Moving Federal R & D into the Marketplace: Creating Industrial Partnerships for a Biofuels Demonstration Plant

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Abstract

- The U.S. Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL) are supporting the scale-up of an enzymatic hydrolysis-based process for converting biomass to fuels, chemicals, and valuable co-products
- One or more private firms will design, construct, and operate a large-scale demonstration plant, with government co-funding and supporting applied research to help offset the risks inherent in process scale-up, changing markets, & custom equipment

- DOE & NREL are building a collaborative partnership program w/ prominent chemical firms, food processors, ethanol producers to create a successful industry involvement program
  - Reducing risks in key process steps
  - Lowering costs of key inputs (I.e., enzymes)
- Industry rather than DOE will determine feedstocks, plant size, & demo plant location
- DOE will structure technology scale-up program based on input from interested firms
- DOE is currently soliciting letters of interest and suggestions from firms that would like to participate in technology scale-up process

Background

- The Department of Energy's Office of Fuels Development (DOE/OFD) has been supporting research at NREL to cost-effectively convert biomass, including agricultural residues, to transportation fuels (i.e., bioethanol) and high-value co-products
- Current plans are to scale up an enzyme hydrolysis based process to a demonstration facility with industry partners

- Three factors are key to determining the cost of ethanol produced from biomass
  - Cost of delivered feedstock
  - Cost of enzymes used to make cellulose accessible to conversion to sugars
  - Capital cost of processing facilities
- Key to market success will be the reduction of the cost of bioethanol to that of competitive fuels and increase the value of co-products (sugars, lignin-based products, etc.)

The Industrial Partnership Premise

- Government & national labs are skilled at defining national goals and conducted targeted basic research. Goals include:
  - 3-5 billion gallons/year of transportation fuels from domestic biomass residues
  - Improving biomass pretreatment to get high yields of C5 sugars & good cellulose digestibility
  - Finding micro-organisms to efficiently ferment C5 & C6 sugars in various biomass feedstocks

- Industrial firms are skilled at
  - Rapid cost reductions for key inputs
  - Rapid increases in process efficiency and/or feedstock throughput
  - Locating low-cost or no-cost feedstocks
  - Finding or creating inexpensive process equipment
  - Co-locating new processes with existing plants to share resources, reduce initial capital costs, & reduce operating costs

Recent Developments & Near-term Plans

- Major contracts awarded to Novozymes Biotech and Genencor International to reduce costs of cellulase enzymes by 10X by 2004
- Meetings held (November 2001) with potential industrial partners to discuss research progress, forms of cooperation, etc.
- External industrial reviewers determined (Jan. 2002) that the NREL Enzyme Sugar Platform was ready to move forward with a focus on core technologies & system integration

- NREL FY2002-2003 research focused on optimizing feedstock pretreatment, strain selection and adaptation, & process modeling
- FY 2003 -- 1 or 2 industrial teams will be selected to design plant, pick feedstock, find location
- In FY 2004-2005, NREL with industrial partners will complete integrated process development (including new low-cost enzymes) and optimization for the industry-selected feedstock and location

The Role of Industrial Partners

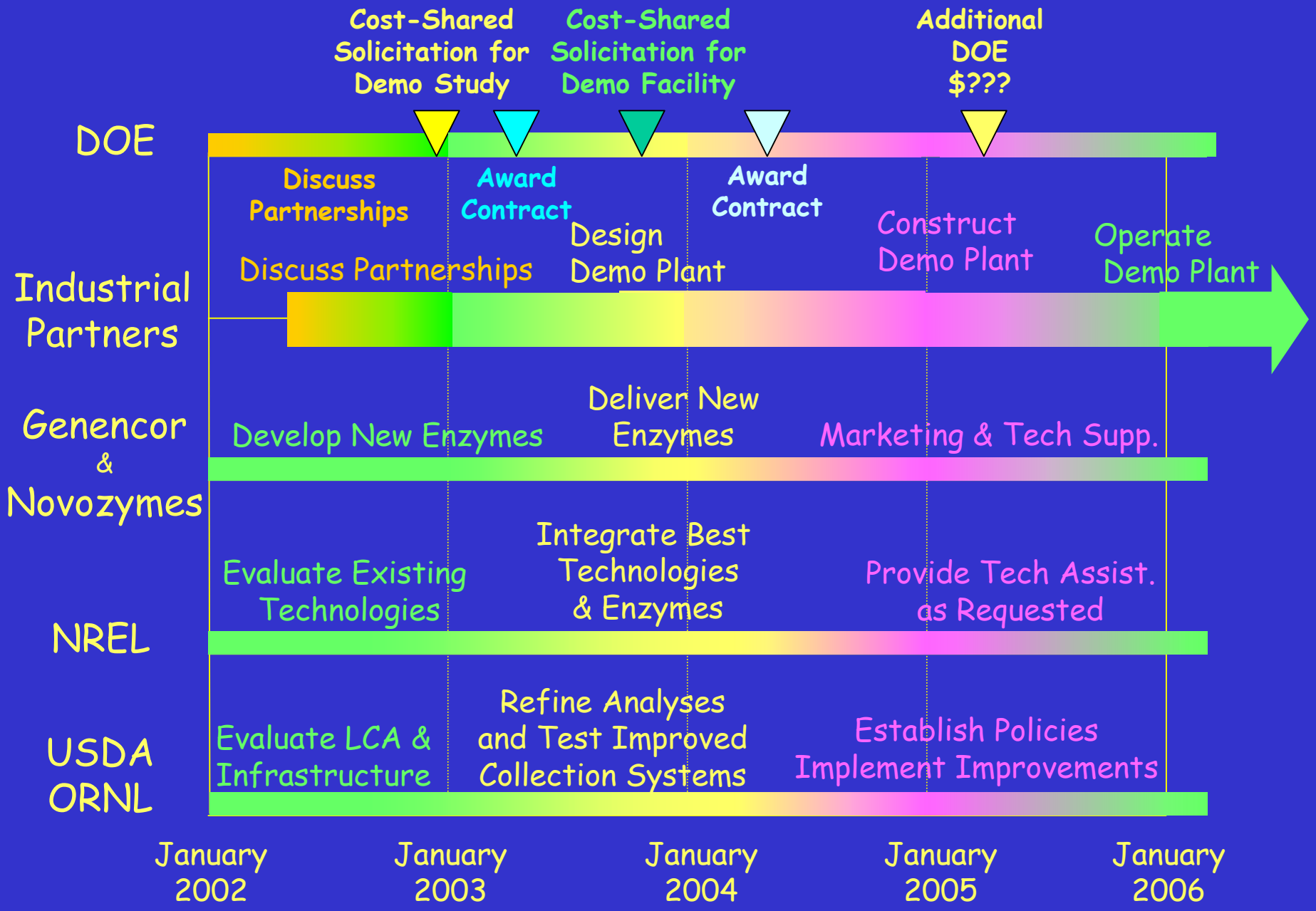
- Stage 3A -- Initial Process Development
  - Develop new low-cost cellulases
  - Advise on pre-treatment approaches
  - Assist with process integration studies
  - Advise on co-location options
  - Advise on preferred scale and co-products for demonstration plant
- Stage 3B Final Process Development
  - Select feedstock and output product slate
  - Conceptual and detailed design for cost-shared demonstration plant

- Stage 4 -- Testing & Validation
  - Determine site for demonstration facility
  - Construct & operate demonstration facility
  - Improve demo facility process flows & equipment to increase profitability
  - Develop additional co-products & markets
- Stage 5 – Commercial Launch
  - Enlist commercial partners and line up plant construction financing
  - Design and construct first commercial plants
  - Operate commercial-scale plant(s)
  - Continue to modify initial designs to increase efficiency, throughput and profitability

The Implementation Schedule

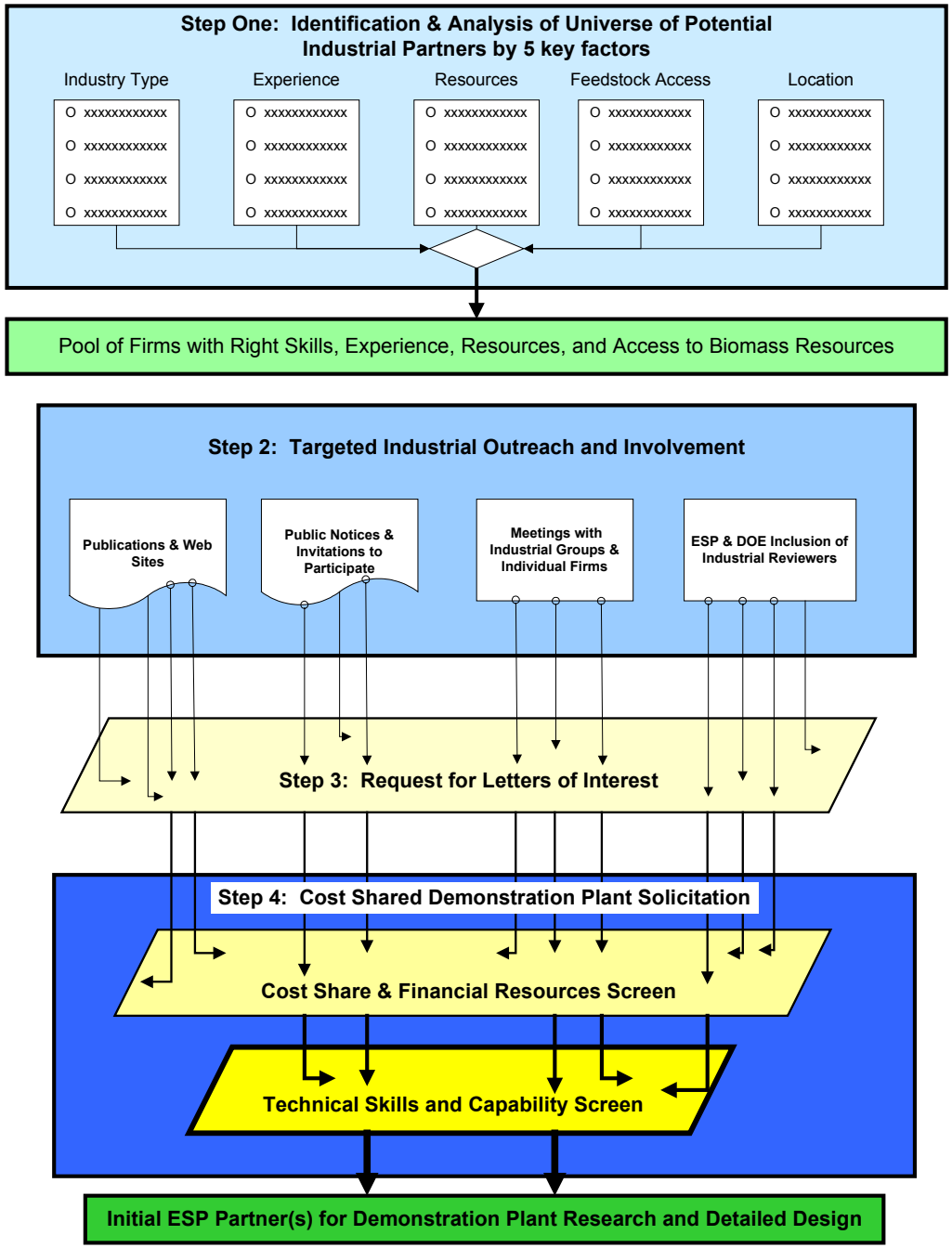
- DOE plans to invite cost-shared industrial participation in the demonstration plant study, including design, in late FY 2002, with a contract award in mid FY 2003
- The detailed plant design would form the basis for a cost-shared solicitation for the demo plant construction in early FY 2004, with plant operation to begin in late FY 2005 or early FY 2006

Major Timeline Elements by Participant



Next Steps for Building the ES Industrial Partnerships

- Finding attributes of ideal partners
- Publicizing program to additional firms active in food processing, ethanol, chemicals and biotechnology arenas
- Studying co-location options and potential cost-savings
- Alerting state & local rural development agencies about need for sites close to low-cost agricultural feedstocks
- Beginning outreach program for petroleum and specialty chemical industries


Step One: Identification & Analysis of Universe of Potential Industrial Partners by 5 key factors
Industry Type
Experience
Resources
Feedstock Access
Location
O xxxxxxxxxxxx
Pool of Firms with Right Skills, Experience, Resources, and Access to Biomass Resources
Step 2: Targeted Industrial Outreach and Involvement
Publications & Web Sites
Public Notices & Invitations to Participate
Meetings with Industrial Groups & Individual Firms
ESP & DOE Inclusion of Industrial Reviewers
Step 3: Request for Letters of Interest
Step 4: Cost Shared Demonstration Plant Solicitation
Cost Share & Financial Resources Screen
Technical Skills and Capability Screen
Initial ESP Partner(s) for Demonstration Plant Research and Detailed Design

DOE Solicitation for Letters of Interest from Potential Partners

- DOE is currently seeking early feedback and guidance from potential industrial partners on the plans for an enzymatic hydrolysis demonstration plant
- Industry input sought on key issues
  - Required scale to reduce commercialization risk
  - Feedstock
  - Slate of end products
  - Government cost-share required

- DOE Golden Field office has requested letters of interest in demo plant from interested firms or groups of firms
- Request posted on DOE/Golden web site: http://www.golden.doe.gov/business%20opportunities/solicitations.html
- Industry responses due by May 1, 2002

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