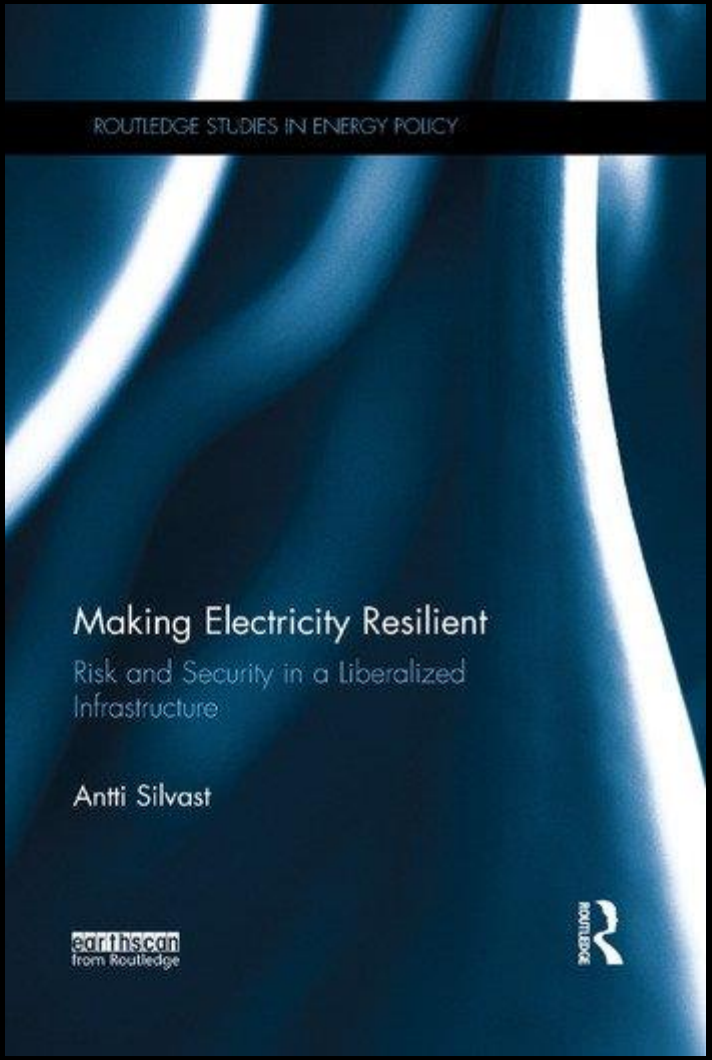
From elections towards an energy-resilient Europe – Pre-midsummer party on 11 June, Brussels

Sustainable energy, resilience and information infrastructure: security and data-driven innovation in energy systems

Antti Silvast
Associate Professor (tenure track)
LUT University, Social Sciences

KEY ARGUMENTS OF THE TALK

- **Energy sustainability transitions** are not linear processes – they involve multiple, interdependent transformations and actors, hence perspectives from various disciplines are necessary to understand them
    - My talk will explore the complementarities and tensions between two ongoing transformations underpinning energy transitions: 1) the digitalisation of energy systems and 2) the growing interdependence and security of energy systems
- **The Finnish model of national emergency supply** (critical infrastructure protection) is deployed as an exemplar of meeting preparedness with a shifting energy system, co-operation, and resilience
- A **socio-technical concept of energy systems resilience is** introduced
    - Not merely about simulation models, diversifying energy resources, redundancy, organizational strategies, policy frameworks, and public-private partnerships
    - A substantial contribution from interdisciplinary **risk science** and **risk sociology** mitigate new risks
    - **Citizen engagement** as the missing solution for accelerated sustainability transitions



Materials and methods:

- My monograph reports a multi-sited examination of how electricity infrastructure and risks are understood and valued in the following fields: management of the electricity network and electricity market in control rooms, national security of supply policy, and social practices in everyday life.
- The research happened 2007-2011, the book completed in my scholarships in **Princeton University** (2014-15) and **University Edinburgh** (2015-16), today updated to reflect the newest **EU policy**

"Silvast's book is a great addition to our understanding of how we depend on infrastructure and how it, in turn, depends on our governance."

Miguel A. Centeno, Professor of Sociology
***Princeton University**, USA*

"Antti Silvast offers an invaluable contribution to our understanding of infrastructure and resilience at a moment when these issues could not be more urgent."

Stephen J Collier, Professor of City and Regional Planning
***UC Berkeley**, USA*

RISK AND RESILIENCE

Invisible policies of infrastructures, yet topical and increasingly urgent in European discussions

Accelerating the Digital Transformation of the European Energy System

Interoperable and open digital solutions, as well as data sovereignty, are key to the digital transformation of the energy system.

Reducing greenhouse gas emissions by 55% and reaching a share of 45% renewables in 2030 can only happen if the energy system is ready for it. To achieve these objectives, Europe needs to build an energy system that is much smarter and more interactive than it is today.

With the electricity consumption expected to increase by around 60% between now and 2030, the electricity networks will need to integrate a large share of variable renewable power. Wind and solar generation capacity must increase from 400 GW in 2022 to at least 1,000 GW by 2030, including a large build-up of offshore renewables up to 317 GW, to be connected to shore.

Therefore, grids need to adapt to a more decentralised, digitalised and flexible electricity system with millions of rooftop solar panels and local energy communities sharing resources.

Investing in digital technologies such as IoT devices and smart meters, 5G and 6G connectivity, a pan-European energy data space powered by Cloud-edge computing servers, and digital twins of the electricity system is instrumental to accelerating the digital and sustainable energy transition, while bringing benefits to our everyday life.

© iStock

EU policy supporting the green and digital transformation of the energy system ›

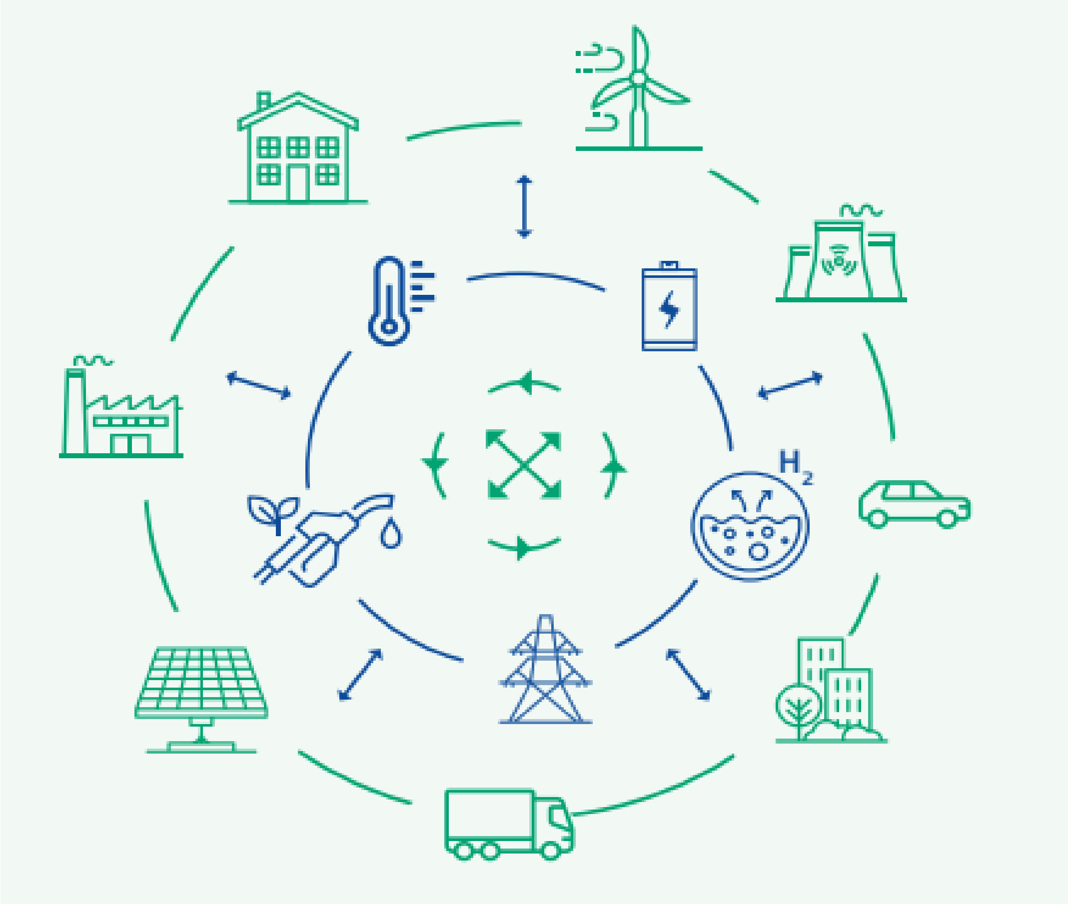
EU programmes to support the digital transformation of the energy system ›

Follow the latest progress and learn more about getting involved.

Source: European Commission:
https://digital-strategy.ec.europa.eu/en/policies/digitalisation-energy

EVERYTHING IS INTEGRATED AND INTERDEPENDENT

- *Future EU integrated energy system: energy flows between users and producers, reducing wasted resources and money ©European Union; Source: [EU strategy on energy system integration (europa.eu)]*



CRITICAL ENTITIES RESILIENCE (CER) DIRECTIVE

- CER Directive (2022) *"on the resilience of critical entities"* replaced the ECI Directive (2008) *"on the identification and designation of European critical infrastructure (ECI) and the assessment of the need to improve their protection"*.
- As can be seen, the concept of **protection** is increasingly replaced by the concept of **resilience**
- **Selected policy differences:**
  - The 2008 CI directive only included two European CI sectors: energy and transportation
  - The 2022 CRE directive includes ten sectors: energy, transport, banking, financial market infrastructure, health, drinking water, wastewater, digital infrastructure, public administration, and space
  - A growing focus on **systems resilience** and **interdependent systems of systems dynamics**: including between the physical-digital interfaces

Source: **From European critical infrastructure protection to the resilience of European critical entities: what does it mean? (Pursiainen & Kytömaa, 2022)**

PREPAREDNESS UNION PROPOSED BY FINLAND

- *"We ask the Commission to develop and publish the first EU Strategy for a Preparedness Union, [which] should be based on a* ***whole-of-society approach****, where the needs and contributions of all policy sectors are taken into account,"* Finnish Prime Minister Petteri Orpo
- A core focus on **growingly complex, cross-border, and multidimensional crises occurring simultaneously**
- The Preparedness Union seeks to **define policy objectives and recommendations** in different sectors in the field of preparedness

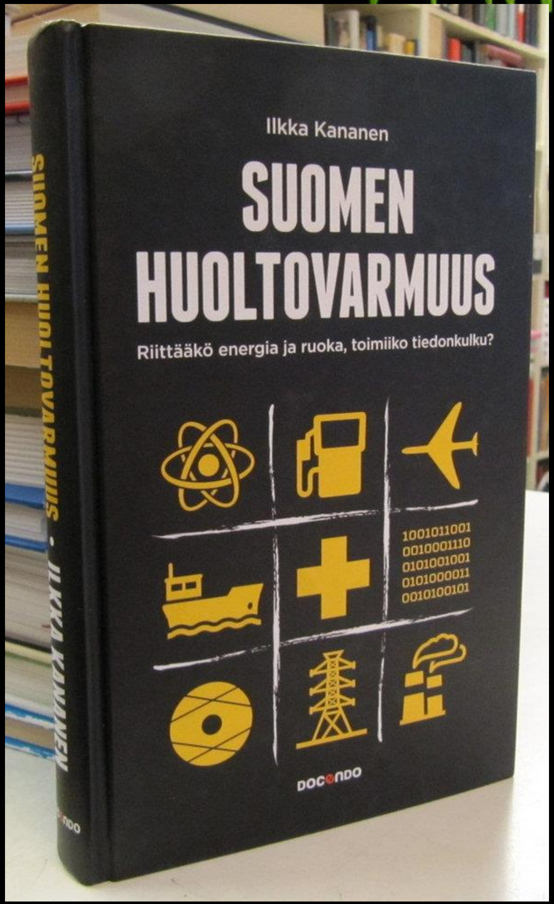
Sources: Euractiv, 2024; Finland Abroad, 2024

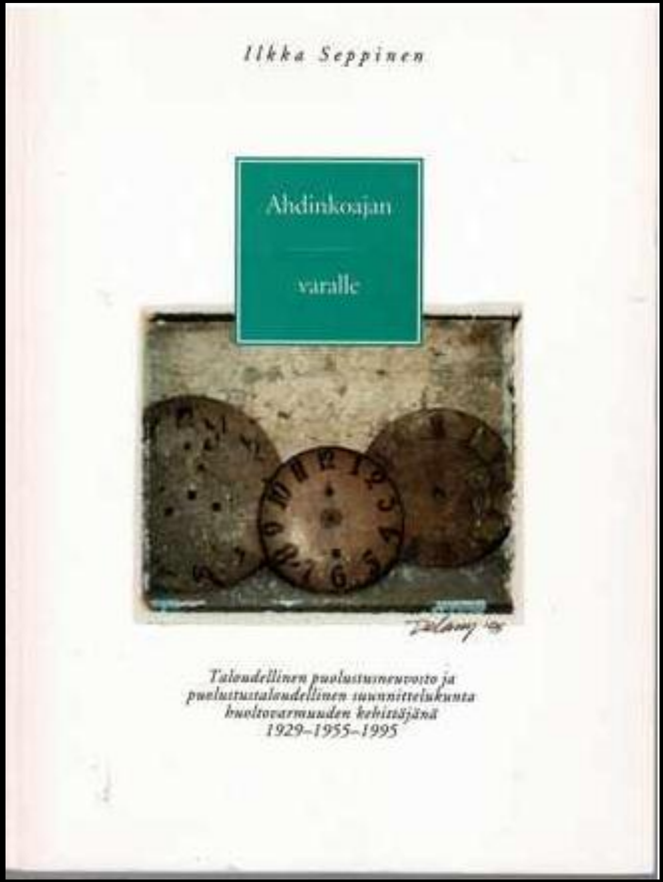
EMERGENCY SUPPLY

A ”Finnish model” introduced

EXPERT DISCOURSE AS A METHODOLOGY

- Management of critical infrastructures is done in normally restricted locations (e.g. control rooms)
- Use expert discourse as a material
  - Participant observation
  - Ethnographic interviews
  - **Especially**: scholarly-policy works written by experts themselves





FINDINGS:

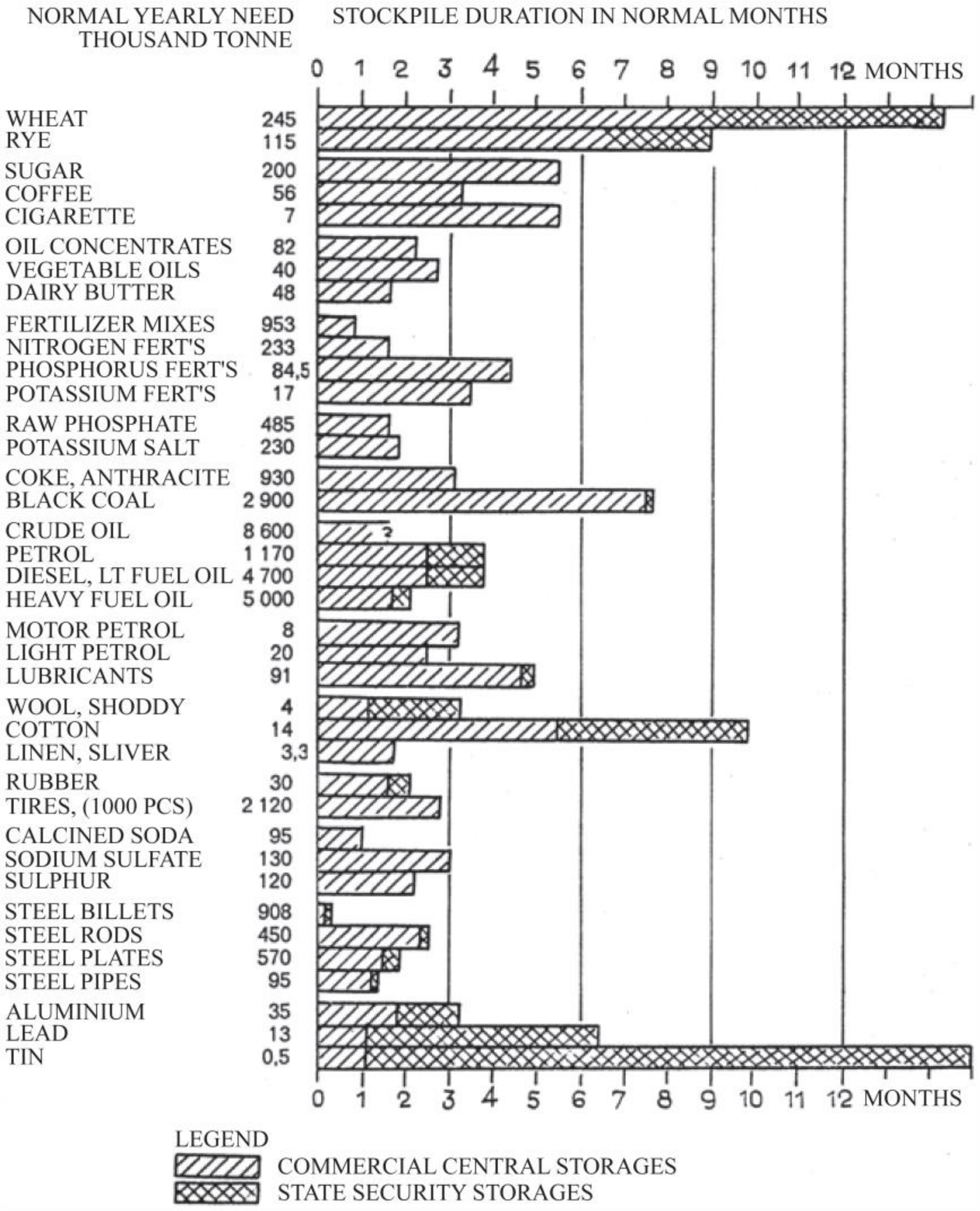
- Histories repeatedly demonstrate uncertainties, ambiguities, ignorance, and complexity in infrastructure systems
- Redundancy (in terms of storage) is not always perceived as a more resilient solution
- The protection of society’s vital infrastructures gives rise to a key tension involving:
  - 1) The practice of *stockpiling* critical resources, such as energy, oil, and industrial products
  - 2) The practice of *security of supply*, which aims to maintain the continous functioning networked systems all the time
- These experts discourses are now extending to new domains – such as cities and even individuals and households, necessating a fresh approach to systems reasoning

EARLY HISTORY: 1917-19 FINNISH FOOD SHORTAGE AND DEPRESSION

“the defence ***preparedness*** *of the* ***whole industry****, the maintaining of* ***agricultural activities*** *and* ***food production****, the rationing of the consumption of* ***food****,* ***fuel****,* ***clothes*** *etc, the organization of many kinds of* ***relief efforts*** *etc.* ***social actions*** *and the arrangement of* ***monetary and credit conditions****.”* (Finnish Government Proposal 14 for allocating a budget to organize economic defence preparedness, 1 February 1929; quoted in Seppinen 1996, 21)

1943
STORAGE
SECURITY

1972 STORAGE SECURITY



A NEW TERM ”SECURITY OF SUPPLY” TO REPLACE ”STORAGE SECURITY”

- *Background of: computer dependence, electricity dependence, oil crises*
- K.H. Pentti (vice CEO of state petrol company Neste, 1977):

*”The old question had been: “**How long do raw resources last** with normal consumption?” Now the question has become: “Which level of **supply** is satisfactory with regards to the **need** of raw material and fuel in **different kinds of crises?**”*

- Ilkka Kananen (former CEO of National Emergency Supply Agency, 2011):

*“As production technology develops and becomes more **complex**, this emphasizes the **security of supply** of components, spare parts, and semi-finished products as well the requirement for **knowhow**. To maintain production one should also take care of **energy, water, and waste supplies, transport and distribution systems, communications, computing, and the functioning of the public administration’s information systems.“***

1984 NATIONAL CATALOGUE OF BASIC SUPPLY SYSTEMS

- Systems necessary for securing the living conditions of citizens:
  - Food supply
  - Clothing supply
  - Dwelling and community services
  - Health care
- Systems necessary for maintaining national independence:
  - Different sectors of national defence
  - Public administration and finance
  - Communications and publicity
- Secondary support systems:
  - Transportation
  - Energy supply
  - Imports and exports

Energia 2030

Energiajärjestelmän murros on yksi 2020-luvun isoja kysymyksiä. Siirtyminen fossiilisten polttoaineiden käytöstä kohti vähähiilisempiä energiantuottamisen muotoja haastaa myös energiahuoltovarmuuden. Energia 2030 on laaja ohjelmakokonaisuus, joka kehittää ratkaisuja häiriöttömän energiansaannin turvaamiseksi myös vähähiilisessä yhteiskunnassa.

Pre-Midsummer Party: From elections towards an energy-resilient Europe

FINNISH EMERGENCY SUPPLY TOWARD 2030

The Finnish model overview

- **High-Level Stockpiling**: Much higher than many other MSs, e.g. 6-month oil reserves.
- **Voluntary Network Cooperation**: Companies willingly participate.

Energy 2030

- Mapping knowledge with new technologies.
- Funding own projects and various initiatives.
- Simulating real-world scenarios and disturbance situations.

Electricity Network Resilience

- **Digital technology impacts:** reduced inertia, remote control.
- **Technical complexity**: e.g. decentralized production.
- **Decentralized intermittent production:** different approach for security of supply to actors.

Risk Identification, Preparedness, and Resilience

- **Technical dimensions** are well-known: storage, materials, capabilities.
- **Social dimensions** are discussed less – for example, the “Priorisation of Electricity Supply Access Points” (2021) report of Energy 2030 mentions “citizens” once and “consumers” twice

ENERGY RESILIENCE

Socio-technical perspective including risk science, cultures of risk, and citizen engagement

ENERGY SYSTEMS RESILIENCE

- *Resilient infrastructure to "different expected and unexpected events, emerging risks, be they natural or man-made, unintentional, accidental or with malicious intent" (European Commission, 2021)*
- *"Resilience is the capacity of an energy system to **tolerate** disturbance and to **continue** to deliver **affordable energy services to consumers**. A resilient energy system can speedily **recover** from shocks and can provide **alternative means** of satisfying energy service needs in the event of changed external circumstances." (UKERC, 2011)*
- **UKERC methods**: simulating the energy system in different operating conditions and unpacking its interdependencies and interactions
- **UKERC findings**: in primary energy supply, the **diversity of energy resources** increases energy system resilience, while **backup power sources and other redundancies** grow resilience in the energy networks and also among the energy end-users

LUT University

Pre-Midsummer Party: From elections towards an energy-resilient

ON RISK SCIENCE

- In the social sciences, risk has somewhat been backgrounded compared to discussions before the past 10 years
- New fields have emerged alongside risk research in the social sciences – for example, risk science, as represented in Society for Risk Analysis Europe Nordic Chapter
- Risk science offers a holistic approach to support decision-making

- Works when uncertainty is measurable (statistical approach), but also when uncertainty cannot be calculated in advance
- Risk science can also be used to take into account information gaps and outright surprises

WHAT IS RISK SCIENCE AND WHY IS IT NEEDED?

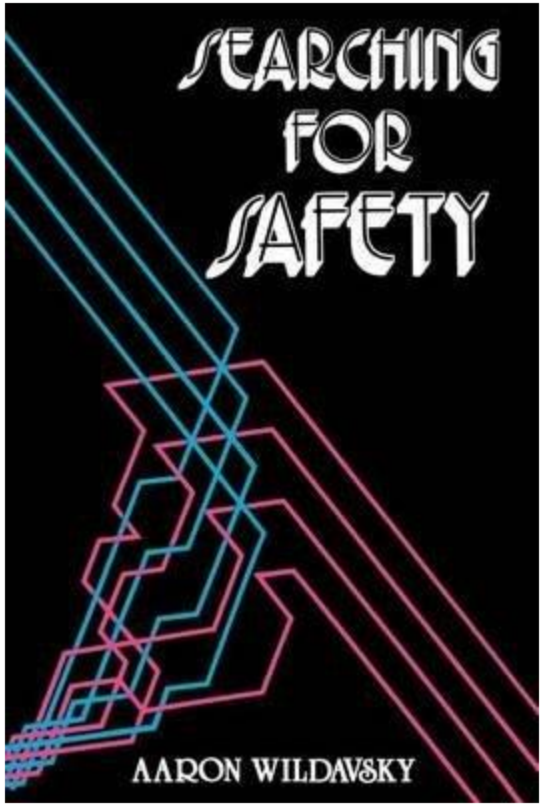
- **Focus areas of risk science (Bouder, Stavanger University):**

1. **Risk Evidence:** Emphasizes the role of risk-taking and risk analysis in decision-making, the quality of risk assessments, and the science used in both the public and private sectors.
2. **Risk Communication:** Addresses trust dynamics, challenges in post-truth environments, and the relevance of these issues in different policy contexts.
3. **Risk Management:** Examines standards applied to risk management, including risk standards for established and emerging technologies.

WHAT IS RISK SCIENCE AND WHY IS IT NEEDED?

- Still, another significant gap in risk science has to do with the neglect of cultural notions of risk.
- Despite more than 50 years of research tradition, there is still a lack of understanding of how people and communities perceive and accept risks.
- As a result, policy programmes tend to overestimate the effects of behavioural change and emphasise one-way dissemination of information.

CULTURAL RISK RESEARCH



- Early hazard research thought experts were "rational" and laypeople "irrational" in their risk rationales
- Cultural risk research, on the other hand, examines the preparedness practices of people and organisations and where the line is drawn between tolerable and unaccetapble risks – for example, people feel immune to risks that they are familiar with
- That said, risk interpretations always inevitably involve contradictions and disagreements. The classic division into four cultural risk relationships follows

FOUR RISK RELATIONSHIPS, TRUST AND RULES

- *Source: https://blogs.lse.ac.uk/politicsandpolicy/culture-theory-organisational-relationships/*

'Group' (i.e. level of trust) ↓	'Grid' (i.e. strictness of rules) → High	Low
High	*Hierarchist* Socially cohesive approach based on rigid rules	*Egalitarian* Cooperative structure with negotiated and flexible rules
Low	*Fatalist* Low-trust, rule-based approach	*Individualist* Low-trust 'market' approach stressing negotiation and bargaining

ENGAGEMENT BEYOND SOCIAL ACCEPTANCE

- Three dimensions of accelerated sustainability transitions amid citizens

1. Sustainable citizenship
2. Human-technology relations
3. Societal renewal

LUT Social Sciences, strategic directions

SUSTAINABLE CITIZENSHIP

- Redefining Citizen Engagement for Climate Sustainability, with a specific focus on energy infrastructures
  - *Focus on innovative ways to involve citizens in long-term energy planning, creating acceptable and sustainable solutions, and building citizens' capacities for energy transitions.*
  - *Understanding the different ways citizens participate in transitions and related capacities to empower marginalized groups and develop just transitions*

CONCLUSIONS AND KEY TAKEAWAYS

- A Socio-Technical Definition of Energy Systems Resilience:

- Resilience is the capacity of the energy system, <u>other interdependent sectors, and the citizens that use energy and their social practices</u> to tolerate disturbance and to recover from external shocks.
- It is necessary for energy providers and policy makers to <u>understand what constitutes reliable energy services</u> to citizens and how citizens (and sectoral organisations) understand and make decisions regarding risks.
- A resilient socio-technical energy system can provide alternative means of satisfying energy service needs and engages citizens and stakeholders <u>in co-design of what those needs are</u> in the event of changed external circumstances.