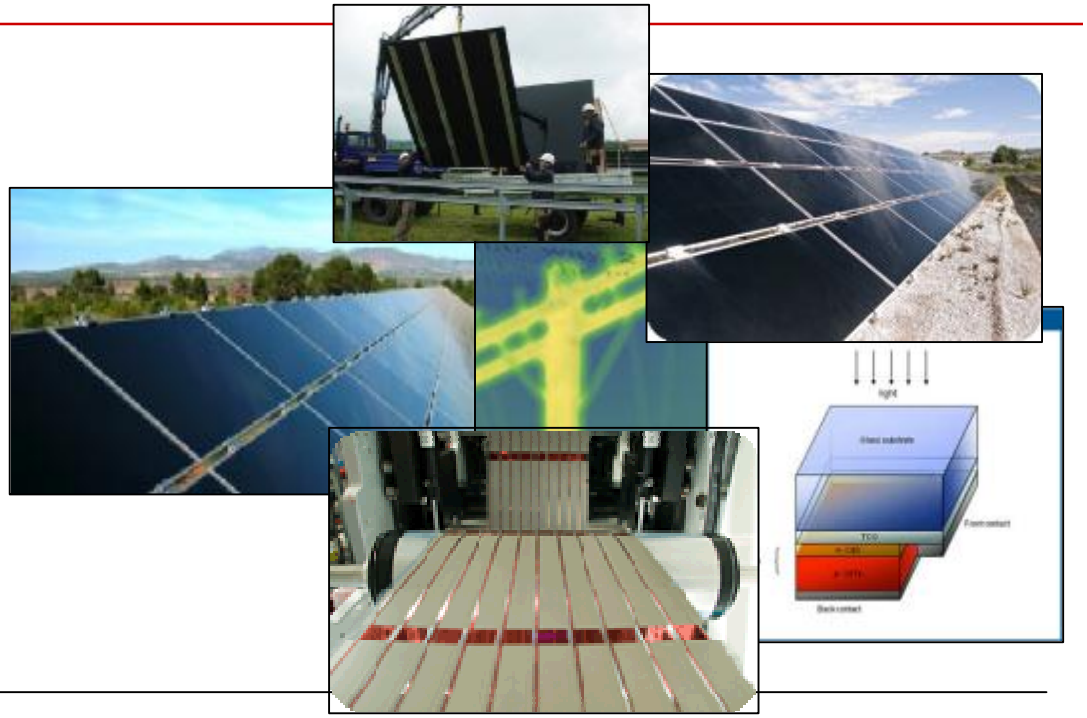
Industry-University Partnerships for Photovoltaics

Nolan Browne, Managing Director

Fraunhofer Center for Sustainable Energy Systems



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Agenda

- Introduction to Fraunhofer Center for Sustainable Energy Systems (CSE)
- The Need for Industry – University Collaboration in US PV
- Common Challenges to Direct Industry – University Collaboration
- Fraunhofer R&D Model in Germany
- Bringing it to the US: Fraunhofer Collaboration with MIT

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The Fraunhofer Gesellschaft

Globally:

- One of world's largest non-profit contract research organizations
- 15 000 employees, mostly scientists and engineers
- 58 research institutes at 40 locations in Germany
- Annual research budget of about US$2 billion
- 50% of the budget from research contracts for industry, 50% government funding

In the United States:

- Fraunhofer USA is an American 501(c)(3) non-profit company funded by US & German government and private sources
- $45M operating budget, 200 employees, 6 Centers
- ***New Fraunhofer Collaboration with MIT***
  Center for Sustainable Energy Systems (CSE) @ MIT

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What is the CSE?

Fraunhofer USA

Fraunhofer - MIT Alliance

Solar PV Module Group

- PV module innovation
- Focus on chemistry and micro-morphology of c-Si and thin film modules
- Manufacturing and certification support

Building Efficiency Group

- Energy efficient building envelopes in commercial and residential retrofit scenarios
- Building integrated systems with solar thermal, advanced heat pumps, and smart controls

Prototyping Unit: Rapid demonstration of new energy device technologies with strong applications focus

Incubation Unit: Support start-ups with technical and business expertise

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There Are Few Non-Profit Applied PV Research Centers…

- **Unrealistic expectations not met can hurt otherwise solid technology:**
  - Compact Florescent Lighting
  - Electric Cars
  - Various PV technologies
  - Some for-profit pressures force companies to cut necessary R&D in favor of profits
- **Misallocation of resources – commercial overinvestment; in PV, early stage technology is often pushed out before its time.**
- **This means:**
  - Promising technologies may be dropped as impractical
  - Capital is not efficiently allocated for scientific research
  - Fewer overall ideas can be funded

…Which Can Lead to Slow or Premature Commercialization.

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University Photovoltaics R&D is Artificially Limited…

- Many manufacturing processes and materials highly proprietary
- National security concerns create major obstacles to applied research in universities
- Relevant equipment is often single purpose and very expensive
- Equipment requires high degree of maintenance
- Most severe for compound semiconductors CIS and CdTe, but also major issue in downstream; modules, power electronic components and balance of systems.

Ø Universities are nearly excluded from all but the most basic PV R&D.

Ø This means:

- Industry is starting from low level of knowledge when starting product development
- Industry is challenged to find experienced talent from universities
- Artificially limited interaction between academic and industrial R&D
- PV R&D leverages only a small fraction of available scientific “firepower” in the US

…Unleashing It Should Yield Major Progress.

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Problem 1: Confidentiality Challenges

Confidentiality hard to maintain in a university

- Collaborative, non-profit mindset
- Lab access must be less secure that industry
- University mission requires publications
- Labs generally are shared across large user groups
- Hard to assign responsibility for disclosures

Security concerns restrict applied research at universities

- Technology transfer restrictions can apply to foreign students

Difficulty using US students on industry-confidential projects

- Students are generally not legally bound by confidentiality restrictions
- Tendency for students to need to share more information for educational purposes
- Students in a non-confidential university atmosphere are less aware of what can be discussed

Problem 2: Resource Mismatch

University often lacks required equipment

- Need for suitable equipment to do relevant applied manufacturing R&D
- Many universities lack the funding for appropriately modern equipment to address current applied challenges.

Fraunhofer's PV-Tec Line has the ideal scale to address industry's applied challenges

University-sponsored research is relatively inflexible

- Project lengths are determined by student thesis times
- New projects can only start after the student enters school
- Must be achievable as a thesis – must end after ~5yrs.
- Difficult to pursue short term projects
- Project must be worked around a thesis

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Problem 3: Mission Mismatch

Educational goals of university can be at odds with for-profits

- On-time project delivery may be less important than educational mandate
- Publication restrictions often not compatible with university restrictions
- Industry contracts not core university mission; more challenging to scope, define and sign contracts
- University tends to be more interested in fundamental issues vs. application issues

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Model Addresses Commercialization Challenges

Problem: **Slow transition** of innovative systems and supporting material technology from university R&D labs to production lines; industry faces **challenges working with universities**

Solution: **Bridge the gap** between basic research and the market by establishing an applied research lab with strong links to both universities and industry that will accelerate commercialization

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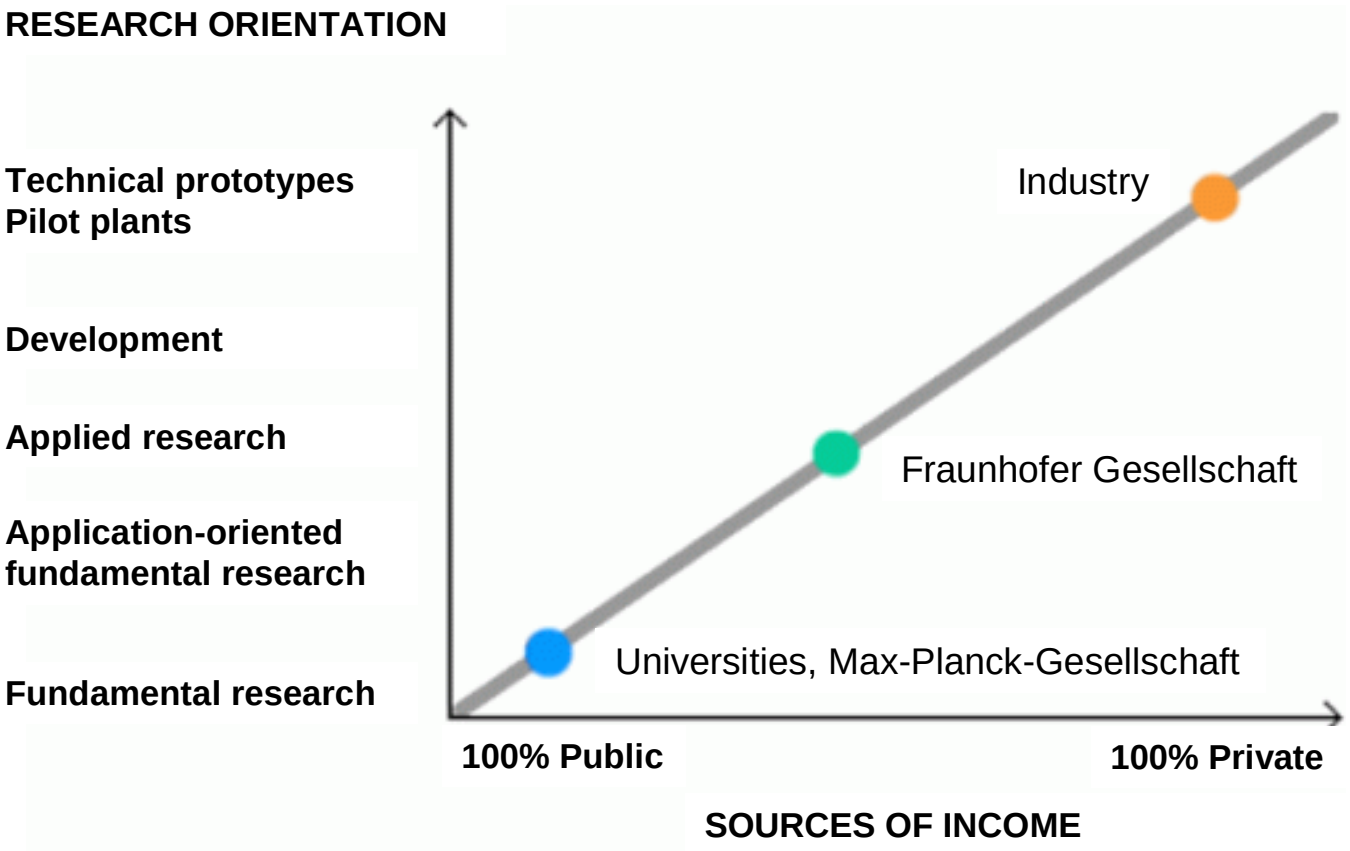
Fraunhofer's Place in the R&D Ecosystem



Fraunhofer is a performance-related funding model.

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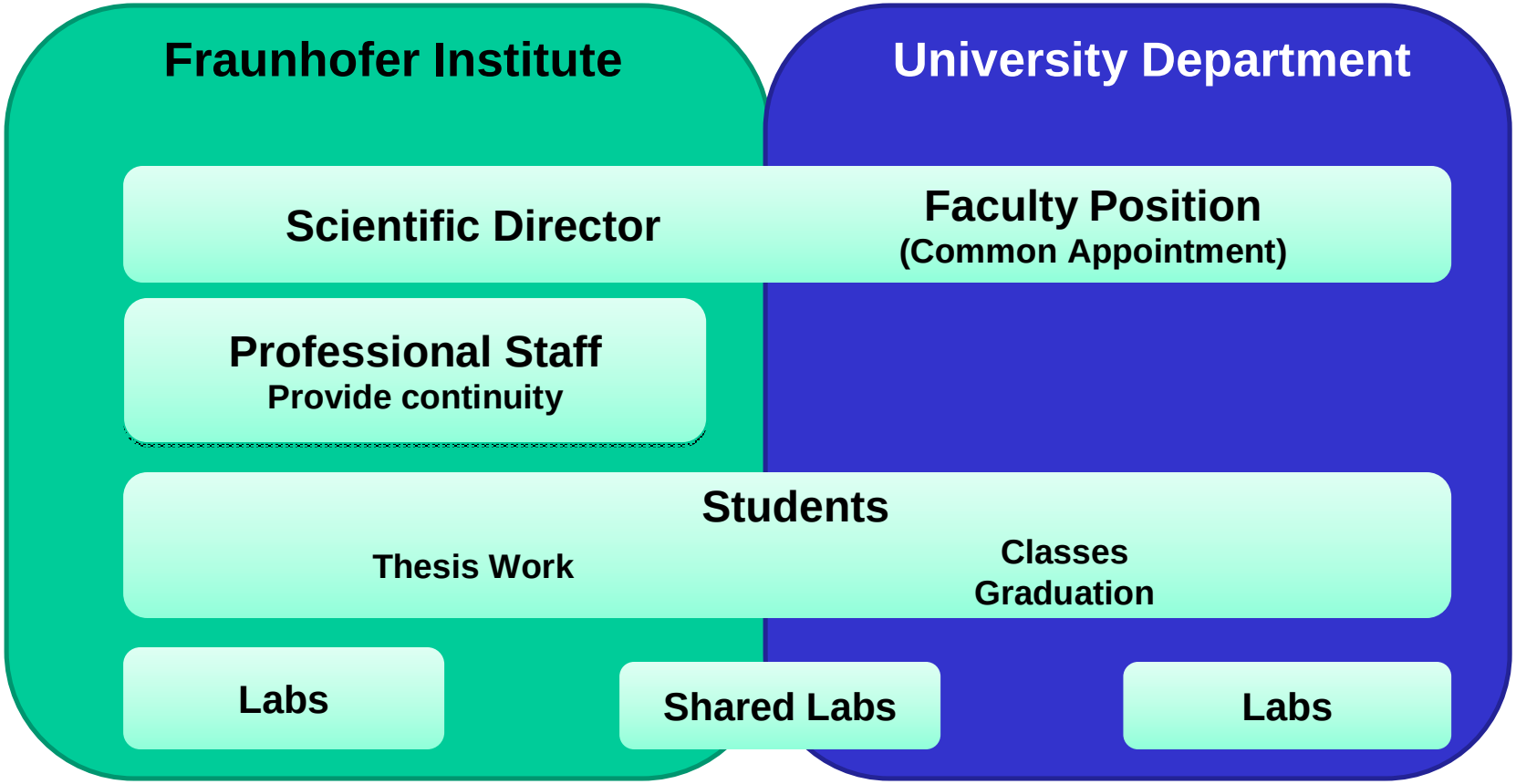
The Fraunhofer Model in Germany

- Fraunhofer Institute and university function independently
- But close cooperation due to shared faculty, students and labs



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MIT – Fraunhofer Framework Agreement

Addressing the Industry – University Challenges

MIT's President Hockfield and Fraunhofer Society's President Bullinger discuss CSE.

Addresses Resource Mismatch:

- Outlines how to identify and share R&D resources across MIT and Fraunhofer
- Establishes standard joint R&D template and responsibilities to reduce negotiation time

Addresses Confidentiality:

- Segments projects into non-confidential and confidential components
- Confidential projects reside within Fraunhofer (Fraunhofer employees / collaborations must be ITAR approved)

Addresses Mission Mismatch:

- Provides flexibility for industry while providing for the educational mandate

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Designing the University – Industry Interface

- Collaborative R&D labs with scale for applied research, ability to protect industrial confidentiality, and manage projects such that both academic and for-profit mandates are fulfilled

Non-Proprietary R&D

Universities e.g.

MIT

Proprietary R&D
Non - Proprietary Background R&D

Relevant Applied R&D for Manufacturing

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Proprietary R&D

PV Manufacturers & Equipment Suppliers

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Key Challenges to Adapting Fraunhofer Model to US

Tuition structures differ between Germany and US

- Need seed grant programs to compensate US universities and incentivize US professors

Developing university – intermediary relationships

- Need to raise more funding from US sources
- Model needs to be more widely promoted to US universities
- Successful first projects

Model needs adaptation to work with start-ups

- Fraunhofer's German model is optimized to serve big & medium-sized industry
- Need to minimize upfront contract setup time and costs to allow smaller project scopes

Fraunhofer ISE – Fraunhofer USA Teambuilding Exercise in Freiburg, Germany.

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Fraunhofer – MIT Seed Grant Program:
Addressing the Tuition Challenge

Provide professors an incentive to work with Fraunhofer lab

- Seed grant made available to professors to fund a graduate student
- These graduate students work in the Fraunhofer lab on collaborative projects
- Provides a foundation for ongoing collaboration between MIT and Fraunhofer

How Policymakers Can Help

- Government, foundation and industrial scholarships to pursue lab work within non-profit research centers will provide a tremendous boost to making the model more successful in the US

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CSE Governance Structure

Developing University Collaboration Model

- MIT Professor Tonio Buonassisi is the Scientific Director of the CSE
- Shapes the technical vision and PV research plan for the center
- Provides MIT input into center operations
- Allows MIT students to work on their MIT thesis work in the Fraunhofer lab

CSE's Leadership Team:
MIT Professor Tonio Buonassisi – Scientific Director
Freiburg Prof. Roland Schindler (on loan from ISE)
Nolan Browne – Managing Director

How Policymakers Can Help

- Encourage more universities to engage with intermediaries
- Promote "applied research" capabilities as desirable for winning government research grants

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Fraunhofer - MIT Incubation Center

Addressing the Start-up Challenge

Technical labs and applied focus ideal for start-up company support

- Ideal place for a PV incubator
- Provides physical start-up area for CSE start-up technical clients
- Provides easy access to Fraunhofer collaborators in common areas (break room, kitchen, lobby, gym)

Other start-up essentials provided:

- Legal - donated by major local legal companies
- Financing - Incubator can be attached to a multimillion dollar start-up fund
- Business Mentoring – Various area business start-up facilitators in the space
- HR – Ability to find required technical and non technical candidates more easily

How Policymakers Can Help

- Start-up grants help overcome high bar necessary to launch a new center or incubator
- Customize more SBIR / start-up grant programs towards working with incubator groups

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Summary

Direct interfaces between university and industry can be challenging

- Confidentiality
- Resource Mismatch
- Mission Mismatch

Intermediating institutions can unlock university resources to support industry and PV commercialization efforts

- Create smooth interface between university and industry
- Very successful models like Fraunhofer exist outside of the US
- Address confidentiality, scale and resource concerns

If US policymakers want to develop university – industry interface through intermediating institutions, they can:

- Help address “tuition” problem by targeting scholarships for thesis work at intermediaries
- Encourage universities to pursue partnerships with intermediating institutions through promotion and grant giving
- Invest more heavily in intermediating institution infrastructure; start-up funding for equipment, space, incubators etc.

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