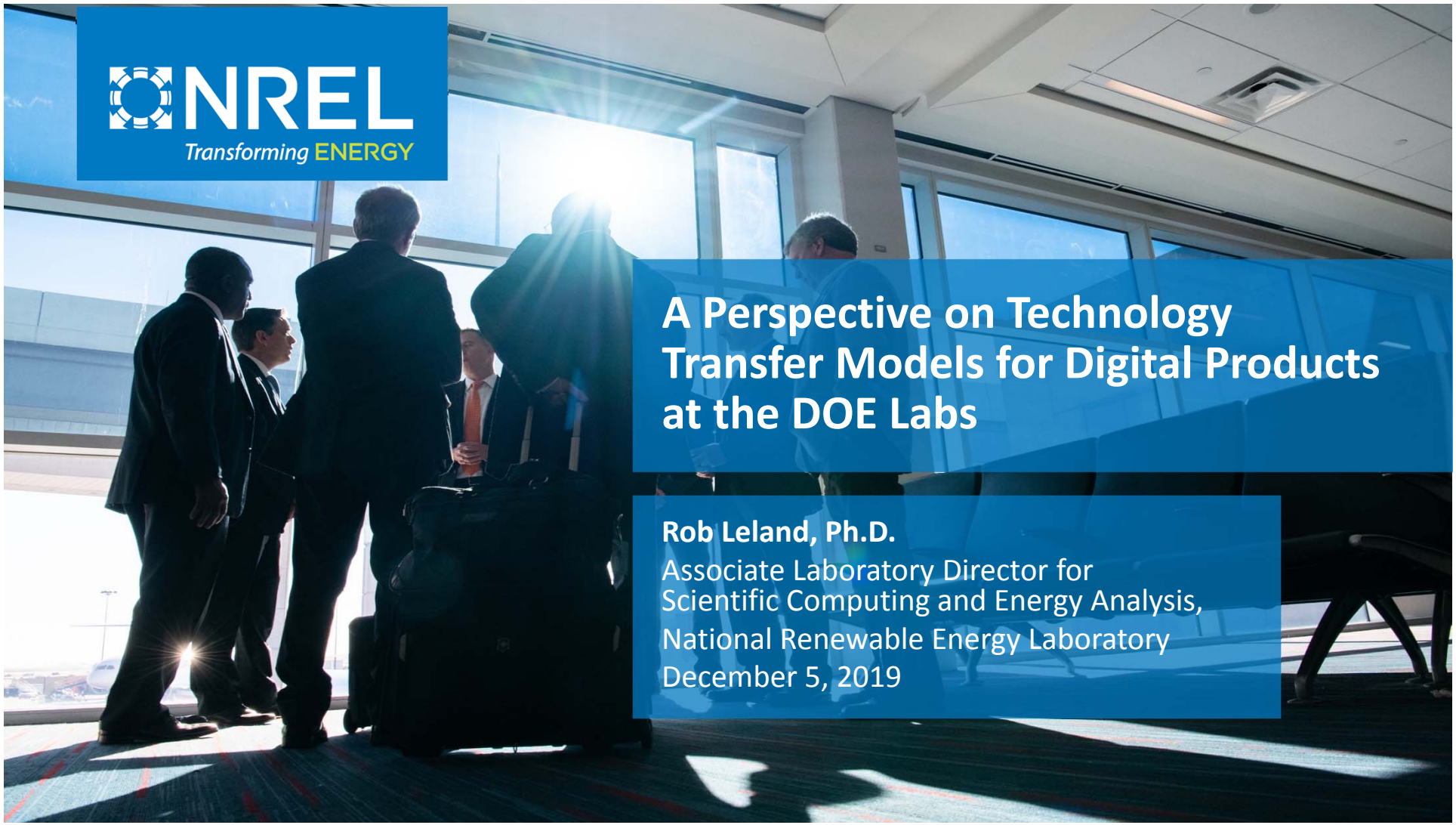

A Perspective on Technology Transfer Models for Digital Products at the DOE Labs

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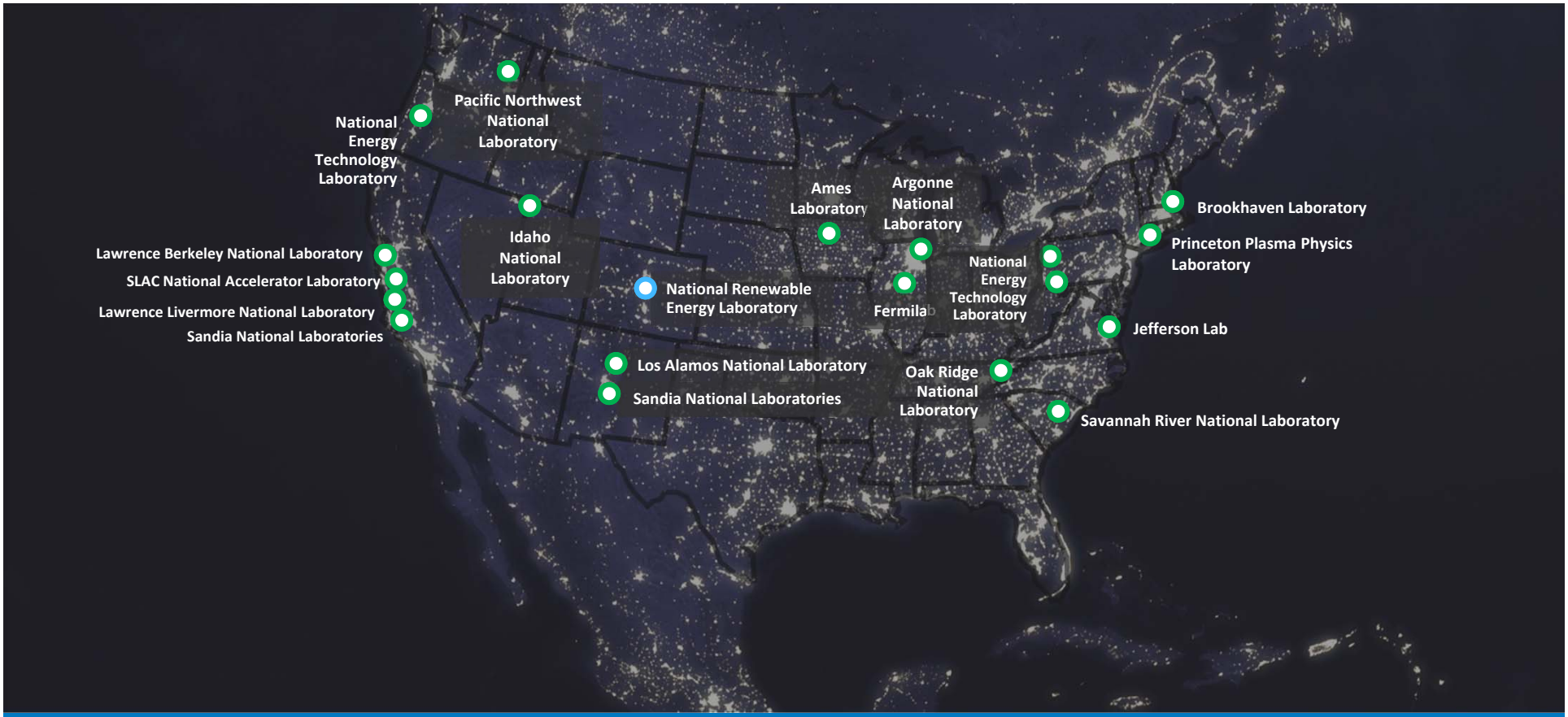
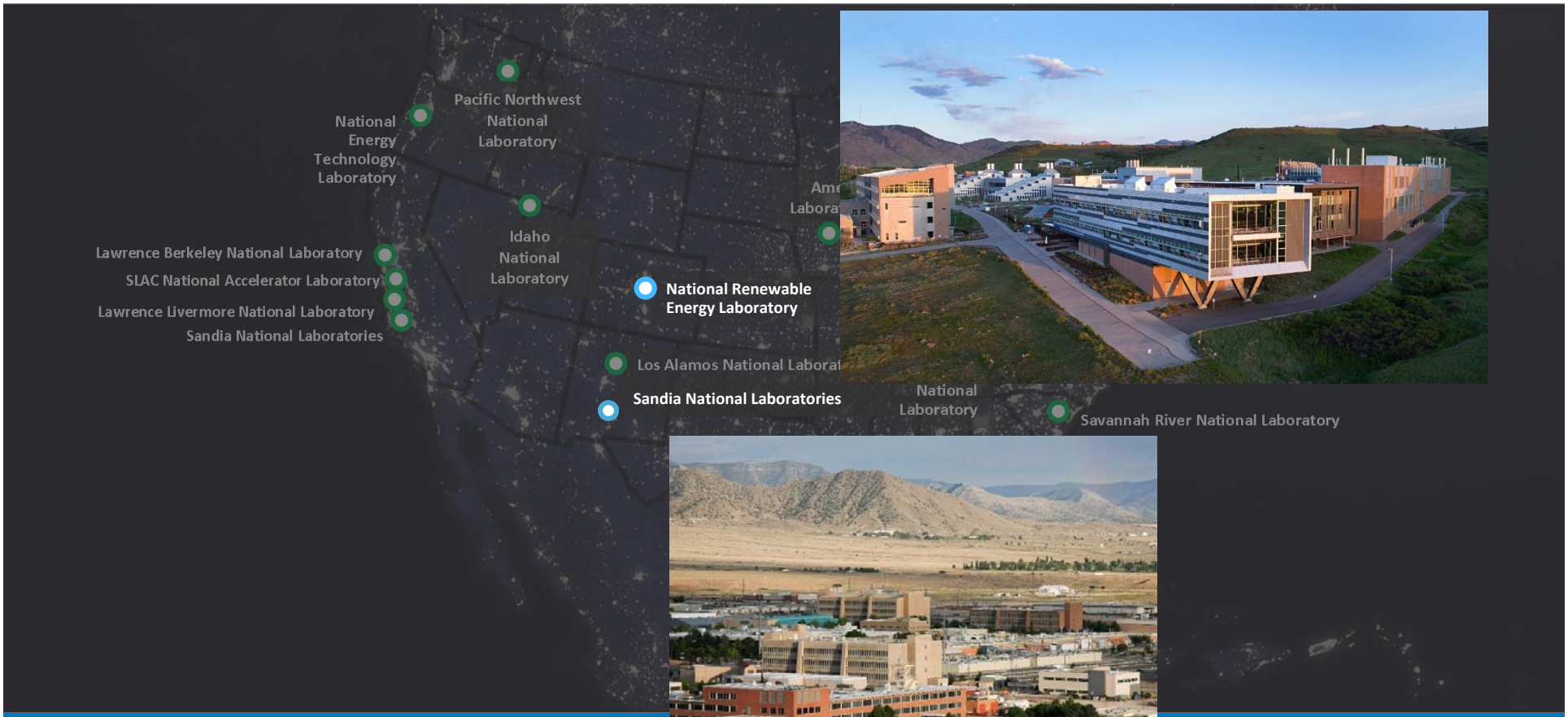
Scientific Computing and Energy Analysis,
National Renewable Energy Laboratory
December 5, 2019



Coast to coast

The **17** National Laboratories have served as leading institutions for scientific innovation in the United States for more than 70 years.



Closer to home

Disclaimer: I am not speaking on behalf of Sandia but rather am relating my past personal experience.

17 National Labs

Mission

Labs are mission driven—national security, science, and applied energy

80

DOE National Laboratory scientists have won 80 Nobel Prizes in the sciences

Partnerships

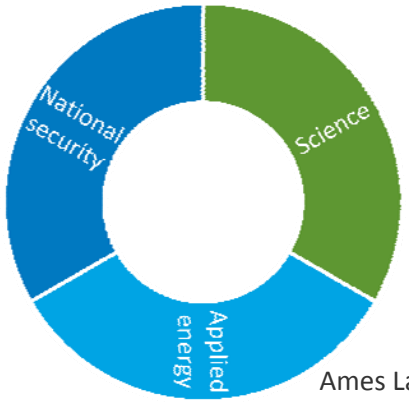
3,051 Partnership agreements

Inventions, Patents and Licenses

Most prolific federal agency

The National Labs have different mission foci

Lawrence Livermore National Laboratory
Los Alamos National Laboratory
Sandia National Laboratory
Savannah River National Laboratory



Argonne National Laboratory
Brookhaven National Laboratory
Fermi National Accelerator Laboratory
Lawrence Berkeley National Laboratory
Oak Ridge National Laboratory
Pacific Northwest National Laboratory
Princeton Plasma Physics Laboratory
SLAC National Accelerator Laboratory
Thomas Jefferson National Accelerator Facility

Ames Laboratory
Idaho National Laboratory
National Energy Technology Laboratory
National Renewable Energy Laboratory

National labs help bring innovations to market

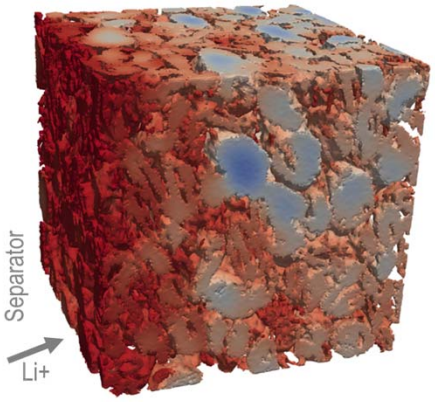
- Bridge the gap from **basic research to commercial application**
- **Forward-thinking innovation** to **benefit the U.S. economy**
- **Accelerated time to market** delivers advantages to American business and consumers
- **Labs generally sit between industry and academia**
  - Time scale
  - Risk tolerance

Some lab tech-transfer models for digital products

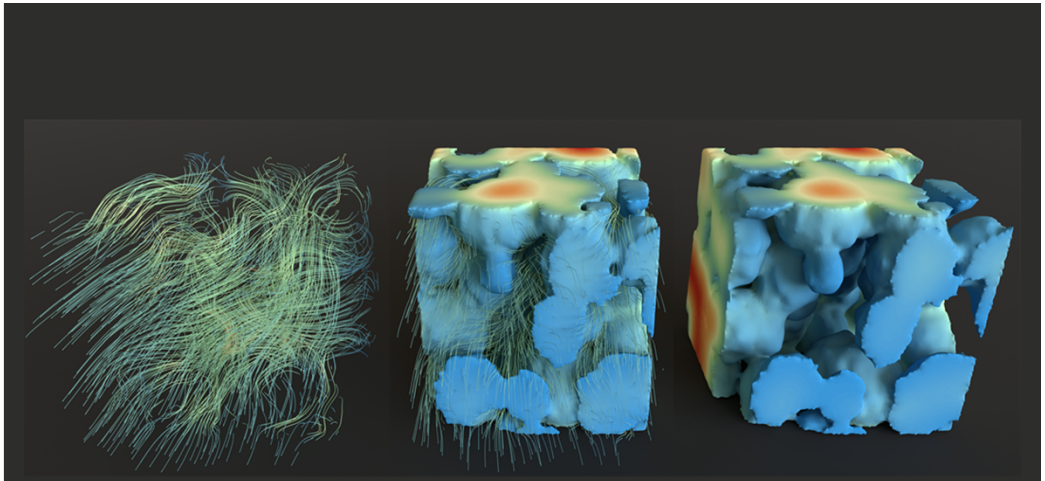
- **License**
  - A license is required to use or modify the code
- **Government Use Agreement**
  - Other labs and federally funded agencies may use for government purposes
  - Code is shared for use but not distribution
- **Software Partnership / CRADA**
  - Partners collaborate on software development
- **Open Access**
  - Digital tools/software are released as free to use
  - Anyone can use but not manipulate the code
- **Open Source**
  - Full source code is released
  - Developers can freely access and change
  - Generally requires some government support until user community is established

CAEBAT: Computer-Aided Engineering for Electric-Drive Vehicle Batteries

Simulation of battery electrode under extreme fast charging conditions



3D microscale electrochemical simulation during 6C charge of graphite electrode. Color is scaled with intercalation fraction.



3D microscale electrochemical simulation during 1C charge of NMC electrode. Solid surface is intercalation fraction, vector field is the lithium-ion flux in the electrolyte.

License

Best for:

- Limited application source code
- Use in proprietary applications

NREL example:

- Battery Model Design (CAEBAT project)

Government Use Agreement

Best for:

- Projects in which code is not yet ready for open-source release
- Use in targeted deployment approach (e.g. closed-source licensing)
- Used with code that isn't well known or widely recognized yet

NREL example:

- NREL works collaboratively with numerous labs under Government Use Agreements

Software Partnership

Best for:

- Collaboration on specific software development
- Eventual licensing

NREL example:

- Customization of WISDEM models to accommodate a wind farm's operating parameters
  - Models to assess wind plant cost of energy (COE)

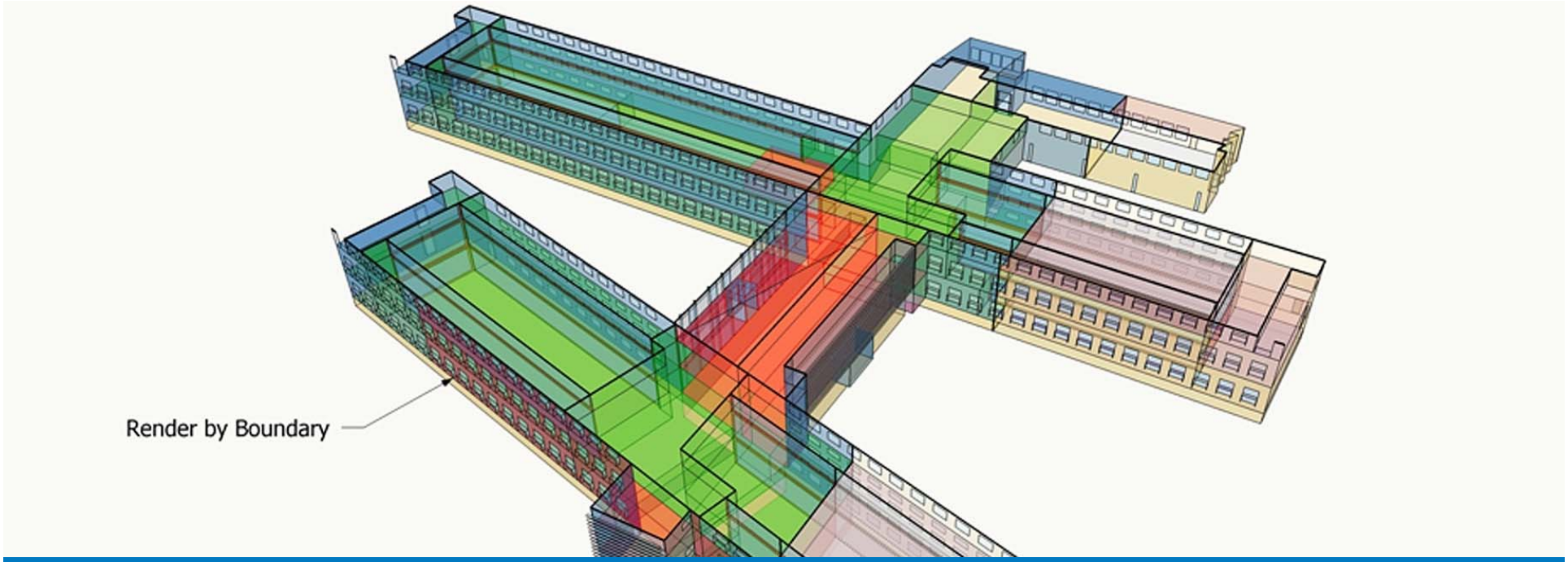
Open Access

Best when:

- Funding available to support internally
- Front end has industry-wide application
- Highly visible and actionable

NREL example:

- CatCost
  - Estimate pre-commercial catalyst Manufacturing costs



Open Source

Best for:

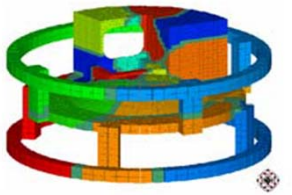
- Existing community of users
- Fostering collaborative iteration

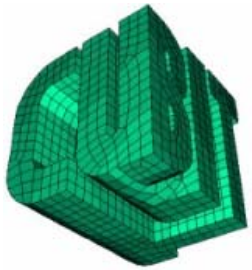
NREL example:

- OpenStudio
  - Building energy modeling and analysis

Examples from my past

- License
  - Chaco
  - CUBIT
- CRADA
  - Goodyear
  - Catamount
- Open Source
  - Cplant
  - Trilinos





Sandia National Laboratories

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Computational Plant

TRILINOS

Agreement for Commercializing Technology (ACT)

- NREL uses ACT when a **partner seeks highly specialized or technical services** to complete a project
- ACT **authorizes DOE labs to partner with businesses using more flexible terms** that are aligned with industry practice

Flexible

More flexible contracting mechanism - All terms negotiable except IP

38 ACT agreements

Enabled unique IN2 program structure and flexible subcontracting

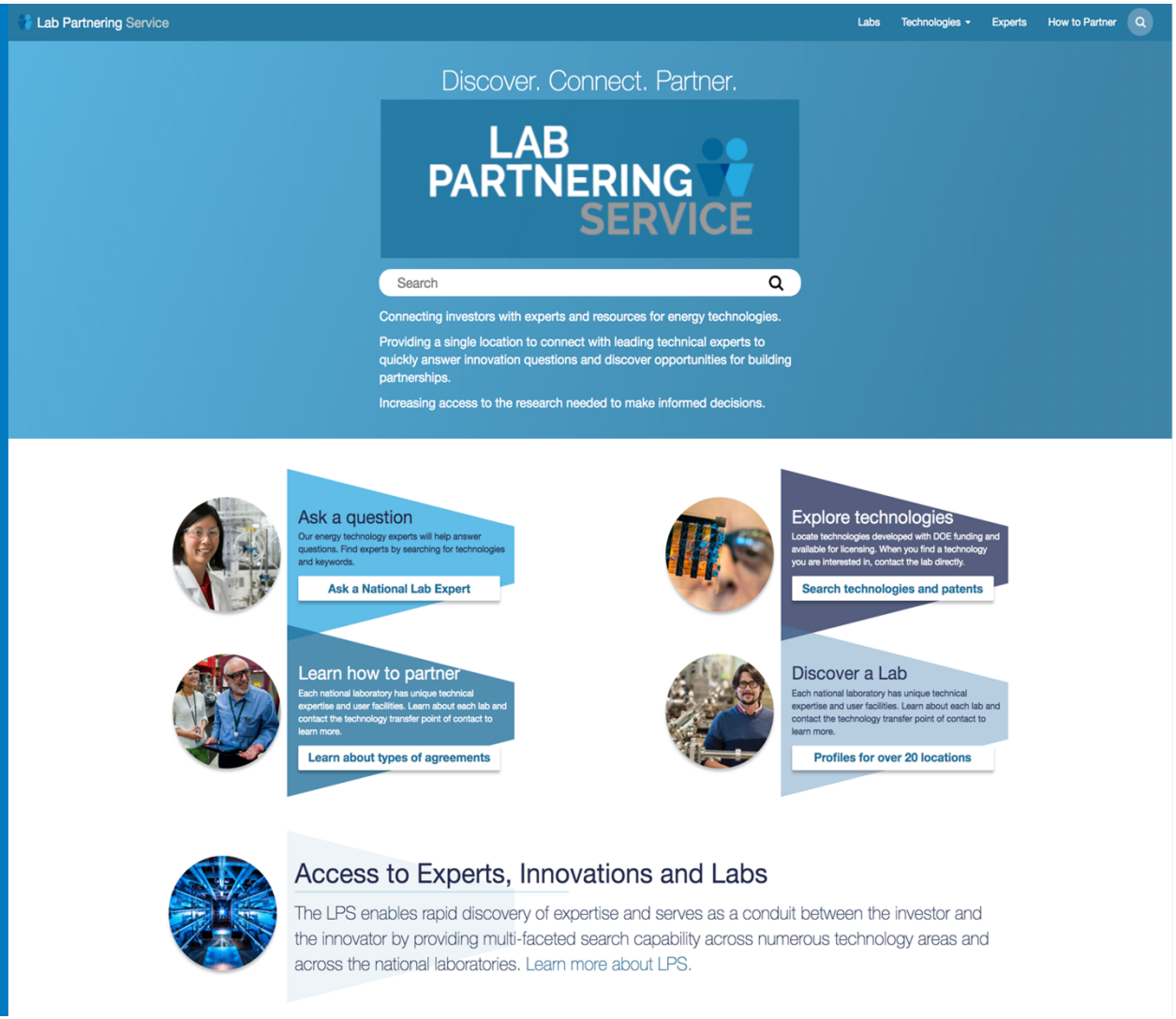
$85M

in value

DOE Lab Partnering Service Tool

- **Connecting investors with experts and resources** for energy technologies
- Providing a single location to **connect with leading technical experts** to
    - quickly **answer innovation questions** and
    - discover **opportunities for building partnerships**.
- Increasing **access to the research to make informed decisions**.

labpartnering.org



Observations

- **Variety of mechanisms exist to meet different needs**
- **General trend seems to be towards more open source/access**
  - Builds mindshare
  - Value garnered downstream
- **And this does not cover important situations**
- **A healthy ecosystem metaphor may be helpful**

Thank you

www.nrel.gov

Some examples of usage and users

- The System Advisor Model (**SAM**) is started once every 2 minutes
  - performance and financial model
  - estimates cost of energy for grid-connected power projects

- NREL's **PVWatts**® Calculator receives more than 2 million hits/month
  - estimates the energy production and cost of energy of grid-connected PV systems

Over 100,000 users in 190+ countries, including from Sunrun, Enphase, AEP, Southern Company, EPRI, & more

- 90+ webinars with > 100,000 views