# SE, S, and T:
## A Sociotechnical Systems Analysis of United States Scientific and Technical Policymaking

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**International Council on Systems Engineering**
*A better world through a systems approach*

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# Today's Agenda

- Defining S&T

- S&T in policymaking

- S&T policy fellowships

- S&T policy fellowship success

- Ongoing work and future directions

# What is S&T Policy?

## Science and Technology

- Encompasses engineering, health, medicine, social science, natural science, industry, technology sector, and more

- Science for Policy and Policy for Science

- S&T Diplomacy

# Hello!

## About Arizona

- Grand Canyon
- Saguaros
- Space Sciences
- No water
- 5 Cs: Copper, Cattle, Cotton, Citrus, Climate

**THE UNIVERSITY OF ARIZONA**

# Why am I doing this?

| | | | | |
|---|---|---|---|---|
| B.S. in Anthropology | M.S. student in Systems Engineering | Engineering Policy & Diplomacy class | Grant funding for Arizona S&T Policy Fellowship Initiative | This project: Modeling science policy success in state governments through a sociotechnical systems lens |

# The Relationship among Science, Technology, and Policymaking

|  | Public Policy Influencing Science and Technology ("Policy for S&T") | Science and Technology Informing Public Policy ("S&T for Policy") |
|---|---|---|
| **Science** | **Policy for Science:** a policymaker's decision as to whether to fund or manage scientific research | **Science for Policy:** a policymaker's decision on how to use scientific analysis in policymaking |
| *Illustrative Examples* | *How much public funding should support climate change research, and how should policymakers prioritize that research funding?* | *Use of scientific information to understand the impacts of climate change and develop policies to adapt to that change* |
| **Technology** | **Policy for Technology:** a policymaker's decision as to whether to fund or manage technical research | **Technology for Policy:** a policymaker's decision as to the degree to which to use technical analysis in policymaking |
| *Illustrative Examples* | *How much public versus private funding should support research into self-driving cars?* | *How should self-driving cars be regulated to protect public safety?* |

Credit: Deborah Stine, PhD, *From Expertise to Impact,* 2024.

# S&T in Arizona

**Water**

**Energy**

**Agriculture**

**Mining**

**Data Centers**

- Water

- Energy

- Industry Regulations

- Resident Satisfaction



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## Project Blue hammered over water & power use for planned Tucson data centers

Hundreds of residents demand answers about info still held secret; Construction project backed by union labor but developers swamped with questions at Weds meeting

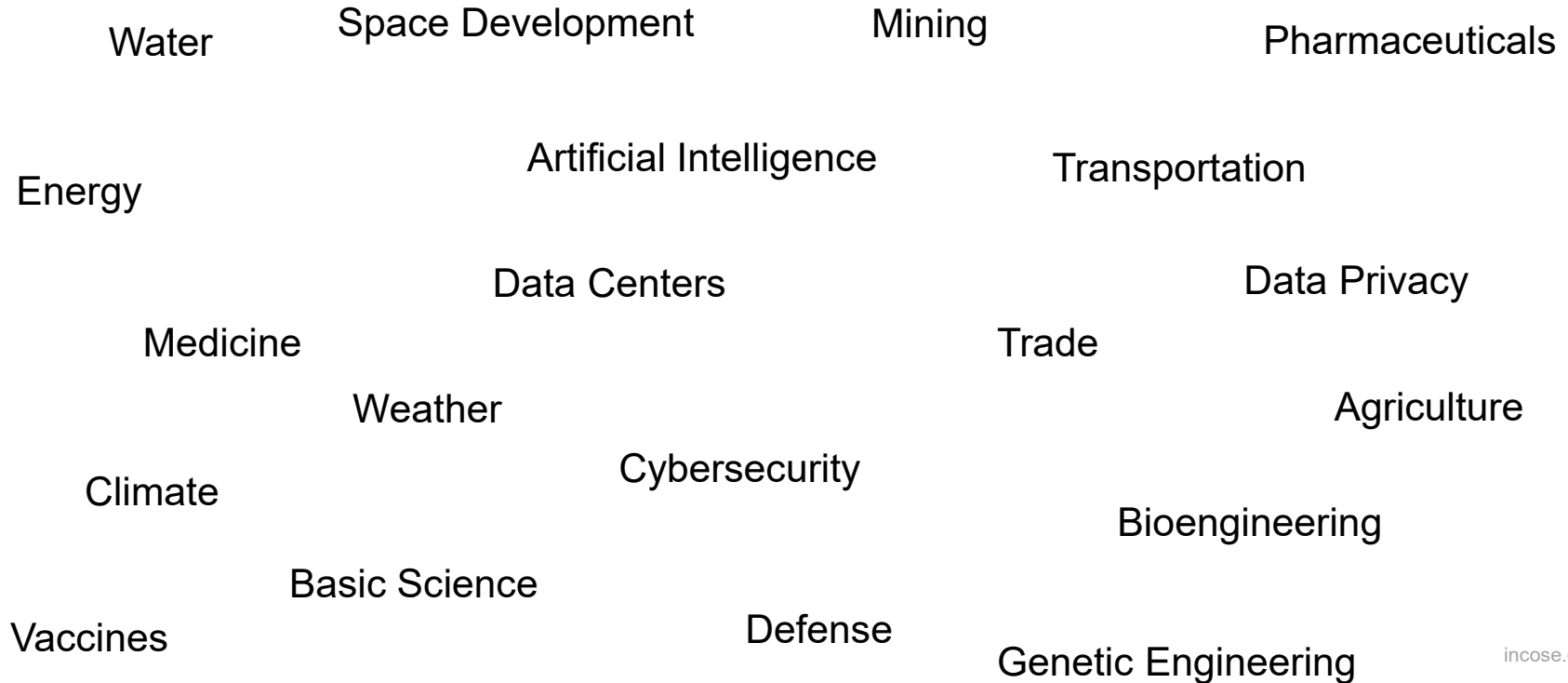Posted Jul 24, 2025, 6:00 pm

Paul Ingram
TucsonSentinel.com

# What S&T issues do you want your policymakers to know about?

Is your industry or sector feeling financial pressures, restrictions, or imperatives related to the current geopolitical climate?
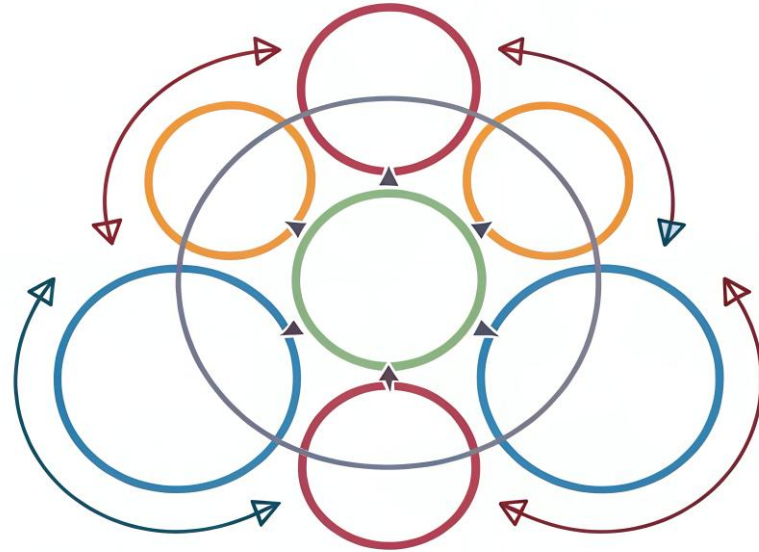
# S&T Topics in Policymaking

Water

Space Development

Mining

Pharmaceuticals

Energy

Artificial Intelligence

Transportation

Data Centers

Data Privacy

Medicine

Trade

Weather

Agriculture

Cybersecurity

Climate

Bioengineering

Basic Science

Vaccines

Defense

Genetic Engineering
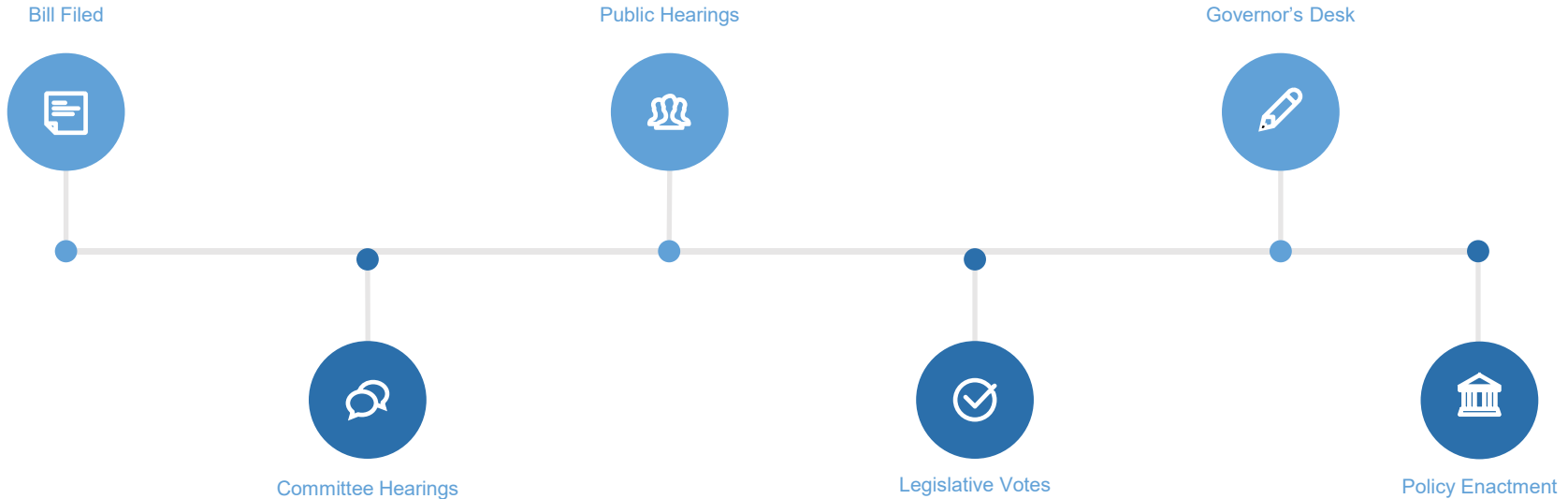
# Where does SE come in?

- Holistic systems perspective

- Process analysis

- Transdisciplinary teamwork

- Social problem solving

- Human factors

- Relationship building

**Goal: design an efficacious engineered system for scientific and technical information to be considered as part of the regular policymaking process within state-level governments across the United States.**

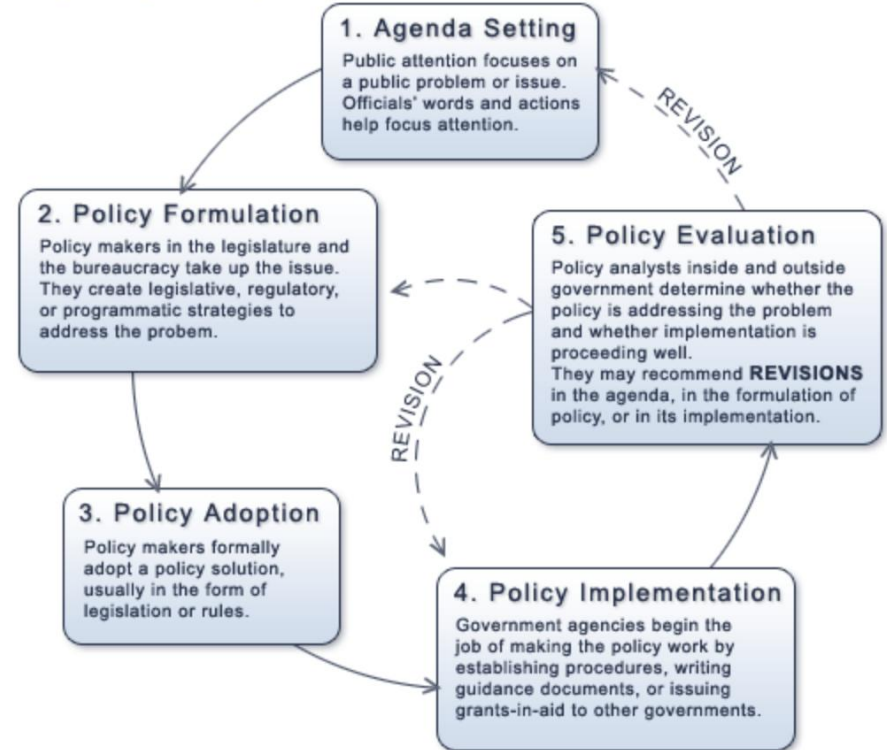# United States Government Policymaking Process

(much simplified)



Bill Filed

Public Hearings

Governor's Desk

Committee Hearings

Legislative Votes

Policy Enactment

# United States Government Policymaking Process

Credit: The Texas Politics Project

https://texaspolitics.utexas.edu/archive/html/bur/features/0303_01/policy.html



Policy Making and Policy Implementation

1. Agenda Setting
Public attention focuses on a public problem or issue. Officials' words and actions help focus attention.

2. Policy Formulation
Policy makers in the legislature and the bureaucracy take up the issue. They create legislative, regulatory, or programmatic strategies to address the probem.

3. Policy Adoption
Policy makers formally adopt a policy solution, usually in the form of legislation or rules.

4. Policy Implementation
Government agencies begin the job of making the policy work by establishing procedures, writing guidance documents, or issuing grants-in-aid to other governments.

5. Policy Evaluation
Policy analysts inside and outside government determine whether the policy is addressing the problem and whether implementation is proceeding well. They may recommend REVISIONS in the agenda, in the formulation of policy, or in its implementation.

REVISION

REVISION

# How do U.S. state-level policymakers learn about S&T topics before voting on them?

- Ask a staffer

- Ask an industry contact

- Ask a lobbyist

- Ask Google / AI

# S&T Policy Solutions

**Federal Level**

NATIONAL ACADEMIES
*Sciences*
*Engineering*
*Medicine*
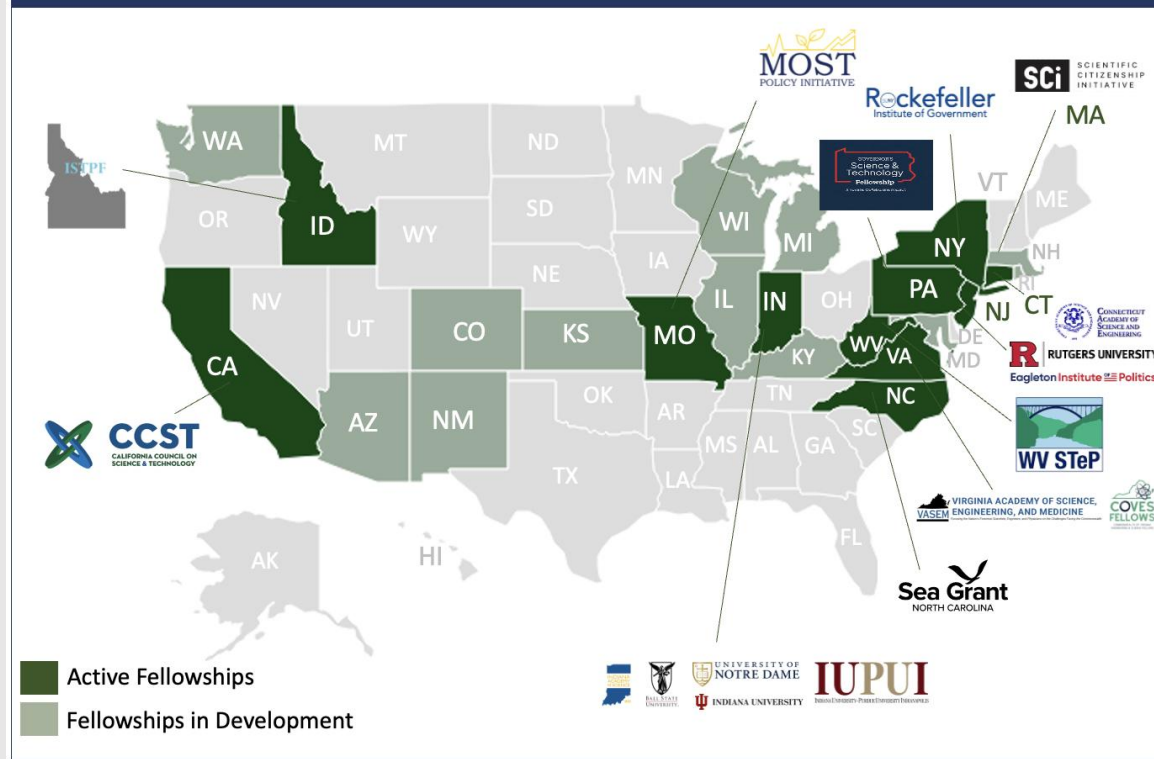
AAAS
AMERICAN ASSOCIATION FOR
THE ADVANCEMENT OF SCIENCE

**State Level**

S&T Policy Fellowships

- Postdoctoral positions bridging S&T and policy
- Serving at the request of state lawmakers
- Providing current S&T information

SCIENCE AND TECHNOLOGY POLICY FELLOWSHIPS IN STATE-LEVEL GOVERNMENT

Created by COPASTEP and LPE

# Arizona S&T Policy Fellowship Initiative

**Dr. Kevin Lansey, Project Lead**

Professor, Civil and Architectural Engineering and Mechanics

**Dr. Caitlyn Hall**

Lecturer, Department of Biosystems Engineering

**Dr. Samuel Myers**

Fellow, California Council on Science and Technology

**Shelley Littin**

M.S. Student, Systems Engineering

**Kayla Smith**

Graduate Student, Planetary Sciences

# Arizona S&T Policy Fellowship Initiative

- Establish a S&T Policy Fellowship Program to address Arizona's unique needs. This program will:

  - Facilitate communication between the science community, technical industry, and government

  - Provide evidence-based policy solutions for consideration

  - Leverage Arizona's growing S&T sector to improve policy decisions and outcomes for its residents

# S&T Policy Fellows

- Fellows will have a professional or doctoral-level degree in a scientific, engineering, or health discipline

- Fellows will serve full-time, for 1-year appointments
  - Serve as honest brokers and provide direct access to scientific and technical expertise
  - Provide nonpartisan unbiased science, engineering, technology, and health information upon request
  - Perform and translate research to support analysis and technical fact checking

- Fellows will not advocate for, promote, or propose any specific legislation or idea for legislation

# Primary Products:

## Science Notes



**DATA CENTERS**
Large industrial buildings that power artificial intelligence models

**Legislative Science Note**                                      **July 29, 2025**

### Short Summary

Phoenix is one of the fastest growing markets for data centers, large industrial buildings that power artificial intelligence models. It is estimated that by 2030 over 16% of the state's energy resources could be powering these data centers. This would require the Phoenix area to more than double its energy production.

### Data Centers and Artificial Intelligence

Artificial Intelligence (AI) models are a rapidly growing technology that is impacting the tech sector broadly. AI technology takes user inputs and then relies on statistical processes to predict what output the user wants. For example, large language models such as ChatGPT and Google Gemini function as "chatbots" that can respond to questions and comments from users as if speaking with a person.

The physical hardware to run these models is often contained in data centers. These warehouse-like buildings contain large amounts of computer equipment and consume large amounts of energy and water. Energy is used both to power the computer equipment and to power cooling systems to keep the equipment from overheating. Water, which is often potable drinking water, is also used in the coolant systems.

In addition to running AI models, data centers are also used to host websites, operate remote storage (e.g., the cloud), and perform other tasks for the technology sector. Thus, data centers touch all aspects of the tech sector and are not localized to AI usage. However, the growth in AI in the past years has led to a massive increase in the number of data centers being built.

### Phoenix is a Datacenter Hub

Nationwide, data centers use roughly 4% of total energy consumption. This value is expected to double or triple by 2028. This energy use is localized in specific areas, including Arizona, due to its particularly favorable environment for these data centers. Namely, Phoenix is located along a major high-speed internet connection

# Fellowship Styles

## Full-time vs. Part-time

**Idaho:** full-time on-site positions serving decision-makers in executive branch agencies and Legislative Services Office

**Indiana:** graduate student fellows from science, health, and engineering disciplines serve in 10-week intensive summer fellowships with state officials

## In-person vs. Remote

**California:** fellowships are in-person with value placed on consistent interactions in a close working environment

**West Virginia**: remote/hybrid response to requests for Science Notes, figures, and presentations. Communicate findings to state and federal policymakers

## Government vs. Agency

**New York**: fellows serve in key roles within executive and legislative branches of New York state government

**Missouri:** Science & Technology Policy fellows serve the Missouri Departments of Labor and Industrial Relations and Health and Human Services

# Fellowship Life Cycle

### 1 Seed/Sustained Funding

Seed funding is acquired, fellowship program protocols and management established.
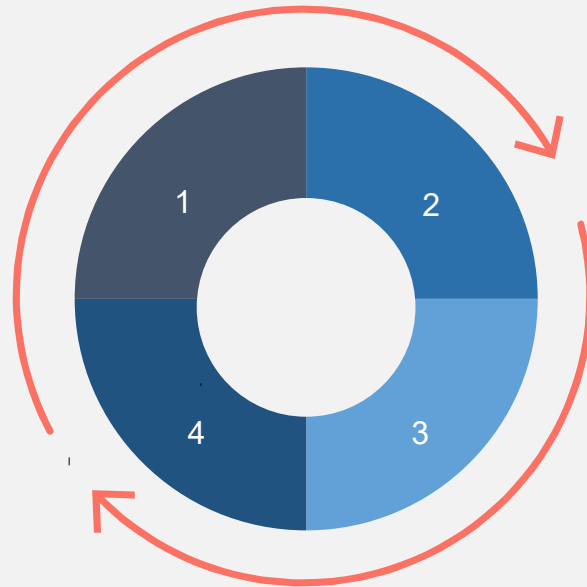
### 2 Fellow Recruitment

Fellows are recruited, hired, and trained in expectations and norms of working in state government.

### 3 Fellow Service

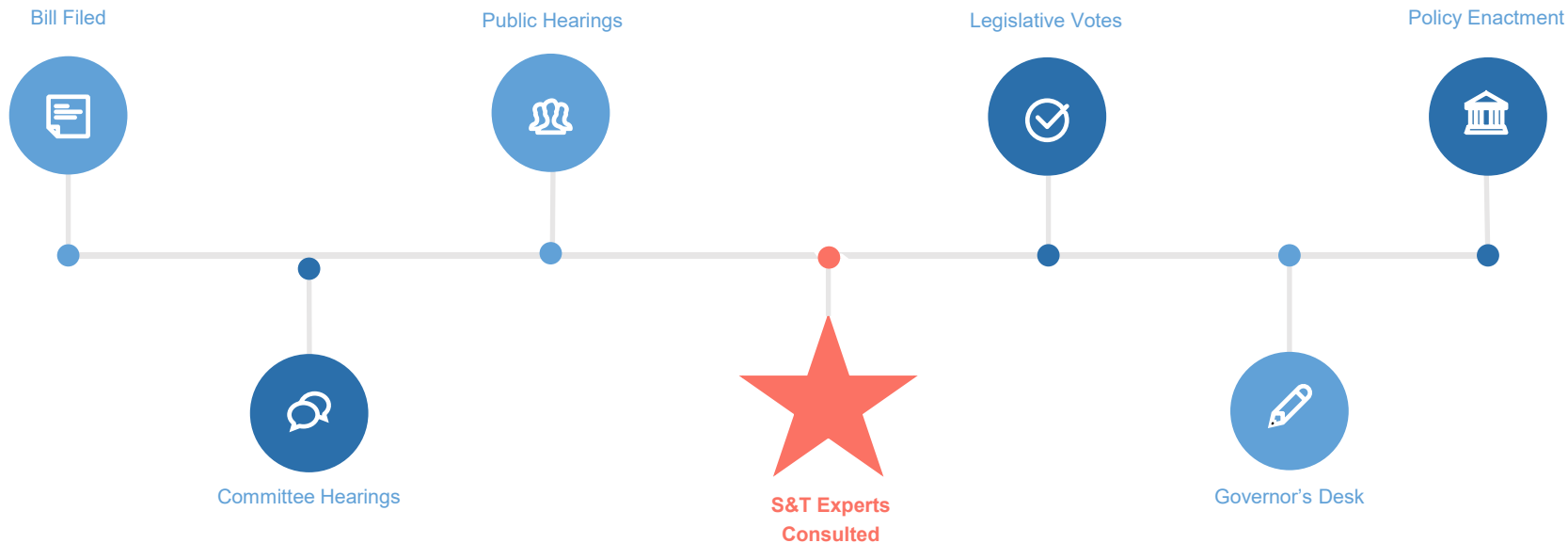Fellows serve their tenure in assigned office; deliver products, presentations, and testimony upon request.

### 4 Mentor and Expert Network

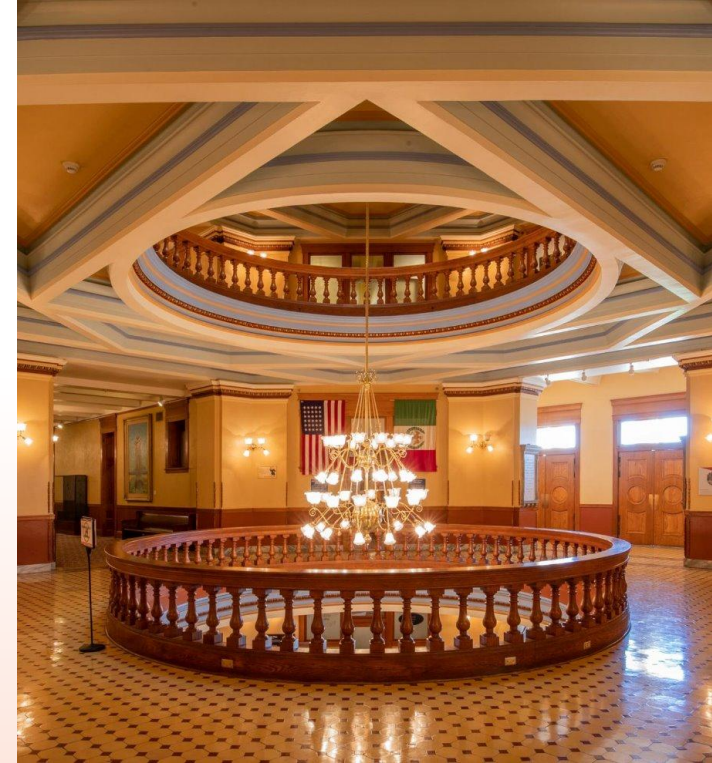Fellowship alumni join a mentor network, helping to educate new fellows; expert network is reevaluated.

# Expected Success Factors

- Program reliability, accountability, and transparency
- Diplomatic and research skills over technical expertise
- Diversified funding portfolio and/or program endowment
- **Development of relational trust in fellows by legislators**

# Types of Trust

**Deterrence-based**

Sanctions for breach of trust exceed potential benefits.

**Calculus-based**

Trustor believes they perceive the trustee's intention.

**Institution-based**

Faith in the system: teamwork culture, legal protections.

⭐ **Relational**

Repeated interactions between the trustor and trustee.

# Work in progress:

### Determine fellowship success factors

- Interviews with program stakeholders assessed with grounded theory

- Success factors as expressed by program funders and donors

- Program modeling and analysis with soft systems methodology
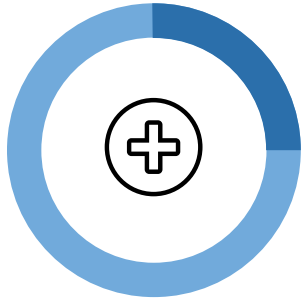
### Describe pathways to building relational trust

- Foundational diplomacy: establishing commonalities, rapport, collegiality

- Delivering reliable, timely, nonpartisan information

- Cross-cultural approaches to developing relational trust
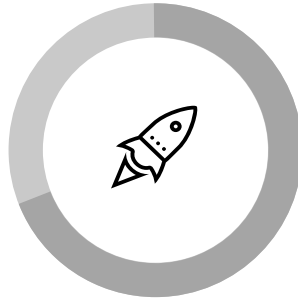
### Develop recommendations for program success

- Understanding baseline government cultures and processes in different states

- Qualitative and quantitative metrics for program evaluation

- Education in diplomacy and trust-building for fellows
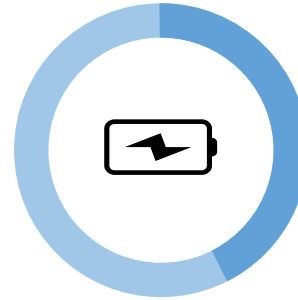
# Why is S&T policy important for society?

## Individual and Collective Wellbeing

Science-informed regulations around food safety, beauty products, supplements, pharmaceuticals, vaccinations.
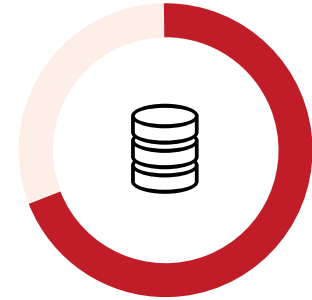
## Technological Advancement

Public-interest technologists informing policy and best practices around technological development and use.

## Economic and Energy Prosperity

Lawmakers understanding complex interconnections of water, energy, economic development, and quality of life.

## Current Issues: AI, Crypto, Data Privacy

Development, adoption, and enforcement of laws for ethical use of AI, intellectual property rights, data, and privacy.

EMERGING TECHNOLOGIES

# We must bridge the gap between technology and policymaking. Our future depends on it

**Nov 12, 2019**

# How can SE help?

▶ *The United Nations sustainability goals serve as a proxy for human needs.*

The United Nations Sustainable Development Goals (SDGs) are a call for action by all countries - poor, rich and middle-income - to promote prosperity while protecting the planet. They recognize that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental quality.

SUSTAINABLE DEVELOPMENT GOALS

| 1 NO POVERTY | 2 ZERO HUNGER | 3 GOOD HEALTH AND WELL-BEING | 4 QUALITY EDUCATION | 5 GENDER EQUALITY |
| 6 CLEAN WATER AND SANITATION | 7 AFFORDABLE AND CLEAN ENERGY | 8 DECENT WORK AND ECONOMIC GROWTH | 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE | 10 REDUCED INEQUALITIES | 11 SUSTAINABLE CITIES AND COMMUNITIES |
| 12 RESPONSIBLE CONSUMPTION AND PRODUCTION | 13 CLIMATE ACTION | 14 LIFE BELOW WATER | 15 LIFE ON LAND | 16 PEACE, JUSTICE AND STRONG INSTITUTIONS | 17 PARTNERSHIPS FOR THE GOALS |

United Nations Sustainable Development Goals: https://sdgs.un.org/goals

**Goal: design efficacious engineered systems for scientific and technical information to be employed in law and policy for the benefit of our collective societies and shared resources worldwide.**

# Acknowledgements: My Advisors



**Dr. Ricardo Valerdi**

Department Head of Systems and Industrial Engineering

Distinguished Outreach Professor

Faculty Athletics Representative

Member of the Graduate Faculty



**Dr. Alejandro Salado**

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**Dr. Kevin Lansey**

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Professor of Hydrology and Atmospheric Sciences

Member of the Graduate Faculty


THE UNIVERSITY OF ARIZONA

# Thank you!

How does policymaking factor into your sector?

How else can a systems approach support law and policy?

What other enterprises could benefit from systems analysis?

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