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**Government funding and support for energy RD&D: what do we know about outcomes?**

Session 4: Regulation and innovation for smarter and cleaner energy markets & networks
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Overview

1. Motivation: government role in energy innovation
   - From how much to how?

2. Public energy R&D institutions in context
   - *US National Labs*
   - *Partnerships with cleantech startups and grants to SMEs*
   - *ARPA-E*

3. Key findings

4. Questions going forward
Government policy plays an important role
Calls for more funding for energy innovation since the mid-1990s

- Government R&D and its combination with other policies has played and continues to play a key role in energy
Budget approved by Congress last month ignored President Trump’s quest
- Different sides of the aisle could get behind different pieces of evidence advancing different goals

ASIDE: In spite of Trump’s proposals, US Congress is not going along with energy R&D cuts]
Work prioritizing R&D investments across technologies

Biggest returns on investments on storage and solar

Anadon, Baker, Bosetti (2017), Nature Energy;
For some time we have pointed out the need for more funding stability.

Anadon, Chan & Lee (2014), CUP

Chan, Bin-Nun, Goldstein, Anadon, Narayananmurti (2017) Nature
2. Public energy innovation institutions
Recent institutional innovation in energy R&D

Updated and adapted from Anadon (2012) in Research Policy & Chan et al. (2017) in Nature:
- $: provision of funds
- circles: direct private sector involvement in decision-making;
- house: creation of new entity during the funding;
- person: provision of expertise in the form of business or technical advice.
Growing evidence on the impact of different federal energy innovation institutions/policies in the US

Data is starting to become available to learn more about the impacts (short term) of different initiatives.

US National Labs

- Particularly timely in the UK since labs were mostly privatized in the 1980s and the Faraday Institution is trying to create a ‘virtual lab’

Lab- (as opposed to HQ-) controlled funds are more productive at the margin in tech transfer terms.

Lab directed funds have decreased twice recently but are the most productive. Increase laboratory directed funds (LDRD) at the margin, further facilitate private sector interaction, and new contracting approaches.

Anadon, Chan, Bin-Nun, Narayanamurti (2016), Nature Energy; See also Chan et al. (2017) Nature “Six guiding principles for energy innovation”
Increased demands for short term ‘results’ (less tolerance to uncertainty) can lead to a vicious circle.

- From interviews and data analysis we found that there is a vicious circle of congressional demands for short-term results, increased admin, less risk taking, less results, which leads to more demands for results...

Anadon, Chan, Bin-Nun, Narayanamurti (2016), Nature Energy
Alliances (joint development, licensing, procurement) between public institutions (e.g., labs) and cleantech startups

Recommendation from the (mainly qualitative) literature to date was (approximately): collaborate as much with as many diverse partners as possible or “Don’t Go At It Alone” Baum et al., (2000, p. 267)

But startups cannot collaborate with everyone: Who holds critical technological resources for cleantech innovation?
Patenting activity: increases with every additional governmental technology alliance when compared to those startups that did not engage in such alliances

- Different expertise, tacit knowledge, facilities, less risk of leakage

Private financing deals: increase for every additional license from a governmental agency (quality signals)

- Quality signals, information asymmetry, correlated with firm openness

Public procurement not associated with better startup outcomes

Doblinger, Surana and Anadon (2018)
DOE R&D grants to small businesses

Regression discontinuity design on U.S. DOE Small Business Innovation Research (SBIR) grant recipients (over 20 years, thousands of awards):

- Award doubles probability that a firm receives subsequent VC and has large, positive impacts on patenting and commercialization

Howell (2017) American Economic Review
Actively managed R&D funding organizations

- Basic Energy Sciences
- EFRCs
- Innovation Hubs
- Applied R&D programs; National Laboratories
- Industry grants & partnerships
- Loan Guarantee Program
- Standards, Tax credits, etc.

Level of risk vs. development stage:
- Basic Research
- Development
- Demonstration
- Commercialization
- Diffusion
Ongoing work on ARPA-E and licenses

Over 400 projects, across 39 states, with over $1 billion in funding

Over 20 focused programs and 3 open solicitations

Recipients:
- 32% led by small business
- 42% by universities
- 14% by large business
- 8% by FFRDCs
- 4% by non-profits

- ARPA-E awardees doing better than awardees and other firms on follow on funding (Goldstein, Doblinger, Anadon 2018, ongoing)

- Compared to other similar awards from DOE, ARPA-E has:
  - Excelled broadly in producing patents
  - Excelled in publications relative to EERE
  - Matched the output of publications from Office of Science (Goldstein & Narayanamurti, 2018, under review)

- Chan (2016) used matching on patents from national labs:
  - Licensing increases spillover benefits to firms (whether or not not-patenting would result in better outcomes is a longstanding question)
3. Key findings
Broad guiding principles from cross national experiences

1. Giving researchers and technical experts autonomy and influence over funding decisions (e.g., labs, ARPA-E)

2. Incorporating technology transfer in research organizations (labs, transfer, joint development, and researcher mobility)

3. Focusing demonstration projects on learning (decades of projects)

4. Incentivizing international collaboration

5. Adopting an adaptive learning strategy

6. [Keep funding stable and predictable]

Chan, Goldstein, Bin-Nun, Anadon, Narayananamurti (2017), Nature (Six principles for guiding energy innovation)
4. Questions going forward
Important questions going forward

- How to think through the balance
  - Portfolio across actors, technologies, and stage of development?
  - Insights from TIS?

- How to measure success beyond patents, licenses, papers, spinoffs, follow-on funding?
  - Incentives to report failures, changes in direction (ARPA-E has revised milestones)
  - GETTING DATA FROM PUBLIC ENTITIES

- What gaps exist in the landscape to attract different actors and other needed types of innovation?
  - Demonstration
    - How to incentivize partnering while sharing learning
  - Use of facilities for actors not yet at a company stage?
  - Attracting large firms?

- How to translate the U.S. insights to other countries with different funding and risk taking environments?
Thank you for your attention!

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