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Sustainability Innovation Foundry: Leveraging Research and Development for a Sustainable Sandia

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Sustainability Innovation Foundry: Leveraging Research and Development for a Sustainable Sandia

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ABSTRACT

Sustainability is a critical national security issue for the U.S. and other nations. SNL is already a global leader sustainability science and technology, but we can do more. This report documents the basis for the Sustainability Innovation Foundry and the outcomes from a workshop held on September 10, 2012. The workshop's goal was to initiate trans-disciplinary discussions and collaboration toward realization of a Sustainability Innovation Foundry (SIF). The efforts of the SIF will support Sandia's national and international security missions related to sustainability and resilience revolving around energy use, water use, and materials, both on site at Sandia and externally. The SIF will leverage existing Sandia research and development (R&D) in sustainability science and technology (SS&T) to support new solutions to complex problems. The SIF will also build on existing Sandia initiatives to transform Sandia into a fully sustainable entity in terms of materials, energy, and water use. The SIF will demonstrate the efficacy of sustainability technology developed at Sandia through prototyping and test bed approaches and will provide a common platform for support of solutions to the complex problems surrounding sustainability. Leadership-level funding will be required, but initial prototype projects are already underway with funding from Facilities.

ACKNOWLEDGMENTS

The taskforce responsible for this initial planning and concept paper was catalyzed by seed funding from SNL Division 6000 and built on collaborations forged over a number of years between SNL Divisions 6000 and 4000. The taskforce acquired additional members from Divisions 4000, 6000, and 8000 to further develop the ideas and to move forward with the vision of making Sandia National Laboratories a foundry for sustainability innovation.

Thank you to the participants at the recent Sustainability Innovation Foundry workshop for your contributions to further the concepts of sustainability science and technology at Sandia National Laboratories. With your help, we will make a difference.

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NOMENCLATURE

AFB	Air Force Base
AML	Advanced Materials Lab
CINT	Center for Integrated Nano-Technology
CRF	Combustion Research Facility
CSP	Concentrated Solar Power
DESERT	DOE Energy Surety Engineering Research and Technology
DOE	Department of Energy
ECIS	Energy Climate Infrastructure Security
EERE	Energy Efficiency and Renewable Energy
ES&H	Environment, Safety, and Health
IX	Institutional Transformation
LED	Light-Emitting Diode
LDRD	Laboratory Directed Research & Development
LVOC	Livermore Valley Open Campus
NNSA	National Nuclear Security Administration
NREL	National Renewable Energy Laboratory
PV	Photovoltaic
R&D	Research and Development
SIF	Sustainability Innovation Foundry
SMU	Strategic Management Unit
SNL	Sandia National Laboratories
S&T	Science and Technology
SS&T	Sustainability Science and Technology

1. INTRODUCTION

“Sustainability,” or sustainable development, in broad terms, involves creating pathways toward re-making our laboratory, communities, nation, and our world such that *the needs of the present are met without compromising the ability of future generations to meet their own needs* [Bruntland Commission, 1987]. Sustainability, when considered across the spectrum of energy, water, land, and against the backdrop of economics, culture, and environment, is a critical national issue that is part of Sandia National Laboratories’ national security mission. Pursuing and achieving sustainability and *resilience* [Zolli and Healy, 2012] is key to our national security.

Arguably, sustainability is already one of the most important driving forces in science and technology (S&T). Climate science, renewable energy, hybrid and electric vehicles, carbon sequestration, desalination and other water purification measures, smart grids, and genetic modification of drought-resistant crops all make a short list of S&T objectives that fit under the sustainability heading. Sustainability science and technology (SS&T) is increasingly important as human population and resource consumption increases, and resource availability decreases.

Recognition of the importance of sustainability research opens significant opportunities for Sandia. The vision of the nascent initiative is to:

Provide integrated solutions for resilience-based sustainability aimed at enhancing the security of the nation relative to material, energy, and water resource availability issues.

Sandia currently conducts research and development (R&D) in numerous areas relevant to sustainability, both at its own sites through measures aimed at site sustainability, and through work for other customers in many other fields (Figure 1). Some of the topics Sandia is involved in are:

- Climate research, mitigation, adaptation.
- Carbon sequestration.
- Microgrids and smart grids.
- Energy and water conservation.
- New urban planning processes.
- New building and transportation technologies.
- Alternative and renewable energy technologies.
- Burgeoning interest in the energy-water-food-ecosystems-security nexus.

Table 1 shows some of the past and ongoing Sandia project work in these areas. To facilitate an integrated Sandia approach for innovative, science-based, systems-engineering solutions to the larger complicated issues of sustainability, we have created a Sustainability Innovation Foundry (SIF). The focus of the Foundry will be both on Sandia site issues (e.g., energy efficiency of facilities) and issues for the broader community (e.g., support for complex energy and water issues). This report outlines the approach to obtain synergism from disparate Sandia research efforts to the benefit of the Laboratories’ national energy surety mission and (potentially) to a broader external community.

Figure 1. Sandia sustainability programs.

Table 1. Examples of sustainability-related modeling projects

	Active Projects (as of November 2010)	Past Projects (beginning in 1992)
Domestic	<ul style="list-style-type: none"> • Upper Rio Grande Simulation Model • Energy, Power & Water Simulation Model • Sun City Model • Water, Energy and Carbon Sequestration Model • Gila Basin-Arizona Water-Settlement Model • Electrical Grid Storage Valuation Model • Alternative Liquid Fuels Simulation Model • Electricity Generation Cost Simulation Model • Virtual Water Market Model • Geothermal Energy-Tradeoff & Scenario Analysis Model • Transition to Renewable Energy – County of Maui • Cut-off Grade Determination for Potash Mining in New Mexico • Validation & Verification of VISION Civilian Nuclear Fuel Cycle Model 	<ul style="list-style-type: none"> • U.S. Energy & Greenhouse Gas Model • Sandia-GM Biofuel Deployment Model • Renewable Energy Systems & Learning Model • String of Pearls Model • Middle Rio Grande Cooperative Water Model • Nambé Pueblo Water Budget Model • Hydrogen Futures Simulations Model • Barton Springs Urban Growth & Groundwater Sustainability Model • US-Mexico Border Permeability Model • Upper Rio Hondo Water Availability Model • Biofuels Feasibility Modeling & Analysis Project • Algae Biofuels Techno-Economic Modeling & Analysis Project • Climate Change Risk-Assessment Model • Willamette Basin Temperature TMDL Model • Insurgency as a Business Enterprise
International	<ul style="list-style-type: none"> • Strategy for Water and Land Resources in Iraq Model • U.S.-Canada Algae Biofuel Co-Location Model • Libyan Water-Energy-Food Model • Strategic Water Allocation Demonstration Model for the Canterbury Region of New Zealand • Spent Fuel Management – Taipower Taiwan 	<ul style="list-style-type: none"> • China Energy and GH Gas Model • India Energy and GH Gas Model • Electricity Generation Cost Simulation Model • Iraq Water-Energy-Food Model • The US/Mexico Water Management Model • The Rainy River Model

Resiliency

One of the important objectives of the SIF is to focus on the relationships between sustainability and resilience. All natural systems, including human systems, oscillate through time (Figure 2). The ability of a system to oscillate but rebound within ‘normal’ boundaries is resilience, and such a system is sustainable. Extreme oscillations (droughts, floods, economic collapses, climate variation, species extinctions, etc.) threaten human well being, and cause non-resilient systems to break, and be unsustainable. We must learn to manage systems, through knowledge and understanding leading to successful decision making, such that the oscillations occur within reasonable bounds and do not ultimately threaten human well being in all its dimensions, including systems that support human well being. Sustainability science and technology research can help with the evaluation of approaches that can dampen oscillations and help the systems remain resilient. Some conditions that help a system remain resilient to natural oscillations over any given time period include 1) anticipating the oscillations and the rates of change, 2) dampening peaks and troughs through process management, 3) matching demand with supply, and 4) finding an alternative to ever-increasing utilization of resources.

Figure 2. Sustainability = Resilience. Wise management of systems can prevent wide oscillations that are potentially destabilizing .

Sustainability at SNL

At the local scale at Sandia, the Facilities organization has initiated planning and implementation of activities to make Sandia a more sustainable institution [Meincke, 2011]. Their vision statement is:

Sandia National Laboratories leads the Department of Energy (DOE) complex, the nation, and the world in innovative, large-scale institutional transformation to a sustainable, carbon-neutral environment while increasing mission effectiveness, resource reliability, and resource security.

Each person at SNL understands and accepts his or her vital role in achieving this vision.

The *SNL Site Sustainability Plan* [Meincke, 2011] details the plans and the progress that has been made. Figure 3 and Figure 4 show the reductions in energy and water intensity at the Sandia New Mexico site over the last several years, respectively. This reduction is due to efforts from the sustainability initiative of the Facilities organization. Significant progress has been made.

Figure 3. Energy intensity

Figure 4. Water intensity. Line shows target levels, with SNL far exceeding them.

The effort to integrate and grow the Sandia R&D areas related to sustainability will lead to substantial site savings and development of sustainability tools applicable elsewhere. Investigators across departments will become aware of complimentary efforts, and diverse opportunities for innovative research will be shared across the sites.

Our goal is to place Sandia in a leadership position in national SS&T and help provide solutions to important site, national, and international sustainability problems. We will provide a forum for collaboration of relevant sustainability research at Sandia in materials, energy, water, climate, systems, alternative fuels, etc. in order to gain momentum and support for a sustainability initiative at Sandia. This fits in well with the Sandia mission for energy surety.

The benefits of a coordinated group at Sandia include synergy between various technologies for sustainability research, leading to potential breakthroughs in tools and analyses for the effort.

Sandia is uniquely positioned to conduct this research due to its systems-level analyses and modeling, coupled with R&D, in specific energy technologies including photovoltaic (PV), microgrid, wind, light-emitting diodes (LEDs), batteries/storage, distributed energy systems, and concentrated solar power (CSP). Sandia also has unique capabilities in stakeholder interactions, policy analysis, and scenario gaming that will help in the analyses of how best to manage these complex systems.

The metrics that will be used to demonstrate success include:

- Reduction in cost (consumption) of energy.
- Recognition by the broader community of Sandia's role in sustainability research.
- Reduction in carbon emissions.
- Tools for rapid turnaround of sustainability analyses (both for Sandia and other built institutions).
- Development of external collaboration with the Foundry.

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2. WORKSHOP SUMMARY

To initiate broad collaboration across Sandia, a workshop was held in Albuquerque, New Mexico on September 10, 2012. Technical staff and management were invited to learn about the nascent SIF organization and its goals and to discuss where and how Sandia can gain leverage in this important intersection of existing infrastructure and new R&D. The participants represented a broad spectrum of organizations within Sandia; they are listed in Appendix A. Figure 5 shows the organizations initially involved in this effort, though additional participation is certainly welcome.

Figure 5. Sandia sustainability participants

2.1. SIF Workshop Introductory Materials

The workshop introduced the topics of sustainability and resilience and described some of the sustainability efforts at Sandia. The agenda for the meeting is shown in the Attachment to this report. The introductory presentation (see slides in the Attachment) pointed out that while much is already going on at Sandia, we can do more by leveraging and integrating the activities going on at various other parts of the Laboratories. As well, the expectation is that the SIF will provide additional difficult-to-quantify benefits for recruitment and overall sustainability branding of Sandia.

2.2. Breakout Section Questions

Following the introductory remarks, the workshop contained several breakout sessions where participants divided into three small groups. Each of the breakout sessions began with a brief introduction followed by small group discussions on specific questions. These breakout sessions are summarized in the following sections.

2.2.1. Current SS&T Research at Sandia

In an effort to set the baseline for SS&T research at Sandia, the participants were asked four questions regarding ongoing R&D. Facilities, which is not conducting R&D as such, attempted to answer slightly different questions about their ongoing work in sustainability.

What SS&T research are you currently doing?

This question resulted in a list of ongoing research and activities in SS&T. Additional detail will be needed to fully populate this list.

- Tribal renewable energy work.
- Materials science and engineering in solar, wind, water, and energy grid.
- Economic and technical viability of energy storage at Sandia.
- Institutional Transformation (IX) system dynamics tool for decision making in resource management.
- Energy surety concept (balance safety, security, reliability, sustainability, and cost effectiveness). Note: The DOE Energy Surety Engineering Research and Technology (DESERT) complex is a proposed flagship for this concept
- Microgrids.
- Renewable energy.

In addition, a number of Facilities' activities were mentioned, including efforts toward reductions in energy and water use and in landfill waste (0 waste to landfill by 2025).

Who are the key researchers and contributors?

As previously mentioned, there are a large number of researchers across Sandia who are primarily in Organizations 1000, 2000, 6000, and 8000. We intend to further identify the scope and sustainability research of participants' projects.

Who are your key customers and collaborators?

Initial list of customers were:

- U. S. DOE Energy Efficiency and Renewable Energy (DOE EERE).
- DOE Office of Electricity.
- Federally recognized tribal nations.

Additional detail on these will be developed.

What are key gaps in the current research?

The groups generated a number of facilities-related opportunities.

Sustainable Acquisition

The SIF supports the concept of procurements that have sustainability as a key characteristic. Current policies may not be strong enough to be effective over the long term. What could be done to institutionalize this? In addition, the yearend funding is often somewhat rushed. This means sustainable purchasing may not be practiced well if the process is not smooth/easy. Pre-screening of commonly purchased items might facilitate this effort.

Reapplication Process

A better approach to reusing/reapplying such things as computers is needed. Because reapplication is not an easy process to follow, it may not be occurring as much as it should.

Lifecycle Cost Integration

Evaluate the full lifecycle cost to Sandia on purchases.

Recycling of Materials

Could we look at the Chemical Information System (CIS) and chemical recycling differently? Chemicals exchanges could be fostered to reduce waste. Lighting systems and their recyclable materials could be evaluated.

Other potential research ideas were also generated:

Data Center Energy Use

Look at alternative cooling/power approaches to reduce consumption.

Local use of R&D

Proactively look for ways to use Sandia R&D on site. Develop test beds, prototyping, and proof-of-concept approaches. Once tested, the R&D results could be taken beyond Sandia. Also, look at ways to share R&D insights across the complex (e.g., helium capture technology developed on site).

Personnel Transport On Site

Look into new ways to transport personnel on and around the site.

Human Factor Analysis

Another research area is to evaluate how humans interact with the current sustainability systems. What can be done to evolve to more efficient and productive sustainable systems?

Zero Landfill Waste

Research new approaches to get to this goal.

Energy Data Sharing

Currently, considerable energy data are produced from the site. How can we enhance the sharing of this information? How can we maintain the data for longer-term analysis? Are there ways to develop incentives with the use of kiosks, brochures or demonstrations that show personnel their savings/use? Can we roll up the information and allow for trending/analysis?

Cost Benefit Analysis of Spending for Security vs. Sustainability

Can we develop an approach to optimizing the analysis? Can we evaluate competing priorities for sustainability?

Information and Data

How can we raise awareness of activities and opportunities for employee contributions? What human behavior research can contribute to solving this?

Sustainability Metrics

Can we develop useful rating criteria for sustainability features or activities?

New Business Model

How do we overcome the current capital investment in the site infrastructure and make the change to sustainability for the future? Innovative economic models need to be researched and developed.

2.2.2. Potential Future SS&T Research at Sandia

The second breakout session generated ideas for future SS&T research.

What are future SS&T research opportunities?

A number of interesting ideas were developed in response to this question. A short list follows.

Human-Machine Interface

Leverage our nuclear reactor operation research toward sustainability issues.

Self-Assessments

Look into assessments of building use over time. What different functions could be envisioned?

Recycling Materials Identification

Explore new technologies to identify and sort materials being recycled – currently, this is a very labor-intensive process.

Energy Storage

What new technologies could we offer? Are there other phase changes to look at or liquids to store besides the molten salt currently under research in CSP?

Develop Dashboards

Provide real-time feedback on each person's personal computer, at building entrances, etc., with reference to their previous year's usage. Each person's energy/carbon footprint could be personalized.

Energy Use

Determine why energy usage at night/weekends is not as low as we might expect.

Sustainable Sustainability

How do we maintain a sustainability program as Sandia management changes? How do we develop and maintain the cultural changes necessary for sustainability?

Energy Surety

Investigate surety programs, such as the DESERT complex and envision a Leed Platinum-certified, net-zero building.

What are the opportunities for integration and synergy within Sandia?

Several opportunities for integration and synergy were identified:

- Develop a prioritized list, and use end-of-year money for sustainability projects.
- Include sustainability on employee annual Performance Management Forms, as part of the standard Environment, Safety, and Health (ES&H) objective. How can we reward sustainability increases? Can cost savings be funneled back to the organization that provided the ideas?

- Add sustainability as an evaluation criterion in Laboratory Directed Research & Development (LDRD) proposals.

Can we submeter extensively, that is, bill those who use electricity the most, rather than taxing everyone? Are there benefits to our “bids” to reduce our overhead charge from sustainability actions or to claim our sustainability programs?

We need to develop an approach to retain and analyze energy consumption data in order to determine trends. Currently, detailed energy consumption data are abandoned a year after collection. Which organizations within Sandia can coordinate with the Facilities energy monitors to develop the plan for this effort?

Who should we try to collaborate with?

There was limited time available for discussion on this question and only a few examples were collected. A more thorough examination of who we might collaborate with is needed.

Examples:

- Reopen discussion with Kirtland Air Force Base (AFB) on evaluation/deployment of a microgrid.
- Pursue a dialogue with tribal and local communities.

What areas should we focus on?

The focus should be on the three areas of energy, water, and materials, which are key to any successful sustainability effort.

Another focus should be on more education on sustainability using existing media such as the Laboratories’ Porcelain Press newsletter, as well as hands-on training and conducting demonstrations, prototypes, and test centers with new technologies. There should be laboratory-wide implementation of new technologies developed at Sandia. Lessons learned from the institutional transformation could be implemented. The Advanced Materials Lab (AML) and Center for Integrated Nano-Technology (CINT) can be used as test facilities as they have external collaborators who could share their useful techniques. A short-term project with a high-impact deliverable could be implemented to show how important sustainability is to Sandia.

2.2.3. Proposed 3-Year Plan for SIF

The future of the SIF was also discussed with the workshop participants. The presentation slides on this session are provided in the Attachment to this report. We considered ideas to develop and move the SIF forward in the next three years.

Sustainability is currently recognized at Sandia as one of the five pillars of energy surety, along with cost efficiency, reliability, safety, and security. Within the U.S. Government arena, Sandia can take an early lead on energy, water, and other resource sustainability issues by helping to:

- Increase the profile of SS&T.
- Tighten the focus within the national laboratory system on the importance of sustainability issues.
- Properly frame national and global issues in the context of sustainability
- Identify S&T solutions.

- Guiding the national global S&T community.

This will open the door to new business at Sandia, and it will help lead the nation and the world in sustainability solutions.

The proposed goals of the SIF for the next three years are ambitious, but they are based on strong fundamental capability within Sandia and a drive to support our mission to support national security.

The top-level goals are as follows:

- 1.) Place Sandia in a leadership position in national SS&T research and implementation.
- 2.) Transform the Sandia institution into a leading edge facility in energy and water use as a demonstration of our commitment and innovation.
- 3.) Leverage existing ongoing sustainability research at Sandia.
- 4.) Continue to develop tools for industry and internal use.
- 5.) Partner with interested organizations and customers to fuel our research and grow a sustainability community.

Sandia is uniquely positioned to conduct this work due to its systems-level analyses and modeling coupled with R&D in specific energy technologies including PV, microgrid, wind, LEDs, batteries/storage, distributed energy systems, and CSP. Sandia also has unique capabilities in stakeholder interactions, policy analysis, and scenario gaming that will help in the analyses of decision-making on how to manage these complex systems in the face of rapid technological change.

The near-term timeline for the SIF is shown in Figure 6. Several activities are planned. The idea generation that began with the workshop and the strengths, weaknesses, opportunities, and threats analysis will be completed in October. The ongoing IX project will provide a discussion of the site model in November and a preliminary analysis review in December. The SIF strategic and implementation plans will be developed in December of 2012 and January of 2013. Additional SIF group meetings are expected to be held in the coming months.

Figure 6. Near term timeline for Sandia Sustainability Innovation Foundry

As outlined in the presentation slides, the following FY12 activities were completed:

- Launch the SIF as a funded collaboration between Centers 4000, 6000, and 8000.
- Identify the SS&T already underway at Sandia and launch communication materials.
- Launch the IX project for immediate application at Sandia and future application at other institutions.

For FY13, the following objectives were presented:

- Define the leadership team for the SIF.
- Collaborate with interested institutions such as DOE labs, University of New Mexico, city of Albuquerque, state of New Mexico, city of Livermore, and the state of California.
- Hold workshops and develop whitepapers on target research.
- Continue the IX project with communication to the broader community on the findings.
- Develop strategy and look for opportunities to market the IX to other institutions and industry.

For FY14, the third year of the SIF, the following objectives were presented:

- Obtain the first external funding to pursue SIF projects at Sandia and elsewhere.
- Complete the IX project at Sandia and begin the launch at other institutions.

The breakout session provided a number of useful suggestions to the proposed 3-year plan.

Collaboration with Livermore Valley Open Campus (LVOC)

Develop appropriate connections with the LVOC community, and the iGATE initiative in Livermore.

Sustainability Champion

Identify a senior management champion for funding any program development activities. Jill Hruby, Division 6000, and Rick Stulen, Division 8000, were suggested.

Alignment

Align the research with sustainability so sustainability becomes what we do every day (e.g., as practiced at the National Renewable Energy Laboratory (NREL) in Golden, Colorado). While concentrating research efforts on sustainability may be difficult for a National Nuclear Security Administration (NNSA) laboratory, Sandia's Strategic Management Unit (SMU) structure, which is promoting programs like DESERT, could become an important connection to push the effort forward. Energy surety could become the "common mission space" to enable this alignment.

Communication

As part of the communication plan:

- Develop evolving displays to help with education of impacts.
- Set targets.
- Describe specific actions that can help.
- Identify materials to use.
- Develop a fine resolution on the information so that it is building- or researcher-specific, as well as what the impact is on the whole of Sandia.
- Integrate the concepts to Techweb.

Sustainability Behavior Incentives

Develop ways to incentivize staff (similar to the initiatives in place for the health miles program, such as wearing pedometers).

3. ARCHITECTURE OF COLLABORATION

Current coordination for development of the SIF includes participation from both research and facilities organizations within Sandia. The leadership team includes participation from both Sandia New Mexico and Sandia California. It includes both operations and line organizations in a tightly coupled integration to facilitate rapid deployment of the research to the site. There are exciting possibilities within the LVOC as they attempt to develop the site with solar PV installation (Cool Earth) and a prototype hydrogen fueling station. Several members of the Combustion Research Facility (CRF)/LVOC leadership team (Andy McIlroy, Daniel Dedrick, and Art Pontau) have been briefed on the SIF concept. The SIF team has also reached out to external organizations in initial attempts to develop a collaborative path forward utilizing Sandia skills along with external university, industry, and public partners. The list of collaboration partners is expected to grow as the Foundry develops.

We will access the SMU structure to support the overall integration of the relevant research and operational programs. Much of the relevant research is occurring in the Energy Climate Infrastructure Security (ECIS) SMU, so this will be the initial focus of the SIF as it evaluates and integrates relevant ongoing research. Another direct linkage in the SIF architecture is with the Facilities team at Sandia, which is already heavily involved in sustainability efforts on existing Sandia buildings/labs. For the initial and ongoing planning efforts, personnel from each of these organizations are included. Web and sharepoint presence will also be a collaboration node for the Foundry.

A number of organizations are already conducting “sustainability” research, which is expected to continue in the coming years. A sample of those programs is included in Table 2.

Table 2. Organizations within Sandia and current sustainability projects examples

Description	Organization
Sunshine to Petrol	6124
Improved coatings for CSP	6124
Water Initiative	6111
Electric Grid Resiliency	1400, 8900, 6113
Climate adaptation	1400
Climate Modeling	1400, 8900, 8353
Renewable Energy - PV	6112
Renewable Energy – Wind	6121
Renewable Energy - geothermal	6916
Renewable Energy - water	6122

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4. FUNDING SOURCES

To develop and sustain this effort, funding from a variety of sources will be needed. Initial funding will be provided by Facilities “energy” funding to develop the prototype modeling capability. In addition, by coalescing multiple projects at Sandia under the umbrella of the SIF, we can proclaim a sustainability initiative to aid in attracting funding at both large and small levels. The initial scan will look toward traditional Sandia customers from DOE. The NNSA and other offices will be reviewed to evaluate the appropriateness for supporting funding. Other governmental agencies (such as the state of California) and industry clients will also be approached to gauge interest in funding. For example, in California, Governor Brown has called for an initiative to evaluate the state-owned facilities as to their energy use with a goal of reduction of energy use over time. Our efforts can be directed toward support of such initiatives.

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5. PATH FORWARD

The SIF workshop held in Albuquerque, New Mexico on September 10, 2012 brought together a diverse set of Sandians. The discussions confirmed the strong interest in sustainability for Sandia, both in ongoing activities and in future direction for the Laboratories. Several actions were identified in order to expand the SIF and to leverage the ongoing research and operations activities.

Existing Funding

The energy savings funding will give the Foundry the ability to develop projects that can further the research and development of sustainability activities at Sandia. Key outcomes from these initial projects can be used as demonstrations of how the Facilities and Research communities can work together.

Follow-on Funding

Evaluate internal and external sources for follow-on funding to expand the SIF. Determine how the SIF fits in with the existing business structure and what part of the organization may become willing champions of the research. Seek research funding from LDRD and other similar sources.

Specific Projects Identified

A few specific projects were identified to support sustainability efforts at Sandia. Additional rigor could be added to purchasing so that sustainable products are purchased, where feasible. A microgrid covering Kirtland AFB and Sandia has been discussed and efforts could be made toward implementation. Energy data management could be updated to archive long-term energy use information for studying trends.

Communication

Continue to develop the sustainability research and facilities community through additional workshops and messages in a variety of venues: Sharepoint, website, newsletters, and presentations (see Appendix B). Approach large programs in Divisions 2000 and 5000 for “Red Team Assessments” of project activities or other specialized interactions.

IX Modeling

Conduct IX modeling of Sandia infrastructure to support Facilities planning for energy and water reduction. Develop this model as a prototype for potential use at other large institutions looking for sustainability advantages.

Proposal Challenge Concept

In an effort to gain additional ideas and participation for the SIF, a contest was announced. Researchers can submit sustainability ideas and then obtain seed money to develop their idea into a proposal suitable for submittal to internal or external sources.

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6. REFERENCES

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2. Meincke, C.L., *FY 2012 Site Sustainability Plan*, SAND2011-9155P, 2011.
3. Zolli, Andrew and A. M. Healy, *Resilience: Why Things Bounce Back*, Free Press, NY, NY, 2012.

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APPENDIX A: WORKSHOP ATTENDEES

Attendees	Dept	Department Name
Jack Mizner	4853	Partnership and Planning, LT
Jerry McNeish	8954	Quantitative Modeling and Analysis
Margaret Ochs	6124	Materials, Devices and Energy Technology
Howard Passell	6926	Earth Systems Analysis
Art Ratzel	4000	Facilities Management and Operations
Carol Meincke	4853	Partnership and Planning, LT
Bernadette Hernandez-Sanchez	1815	Ceramic Processing and Inorganic
Ryan Hess	1716	Microsystem-enabled detection
Stephanie Fitchett	431	Human Factors and Statistics
Phil Pohl	6231	Risk and Reliability Analysis
Dhruv Bhatnagar	6113	Energy Storage and Transmission Analysis
Ryan Elliott	6113	Energy Storage and Transmission Analysis
Juan Torres	6120	Renewable Energy Technologies
Rick Dotson	4142	Long Term Stewardship
Sean Hendrickson	9517	Mission Information Services
Tod Embree	5712	Optical Payload D&R
Chelsea Chee	8124	Materials, Devices and Energy Technology
Doug Vetter	4143	Environmental Programs
Ralph Wrons	4144	Waste Management and Pollution Prevention
Marissa Reno-Trujillo	6926	Earth Systems Analysis
Steve Ward	4000	Partnership and Planning
Elizabeth Lucero	1932	Partnership Development & Business Intelligence

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APPENDIX B: COMMUNICATION PLAN

An important component of the SIF is a multifaceted communication strategy that educates and motivates staff to greater sustainability solutions. A handout describing the SIF is presented as Exhibit 1. The SIF sharepoint site front page is displayed in Exhibit 2. Further efforts to communicate and build interest in the SIF will include a collaborative website, regular meetings of those involved, and ongoing white paper development in support of solicited and unsolicited proposals.

Exhibit 1. Sustainability Innovation Foundry information Flyer

SAND2012-7363 P

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Sustainability Innovation Foundry

What is Sustainability?

Sustainability is the condition in which a system remains resilient to oscillations over a given period. All complex systems—human population and economies, river hydrographs, global temperature, to name a few—oscillate over different temporal and spatial scales. Extreme oscillations, upward or downward, can compromise a system's resilience and be destabilizing. Sustainability science and technology (SS&T) develops tools and approaches that are used to evaluate and make decisions to dampen or mitigate oscillations, improve resilience, and help avoid the destructive consequences of extreme oscillations.

Sustainability pertains to energy, water, agriculture, and ecosystems. It is a driving force in economics, culture, and politics, expanding into a critical issue of national security for the United States and other nations.

A consistent focus on sustainability will be increasingly important as global population increases and resource availability decreases. Sustainability is already one of the most important drivers in S&T, encompassing climate science, renewable energy, hybrid and electric vehicles, carbon sequestration, desalination and other water-purification measures, smart grids, and engineering new crop types.

What's New at Sandia?

Sandia National Laboratories (Sandia) currently conducts on-site research and development (R&D) in numerous areas relevant to sustainability, as well as working with other customers in a wide array of relevant fields (Figure 1).

- SNL Site Sustainability Plan (SSP)
- Climate research
- Combustion research
- Renewable energy: PV, CSP, wind, geothermal, & biofuels
- Microgrids & smart grids
- Water Program: safety, security, & sustainability
- National Infrastructure Simulation and Analysis Center (NISAC)
- Earth Systems Analysis
- Decision-support: water, energy, food, ecosystems, & security

Figure 1. Current SNL SS&T Capabilities

Sandia's Sustainability Innovation Foundry facilitates and integrates Sandia's efforts at innovative, science-based, systems engineering solutions to the complicated issues of sustainability. The Foundry will focus on SNL sustainability issues and solutions for applications at SNL and within the broader community. The Foundry will work to reduce site energy and water footprint through improved facilities engineering and management, development, and implementation of new technologies, installation of renewable energy technologies, and other issues as they are identified.

The Foundry will work to make explicit links between sustainability and national security, generate more SNL research opportunities in SS&T, and raise SNL's "sustainability laboratory" profile.

Sandia National Laboratories
SUSTAINABILITY
INNOVATION
FOUNDRY

Examples of Existing SNL SS&T Projects

Institutional Transformation (IX) will develop a computer-simulation model and a stakeholder process to help Sandia and other large institutions—national laboratories, military installations, governments at all levels—transform their facilities and sites to become more sustainable. Collaborative, stakeholder-driven resource-modeling projects addressing water, energy, and food in numerous locations in the United States and around the world have helped resource managers and other stakeholders in developing resource-management plans to ensure future sustainability (Figure 2).

Figure 2. Aerial View Of SNL/NM, Looking North

Joint BioEnergy Institute (JBEI), located in Emeryville, California, is a partnership led by Lawrence Berkeley National Laboratory and includes Sandia National Laboratories, Lawrence Livermore National Laboratory, the University of California campuses of Berkeley and Davis, and the Carnegie Institution for Science. JBEI's primary scientific goal is to further develop the next generation of biofuels derived from solar energy stored in plant biomass (Figure 3).

Figure 3. JBEI

Climate Modeling and Analysis at SNL seeks to develop a risk-assessment methodology to evaluate uncertain climatic conditions and the consequences posed to humanity. Results will influence national policy on security and energy issues, state-level economies, and energy generation and use (Figure 4).

Figure 4. Climate Map of the World

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SNL Site Energy-Reduction Projects are selected for their suitability and overall energy-reduction potential. Sandia has installed several innovative systems, to help Sandia meet its sustainability goals:

- **NightWatchman®**, a computer power-management system allows Sandia to securely, remotely, and centrally manage power consumption on desktop computers by sending them into automatic standby, to reduce costs, energy use, and carbon emissions.
- **Occupancy Sensor Installations** are taking energy-reduction sensing to a higher level by connecting building occupancy sensors to office lighting and to the Building Automation System, which controls the heating, ventilating, and air-conditioning (HVAC) system.
- **"Free Cooling"** uses dry, low-temperature ambient air to produce chilled water to cool interior spaces of buildings and processes, without the need for either compressors or refrigerant gases. Free cooling is great for spaces with a constant load such as heavily air-conditioned data centers and other internal load-dominated systems (Figure 5).

Figure 5. Cooling Tower and Cold-Plate Heat Exchanger

- **Fume-Exhaust Modifications** have been completed in a building having above-average energy consumption owing to a constant-speed exhaust system. The existing system was replaced with a variable-speed system, and ductwork was enlarged to reduce flow restrictions. Energy data show significantly reduced energy use.

Exhibit 2. SIF Sharepoint Site Home Page

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DISTRIBUTION

1	MS0924	Jack Mizner	4853
1	MS0734	Margaret Ochs	6124
1	MS1137	Howard Passell	6926
1	MS9159	Jerry McNeish	8954
1	MS0899	RIM-Reports Management	9536 (electronic copy)

ATTACHMENT: WORKSHOP SLIDES

The workshop held on September 10, 2012 followed the agenda presented herein. Slides from the presentations are also attached here. The introductory slides for the workshop were presented by Jack Mizner and Howard Passell. The slides for each of the breakout sessions are included here. Jerry McNeish led the discussion on the current SS&T at Sandia. Margaret Ochs led the discussion on future SS&T at Sandia. Howard Passell presented the proposed 3-year plan for the SIF and led that discussion. The sustainability idea competition slides were presented and discussed by Jack Mizner.

AGENDA

Sustainability Innovation Foundry Workshop

September 10, 2012

1:00 pm Welcome – Art Ratzel (4800)

- Establish the community**
- Sustainability vision and ongoing Facilities actions**

1:10 pm Sustainability Innovation Foundry Overview– Jack Mizner (4853)/Howard Passell (6926)

BREAK OUT SESSIONS

1:30 pm Current Sustainability Science & Technology (SS&T) – Jerry McNeish (8954)

2:00 pm Future SS&T opportunities – Margaret Ochs (6124)

2:30 pm Reconvene and summarize SS&T opportunities - All

3:00 pm How do we move sustainability at SNL forward? – Howard Passell

- 3-Year Plan review and critique**

3:30 pm Sustainability Idea Competition – Jack Mizner

- Present basics of the bold competition and pool of proposal funding**

3:45 pm Q&A, meeting summary of actions, working groups, and path forward – Jack Mizner/Howard Passell

4:00 pm Closing

SLIDES

SIF Introduction Session	3
Current SS&T at Sandia	15
Future Sustainability Research	19
SIF Three-Year Plan	21
Sustainability Idea Competition	25

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Sustainability Innovation Foundry

September 10, 2012

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Welcome

- Introductions
- Why are we here?
- Desired outcomes?
- Summary & path forward

2

What Is Sustainability?

Defined in terms of human demand for resources:

“...the needs of the present are met without compromising the ability of future generations to meet their own needs.”

Report of the Brundtland Commission, 1987

Driving questions:

- What are the needs of the present?
- What are the needs of the future?

3

Site Sustainability Plan - Vision

“Sandia National Laboratories leads the Department of Energy (DOE) complex, the nation, and the world in innovative, large-scale institutional transformation to a sustainable, carbon-neutral environment while increasing mission effectiveness, resource reliability, and resource security.

Each person at SNL understands and accepts his or her vital role in achieving this vision.”

4

SNL Energy Use Statistics

ENERGY STREAM	SNL/NM (BTUs)	SNL/CA (BTUs)
Electricity	873,963,723,792	128,526,628,000
Natural Gas	326,602,035,800	79,897,345,000
Other	16,528,662,788	
Total	1,220,343,192,300	208,423,973,000
# of SW Homes	13,560	2,315

Equivalent to a city of 50,000 residents

Sustainability Science & Technology (SS&T)

SS&T

- Will become increasingly important as global population, resource consumption, and resource scarcity increase
 - climate research, mitigation, adaptation
 - carbon sequestration
 - microgrids & smart grids
 - energy and water conservation
 - new urban planning processes
 - new building & transportation technologies
 - alternative & renewable energy technologies
 - burgeoning interest in the energy-water-food-ecosystems-security nexus

SNL: A Leader in SS&T

ENERGY

- Electric grid
- Combustion engineering
- Renewable energy [PV, wind, geothermal]

WATER

- Water resource evaluation
- Stakeholder Support

CLIMATE

- Modeling
- Adaptation

POLICY

- Climate
- Biosurveillance
- Natural disaster response

Partnership & Planning (Dept. 4853)

Earth Systems Analysis (Dept. 6926)

Other Sustainability Initiatives

National Laboratories	
ORNL Sustainable Campus Initiative	Ames NL Site Sustainability
LLNL Site Sustainability Plan Sustainable NREL	BNL Site Sustainability
PNNL Innovative Solutions for a Sustainable World	Fermilab Site Sustainability
LBNL Institute for Globally Transformative Technologies	

Universities
Columbia University: Earth Institute - www.earth.columbia.edu
University of California: http://sustainability.universityofcalifornia.edu
UC Berkeley: 2009 Campus Sustainability Plan; Chancellor's Advisory Committee on Sustainability (CACS); Sustainable Water Plan; Cal's Climate Action Partnership – http://sustainability.berkeley.edu/
Purdue University: Sustainability Council - http://www.purdue.edu/sustainability/energy.htm
Kansas State University: Center for Sustainable Energy - http://sustainable-energy.ksu.edu/
University of Maryland: Office of Sustainability; University Sustainability Fund; Climate Action Plan; Green Cleaning Initiatives – http://www.sustainability.umd.edu/index.php
Arizona State University: School of Sustainability – http://schoolofsustainability.asu.edu
University of Michigan: Special Counsel to the President for Sustainability – http://sustainability.umich.edu
University of Arkansas: Office for Campus Sustainability – http://sustainability.uark.edu

Sustainability Innovation Foundry

Mission

- Unify and institutionalize sustainability efforts at SNL
 - save money through energy and other resource savings
 - be recognized as a sustainability R&D lab
 - attract more business
- Define and pursue important R&D
 - develop proposals, workshops, papers, collaborations
 - develop roadmap and implementation plan for SS&T R&D at SNL
 - adopt sustainability as a lab-wide “thrust”

What Is Sustainability?

Defined in terms of human demand for resources:

“...the needs of the present are met without compromising the ability of future generations to meet their own needs.”

Report of the Brundtland Commission, 1987

Driving questions:

- What are the needs of the present?
- What are the needs of the future?

Sustainability & Resilience

Complex systems oscillate:

Humans try to dampen oscillations.

15

What Is NOT Sustainable?

Complex systems oscillate:

This is **NOT** sustainable.

16

Sustainability

The condition in which a system remains resilient to natural oscillations over any given time period

- Anticipate oscillations & rates of change
- Dampen (“manage”) peaks & troughs
- Match demand with supply
- Eliminate constant increase

17

Sustainability at SNL

Institutional Transformation (IX) Centers 4000 & 6000 & 8000

- Develop a prototype system model of site infrastructure
- Use the model to build & evaluate alternative SNL future development scenarios
- Develop testbeds for specific new technologies

SNL/NM

SNL/CA

18

Sustainability Elsewhere

IX for the City of Rutland, VT - proposal

- ARPA-E proposal submitted to implement IX
- Partners: City of Rutland, Green Mountain Power, & Middlebury College
- Evaluate the energy efficiency of municipal facilities at a system level
- Create development plan with Rutland stakeholders

<http://www.peterhuntoon.com>

Sustainability Papers & Presentations

Atlantic Council of the U.S. Energy-Water Nexus Conference,
Washington, DC - June 2012

White House Roundtable on Water
SNL – expected in 2013

Transformational solutions for bridging the gap between future energy and water supply and demand in the western U.S.

20

Summary

Sustainability Innovation Foundry

- Places SNL in a leadership role in sustainability innovation
- Leverages existing SNL research for greater value
- Transforms the SNL institution to a leading-edge facility in energy & water use
- Develops tools for utilization by industry & worldwide
- Develops collaborations

Additional Slides

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Current Sustainability Science and Technology at Sandia

September 10, 2012

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SNL: Already a Leader in SS&T

ENERGY

- Electric grid
- Combustion engineering
- Renewable energy [PV, wind, geothermal]

WATER

- Water resource evaluation
- Stakeholder Support

CLIMATE

- Modeling
- Adaptation

POLICY

- Climate
- Biosurveillance
- Natural disaster response

Partnership & Planning (Dept. 4853)

Earth Systems Analysis (Dept. 6926)

Sustainability Science and Technology @ Sandia
	Active Projects (as of November 2010)	Past Projects (beginning in 1992)
Domestic	<ul style="list-style-type: none"> • Upper Rio Grande Simulation Model • Energy, Power & Water Simulation Model • Sun City Model • Water, Energy and Carbon Sequestration Model • Gila Basin-Arizona Water-Settlement Model • Electrical Grid Storage Valuation Model • Alternative Liquid Fuels Simulation Model • Electricity Generation Cost Simulation Model • Virtual Water Market Model • Geothermal Energy-Tradeoff & Scenario Analysis Model • Transition to Renewable Energy – County of Maui • Cut-off Grade Determination for Potash Mining in New Mexico • Validation & Verification of VISION Civilian Nuclear Fuel Cycle Model 	<ul style="list-style-type: none"> • U.S. Energy & Greenhouse Gas Model • Sandia-GM Biofuel Deployment Model • Renewable Energy Systems & Learning Model • String of Pearls Model • Middle Rio Grande Cooperative Water Model • Nambé Pueblo Water Budget Model • Hydrogen Futures Simulations Model • Barton Springs Urban Growth & Groundwater Sustainability Model • US-Mexico Border Permeability Model • Upper Rio Hondo Water Availability Model • Biofuels Feasibility Modeling & Analysis Project • Algae Biofuels Techno-Economic Modeling & Analysis Project • Climate Change Risk-Assessment Model • Willamette Basin Temperature TMDL Model • Insurgency as a Business Enterprise
International	<ul style="list-style-type: none"> • Strategy for Water and Land Resources in Iraq Model • U.S.-Canada Algae Biofuel Co-Location Model • Libyan Water-Energy-Food Model • Strategic Water Allocation Demonstration Model for the Canterbury Region of New Zealand • Spent Fuel Management – Taipower Taiwan 	<ul style="list-style-type: none"> • China Energy and GH Gas Model • India Energy and GH Gas Model • Electricity Generation Cost Simulation Model • Iraq Water-Energy-Food Model • The US/Mexico Water Management Model • The Rainy River Model

Process

- Breakout into 5-6 groups
- Designate a scribe and a spokesman
- Discuss and evaluate the following:
 - What SS&T research are you currently doing?
 - Who are the key researchers/contributors?
 - Who are your key customers? Collaborators?
 - What are the key gaps in the current research
- Reconvene after 20 minutes
- Report out of 2-3 minutes from each group
- Group discussion

Template

- What SS&T research are you currently doing?
- Who are the key researchers/contributors?
- Who are your key customers? Collaborators?
- What are the key gaps in the current research

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Future Sustainability Research Ideas

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Future Sandia Sustainability Research

- Brief discussion of some ideas about opportunities
- Expand and connect the areas of SS&T research at SNL
 - Through leveraging, partnerships, and building on past successes
- Grow our customer base – introduce receptive funding agencies to the SIF at Sandia
- Identify and address challenges to pursuing SS&T research

2

Group Process

1. Break out into groups
2. Designate a scribe and a spokesperson
3. Discuss and evaluate the following:
 - What are future SS&T research opportunities?
 - What are the opportunities for integration & synergy within Sandia?
 - Who should we try to collaborate with?
 - What areas should we focus on?
4. Reconvene after 20 minutes
5. Report from each group (2 to 3 minutes)

3

Template for Discussion

- What are future SS&T research opportunities?
- What are the opportunities for integration & synergy within Sandia?
- Who should we try to collaborate with?
- What areas should we focus on?

4

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Sustainability Innovation Foundry Three-Year Plan

September 10, 2012

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Foundry Focus Areas

- Place SNL in a leadership position in national SS&T research
- Transform SNL to a leading-edge facility in energy and water use
- Leverage ongoing research at SNL
- Continue developing tools for industry and internal use
- Partner with interested organizations and customers to fuel SNL research and grow a sustainability community

2

Year 1 - FY 2012

- Launch Sustainability Innovation Foundry as a funded collaboration between Centers 4000, 6000, 8000:
 - Identify SS&T already underway at SNL, and future targets
 - Launch web site and other outreach materials
- Launch IX project for immediate application at SNL and future application at other institutions

P

Year 2 - FY 2013

- Name Sustainability Innovation Foundry team co-leads from Centers 4000 and 6000
- Collaborate on Foundry projects with interested institutions, e.g., DOE labs, UNM, City of Albuquerque, State of NM, City of Livermore, State of CA:
 - Hold workshops
 - Write proposals and white papers
- Continue IX at SNL
- Market IX to other institutions

4

Year 3 - FY 2014

- Receive first external funding to pursue Foundry projects at SNL
- Complete IX at SNL, launch at other institutions

5

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Sustainability Idea Competition

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Competition for New Sustainability Ideas

- Develop a 1-page idea abstract
- Best ideas will be given up to \$5K funding to detail out the idea into a whitepaper [\$30K available for funding]
- Ideas should include the benefit to Sandia Sustainability
- Deadlines:
 - 1 page idea abstract: October 15, 2012
 - Evaluation and notification: October 22, 2012
 - Whitepaper proposal: November 15, 2012

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