# An Impact Evaluation Framework for Public-Private Collaborations on Research, Manufacturing, Supply Chain and Early Markets

Presented at the
International Energy Program Evaluation Conference
Rome, Italy June 2012

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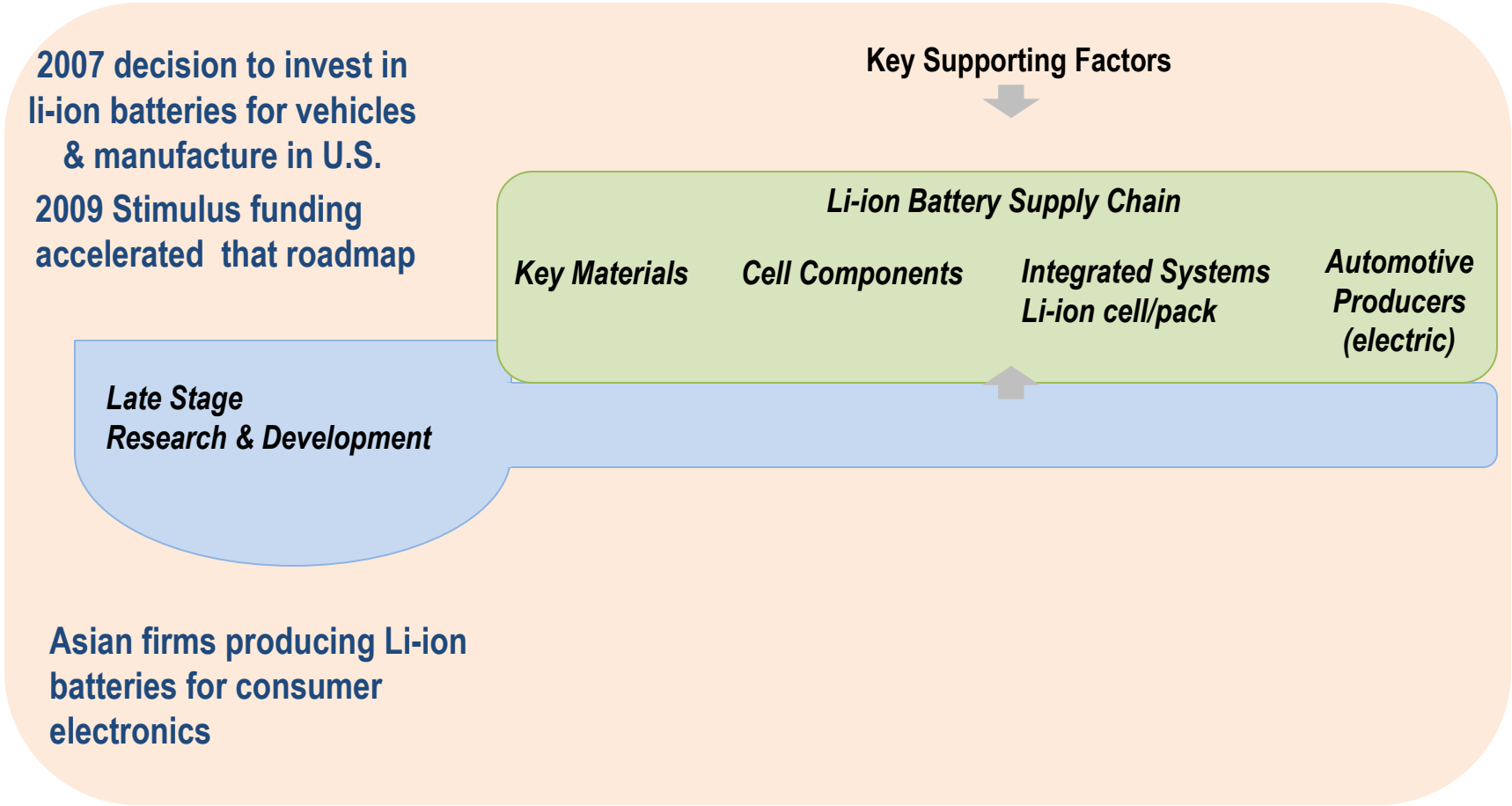
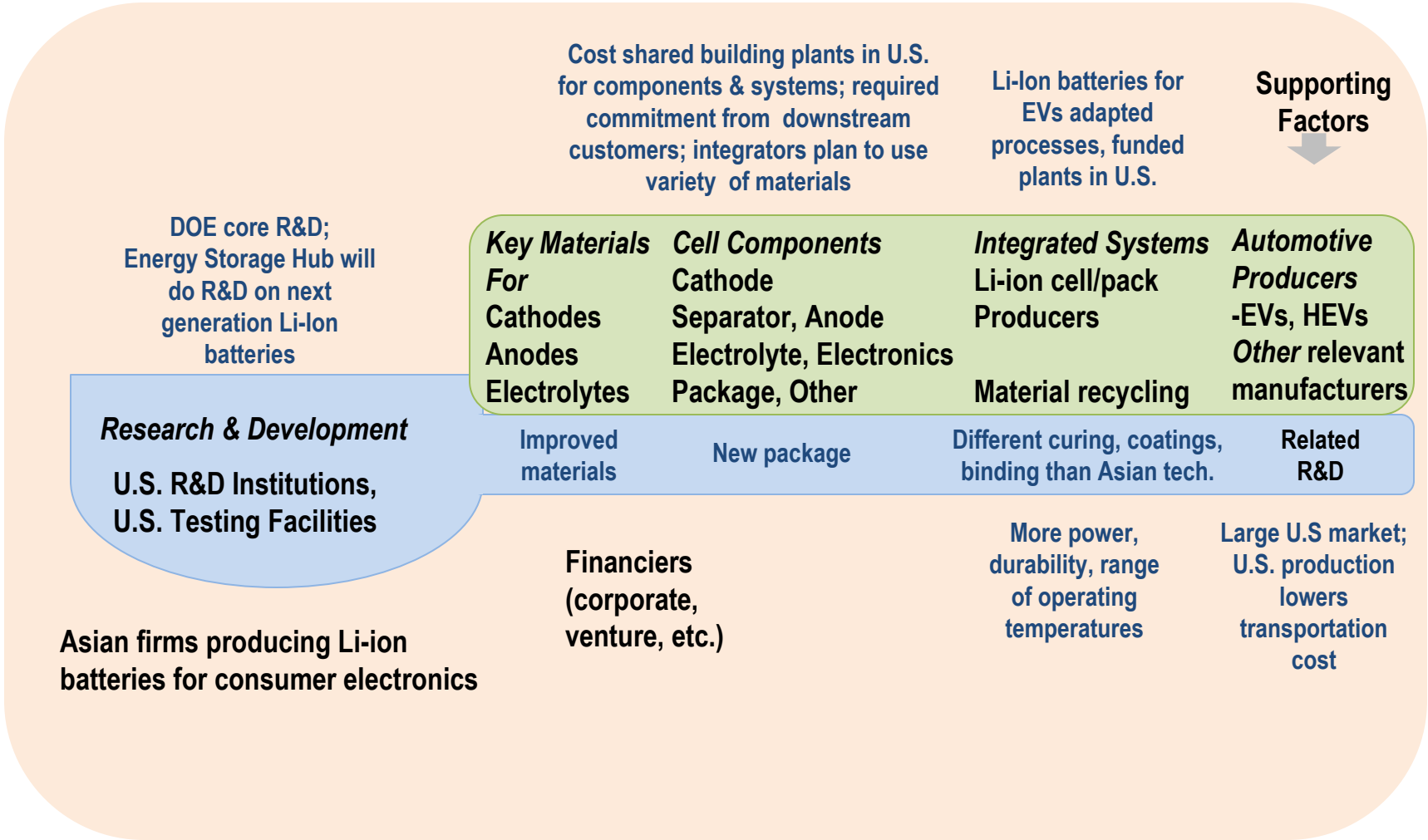
# Amid shifting global dynamics there is increasing U.S. government involvement in retaining key technology supply chains. For example, in li-ion batteries…



# U.S. Department of Energy actions are strengthening the U.S. supply chain for li-ion batteries for vehicles.



# How can these initiatives be evaluated?

Current practice is to rely on technical milestones, expert review, or large retrospective studies of impacts.

Congress wants evidence collaborative efforts are working in the near term (2-5 years) which requires looking at what happens early in a technology life cycle.

Questions our framework intends to answer:

- Are investments creating desirable changes
  - in network connectivity and approaches to R&D/supply chain
  - In accelerating commercialization
  - In capabilities of suppliers, manufacturers and distributors?
- What other early-stage impacts of investments have occurred (pre energy or environmental impacts)?
- Would these have occurred in this time frame without DOE action?
- What mid-course corrections, if any, are needed for improving the effectiveness of investments?

# Why develop a generic framework?

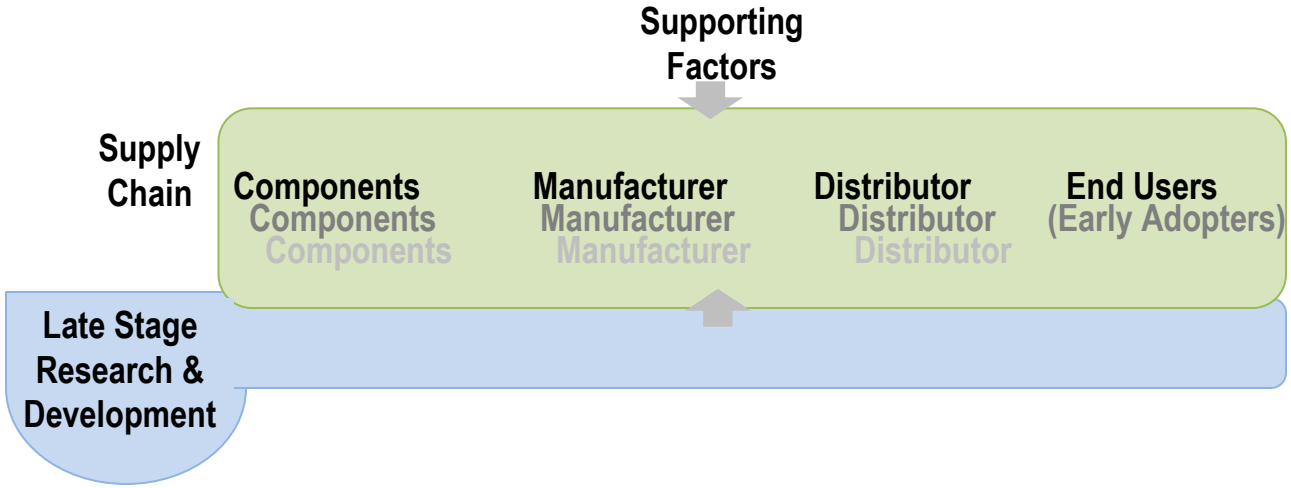
- Guide evaluation planning and implementation
- Lower the cost of evaluation planning
- Help ensure high quality evaluation
- Increase the consistency and therefore credibility of evaluation findings
- Allow synthesis across evaluations, and learning that goes beyond any one initiative.

# Overview of Approach

- Focus is on the early part of the technology/product life cycle: late stage technology development, manufacturing, early market
- Level of analysis is a specific technology and its application OR a type of intervention such as manufacturing R&D
- Draws on accumulated findings in supply chain, network analysis, technology innovation
- Rests on a theory of change for targeted interventions in a supply chain (a system) in context of the larger innovation system
- Suggests evaluation design and methods
  - the basic process and impact questions to be answered
  - indicators of progress and good practices
  - specific questions that may be supported by a particular data collection method
- Provides advice on how to communicate findings to diverse audiences.

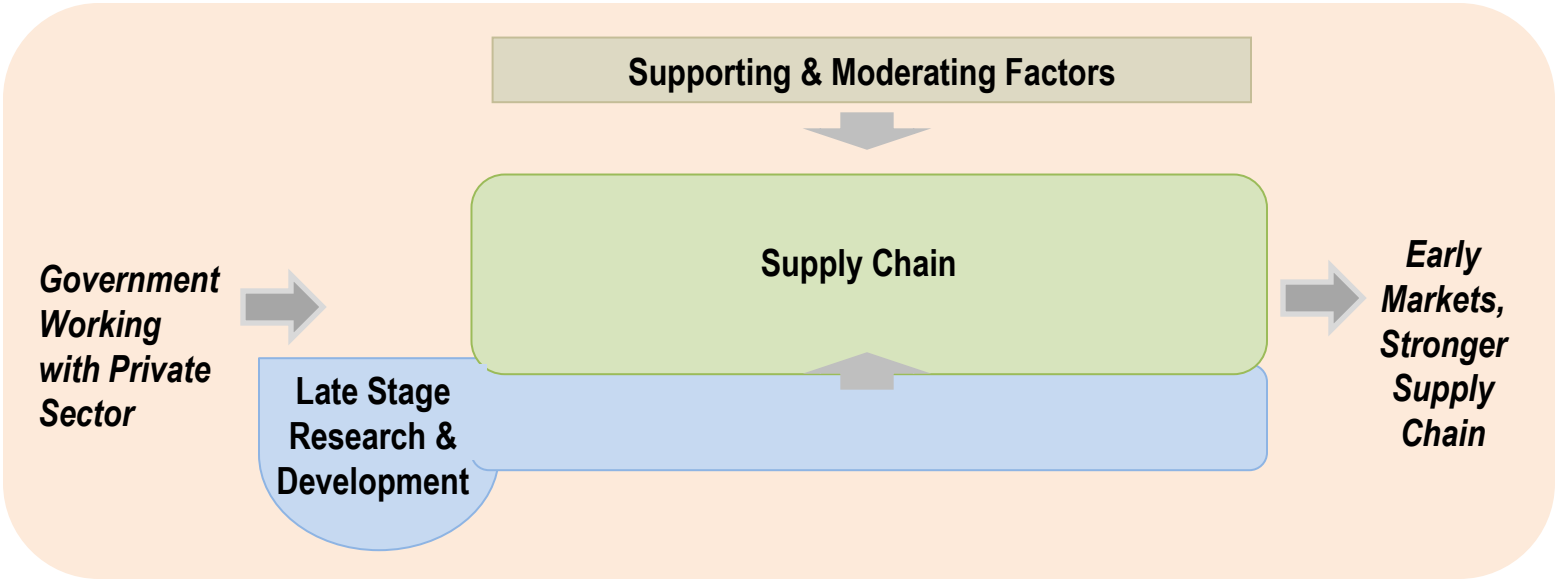
# Key Points: Theory of Change Model
# The theory of change has to address the supply chain.

- A Supply chain is movement of goods and services from
  - Suppliers of materials and components and subsystems,
  - Production or assembly firms,
  - Distribution and retail firms, to
  - Consumers.
- New technologies require research and development (R&D) all along the supply chain (idea creation, design, manufacturing, delivery, marketing)



# Key Points: Theory of Change Model
# Scope is limited --late stage development to early markets

- Focus is Technology Readiness Levels (TRL) 5 through 9, from semi-integrated component validation/produce in lab, to actual system and limited production demonstrated, to early niche markets.
- Evidence suggests this period of "adolescence" is a time of lots of change where decisions often have profound effects later.



# Key Points: Theory of Change Model
# Strategies for technology and supply chain development

Two of these are

Theory and empirical evidence suggests collaborations can accelerate new product development and adoption, e.g.

- Among development stages, such as manufacturing issues considered in earlier stages of research
- Between firms in one area of the chain, such as suppliers of various components
- Between parts of the chain, such as manufacturers making requirements clear to suppliers or listening to consumers

Government invests where industry would not

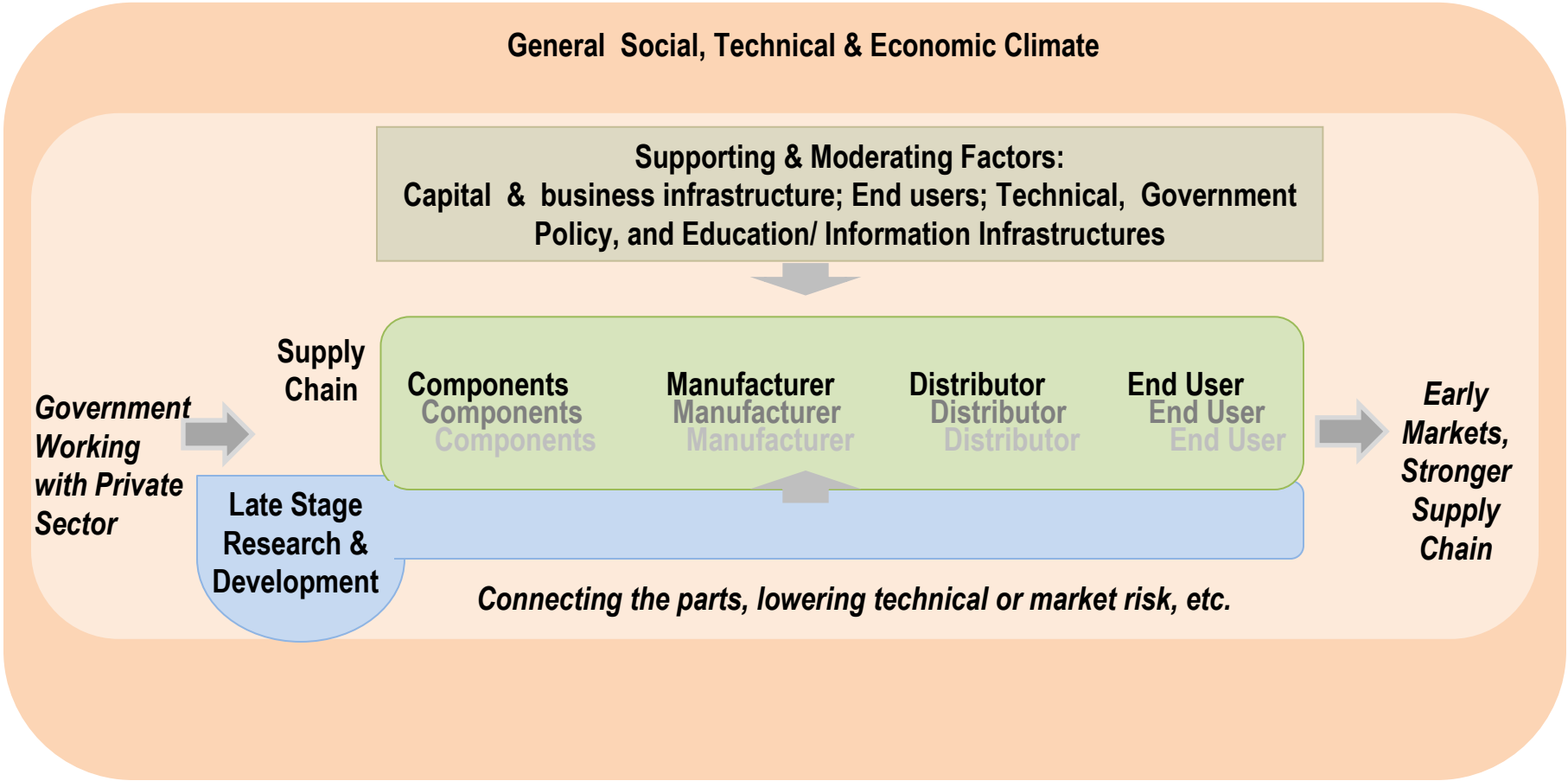
- Risk level too high
- Would be unable to keep benefits to themselves
- Incentives for industry do not reflect externalities

# Key Points: Theory of Change Model
# Supporting and moderating factors play a huge role

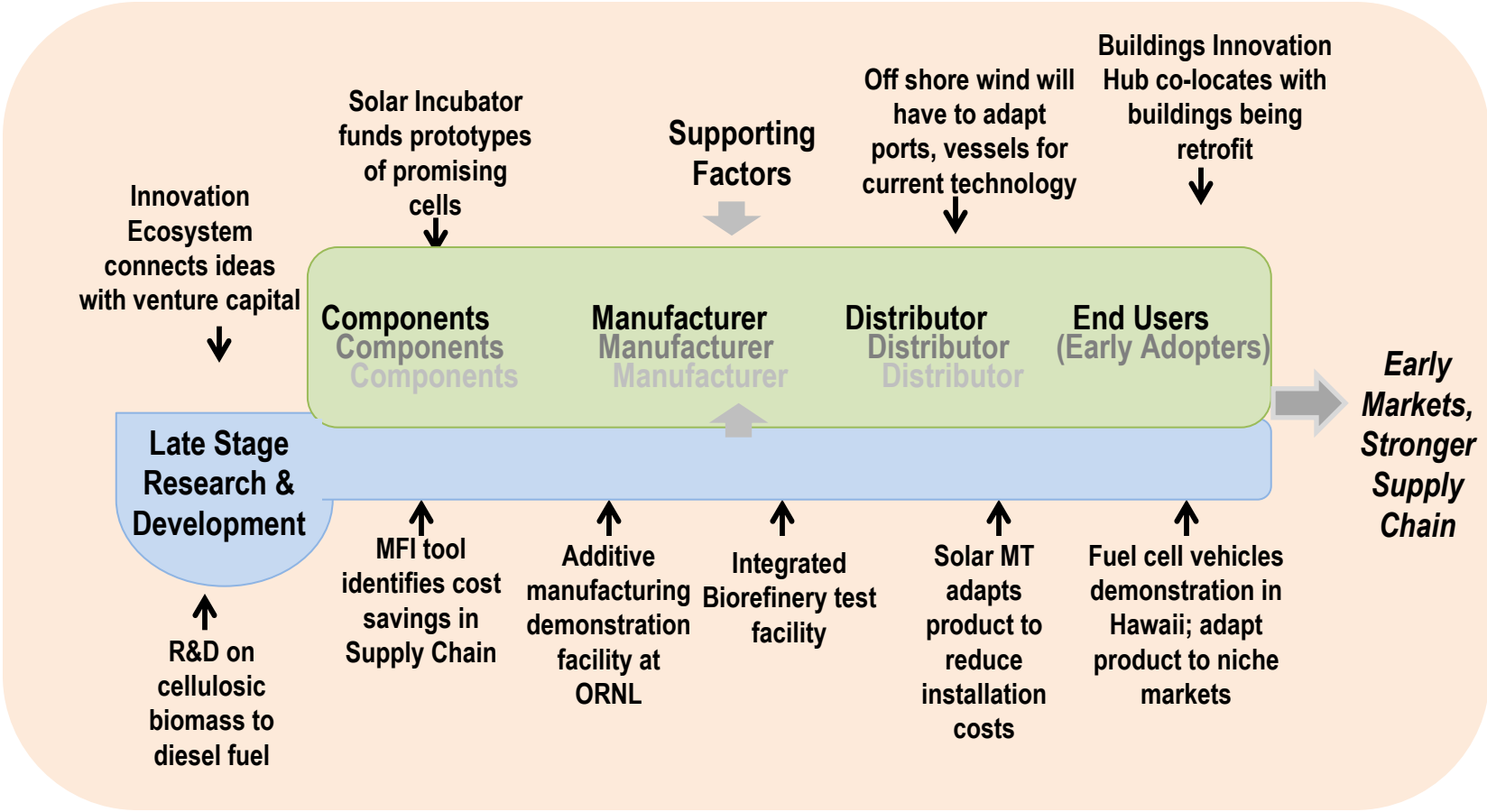
Framework looks at programmatic and non-programmatic influences.

| | |
|---|---|
| **General Economic & Social Climate** | Level of GDP, natural resource base, attitudes toward global warming, etc. |
| **Capital & Business Infrastructure** | Availability of capital, existence and characteristics of manufacturers, retailers, operating & maintenance, etc. |
| **Technical Infrastructure** | Science base, research and testing equipment and facilities, standards, etc. |
| **Education/ Information Infrastructure** | Skilled workforce, validated information about product performance and cost, information delivery mechanisms, etc. |
| **Government Policy Infrastructure** | Regulations, subsidies, taxes, programs, etc. |
| **End Users** | Do they see technology has a comparative advantage over alternatives, is compatible with current practices/processes? |

# Putting this all together, our theory of change for initiatives to accelerate sustainable innovation early in a technology life cycle



# U.S. DOE initiatives address different points in a supply chain. Here is a sample of these.



# A menu of possible indicators

| | Strengthened Connections | Technology Development | Supply Chain Development |
|---|---|---|---|
| Interim Results | Actors present by area; cooperative & collaborative ties within and across<br>Supply chain flexibility, robustness | Changes in product functionality, cost<br>Validation of readiness level<br>Capital invested<br>Acceleration | Increased supplier capability<br>Production/ distribution capabilities<br>Niche markets emerging<br>Sustainability |
| Good Practices | Network structure, nature of ties<br>Geographic clustering<br>Targeted interventions | Improved design processes<br>Cross functional teams<br>Use of Stage Gate<br>Voice of customer | Incentives for firms to enter<br>Searching for potential<br>Manufacturing flexibility<br>Vitality |
| Systems context | In each of the six areas, what exists, who did what when, what changed, to what extent is it favorable?<br>Why was DOE intervention necessary to accelerate innovation? | | |

# Some specific questions for network analysis

<u>Connectivity</u>

- Does the structure enable efficient sharing of info, ideas and resources? Who is in core and who is in periphery, where is bridging and bonding occurring, are needed connections missing?
- How are actors connected – communication, collaboration, alliances, ventures?

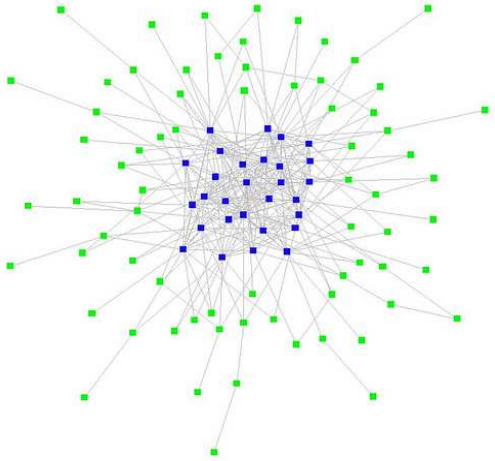


Figure 4 – Core/Periphery Network

<u>Overall Network Health</u>

- How diverse is the network? Is the network balanced and growing – able to grow more inclusive, sustain collaboration?
- Is structure appropriate for the work of the network?

<u>Outcomes/Impacts</u>

Evidence of greater coordination and collaboration – alignment of priorities/R&D, working agreements, alliances, joint ventures, etc.

# Questions we are puzzling over

- In current environment, what intermediate results will convince people the public R&D investment in late stage technology and supply chain development should continue?
- What best practices shall we look for in this area? Do these differ for the energy sector, particularly for renewables and efficiency?
- Do best practices and metrics differ depending on some archetypical scenarios or contingencies so we should address them differently?
- How can we attribute changes to DOE actions: counterfactual, before and after, quasi experimental design?

# Summary

- Our focus is on the early part of the technology/product life cycle: late stage technology development, supply chain, early market.
- Assessing interventions in this portion of the product life cycle is an important new area for R&D evaluation.
- Current metrics and evaluation practice are not satisfying Congress.
- We are proposing a theory-based evaluation framework to provide more information by which those involved can judge progress and make mid course corrections.
- This framework will cover, and be tailored to, multiple types of interventions, technologies and markets.

# Acknowledgements

Other members of the project team

- Thomas Choi of Arizona State University
- Rosalie Ruegg of TIA Consulting
- Angela Becker-Dippmann of Pacific Northwest National Laboratory
- Yaw Agyeman of Lawrence Berkeley National Laboratory

# *Thank you for your attention!*

Comments and suggestions are welcome.

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