Rethinking the traditional “feedforward” design flow path for energy systems
Technology Development in Power

Most of the Risk Lies Here

Concept
Lab Testing
Numerical Models
Opportunity Identified
Pilot Plant
Feasibility Study

Project Development
Financial Closing
Detailed Engineering
Start of Construction
Power Plant
Need for a Pilot Plant

1. Conduct Initial Assessments
   a. Engineering
   b. Environmental
   c. Economic
   d. Legal

2. Technical Assessment

3. Conceptual Costs and Schedule

4. Summarize Results

5. Management Direction

1. Fuel Type/Availability
2. Technical Risk
3. Controls Development
4. Uprate Capability
5. Time to Construct
6. Emissions
7. Reliability, Availability, Maintainability
8. Footprint
9. Delivery Schedule
10. Delivery Logistics
11. Cycling Capability
12. Fuel Flexibility
13. Equipment Costs
Technology Development Resources
Technology Development Valley of Death

Highest Risk in Technology Development

Concept → Models → Pilot → Commercial

Number of Projects

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<th>Stage of Development</th>
<th>System Modeling</th>
<th>Dynamic Models</th>
<th>Neural Net</th>
<th>HILS</th>
<th>CPS</th>
<th>Full Pilot Scale</th>
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U.S. DEPARTMENT OF ENERGY
Technology Development Pathways

- Concept & Lab Testing
- Numeric Models
- Pilot Plant
- Power Plant

Cyber-Physical System

Material and Geometry

Iteration
Technology Development Capital Costs

Siemens Westinghouse pilot demonstration
220kW SOFC/GT Hybrid

Cost: ~$10 M

NETL cyber-physical system
400kW SOFC/GT Hybrid

Cost: ~$1 M
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Thank You
David Tucker, Ph.D.
U.S. Department of Energy
National Energy Technology Laboratory
Morgantown, WV 26507-0880
Sydni.Credle@netl.doe.gov