizing with experienced multi-discipline team to establish the initial internal design and operation concepts and parameters:
  - Define design concepts and options and parameters for wind energy capture based on established parameters (sail rig, use of commercial wheel sets, etc.) using “reasonable” assumptions concerning operating conditions, i.e. within limits of reliable technology and scale. This will include range of wind speeds, wind directions, carriage speed, carriage spacing, guideway oval length, etc.
  - Identify commercial sources for major equipment that can be incorporated into the system design
  - Scale factors will be discussed and agreed prior to the disciplines commencing on their own work.
  - Estimate the wind speed and direction frequencies on avail wind data.
  - Estimate range of driving force and various loads from sail rig on carriage, track and related support elements from wind energy capture based on local wind regime and maximum scale of system
  - Investigate design configurations, speed range, and spacing for carriages
  - Investigate guideway / track configurations and dimensions
  - Estimate expected range of power output range in KW and KWh
  - Prepare outline of design basis with ranges for parameters as required

5. Compare and decide on alternate design concepts for estimating and system scale.
6. Prepare PowerPoint presentation summarizing Phase 1.
7. Progress meeting with Cleancore

## Phase 2: Engineering for Proof of Concept Design Development

1. Mobilize discipline skills required.
2. Phase 2 Kick-Off meeting to define project and phase goals and deliverables.
3. Engineering to develop the design concepts and generate outline requirements, specifications, dimensions and quantities for system components to allow cost estimates to be produced.
  - Develop a Work Breakdown Structure (WBS) for the system, identifying all of the significant components that require concept development engineering and estimating
  - Refine loads for wind power capture using sail rig
  - Estimate dynamic loads on all equipment and structures and how loads are transferred from the sail rig through the carriage to the track and foundations and between the carriages on the track
  - Refine options for power conversion:
    - from carriage to generated electrical energy (with conventional rotating motor-generator)
    - from electrical energy generated to delivered electrical power at the end user (including AC vs. DC power generation and transmission)
  - Define electric power pick-up and substation options and electrical infrastructure
  - Develop guideway / track design
  - Identify Geotechnical issues and requirements
  - Identify environmental issues and permit requirements
  - Identify health, safety and security issues and options for mitigation
  - Develop controls logic and concepts
  - Prepare preliminary drawings and sketches to illustrate the conceptual schematic design and general arrangement
4. Develop scope for cost estimates for the system based on the conceptual design
  - Quantity takeoffs and estimates for equipment and systems (as design development progresses)
  - Identify potential suppliers and sources of expertise for specialized equipment
  - Obtain budget pricing for large and specialized equipment and materials (e.g. sail rig, carriage wheels and suspension, power train, etc.)
  - Obtain local pricing for special construction materials and labour (not available from CH2M HILL recent project costing data files)
5. Progress meeting with Cleancore to present the final design concepts and scope for cost estimating and economic evaluation in Phase 3.

## Phase 3: Cost Estimate, Economics, and Report

1. Kickoff Meeting for Phase 3 to define project and phase goals and deliverables.
2. Summarize concept design basis and WBS for cost estimates
3. Complete Capital Cost Estimating

- Prepare Class 5 TIC estimates for including direct construction costs: site preparation, site civil and infrastructure, structures, major equipment, bulk materials, installation, power transmission, utility or plant interconnection costs, etc. and factored indirect construction costs
  - Estimate site acquisition, permitting and related project costs
4. Estimate operating and maintenance costs for systems (management, operating and maintenance labour, rentals, taxes and fees, fuel, operating supplies, maintenance, parts, etc.)
  5. Estimate seasonal system availability and power generation potential
  6. Prepare preliminary revenue and cost estimate for power generation based on existing cost of power
  7. Identify value of economic incentives for green power that could be applied to the system
  8. Prepare a conceptual life cycle economic analysis
  9. Identify project risks and impacts
    - Technology risks
    - Capital cost risks - estimate the range of accuracy / reliability for the cost estimates
    - Operating and maintenance cost risks
    - Revenue risk
  10. Prepare a Summary Report:
    - Describe the system with descriptions, schematic and arrangement drawings, photos of similar system components and illustrations
    - List the system design basis
    - Summarize project capital costs
    - Summarize operating and maintenance costs
    - Summarize life cycle economic analysis
    - Provide economic outputs \$Capital Cost/kW of installed capacity, and \$/kWh produced power and a comparison with conventional wind power generation technology economics in the same wind regime.
    - Provide suggestions for future development
  11. Present Report at meeting with Cleancore



## Methodology

The Translating Wing Power Generation Project is a novel concept that will require coordination of currently separate wind power and rail transportation technologies. CH2M HILL has all of the required expertise within our North American offices to carry out this study in a cost effective manner.

We propose to base this project in our Burnaby, BC office as the required Project Management, Estimating, and major infrastructure disciplines (Electrical, Mechanical, Instrument & Controls, and CAD) are available there. Specialist input will be delegated to other CH2M HILL offices or outside experts as required.

This approach will give Cleancore a single point of contact, the Burnaby based Project Manager, for all aspects of this study.

CH2M HILL will control the project and keep track of all cost, man hours, productivity, and progress. Bi-weekly flash reports of man hours expended, broken down by discipline and progress, along with issues arising and a 2 week look-ahead will be issued to Cleancore. We also propose 3 project progress meetings with Cleancore after 2 weeks, 6 weeks, and 10 weeks, to ensure that all stakeholders are fully informed of the project status and direction.

We believe that this approach will bring together the highest levels of technical expertise and allow cross-discipline interactions that are essential when developing novel technologies such as this.



*We plan to base this project at our Burnaby location, which is home to a CH2M HILL Energy and Chemicals office as well as the Commonwealth Construction head office. We will also have support from technical experts across the CH2M HILL organization.*



## Proof of Concept Design

A simple “proof of concept” design for the Translating Wing Power Generation Technology will be developed using commercially-available airfoils, equipment, and systems from the transportation and power generation industries. The major components that must be assembled for a complete system include:

- Airfoils for wind energy capture with associated structural supports
- Carriages complete with airfoil mounting fixtures
- Carriage wheel assemblies to transfer loads from the airfoils to the track or guideway
- Carriage power transmission and braking assemblies
- On-carriage electrical power generation equipment
- Carriage-to-ground sliding electrical power transmission connections
- On-carriage control systems and auxiliaries for adjustment of the airfoils
- Tracks or guideways for carriages to run on with foundations or supports to take loads from the carriages
- Electric power collection and substation equipment
- Control centre with supervisory controls, communications and related systems
- Maintenance and other facilities
- Site development work

### Airfoils – Sail Rig

The complete sail rig (spars, standing rigging, sails, running rigging, etc.) from a large single-masted (sloop-rigged) commercial production sailing yacht will be used as the airfoils for the proof of concept system. The largest commercial production sailing yachts are in the range of 50 to 55 ft overall length. A typical model is the Sun Odyssey 54.

- 55 ft overall length and 16 ft beam
- 66 ft mast height
- 1527 ft<sup>2</sup> total sail area, including a 661 ft<sup>2</sup> furling main sail and a 866 ft<sup>2</sup> furling genoa sail

Furling sails allow the sail rig to effectively match sail area to wind speed to prevent excessive heeling force in higher wind speeds. This feature in addition to the traditional sail position and tension adjustments and other rigging adjustments, provide the ability to automatically adapt sail area to varying wind speeds and restrict maximum overturning loads on the carriages and guideways.



*CH2M HILL will minimize new conceptual design work and the associated cost of the study by utilizing as many commercially-available components from the transportation and power generation industries as possible for the concept design.*



*The 55 foot Sun Odyssey 54 is a large commercial production sailing yacht with furling sails.*

There is potential to use sail airfoils up to 4 times the height and 26 times the total sail area. The largest single-masted sailing yacht is currently the *Mirabella V* :

- 247 ft overall length and 48 ft beam
- 292 ft mast height
- 40,000 ft<sup>2</sup> total sail area, including a 16,760 ft<sup>2</sup> main, 19730 ft<sup>2</sup> genoa and a 3445 ft<sup>2</sup> staysail.

Some even larger multi-mast sailing yachts have also been built, including a 289 ft long “clipper”, the *Maltese Falcon*, with a much larger sail area but with a shorter mast height of 187 ft.

The mast, boom, rigging, sails and various items of equipment for sail control and optimization are all designed and commercially available. There will be little or no cost to design these components and limited risk in assuming these will work for a commercial wind power operation (except for risks of performance in extremely cold weather or high maintenance costs).

One of the commercial sailing rigs will be mounted on the upper deck of each carriage for the “proof of concept” design as they would be on the yacht. Points for attachment of the mast, rigging and sheets will match those on the deck of the yacht. Loads from the airfoil and rigging on the carriage are readily available.

The sail rig for commercial production yachts will likely be a lower cost than for the larger custom-designed and built sailing yachts.

Wing-type airfoils can be considered at a later stage of system development, as part of system optimization. The wind capture area of wings, however, do not approach sails. For comparison, the longest airplane wings ever built were for the Hughes H-4 Hercules “Spruce Goose” at approximately 150 ft long. These are longer than the commercial sail rig, but about one-half the length of the largest sailing rig. The wing cost will increase significantly as the length increases owing to required stiffening to prevent wing flutter and damage. The cost and power capture effect of longer wings can be estimated.

## Wheel, Drive, and Braking Assemblies

Subway or metro cars, railcars and highway trucks are similar in length to the commercial yacht and their available wheel loading capacity should be adequate to support the wind power carriages and allow it to travel at speeds up to 100 km/hr. The bogies and wheel assemblies can use rubber tires on concrete guideways, steel wheels on steel rails and combinations to take the various lateral, heeling, pitching and slewing loads associated with their travel.

While the lengths of these transportation vehicles are similar to large commercial production sailing yachts, the wheels are relatively narrower than the yacht beam. Part of the study will be to consider



*The 247 foot Mirabella V is the largest single-masted sailing yacht in the world.*



*The Maltese Falcon is a 289 foot multi-mast yacht with a very large sail area*



*The Hughes H-4 Hercules “Spruce Goose” had the largest airplane wings ever built at 150 feet in length.*

alternative design arrangements to transfer the heeling, pitching forces from Overall dimensions for these three vehicle types are shown in the table below.

### Typical Vehicle Dimensions

Type of Vehicle	Subway/Metro Car	Highway Truck	Railcar
Length	51 ft	53 ft	55-68 ft
Width (track)	8 ft 7 in (4 ft 8.5 in)	8 ft 6 in	10 ft 6 in (4 ft 8.5 in)
Height	11 ft 10 <sup>5</sup> / <sub>8</sub> in	13 ft 6 in	13 ft
Wheel diameter	34 in	38-43 inch	33 and 40 in
Weight (full)	90,000 lb	80,000 lb	120-140,000 lb
Speed	55 - 65 mph	55-70 mph	50-90 mph

Additional unpowered wheel assemblies will be provided to handle the running and uplift loads from the mast and rigging. Braking systems will be included with the wheel assemblies.

Steel wheel assemblies with steel rails will be compared with rubber-tired wheel assemblies on concrete running surfaces.

Advantages of rubber-tired (metro) systems (compared to steel wheel on steel rail):

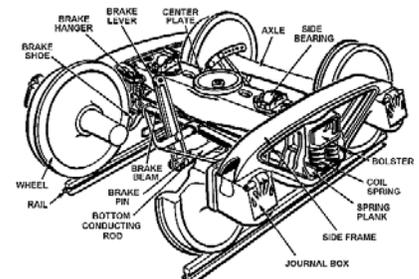
- Smooth ride (with little "jostling" around)
- Faster acceleration and shorter braking distances,
- Quiet ride in open air (for residents and those outside the train)
- Disadvantages of rubber-tired (metro) systems:
- Higher energy consumption loss than steel-on-steel and more heat generated
- Heavier equipment
- Tire replacement cost

## Tracks or Guideways

The tracks or guideway design will depend on the wheel systems chosen. For the rubber-tired option, a track or guideway is envisioned as being constructed using a series of precast concrete T or U beams supported at the connections with fabricated steel connectors that provide expansion and support from the pilings to the beams. Cross tie beams and bracing will stiffen the assembly in bending and twisting. Carriage wheels will run directly on various surfaces of the concrete guideway.

Fabricated steel guideway construction will be compared.

For the steel wheel option, a similar guideway with steel rails could be used. Alternatively, it may be possible to use conventional ballasted



*US-style railroad truck with steel wheel assemblies and journal bearings*



*Rubber-tired metro bogie*



*Monorail track switch*

railway tracks as the core of the guideway with additional structures to take the overturning loads.

## Foundations

Rather than using conventional concrete foundations, which would require significant depth, one option would be to use multiple screw piles to take the bearing, uplift and shear forces from the guideways. Piles can be attached to the guideway connector assemblies with welded and bolted connections.

Buried concrete foundations and mass concrete foundations are an option that should be compared.

For conventional railway tracks, simple prepared soil foundations may be possible with adequate track elevation and drainage to prevent frost heaving.

## Electrical

An insulated pickup electrical bus can be installed along the guideway in a shielded location to prevent accidental contact and to keep it protected from weather. The bus could be connected with armoured cables to one or more substations around the track. Substations will provide switchgear, breakers, step-up transformers and control and two-way metering equipment. Interconnection and metering equipment will be designed as required to meet the utility requirements.

## Control System

Automatic control of the sails should be relatively simple, based on the equipment used on sailing yachts. In fact, without the heeling and plunging that the yacht does moving through the water this should be easier. There are a number of self-steering and sail position optimizing programs available that can be adapted to the wind power carriage application. Wind direction and speed sensors located at various positions on the carriage, in the rigging and on fixed land locations will provide information for the sail control. The electric-driven furling action of the sails allows adjustments in sail area if the wind force is too strong. Other electric driven, hydraulic powered or pneumatic powered actuators will be added to enable full remote operation of the system.

An onboard PLC control system would likely operate the sails and power generation system and provides safety systems control for the carriage-mounted equipment. Software and programming from sailing yachts will be selected to assist with control of the sails and rigging for optimum capture of wind power.

A land-based supervisory monitoring and control system possibly with additional adaptive computer-based control system will be used to facilitate full automatic operation and control of the system.



*Light rail system powered by overhead electrical wires*



*Electric substation for an electric trolley line*



*Sailboat rigging with in-boom electric furling action*

## Auxiliary Equipment

Auxiliary equipment and systems will be added to the carriage and to the ground-based portion of the system as required to complete the system. These may include, but not be limited to:

- Air compressor and/or hydraulic power system for control power
- Batteries and charger for control power
- Lube oil system for gearboxes
- Emergency generator system with fuel storage for “black start” capability
- Wireless data communication system



# Schedule and Key Milestones

## Tasks by Project Phase

This study will comprise three phases:

- Phase 1 - Define Design Basis 2 weeks (after mobilization)
- Phase 2 - Engineering Concept Development 6 weeks
- Phase 3 - Cost Estimate, Economics and Report 3 weeks

Project Phase	Week												Hours
	1	2	3	4	5	6	7	8	9	10	11	12	
Kickoff Meetings	●		●						●				
Client Progress Meetings		●				●				●			
Phase 1 - Concept Definition	■												
Phase 2 - Design Development			←—————→										
Engineering Design Development			■										
Drawings			■	■	■	■	■						
Materials Take-offs				■	■								
Major Equipment Budget Pricing						■							
Capital Cost Estimating						■							
Phase 3 - Completion & Report									←—————→				
Cost Estimating								■					
Drawings								■	■	■	■		
Economic Analysis								■			■		
Report								■					
Presentation											■	●	
Project Management & Admin													250
	<b>Total Hours</b>											<b>1750</b>	



## Project Team

**Project Manager** – Provides overall direction and control of the project. Understands how to “herd cats” and maintain schedule and budget with a creative team on a unique project.

**Project Sponsor** – Champion for the study. Sponsor understands resources within CH2M HILL and how to make things happen as required when difficulties arise.

**Project Coordinator** – Assists the project manager to maintain information flow and storage, schedule and cost monitoring and other duties as assigned.

**Cleancore Representative** – Participates in meetings with CH2M HILL.

**Wind Consultant** – Reviews available wind data and site information and develops an estimate of wind power available and useable based on the configuration of the facility.

**Aerodynamics Consultant** – Provides advice and guidance on system configuration and interactions.

**Sail Rig Consultant** – Reviews application proposed for sail rig and wind information and provides estimate for driving force available from the sail rig and associated forces transferred to the carriage. Also advises on available equipment and systems for automated control of the sail rig, and on sail rig life and maintenance costs.

**Transportation Consultant** – Reviews application and identifies available equipment and sources for wheel, drive and braking components and their performance. Also advises on adapting available equipment to the required application, and on equipment life and maintenance costs.

**Mechanical Design Engineers** – Provide conceptual design for carriage, guide-way and auxiliary systems, obtain information and pricing for components and estimate material quantities for estimating.

**Civil and Structural Design Engineers** – Provide conceptual structural design for carriage, guide-way, foundations, site preparation and services and estimate material quantities for estimating.

**Electrical Engineers** – Provides conceptual design for power collection and transmission systems, facility utility power and lighting systems and control system wiring.

**Control System Specialists** – Provides conceptual design for onboard monitoring and control, communications, and central supervisory control systems.



*CH2M HILL manages and executes projects with proven procedures and state-of-the-art software and methods. But in the final analysis, it is people who build projects.*

*We strive to build long-term relationships with our clients based on integrity and trust. We realize that goodwill and the cooperation of a cohesive team will bring continuing success with Suncor*



*CH2M HILL's knowledge of the industry is so exhaustive that they seem to provide us with more current information than our own marketing research firms do. We've never worked with a company that brings to bear such exhaustive knowledge and skill.*

*—Leading Flat Panel Technology Research Company*

**Cost Estimators** –Develops cost estimates for the facility based on equipment and system prices and quantities from design engineers.

**Financial analyst/Economist** – Uses estimated power sales revenue, capital cost, operating cost, maintenance cost, financing cost, taxation rates, tax credits for green power, depreciation, etc. to prepare project financial proforma, life cycle project economics, and power costs.



*As an employee-owned firm, CH2M HILL fosters a culture of self-motivation and personal responsibility.*

*Our culture uniquely links our personal investment with our job performance and satisfaction and ensures our commitment to outperform for you.*



## Commercial

This proposal addresses the conceptual study as described in Section 2 of this proposal.

We propose to perform these services on a reimbursable basis under a professional services agreement. We will be happy to provide our standard professional services agreement to use as a starting point for this discussion.

### Effort Hours

Our Estimate for project management, engineering, and cost estimating is 1,500 hours plus contingency.

The table below provides an indicative estimate of the effort hours to complete the preliminary engineering phase, which includes producing cost estimates for the Translating Wing Power Generation Study. Before we start work on this study, a meeting should be held with Cleancore and finding agencies to ensure the scope and level of effort proposed will achieve the required study deliverables.

Cost Estimate			
Kickoff Meeting	4 people x 20 hrs	80 hrs	\$9,600
Coordination Meetings	8 ea x 4 people x 3 hrs	96 hrs	\$11,520
Mechanical design		180 hrs	\$21,600
Subcontractor or Software for Sail load Calculations		est.	\$20,000
Subcontractor for Wing Calculations		est.	\$20,000
Civil/Structural design		160 hrs	\$19,200
Electrical/Controls design		280 hrs	\$33,600
Mechanical cost estimating		150 hrs	\$18,000
Civil/structural cost estimating		100 hrs	\$12,000
Electrical/controls cost estimating		100 hrs	\$12,000
Project Management		300 hrs	\$45,000
<b>Subtotal</b>		<b>1446 hrs</b>	<b>\$222,520</b>
Expenses			\$12,000
<b>Subtotal (including expenses)</b>			<b>\$234,520</b>
Contingency (20%)			\$45,480
<b>Total</b>			<b>\$280,000</b>

### Budget

Our budgetary estimate for the complete conceptual study is \$280,000.

### Validity

Our proposal is valid through February 28, 2009.

# Appendix

---



CH2MHILL



Wind Energy Services



*From prospecting through performance monitoring, CH2M HILL's skilled professionals help you meet your wind energy project objectives.*

## **HSEQ** **Target Zero** World-Class Performance

At CH2M HILL, safety is a core value, not just a priority. For a project to be successful, it must be not only technically sound, but safe for workers, the environment, and the community. To that end, we have created and implemented "Target Zero," a commitment to achieve zero injuries, illnesses, environmental impacts, motor vehicle accidents, errors, or omissions on every project we deliver.

CH2M HILL enables you to meet the world's demand for energy by safely delivering your most challenging programs and complex projects globally and locally. From the Arctic to the desert, on land and on sea, we provide safe and innovative consulting, engineering, procurement, construction, and operations solutions that span the entire energy value chain in all major segments.

Our comprehensive portfolio includes the delivery of alternative energy projects, including wind, photovoltaic (PV), solar thermal, biomass power, biofuels, geothermal, hydropower, and cogeneration systems in addition to conventional energy systems such as oil and natural gas. With advanced resources and seasoned professionals, our fully integrated project delivery teams will help you achieve your global business, operations and project objectives.

CH2M HILL has delivered essential services to our wind energy clients for decade, on projects ranging from single-turbine installations to commercial scale wind farms. We offer the professional expertise and resources necessary to plan, engineer, procure, construct, and operate and manage your wind energy projects anywhere in the world.

### **CH2M HILL's Wind Energy Services**

#### **Project Feasibility**

- Market Definition
- Initial Resource Evaluation
- Technical Assessment
- Preliminary Economic Analysis

#### **Site Selection**

- Land Use Investigation
- Transmission & Interconnection Analysis
- Wind Resource Assessment & Quantification
- Environmental Fatal Flaw Analysis
- Preliminary Turbine Layout Design

#### **Planning and Design**

- Permitting & Licensing
- Electrical, Structural & Site Civil Design
- Geotechnical & Environmental Studies
- Community Outreach
- Production Estimates
- Conceptual Project Design & Visualization

#### **Construction Management**

- Detailed Engineering
- Subcontractor Selection
- Turbine & Balance-of-Plant (BOP) Procurement
- Project Controls and Logistics
- Owner's Engineering

#### **Operations & Management**

- Project Delivery
- Cost Management
- Schedule Management
- Contract Maintenance
- Performance Monitoring
- Production Forecasting
- Health, Safety, Environmental & Quality Management
- Portfolio Development



CH2M HILL has received nine VPP awards over the past 8 years from OSHA and the U.S. DOE.

## Banks Island Wind Farm North Coast Wind Energy, Banks Island, British Columbia, Canada

### Project Characteristics

**Client:** North Coast Wind Energy

**Location:** British Columbia, Canada

**Stage:** Estimated completion date of 2014

**Scope:** 700 MW generation facility

CH2M HILL is owner's engineer for North Coast Wind Energy's new facility on the north end of Banks Island in British Columbia. The project will answer BC Hydro's "Call for Power" by helping the utility meet the Province's 2016 target to produce 90 percent of their energy from renewable resources. The wind farm will produce 700 megawatts (MW) of power when completed in 2014. CH2M HILL is providing the client with a full-service package, from resource assessment through commissioning, helping to streamline the development process and allow North Coast Wind Energy to pursue future endeavors.

## Restoration Program Air Force Center for Engineering and the Environment (AFCEE) Massachusetts Military Reservation, Bourne, Massachusetts

### Project Characteristics

**Client:** Air Force Center for Engineering and the Environment

**Location:** Massachusetts Military Reservation, Bourne, Massachusetts

**Stage:** Final Design

**Scope:** Potential full service design build

CH2M HILL performed a design and constructability assessment for a wind turbine project for AFCEE at the Massachusetts Military Reservation. We prepared the technical specifications and drawings for the project's BOP work, which were used in the firm-fixed-price bid process. We also conducted a geotechnical analysis and a National Environmental Policy Act (NEPA) environmental assessment, analyzing potential impacts on avian and bat mortality, air quality, cultural resources, visual resources, land use, and noise levels. CH2M HILL has provided the client with an economic analysis of available power sale options, including reviews of state laws and regulations that may include net metering provisions. Our expertise in wind siting and permitting is helping the client navigate through the compliance, permitting, and approval processes.

## Wind Site Development and Technical Support Confidential Client, Western United States

### Project Characteristics

**Client:** Confidential Client

**Location:** Western United States

**Stage:** Siting and Permitting

**Scope:** Overall siting for a portfolio of wind projects

CH2M HILL is assisting a confidential client with overall siting for a portfolio of wind projects in the Western US. We are performing wind resource assessments, assisting with turbine selection, conducting site reconnaissance to assess constructability, designing site layouts, investigating environmental and ecological fatal flaws, developing permit applications, conducting wetland and wildlife studies, and environmental constraints analysis. Our team of permitting, meteorological, and wildlife experts is also participating in and facilitating meetings with state and federal agencies. We have assisted the client with fast-track entry into wind development by providing a powerful suite of services that combine our environmental, engineering, meteorological, ecological, and permitting expertise.



*"I have been very impressed with the performance of the CH2M Hill team, particularly on our Northwest projects. The two most important things that we look for in a consulting firm are responsiveness and knowledge of wind energy permitting, and CH does a very good job at providing both of these."*

—Sara Parsons, Wind Permitting Manager, PPM Energy

*"CH2M HILL has provided Katabatic Power, and our joint venture partner Deutsche Bank, with professional project managers and staff who are playing a key role as owner's engineer in the overall development process for our wind energy projects here in British Columbia. In today's often rushed wind energy industry, they have provided quality, on time deliverables that have met or exceeded our expectations."*

—Gavin Berg, Executive Vice President Project Management, Katabatic Power



## Worldwide Project Experience—Local Project Delivery

CH2M HILL is a global consulting, engineering, procurement, construction, and operations and maintenance firm with 24,000 professionals who manage programs and deliver projects for energy and industrial clients worldwide.



## Energy & Chemicals Delivery Centers

Please check [ch2mhill.com/energy](http://ch2mhill.com/energy) for our contacts in:

- |                                 |                                     |
|---------------------------------|-------------------------------------|
| Abu Dhabi, United Arab Emirates | Mexico City, Mexico                 |
| Anchorage, Alaska, USA          | Moscow, Russia                      |
| Atlanta, Georgia, USA           | New Delhi, India                    |
| Bellingham, Washington, USA     | Prudhoe Bay, Alaska, USA            |
| Buenos Aires, Argentina         | Sakhalin, Russia                    |
| Calgary, Alberta, Canada        | Sao Paulo, Brazil                   |
| Denver, Colorado, USA           | Shanghai, China                     |
| Durango, Colorado, USA          | Singapore, Singapore                |
| Fairbanks, Alaska, USA          | Spartanburg, South Carolina, USA    |
| Houston, Texas, USA             | Vancouver, British Columbia, Canada |
| Kenai, Alaska, USA              |                                     |

CH2M HILL has expertise in a wide range of renewable energy technologies including:

- Hydroelectric
- Photovoltaics
- Solar Thermal
- Concentrating Solar Power
- Geothermal
- BioEnergy
- Marine
- Fuel Cells
- Hydrogen
- Wind

**Engineering News-Record** consistently ranks CH2M HILL:

- #1 Program Management
- #1 Construction Management for Fee
- #1 Environmental Management
- #1 Water & Wastewater Treatment

## Contact

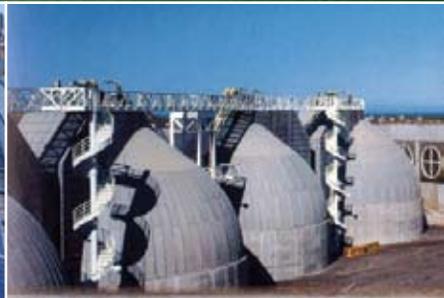
### Scott Kaminky

Renewable Construction Manager  
6399 S. Fiddlers Green Circle  
Suite 120  
Greenwood Village, CO 80111  
Tel: 720-286-1548  
E-mail: [scott.kaminky@ch2m.com](mailto:scott.kaminky@ch2m.com)

### Erin Toelke

Client Service Manager  
Renewable Energy Siting  
and Permitting  
1295 Northland Drive, Suite 200  
Mendota Heights, MN 55120  
Tel: 651-365-8517  
Email: [erin.toelke@ch2m.com](mailto:erin.toelke@ch2m.com)

[ch2m.com/renewable\\_energy](http://ch2m.com/renewable_energy)



Renewable Energy Services



## Why CH2M HILL?

### **We understand your challenges—we deliver the solutions**

CH2M HILL is a leader in addressing the complex resource and infrastructure issues related to global climate change. Environmental stewardship and sustainability have been part of our culture from the beginning. Today, we are focused on helping our clients find solutions for the challenges presented by volatile energy prices, peaking energy supplies, and increasing global energy demand.

In our 1975 Annual Report, Jim Howland, one of the founders of the company, envisioned a sustainable society as a world with “clean water, a safe and livable environment, efficient transportation, adequate food and energy, and a stable economy.” We still believe in his vision, and we work daily to make it a reality within CH2M HILL and for our clients.

As our clients increasingly request program and project solutions that address a broad range of global sustainability issues, we have responded with hundreds of renewable energy and other sustainable projects around the world—from the siting of a wind farm on the Oregon-Washington border to the program management of a zero-carbon, zero-waste sustainable city in Abu Dhabi—from the delivery of award winning landfill gas (LFG) projects in Canada and the United States to providing engineering, procurement, and construction management (EPCM) for an innovative ethanol plant in Georgia. We understand your challenges and your objectives when it comes to implementing these types of capital projects.

We also believe that safety and time-to-market are fundamental in addressing today’s global energy challenges and meeting the business objectives of our clients. As industry leaders, we must work together to safely deliver timely sustainable solutions to meet the world’s rising energy demands.

### **Full-Service Portfolio**

Our knowledge and experience provide you with full-service solutions to bring your project from initial planning and design to final operation and production. We tailor our services to meet your specific needs.

### **Safety Performance**

Like you, our first consideration in making business decisions is safety. Our safety culture and Target Zero program create a blueprint for delivering safe, sustainable facility design, construction, and operations.

### **Predictable Project Success**

As a global leader in consulting, program management, and engineering, procurement, and construction (EPC), we have the experience, resources, and personnel to effectively and efficiently manage and deliver major renewable energy projects anywhere in the world.

### **Reducing Costs through Eco-efficiency**

We help our energy, water, transportation, and industrial clients save millions of dollars by producing more with less—less materials, water, waste, and energy. Our in-house environmental and waste management experts tailor sustainable approaches and solutions to help you minimize cost and environmental impacts.

### **Time-to-Market**

Concerns about rising energy costs and the global environment are driving state and federal legislation toward the rapid deployment of renewable energy alternatives. CH2M HILL has the regulatory relationships and engineering prowess to help you stay ahead of the curve in bringing your renewable energy operations online.

*CH2M HILL was selected as one of the FORTUNE magazine’s 100 Best Companies to Work For in 2003, 2006, and 2008.*



## Full-service portfolio—tailored solutions

CH2M HILL's comprehensive portfolio includes the delivery of alternative energy projects and programs, including wind, PV, solar thermal, biomass power, biofuels, geothermal, hydropower, and cogeneration systems in addition to conventional fossil fuel facilities. With global resources and seasoned professionals, our fully integrated project delivery teams will help you achieve your business, operations, and project objectives anywhere in the world.

### Consulting

- Location analysis and site selection
- Permitting
- Lean enterprise
- Supply chain logistics
- Greenhouse Gas (GHG) management
- Energy conservation and optimization
- Critical water resources
- Sustainable development

### Integrated EPC

- Program management
- Engineering
- Procurement
- Construction/construction management
- Commissioning

### Sustaining services

- In-plant engineering
- Plant expansion
- Shutdowns and turnarounds
- Upgrades
- Operations and maintenance
- Decommissioning

### Environmental services

- Air quality
- Water/wastewater management
- Solid and hazardous waste management
- Contaminated site assessment and remediation
- Facility environmental management systems and permits





## Safety performance—a core value

We recognize that for a project or operation to be successful it must not only be technically sound but also safe for workers, the environment, and the community. At CH2M HILL, safety is a core value, not just a priority. We have created and implemented “Target Zero,” a commitment to achieve zero injuries, illnesses, environmental impacts, motor vehicle accidents, errors, or omissions on every project we deliver.

Safety accountability is aligned with every person on every job we do. Our leadership walks the talk, promoting a safety-based culture that builds team spirit and pride. CH2M HILL uses behavioral-based safety programs and provides training customized for each project to eliminate injuries and incidents. Close collaboration and teaming with our clients is a key component of our safety excellence.

CH2M HILL projects have received nine VPP Star awards from OSHA and the U.S. Department of Energy. They include:

- U.S. Department of Energy, Idaho Cleanup Project, Idaho National Laboratory, Idaho Falls, ID
- Dominion Energy Power Plant Retrofit, Mt. Storm, WV
- Xcel Energy High Bridge Power Generation Plant, St. Paul, MN
- DSM Dyneema, LLC, Greenville, NC



CH2M HILL’s energy and industrial safety awards include:

### Cherry Point Refinery Blaine, Washington

This award-winning project replaced BP’s large aluminum API separator covers with permanent, cast-in-place concrete lids—eliminating leaks of volatile organic compounds and reducing maintenance costs. The project finished ahead of schedule, 28 percent under budget and with a perfect safety record. The old aluminum covers were recycled.

### Alcoa Bohai, Qin Huang Dao, China

The CH2M HILL-Alcoa Bohai project team was able to celebrate more than 3 million work hours without a lost-time incident at the flat-rolled products plant, largely due to the innovative safety programs CH2M HILL implemented to support the EPC project. The safety record earned the project the 2007 Alcoa Asia Impact Award for Environmental Health and Safety and the CH2M HILL Target Zero Award.

### 5 Million Hhours

Over the past 5 years, CH2M HILL has delivered more than 13 construction projects for the power industry without a lost time incident. The projects have included union and non-union laborers, subcontractors, and self-performing employees working a total of 5,073,642 hours.





## Predictable project success—resources, personnel, industry knowledge

We partner with energy companies, industry, utilities, independent power producers, and original equipment manufacturers to lower project costs, improve client competitiveness, and manage risk. Our joint alignment around your project goals, business objectives, and processes helps us to accurately plan and safely and efficiently implement your projects, saving you time and money.

CH2M HILL's worldwide presence and integrated communications and information systems enable us to transparently apply our global resources and solutions locally. That local expertise means a better understanding of the cultures, regulations, political and economic conditions, and business practices that impact your projects. We make it a practice to hire locally and our staff frequently team with local professionals and companies who contribute critical site-specific knowledge and experience.

### **Masdar City, Abu Dhabi, United Arab Emirates**

CH2M HILL is the program manager for the development of Masdar City, a sustainable city nestled in the heart of Abu Dhabi and focused on the development and commercialization of advanced and innovative renewable, alternative, and sustainable energy technologies. Energy facilities planned for the zero-carbon, zero-waste development include a solar thermal power plant, a photovoltaic (PV) manufacturing facility, and a 10 MW PV power plant. The firm will also provide program management for the first phase of Masdar's Carbon Capture and Storage project.

### **BP Solar, Madrid, Spain**

When BP Solar elected to acquire an existing microelectronics site near Madrid, Spain, CH2M HILL undertook complete assessment, planning, layout, design, and construction management for this facility's conversion to an advanced-technology solar cell processing plant.

### **Tian Zi Ling LFG Utilization Project**

CH2M HILL provided project management for the development and implementation of the Tian Zi Ling Landfill Gas Utilization Project in Hangzhou, China. The installed capacity of the LFG-to-energy plant was 2 MW with a design for future expansion of up to 3 MW. We provided preliminary project design (LFG collection, processing, and utilization), environmental permitting, technology transfer, training, local government coordination, and overall management. We also assisted with transition of project into a locally managed and operated company.

### **Banks Island Wind Farm**

CH2M HILL is owner's engineer for a North Coast Wind Energy facility on the north end of Banks Island in British Columbia. The project will answer BC Hydro's "Call for Power" by helping the utility meet the Province's 2016 target to produce 90 percent of their energy from renewable resources. The wind farm is expected to generate 700 MW of power by 2014.



## Reducing costs through eco-efficiency—producing more with less

In today's competitive market, the long-term sustainability of your business and your competitive advantage rely heavily on innovation, corporate social responsibility, and eco-efficiency—implementing programs and practices that improve your economic and environmental performance by minimizing materials, energy, and water usage and by reducing waste.

CH2M HILL's environmental and waste management experts help our clients make more efficient use of energy through process and facility designs that reduce ecological footprints and minimize CO<sub>2</sub> impacts. From the supply of resources to the delivery of the final product—we help our clients combine environmental and economic performance to create more value.

### Jenkins Brick LFG Project

LFG is being used to fuel the new Jenkins Brick manufacturing facility in St. Clair County, Alabama. CH2M HILL provided environmental consulting and landfill/natural gas design for this \$56 million project, which will reduce greenhouse gas emissions by 62,000 metric tons of CO<sub>2</sub> annually. Methane, a byproduct of waste decomposition, is pumped through a 6.5-mile pipeline from the Veolia Environmental Services Star Ridge Landfill to fire the plant's brick-making kiln in place of natural gas. When up to full capacity, the plant will produce and ship about 136 million bricks a year. The project won the U.S. EPA's Landfill Methane Outreach Project of the Year Award in 2006.

### Aurora Organic Dairy Master Plan

The Aurora Organic Dairy (AOD) selected CH2M HILL to guide its efforts in designing a sustainability master plan for its Platteville, Colorado, farm and dairy plant—a plan that would establish a benchmark for the dairy industry. CH2M HILL worked with AOD's leadership and staff to develop the master plan and implementation schedule. The dairy combines animal waste and farm-generated wastewater in an anaerobic digestion system that produces biogas to generate electricity for milk production.

### LFG-to-Energy Project

CH2M HILL assisted in the development, design, and operation of a LFG energy project north of Corvallis, Oregon, for the Pacific Northwest Generating Cooperative. The Coffin Butte LFG project involved installation of three 16-cylinder engine generators running on LFG, producing 2.5 MW of electrical power and using 1.25 million cubic feet of LFG per day. We were involved in all aspects of the project, including initial feasibility studies, selection of a turnkey contractor, contract documents, loan permits, land use permits, environmental impact assessments, scheduling, and operation of the newly constructed LFG collection system.

### Biosolids to Biogas

CH2M HILL was the prime technical consultant for a \$220 million expansion and modernization program to provide innovative biosolids processing and a threefold increase in plant capacity at the Ottawa-Carleton Robert O. Pickard Environmental Centre in Canada. We provided design and field inspection services for biosolids processing and residuals handling facilities, including an anaerobic digestion facility and cogeneration system. Excess biogas is combusted in three cogeneration units that supply electricity and reduce the plant's monthly energy purchases by more than \$38,000.



## Time-to-market—the race to deployment

Rising energy costs and environmental concerns have impelled utilities to generate varying amounts of their power from renewable energy sources—the percentage and technologies selected depending on each individual state’s legislation.

As regulatory deadlines approach, the cost and schedule for implementing renewable energy projects can be daunting—as can procuring the equipment and materials needed to build the facilities.

CH2M HILL can help you take advantage of federal and state tax credits and benefits to reduce your capital costs. Our renewable energy and program management experts can take you through every stage of planning, development, and deployment—integrating all aspects of your project from initial concept and siting, through design, to operational start-up and management.

### Wind Turbine Blade Production Facility

CH2M HILL performed site master planning, site development, scheduling, project controls, and procurement of facility equipment for LM Glasfiber of Denmark’s new wind blade production facility. Our services also included the development of estimates and schedules and owners representative services during construction. The fast-track project broke ground in October 2007, and started production in summer 2008. The facility will ultimately support eight production buildings and create more than 1,000 jobs. It is the first of LM Glasfiber’s “model” factories that they envision replicating around the world.

### Solar Manufacturing Facility

SCHOTT Solar, Inc. selected CH2M HILL as their EPCM contractor for a new \$100 million, 200,000 square foot plant in Albuquerque, New Mexico. The facility will produce PV modules and receivers for concentrated solar thermal power plants. A CH2M HILL site selection team evaluated dozens of potential sites for SCHOTT, analyzing such factors as labor, utilities, capital expenditures, shipping, distribution, taxes, and incentives. We also used our business planning and solar-specific economic models to help the company maximize the return on its New Mexico investment. The new plant will create as many as 1,500 jobs for Albuquerque at peak production.

### Cellulosic Ethanol Plant

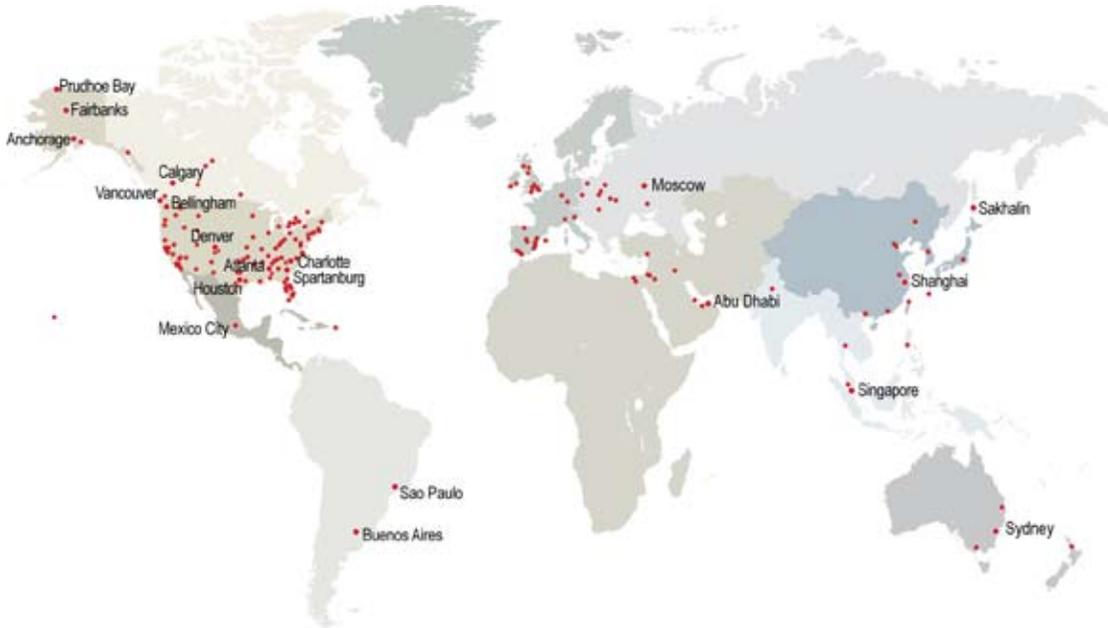
CH2M HILL is providing EPCM services for a first of its kind commercial-scale cellulosic ethanol plant for Range Fuels in Soperton, Georgia. The plant will be the first in the United States to produce commercial quantities of ethanol from biomass, which includes all plant and plant-derived materials, such as wood, grasses, and corn stover.





## Worldwide Project Experience—Local Project Delivery

CH2M HILL is a global consulting, engineering, procurement, construction, and operations and maintenance firm with more than 25,000 professionals who manage programs and deliver projects for energy and industrial clients worldwide.



**CH2M HILL has expertise in a wide range of renewable energy technologies including:**

- Wind
- Photovoltaics
- Solar Thermal
- Concentrating Solar Power
- Hydroelectric
- Geothermal
- BioEnergy
- Marine
- Fuel Cells
- Hydrogen

**Engineering News-Record consistently ranks CH2M HILL:**

#1 Program Management

#1 Environmental Management

## CH2M HILL energy and chemicals project delivery centers

Please check [ch2mhill.com/energy](http://ch2mhill.com/energy) for our contacts in:

Abu Dhabi, United Arab Emirates  
Anchorage, Alaska, USA  
Atlanta, Georgia, USA  
Beijing, China  
Bellingham, Washington, USA  
Buenos Aires, Argentina  
Cairo, Egypt  
Calgary, Alberta, Canada  
Denver, Colorado, USA  
Durango, Colorado, USA  
Fairbanks, Alaska, USA  
Houston, Texas, USA  
Kenai, Alaska, USA

London, England  
Madrid, Spain  
Mexico City, Mexico  
Moscow, Russia  
New Delhi, India  
Prudhoe Bay, Alaska, USA  
Sakhalin, Russia  
Sao Paulo, Brazil  
Shanghai, China  
Singapore, Singapore  
Spartanburg, South Carolina, USA  
Sydney, Australia  
Vancouver, British Columbia, Canada

## Contact

CH2M HILL

Energy Business Americas

Renewable Energy Group

6399 S. Fiddlers Green Circle

Suite 500

Greenwood Village, CO 80111

Email: [renewables@ch2m.com](mailto:renewables@ch2m.com)

[ch2m.com/renewable\\_energy](http://ch2m.com/renewable_energy)

---

PROPRIETARY NOTICE

The data, information, concepts, and approaches contained herein are proprietary information and shall not be disclosed to third parties without the express written consent of CH2M HILL. It shall not be duplicated, used, or disclosed in whole or in part for any purpose other than the consummation of a business agreement between CH2M HILL and the company to which this document is submitted. The data subject to this restriction is contained in all pages of this document.

© 2007 CH2M HILL