JISEA Joint Institute for Strategic Energy Analysis

Summary of the August Workshop to Identify Potential Synergies between Nuclear and Renewable Energy Opportunities

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Workshop Report at:

http://www.nrel.gov/docs/fy12osti/52256.pdf

Summary Presentation Outline

- Purpose and mission of the initiative
- Workshop summary
- Path forward

Initiative's Purpose / Mission

The objective of the workshop was to assemble experts in nuclear energy and renewable energy to

Identify and prioritize potential synergies between nuclear energy and renewable energy / energy efficiency

Identify potential leveraging opportunities

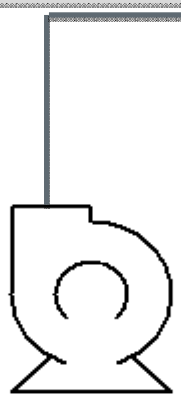
Why?

Meeting the U.S.'s energy needs will be challenging especially if carbon emissions are constrained or domestic and / or non-traditional sources for transportation energy become more important. Synergies may lead to additional and better options.

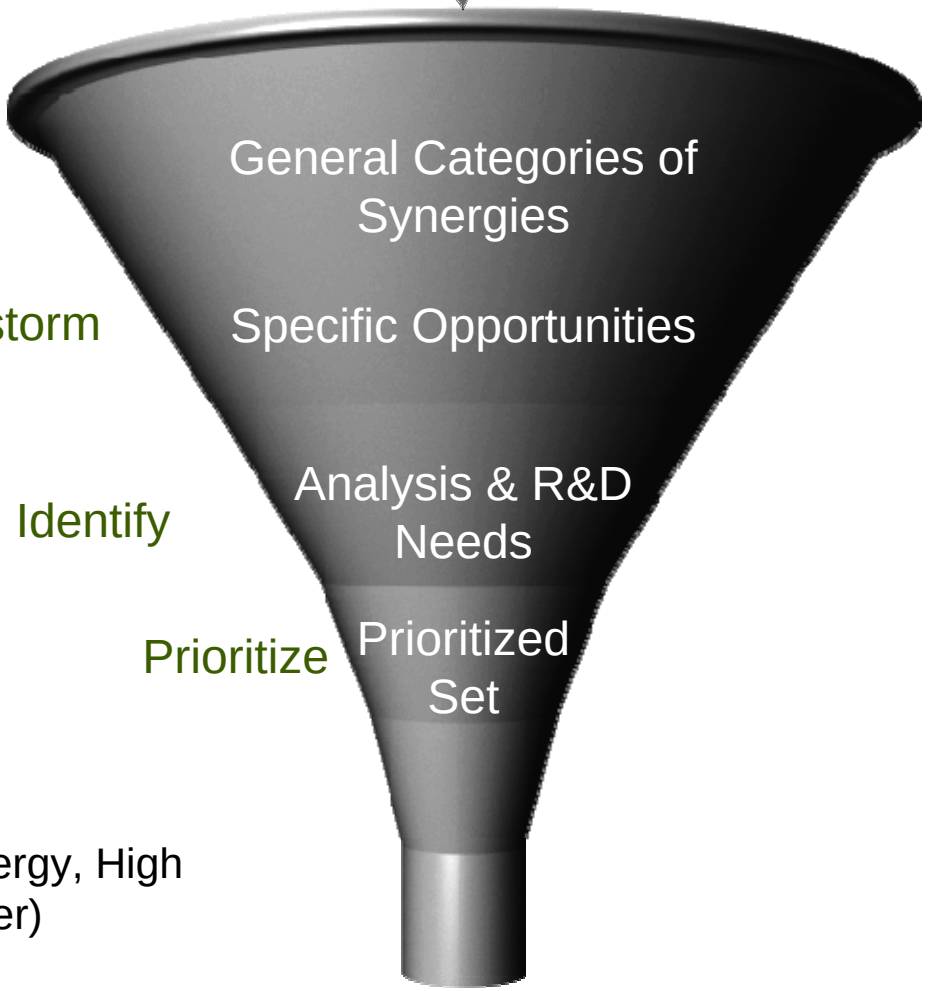
Advantages/Challenges of Each Technology

	Nuclear	Renewable
Advantages	• Low GHG emissions • Energy security – fuel needs can be met in the U.S. • Proven, commercial technologies with ~20% market share and many potential improvements • Baseload power supply with very low fuel cost • High power density – small footprint	• Technologies gaining market share • Low to zero feedstock price volatility • Many of the technologies have the potential for distributed generation
Challenges	• Spent nuclear fuel • Concerns regarding potential accidents • High up-front capital requires high capacity factors & makes financing challenging • Long-lead times • Many designs have large water reqs.	• Intermittent and variable production leads to integration challenges • Reductions to levelized costs are needed for some technologies • Siting is limited for some technologies leading to transmission challenges • Land area requirements can be challenging to meet

Workshop Structure



Pump primed with specific idea presentations



32 Attendees:
-18 from National Labs
-3 from DOE
-1 from NRC
-2 from White Sands Missile Range
-1 from academia (MIT)
-7 from industry (AREVA, CH2M Hill, Duke Energy, High Bridge Associates, Lifeboat Energy, TerraPower)

Leveraged Needs

Workshop report to be public by December 9, 2011

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Workshop Presentations (1)

- U.S. Nuclear Power Policies and R&D Programs
  - Pete Lyons – Assistant Secretary for Nuclear Energy at DOE
- Nuclear/Wind/Hydrogen Systems for Variable Electricity and Hydrogen Production Synergies
  - Charles Forsberg – MIT
- Potential Role of Thermal Energy Storage
  - Paul Denholm – NREL
- Southeast Defense Energy Initiative
  - Ben Cross for Mike Navetta – SRNL

Workshop Presentations (2)

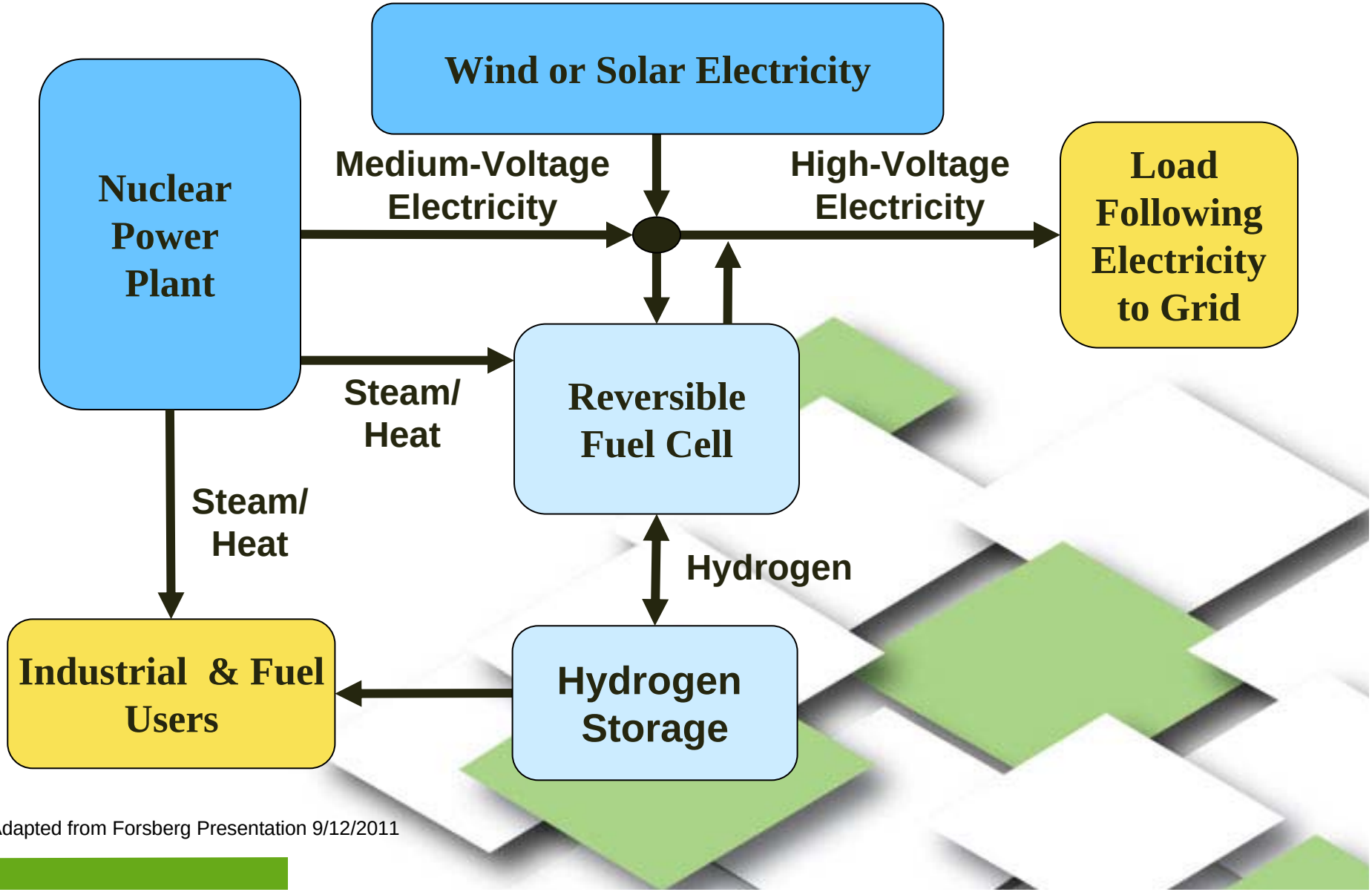
- Small Reactors for Energy Supply: Islanded Generation and Load Management
  - Philip Moor – High Bridge Associates
- Grid Scale Hybrid Energy Systems: Integrating Renewable and Nuclear Power
  - Richard Boardman – INL
- Non-Technical Considerations for Small Modular Reactors
  - Phillip Bond – White Sands Missile Range
- Small Modular Reactors – NRC Readiness for Licensing Reviews
  - David Matthews - NRC

Identified & Prioritized Opportunities

- Hybrid energy systems
- Energy for transportation
- Value Proposition/Business case development

- Example from Hybrid Team
  - Balancing capacity on the grid / grid optimization
  - Islandable Micro-grids with Small Modular Reactors (SMRs) and renewable energy
  - Nuclear energy source for industrial applications
  - Lessons-learned
  - Permitting / licensing / financing / risk
  - Policy and institutional opportunities
  - Common R&D needs

Example Nuclear-Renewable Hybrid System



Adapted from Forsberg Presentation 9/12/2011

Hybrid Energy Systems

Potential	• Basis of a sound national energy policy with improved sustainability and energy security and without reducing quality of life. • Increase domestic energy production, which improves energy security and balance of trade ratios.
Challenges	• Stovepipes between regulatory agencies for nuclear and renewable energies • Financing and risk assessment • Management.
Priority Analysis Needs	• Requirements definition • System design • Engineering components (effects of different generation services, intermediate carriers, storage systems, and tradeoffs with storage/service options)
Priority R&D Opportunities	• Integrated, dynamic models • Pilot integration especially with disparate technologies • Enabling technologies such as energy storage, reactor design, energy conversion components, and interface components.

Energy for Transportation

Potential	• Might improve cost competiveness of biofuels and transform their potential from boutique fuels to viable alternatives to oil. • Converting to a biofuels-based transportations system would contribute to several national policy goals
Challenges	• Same as hybrid systems • Developing economic options for combining heat/power/hydrogen from nuclear facilities for generating fuels • Overcoming benefits of sunken capital in existing fuel infrastructure • Developing technologies to increase the density of biomass for transportation • Addressing concerns about nuclear safety
Priority Analysis Needs	• Top-level systems analysis that includes what ifs, econometrics, customer input • Cost analyses for scenarios • Scale balancing and optimization.
Priority R&D Opportunities	• Processes where all of the biomass is converted to biofuel instead of a large portion used for heat, electricity, and hydrogen • Processes that provide low cost hydrogen with a focus on nuclear processes • Energy crops with high energy-to-land densities

Value Proposition Development

Potential	• Expansive markets and huge potential
Challenges	• Bold vision and strong leadership • Involvement of multiple stakeholder points of view • Technical difficulty • Engaging all stakeholders • High risk / Quantification of risk
Analysis and R&D needs	• Systems Analysis (Techno-economic, policy) • Quantification of the risks of the current energy system • Identification of the barriers to entry with the increasing complexity of integrated systems • Gap analyses looking at the build-out from current to the future state • Computational Tool Development • Energy management studies • Market acceptance studies

Conclusions & Path Forward

- High level of interest in the potential for synergies between nuclear, coal, and renewable hybrid systems
- A 2nd workshop with INL in March 2012.
- Continue the Dialogue & Further input for a roadmap that identifies:
  - Multiple options for hybrid systems
  - Tool, simulation, and modeling
  - Necessary assessments (risk, demand variability, etc.)
  - Gaps for R&D focus
  - Regional, national, and international opportunities and organizational needs
- Workshop Report at: http://www.nrel.gov/docs/fy12osti/52256.pdf