SRS Energy Park

The Bridge to Sustainable National Energy Security

Vision and Implementing Concepts

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Acronyms

DOD-Department of Defense
DOE-Department of Energy
EM-Office of Environmental Management
GHG-Greenhouse Gas
HEU-Highly Enriched Uranium
HTGR-High Temperature Gas Reactor
LWR-Light Water Reactor
MOU-Memorandum of Understanding
MOX-Mixed Oxide Fuel Fabrication
MWe-Megawatts Electric

NNSA-National Nuclear Security Agency
NRC-Nuclear Regulatory Commission
Pu-Plutonium
SMR-Small Modular Reactor
SRNL-Savannah River National Laboratory
SRNS-Savannah River Nuclear Solutions, LLC
SRS-Savannah River Site
SWOT-Strength-Weakness-Opportunity-Threat
TRSWA-Three Rivers Solid Waste Authority
What is an Energy Park?

- Redeploys under-utilized DOE assets to produce diverse, green, domestic energy sources
  - Solar, wind, biomass, geothermal, nuclear, clean coal, hydrogen
  - Smart grid, storage, efficiency manufacturing
- Cuts greenhouse gas emissions
- Reduces dependence on foreign oil; improves energy security
- Restores American leadership of energy/climate technology
- Provides sustaining missions for DOE Sites
- Joint effort of DOE, local and regional communities, private sector, unions, and other interested parties
What is the role of SRNS?

- Inventory SRS assets and competencies
- Identify national energy security needs
- Assist DOE with the development of an SRS Energy Park vision
  - Align SRS assets and competencies with national energy security needs
- Generate concepts for consideration by DOE and stakeholders
What has SRNS done?

- 2 Strength-Weakness-Opportunity-Threat (SWOT) workshops
  - Inventoried SRS assets and competencies
  - Targeted 3 pressing national needs
- Assisted with 2 DOE public workshops
- Strategic View Interviews
  - >100 long-term employees
  - 115 representatives of DOE/NNSA, community, industry, academia, and gov’t
- Formulated vision and implementing projects
  - Long-term vision—National Fusion Energy Park
  - Implementing Projects—BioEnergy Integration Center, Modular Reactor Demonstration Complex, Modular Reactor Power Park, U.S. Energy Freedom Center™
- Energy Park Executive Roundtable
  - Focus group on vision and projects
  - 35 representatives of industry, community, and SRS
- Launched Modular Reactor Demonstration Complex
  - Hyperion memorandum of understanding (MOU)
What has SRNS learned?

- Focus should be on energy security, climate change, and **ECONOMIC SECURITY**
- Energy park must transcend Site boundaries
- Public-private partnerships are essential
- Authorizing legislation and appropriated "seed" funding needed
- SRS has many relevant capabilities and assets
  - nuclear materials processing, biomass, and other renewables
  - BUT, SRS is primarily a nuclear site
- The backbone the SRS energy park must be **nuclear**
Targeted National Needs

- Energy Security
  - Achieve independence from foreign oil
  - Improve electricity generation, storage, and efficiency
    - Solar and Wind—advanced collection and conversion
    - Clean Coal—gasification and carbon capture
    - Nuclear—greater utilization of uranium, recycle used fuel
    - Transmission/Distribution—advanced batteries, superconductors, smart grid
  - Develop and deploy fusion energy

- Climate Change
  - Reduce greenhouse gas (GHG) emissions
  - Close carbon fuel cycle

- Nuclear Nonproliferation
  - Secure and disposition surplus weapons materials
  - Recycle used nuclear fuel without separating Pu
Vision for SRS

*Putting SRS to Work for America on the Path to Fusion*

- **2010-2050**
  - Renewable fuels
  - Nuclear stepping stones to fusion
    - Small modular reactors
    - Light isotopes and hydrogen
    - Advanced fuel cycles
    - Recycle used nuclear fuel

- **Beyond 2050**
  - National Fusion Energy Park
  - Host site for 1st generation of fusion and fission-fusion hybrid technologies
Convert Vision to Reality

Intersecting SRS capabilities with pressing national needs while maintaining long-term focus on fusion

- Large, nuclear-trained workforce
- Safety culture
- 310 square miles of highly-characterized, federally-controlled property
- Geographic location
- Nuclear materials processing
- Hydrogen
- Supportive community
- Complex project/program integration

2010
Closed Nuclear Fuel Cycle
High temperature

2050
Fusion

2010
Closed Carbon Fuel Cycle
Biofuels and Synfuels

2050
Hybrid Energy Systems

- Biomass
- Hydrogen
- Geographic location
- Support community
- Complex project/program integration
Build the Energy Park

Bridging the Technology Gap to Fusion

• **Approach**
  – Leverage EM and NNSA missions and assets

• **Span**
  – Implement Energy Park Projects

• **Destination**
  – Evolve into the Fusion Energy Park

EM | Environmental Management
---|---
safety + performance + cleanup + closure

2010
- ENHANCED NNP MISSION
- WORKFORCE OF THE FUTURE
- ENHANCED TRITIUM MISSION

2050
REduced CARbon FOOTPRINT
SRS Energy Park Concepts

Progressively complex fusion energy building blocks

- **Near-Term, 2010 to 2025**
  - BioEnergy Integration Center—transportation fuels from algae and biomass
  - Modular Reactor Demonstration Complex
  - Modular Reactor Power Park

- **Mid-Term, 2026-2050**
  - U.S. Energy Freedom Center™
    - Hybrid energy systems
    - Closed and integrated nuclear and carbon fuel cycles

- **Long-Term, Beyond 2050**
  - National Fusion Energy Park
    - Fusion and fission-fusion hybrid reactors
SRS Energy Park Master Plan

Staying on the path to fusion energy

- BioEnergy Integration Center
  - Algae Photosynthesis
  - Cellulolysis
  - Pyrolysis

- Small Modular Reactors
  - Modular Reactor Demo Complex
  - Modular Reactor Power Park

- U.S. Energy Freedom Center™

- National Fusion Energy Park

2010  2020  2030  2040  2050
BioEnergy Integration Center

_Greening the renewal of SRS_

Features
- Flexible feedstock biorefinery
  - Algae, biomass, solid waste recycling residue
- Located near landfill and cogeneration plant
- ~$200 million in new construction

Benefits
- Integrates with Three Rivers landfill and Ameresco biomass cogeneration plant
- ~500,000 tons/yr reduction in carbon footprint
- ~5 million gal/yr “drop-in” green transportation fuels
- Diversification of site missions
- Hundreds of high-paying and enduring green economy jobs
- Improves economics of recycling
- Reduces landfilling
Algae Biofuels Production

Taking the first SRS step to carbon-neutral fuels and electricity
Modular Reactor Demo Complex

Ensuring American workers benefit from the global nuclear renaissance

- **Features**
  - Small modular reactor (SMR) test bed
    - One test bed, shared utilities and support systems/services
    - Each <300 MWe
    - Wide range of designs
    - Some burn used light water reactor (LWR) fuel and surplus Pu and highly enriched uranium (HEU)
    - ~$500 million investment required

- **Benefits**
  - Accelerated NRC licensing
    - Deployed at SRS in parallel with licensing process
    - Cuts 10 years out of development cycle
  - Shared overheads, reduced costs
  - American leadership of SMR technology
  - Green electricity, process heat, and medical isotopes
  - JOBS, JOBS, JOBS

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**Small Packages**

True to the old saying about small packages, SMRs offer flexibility that traditional LWR operations simply cannot equal.

**Standard LWR Footprint**

**SMR Footprint**

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A number of competing designs could be prototyped at SRS in the SMR Demonstration Complex.

<table>
<thead>
<tr>
<th>Design</th>
<th>Power Capacity</th>
<th>Fuel Type</th>
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<tbody>
<tr>
<td>PRISM</td>
<td>300 MWe</td>
<td>Liquid metal cooled</td>
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<tr>
<td>mPower</td>
<td>125 MWe</td>
<td>Pressurized water reactor</td>
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<tr>
<td>NuScale</td>
<td>45 MWe</td>
<td>Pressurized water reactor</td>
</tr>
<tr>
<td>Energy Multiplier Module (EM2)</td>
<td>240 MWe, helium gas cooled</td>
<td></td>
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<tr>
<td>Hyperion Power Generation, Inc.</td>
<td>25 MWe, Pb-Bi cooled</td>
<td></td>
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<tr>
<td>Pebble Bed Modular Reactor</td>
<td>Eskom (South Africa) and Toshiba-Westinghouse</td>
<td>80 MWe, helium gas cooled</td>
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<tr>
<td>Traveling Wave TerraPower, LLC</td>
<td>300 MWe, liquid-metal cooled</td>
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<tr>
<td>IRIS</td>
<td>350 MWe</td>
<td>Pressurized water reactor</td>
</tr>
<tr>
<td>4S</td>
<td>10-50 MWe</td>
<td>Liquid metal cooled</td>
</tr>
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Modular Reactor Power Park

Collaborating with DOD on green security

At SRS
- Pit Disassembly (K-Area, in design)
- MOX Plant (F-Area, under construction)
- Fuel fabrication / recycle center (New)
- Small modular reactor (New)
- Clean electricity and steam to NNSA operations (New)
- Tritium and medical isotopes (New)

Off-Site
- Electricity to smart, secure mini-grids at Fort Gordon and other nearby military installations (New)
- Disposition path for used commercial fuel in South Carolina (New)
U.S. Energy Freedom Center™
Prototyping hybrid clean energy systems at SRS

Closed Nuclear Fuel Cycle
- Advanced Reactor(s) (new)
  - HTGR or modular reactor(s)
- Fuel Recycling Facility (new)
- Pit Disassembly and Conversion (in design)
- MOX Plant (under construction)

Closed Carbon Fuel Cycle
- Carbon-Neutral Fuel Manufacturing (new)
- Algae, biomass, recycled CO₂, coal feedstocks

Water and Hydrogen Facilities
- Desalination Plant (new)
- Water Splitter (new)

Medical Isotopes
- Mo-99 and others (new)
U.S. Energy Freedom Center™
Creating a national model for hybrid energy parks

At SRS
- Nuclear fuel fabrication and recycling facilities
  - Expanded on modular basis to support nationwide network of reactors

At Each DOE Site
- Next Generation Nuclear Plant or SMR Demo Complex
- Water Purification Plant
- Hydrogen Production Plant
- Carbon-Neutral Fuel Production Plant
Benefits to America

Transformational Energy and Climate Technology

- Carbon-neutral electricity, "plug-in" fuels, and hydrogen from surplus weapons and used nuclear fuel
- Pathway to independence from foreign oil
- Revitalization of the American manufacturing sector
- Renaissance of science and mathematics education
- Sustainable clean energy jobs
Benefits to the Region


- Keeps SRS on the path to fusion
- Makes SRNL the clean energy integration laboratory
- Potential for up to 25,000 sustainable, high-paying jobs
- Increases clean water supplies for regional growth
- Expands potential for light element and medical isotope missions at SRS
- Reutilizes EM assets following Recovery Act footprint reduction
- Delivers the new missions and state of the art facilities needed to attract workforce of the future
Implementation Plan

- Forge an industry-DOE-NNSA-DOD-community partnership
- Develop a compelling business case
- Induce an “Apollo-like” Presidential challenge
  - Align with the President’s agenda for nuclear nonproliferation, energy, and climate change
  - Acquire local and regional buy-in
  - Expand to a broad national coalition of support
    - Public, elected officials, industry, labor, environmentalists
- Secure “seed” funding
- Plan and launch with resolve
  - Realize big vision through a series of small implementing projects
    - First Project--Hyperion Power Module
SRNS Expectations

- Continue role as incubator of concepts and facilitator of implementation
- Acquire buy-in from DOE/NNSA and the "community" to a common energy park vision within 6 months
- Transition leadership and ownership of the Energy Park Initiative to the "community" within 12 months
- Put the "shovel in the ground" for the first implementing project(s) within 18 months
  - Modular Reactor Demonstration Complex
  - BioEnergy Integration Center
“I am convinced that whoever builds a clean energy economy, whoever is at the forefront of that, is going to own the 21st Century economy.

I’m convinced America can win the race.

Let’s get it done.”

President Barack Obama
February 3, 2010
Perhaps he meant to say...

Let’s get it done right...

— Using DOE/NNSA assets
— Starting at SRS
— Engaging the Community and Region
Back-Up Slides
Hyperion Power Module

- 25 MWe, Pb-Bi metal cooled fast reactor
- Factory-built
- Capable of burning downblended HEU from surplus weapons
  - Another great fit for SRS
- Ideal design for military bases and other government complexes
- MOU executed between Hyperion and SRNL earlier this month
General Electric PRISM

- 300 MWe sodium cooled fast reactor
- Factory-built reactor vessel
- Burns surplus Pu and recycled LWR fuel
  - Fits SRS core competencies
  - Potential alternative to Yucca Mountain
- Significant prior DOE investment in technology
  - *America’s Fast Reactor*
- Included in SRNS’ original proposal to DOE in 2007 as alternative for EM Pu disposition
- MOU being developed
General Atomics EM2

- 240 MWe gas-cooled fast reactor
- Factory-built, transportable
- Capable of burning surplus Pu and HEU as start-up fuel
  - Great fit for SRS
- Burns used LWR fuel without conventional reprocessing
  - Potential alternative to Yucca Mountain
- Significant new mission for SRNL and other SRS facilities
- General Atomics and SRNL talking
TerraPower Traveling Wave

- 300 MWe, liquid metal cooled fast reactor
- Capable of burning surplus Pu and HEU as start-up fuel
  - Another great fit for SRS
- Burns used LWR fuel without conventional reprocessing
  - Potential alternative to Yucca Mountain
- Financially supported by Bill Gates
- TerraPower and SRNL talking