Executive Summary

Colorado State University’s Center for Environmental Management of Military Lands (CEMML), a unit of the Warner College of Natural Resources (WCNR), recognizes the growing need for sustainability planning, implementation, and facilitation on United States military bases. CEMML is already a proven global provider of research and sustainable management of natural and cultural resources on federal lands. Our Fort Collins, Colorado, on-campus staff includes a full range of environmental and compliance professionals, as well as technical staff embedded at military installations across the U.S., including Hawaii and Alaska.

CEMML has developed a Colorado State University (CSU) cross-campus consortium that provides technical expertise in support of broader sustainability initiatives at Department of Defense (DoD) installations. CSU is a leading test bed for our changing energy culture, as well as a research forerunner in terms of environmental, economic, and social sustainability issues. CSU teams can be quickly formed to address specific challenges facing military installations while also providing Research & Development at the service or DoD headquarters level. CSU departments and research centers collaborating in this effort include:

- Engines and Energy Conversion Laboratory
- Center for Contaminant Hydrology
- InteGrid Test & Development Laboratory
- Industrial Assessment Center
- Materials Engineering Laboratory
- Department of Sociology
- Department of Psychology
- Department of Construction Management
- Institute for the Built Environment
- Department of Human Dimensions of Natural Resources
- Restoration Ecology Laboratory
- CSU Facilities Management

Their combined expertise will leverage CEMML’s strong relationships at military installations, and complement our existing expertise in the sustainable management of natural and cultural resources on military and other public lands.

"Several universities offer curriculum and technical assistance in corporate sustainability issues, but CEMML and Colorado State University are unique in offering a holistic approach to sustainability challenges across the installation landscape."
Executive Order (EO) 13514 articulates both general and specific requirements to improve federal government efficiency through the development of a green economy and a decreased dependence on fossil fuels. The DoD Strategic Sustainability Performance Plan (the Plan) provides a coherent approach both for complying with multiple federal requirements for sustainability and for assuring the mission. The linkages between sustainability and the DoD mission are strong and direct. There are four key areas of intersection that form priorities for the Department:

1) Energy and Reliance on Fossil Fuels
2) Chemicals of Environmental Concern
3) Water Resources Management
4) Maintaining Readiness in the Face of Climate Change”


As an independent CSU research center dedicated to the management and stewardship of military lands, CEMML draws on CSU’s vast technical and academic expertise in the areas of green technology and sustainability for application to the DoD’s considerable sustainability challenges.

CEMML has worked at over 150 U.S. military installations across the U.S. and in other countries (see map). We have first-hand knowledge of the challenges DoD faces in maintaining installations in a cost-efficient and sustainable manner. CEMML is unique in its ability to address specific needs related to the mission and the individual circumstances of each installation through strategic team–building with other CSU researchers. We are also capable of addressing quality of life concerns, regional collaboration, and full ecosystem issues.

**What CEMML Can Do For DoD Installations**

CEMML and CSU can assist U.S. military installations in all of these areas.
Land Use, Ecosystem Management, Training Lands

Robert Brozka, M.S., Forestry
Calvin Bagley, M.S., Range Science
Andrew Beavers, M.S., Fire Science

Effective resource management requires information about status, trends, and changes over time. Accurate and precise data collection is the important first step in assessing resource condition and evaluating the effectiveness of management activities and land uses. Sustaining a realistic military training environment is dependent upon maintaining functional ecosystems on an installation. Ecosystem management protects biodiversity by maintaining total numbers of species, managing for varied habitats, and maintaining and restoring natural processes to the landscape.

CEMML also provides high quality fire management planning advice and documentation specifically tailored to the unique needs of the military. A significant risk of fire is inherent in military training. Many munitions commonly used by the Armed Forces are also ignition sources.

- Natural Resource Inventory and Management
- Environmental Planning
- NEPA
- Ecosystem Management
- Integrated Natural Resource Management Plans (INRMP)
- Integrated Training Area Management (ITAM)
- Integrated Wildland Fire Management Plans
- Munitions Ignition Mitigation
- Operations Planning

Cultural Resources and Sustainable Building

James A. Zeidler, Ph.D., Anthropology
Amy Cook, M.S., Construction Management, LEED AP O+M

CEMML works closely with installation resource managers to ensure that cultural resources are managed in accordance with the requirements of all Federal and state historic preservation legislation, as well as DoD and service-specific regulations governing cultural resource management (CRM). CEMML also provides consultation on sustainable building projects for new and existing construction within the DoD. Installations benefit through the reduction of environmental damage due to construction and related activities, reduction of operational energy cost, and the enhancement of occupant comfort, health, and well-being.

- Integrated Cultural Resource Management Plans (ICRMP)
- Sustainable Building and LEED Consultation
- Sustainable Installation Management Planning
- Consultation for Historic Preservation, Rehabilitation and Retrofit
- Sustainable Operations & Maintenance Implementation Support (SOMIS)
- Condition Assessment Data Evaluation and Cost Estimation (CADEnCE)
- Energy Use Reduction
Environmental compliance and pollution prevention are critical aspects of any successful environmental program. The Center provides technical support in these key areas. CEMML can provide on-site and/or offsite technical assistance that is tailored to meet the needs of environmental managers. CEMML storm water capabilities include hydrologic and hydraulic modeling of watersheds with PCSWMM software for urban drainage modeling that incorporates GIS and CAD data and enables the transfer of useful information and data files such as sub-catchment delineations and conveyance structures to on-site GIS departments at the conclusion of projects.

- Interpretation and/or implementation of state, federal, and agency regulations;
- Permitting, planning, and reporting; and
- Inspections and operations.
- Technical support for projects under CERCLA, RCRA, and state voluntary actions
- Analyses of existing drainage systems
- Analysis of both storm and combined sewer systems
- Identification of inadequate and undersized areas of systems
- Quantification of changes in runoff subsequent to proposed construction activities
- Evaluation of effectiveness of best management and low impact development practices
- Floodplain modeling of natural and man-made channel systems

Outreach, Training and Education on Sustainability Issues

CEMML is developing a series of on-line courses and training webinars through CSU’s Continuing Education program. Courses can be tailored to the individual needs of each installation, as well as created for specific purposes and audiences. CEMML will partner with CSU’s reach-back teams for specialized course instruction on sustainability and energy conservation issues. CEMML can also engage local communities and regional planners on issues related to energy conservation and sustainability through public outreach activities and more formal consultation such as design charrettes.

- Cultural, Community and Regional Interaction
- Workshops
- Short Courses
- Training
CEMML’s Sustainability Research Partners

Engine and Energy Conversion Laboratory
Bryan Willson, Ph.D., Director
Morgan DeFoort, Ph.D., Co-Director

Colorado State University has created the largest and most prominent independent engines research laboratory in North America. The Engine and Energy Conversion Laboratory (EECL) has developed solutions to reduce emissions from large industrial engines, supported dozens of companies with new engine technology, made important contributions to basic combustion science, worked to define the architectures for the future electric grid, and brought clean energy solutions to the developing world. With a focus towards market-driven solutions, products developed at the EECL in partnership with their Industrial Sponsors have reduced emissions by more than 1 million tons, saved more than 50 billion cubic feet of natural gas, and reduced greenhouse gases by millions of tons.

EECL’s Capabilities:
- Engines and engine controls
- Energy systems
- Smart grid
- Energy for development
- Advanced biofuels

EECL Associated Startup Companies:
- Envirofit International
- Solix Biofuels
- Global Social & Sustainable Enterprise Program

Center for Contaminant Hydrology
Tom Sale, Ph.D., Director

The Center for Contaminant Hydrology in CSU’s Civil and Environmental Engineering Department focuses on research and consulting for innovative solutions to groundwater contaminants in source zones and plumes. The Center for Contaminant Hydrology currently supports three full-time staff members, funds seven students, and conducts $800,000 in remediation research annually. Current sponsors include the DoD as well as SERDP-ESTCP research grants. Dr. Tom Sale has been selected for the Environment Protection Agency DNAPL Source Expert Panel and the National Research Council’s Army funded Committee on Source Removal of Contaminants in the Subsurface.

Research:
- Source Zone Remediation Via ZVI-Clay or ISCO Soil Mixing
- Contaminants Stored in Plumes
- Decision Support Tools
- Electrolytic Reactive Barriers
- LNAPL Stability
- Tools for Emerging Contaminants
InteGrid Test and Development Laboratory
Dan Zimmerle, Ph.D., Director

Military interest in microgrids has been driven by two goals: (a) acquiring the ability to operate facilities “off grid” for extended periods in times of crisis, and (b) reducing energy usage and cost when connected to the grid. Commercially available systems for generation, load control and renewable energy can provide the basis for both applications. However, integration of these systems into a working microgrid requires additional development, including:

- Defining the appropriate sub-set of the facility to “island” as a microgrid, including necessary system upgrades, communications security, and operational constraints.
- Implementing “supervisory” controls to operate the microgrid reliably while integrating renewables and demand response, reducing fuel consumption in islanded mode or reducing utility costs in grid-tied mode.

CSU has active research programs in these areas, including partnerships with major commercial system providers and projects funded by DoE and DoD. Examples:

- FortZED/RDSI program to control peak load at the feeder level (Industry, DoE)
- Building energy estimation and control (Industry, NSF, DoE)
- Optimum architecture of a microgrid (JISEA, DoE)
- Integrating expeditionary generation into a microgrid (DoD)
- Integration of controlled charging and Vehicle-to-Grid into grid systems (DoE)

CSU’s capabilities include:

- Research faculty or scientists in power systems, controls, electric vehicles, communications and microgrids.
- The InteGrid research laboratory – amount the largest and most complete power research facilities in the world, including the capability of islanding a 1MW microgrid containing more than 10 major assets, four decoupled busses, and ability to export power to the local utility. Assets include PV and wind emulators, grid-attached battery storage, multiple generators, load simulation, and a utility SCADA system.
- A real-time, hardware-in-loop simulation system, containing 12 cores.
- Multiple simulation system, including Mathworks™ SimPowerSystems™, PowerFactory™, PSSE, PSCAD™, PowerWorld™ and MilSoft™ simulators.

Industrial Assessment Center
Michael Kostrzewa, P.E., Assistant Director

Since 1984, the U.S. Department of Energy sponsored Industrial Assessment Center at Colorado State (CSU IAC), located within CSU’s Mechanical Engineering Department, has provided eligible small and medium-sized commercial buildings with comprehensive on-site industrial assessments to determine resource and cost savings. An industrial assessment involves an on-site visit and in-depth review of a plant site, including its facilities, services, and industrial operations. The assessment involves a thorough examination of potential savings from:

- Energy efficiency improvements
- Productivity improvement
- Waste minimization and pollution prevention
Materials Engineering Laboratory
W.S. Sampath, Ph.D., Professor

The Mechanical Engineering's Materials Engineering Lab (MEL) has been in the forefront of CdTe photovoltaic manufacturing technology development since 1991. Several unique testing hardware, capabilities and expertise have been developed by MEL. The team first demonstrated this technology on a machine that produces 3"x 3" solar cells; and then on 2ft X 4ft solar cells by start up company Abound Solar. Abound Solar is commercializing the research from the Materials Engineering Laboratory. The innovations they have made in the areas of production process, production hardware and design of PV modules have the potential to reduce the cost of manufacturing PV modules to less than $1/watt. At these costs, solar electricity will be competitive with current methods of electricity generation in most areas of the U.S. and the world.

Materials Engineering Lab Developments:
- Continuous in-line system for processing 3 x 3 inch substrates for CdS/CdTe photovoltaic devices; The system has capabilities for glass heating, CdS deposition, CdTe deposition, CdCl2 treatment and back contact.
- Substrate preparation and automated cleaning in a cleanroom mini-environment.
- Substrate heaters, deposition sources.
- Spray metallization for back electrode formation.
- Small area device fabrication for analysis.
- Stress testing of devices under accelerated conditions with controlled temperature and illumination
- Exposing and testing devices under outdoor conditions emulating sealed modules.
- Device characterization including dark JV, light JV, CV, CF, TAS, TID, PHCAP etc. and the capability to perform these as a function of temperature using cryostat.

Department of Sociology/Department of Psychology
Jennifer Cross, Ph.D., Assistant Professor, Sociology
Pat Aloise-Young, Ph.D., Associate Professor, Applied Social Psychology
Zinta Byrne, Ph.D., Associate Professor, Industrial Organizational Psychology

Organizational Innovation for Energy Conservation
Organizations face individual, organizational, and institutional barriers to the adoption of conservation practices and initiatives. Successful sustainability initiatives use a variety of strategies to overcome the barriers at multiple levels. The Department of Sociology & Department of Psychology offer services for behavioral change and sustainability initiatives in large and small organizations.

The departments have experience in the following areas:
- University departments
- Residence halls
- Public schools
- City governments
- Private organizations
Colorado State University’s Department of Construction Management is among the top-rated programs in the U.S. with strong industry support and interaction. The faculty has diverse backgrounds including engineers, architects, and construction managers, many of whom are LEED Accredited Professionals (Leadership in Energy and Environmental Design). The Department benefits from multiple industry resource points that add value and expertise to the Construction Management program and research endeavors. The Department has asphalt, materials testing, and a soils lab that enable broad areas of research and experiential learning. Sustainability in construction has become one of the broad drivers for departmental research.

Faculty areas of sustainable research within construction management focus on:

- Life-cycle assessment
- Life-cycle costing
- Infrastructure management
- Project Delivery Process Improvement
- Building Information Modeling (BIM)
- Integrated design-build processes
- Healthy buildings
- Gray water use

Institute for the Built Environment
Brian Dunbar, LEED AP, Executive Director

The Institute for the Built Environment (IBE) specializes in facilitating the integrated design, construction, and operations processes to help teams realize their green building and sustainability goals.

Green Building Services

- Design Charrettes, Workshops, and Integrated Planning Meetings
- Identification of key green strategies and technologies
- Preliminary evaluation for 3rd party certification (e.g. LEED® certification)
- 3rd Party Certification Management (LEED®, CO-CHPS, Green Globes)

Department of Human Dimensions of Natural Resources
Peter Newman, Ph.D., Professor, Associate Dean of Warner College of Natural Resources

- Military noise pollution
- Soundscapes
- Human dimensions of natural resource management
- Social carrying capacity decision making in the context of protected areas management
Restoration Ecology Lab
Mark Paschke, Ph.D., Warner College of Natural Resources Research Associate Dean

The Restoration Ecology Lab's primary research focus is on the mechanisms controlling community assembly in terrestrial plant communities. We are interested in understanding the mechanisms that cause or prevent shifts in plant community composition. Such questions are central to the field of Restoration Ecology in that in order to move communities from one state to another, we must understand these mechanisms. To this end, we focus on:

- Invasive Species
- Soil Process and Amendments
- Toxic Compounds
- Revegetation Techniques

CSU Facilities Management
Carol Dollard, P.E., LEED AP, Energy Engineer

Facilities Management is the department charged with managing the physical aspects and daily operations of the Colorado State University system. The department is committed to projects that conserve resources creating a more sustainable campus and community. Some of their achievements at CSU are as follows:

- Six total solar arrays including a 5.3 megawatt solar plant, a public–private partnership with a third party developer and the local utility.
- CSU is saving more than $600,000 per year in electric and water utility costs.
- The Foothills Campus biomass boiler is another step toward utilizing a readily available local, renewable resource. The fuel cost is approximately one-half the cost of natural gas.
- Housing and Dining Services has a fully automated 30 yard capacity composting system. Over 15,000 pounds of pulp and organic material will be taken to the composter each week.
- All new construction on campus is built to LEED Silver Certification standards at the minimum.
- CSU is a signatory to American College & University Presidents’ Climate Commitment, vowing to take the University to climate neutral.

CSU has hundreds of achievements in sustainability. The ongoing list can be found at: http://www.green.colostate.edu/multimedia/green-compliation-1-2011.pdf
Affiliated Subject Matter Experts

Hittle, LLC
Douglas C. Hittle, Ph.D., PE, President

Dr. Hittle is a professor emeritus of Mechanical Engineering at Colorado State University (CSU) and immediate past Director of the University’s Solar Energy Application Laboratory.

Areas of expertise:
- Thermal science
- Building heat transfer
- Energy storage
- Passive and active solar
- Energy performance simulation

Most recent research:
- Application of phase change materials in building envelopes
- Development of artificial intelligence system for building energy systems

Veterans Green Jobs
William (Bill) W. Doe III, Ph.D., PE, U.S. Army Veteran, CEO

Veterans Green Jobs’ mission is to connect military veterans with meaningful employment opportunities that serve our communities and environment. Veterans Green Jobs is dedicated to helping all veterans transition into successful career paths by focusing on opportunities in stable economic sectors related to:

- Environmental restoration, preservation and sustainability
- Clean energy and renewable energy
- Energy efficiency and conservation

Greenleaf Building Performance
Ivars Mikelsons, P.E., M.S., Civil Engineering, Owner

Energy Auditing & Energy Rating: On-site evaluation, assessment and consulting services for residential and commercial energy efficiency. New construction, remodeling, retrofit.

Critical Environments, LLC
Nevel E. (Ed) Hegwood, LEED AP O+M, Energy Efficiency Advocate

Energy analysis including operation and maintenance plans for building sustainability that identifies what to do and for what benefits. Analysis that identifies energy use among various installations and defines opportunities for energy conservation. Services include:
- Identification of waste energy
- Assessment of present patterns of energy consumption
- Implementation of different measures of energy conservation
- Revision of energy saving targets
- Creating operation and maintenance plans that sustain energy efficiency gains
For more information on CSU’s Sustainable R&D Consortium for DoD Installations, please contact:

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