

# Analysis of energy system resilience under wicked socio-environmental disruptions – a framework

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# Resilience & Energy security (by IEA)

**Energy security** = An uninterrupted availability of energy sources at an affordable price

**Resilience** = Capacity of the energy system to cope with a hazardous event or trend, to respond in ways that maintain its essential functions and structure; and its capacity for adaptation, learning and transformation

- 1) Robustness
- 2) Resourcefulness
- 3) Recovery

# Wicked socio-environmental disruptions

- Result of **interconnected** and extremely **complex techno-economic, environmental, and societal** developments.
- Underlying often **global forces** beyond national control
- Urgent decisions needed in extremely vague situations
- Solutions may cause even more problems

# Example of wicked socio-environmental disruptions

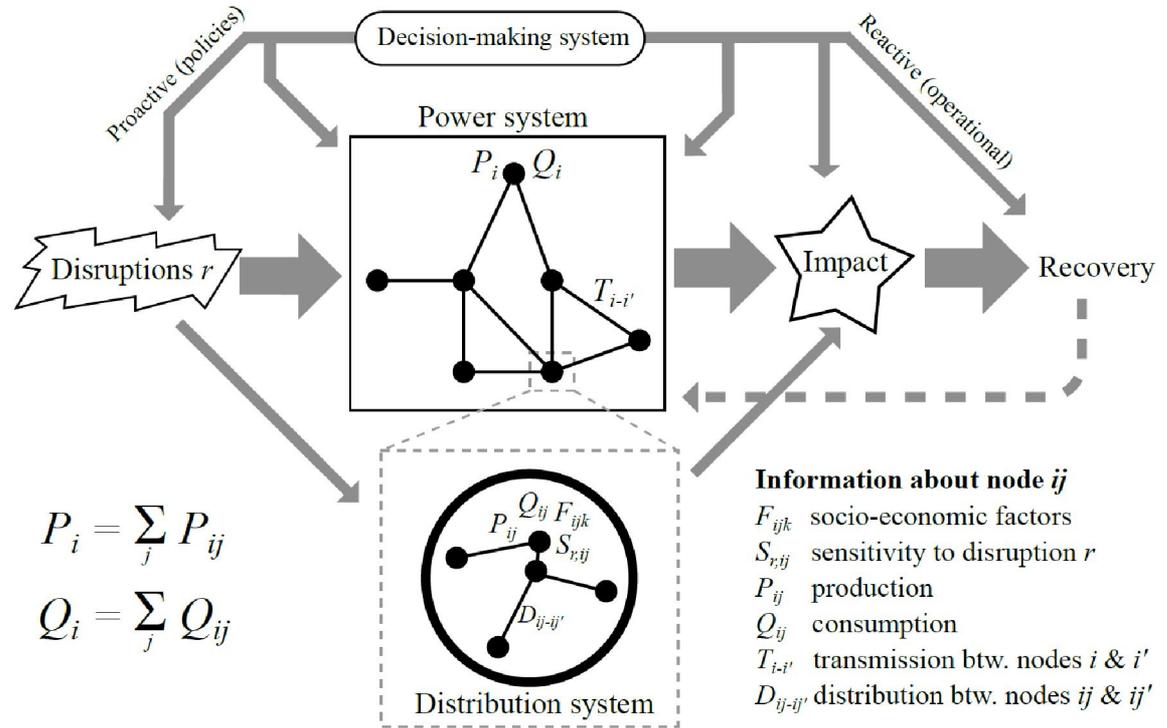
**This could be true in Finland:**

*Climate change causes more frequent **storms**, one of which hits during a February **cold spell**. Tens of thousands of households are left **without electricity** and burden not just electric utilities but **emergency** and **health care** services as well. At the same time a Helsinki—Tallinn passenger **ferry collides** with a Russian oil tanker, triggering widespread rescue and **oil spill** operations. Oily seawater penetrates the cooling system of the Sosnovyi Bor nuclear power plant and forces a **rapid shutdown**, which however fails and causes a **nuclear accident**. Chronic wars in the Middle East lead to yet another **wave of refugees** at the border crossing points between Finland and Russia. Healthcare officials expect an exceptionally serious **influenza epidemic** to peak in Finland within the next few weeks.*

Source: [www.wiseproject.fi/en](http://www.wiseproject.fi/en)

# Modeling social aspects and effects of decision-making

Disruption  
 ↓  
 Technical issues  
 ↓  
 Social impacts



# Disruptions in various forms

## Threats:

### Extreme weather events

- storms, floods, earthquakes...

### Technical failures

- power plants, grid, communication, lack of reserves, fire...

### Human operator errors

### Cybersecurity

### Terrorism

### Country/political risks

## Long-term

- Proactive decisions to prevent

## Short-term

- Reactive decisions to recover

# Socio-economic layers on top of energy system

Environment

Food/water supply

Jobs

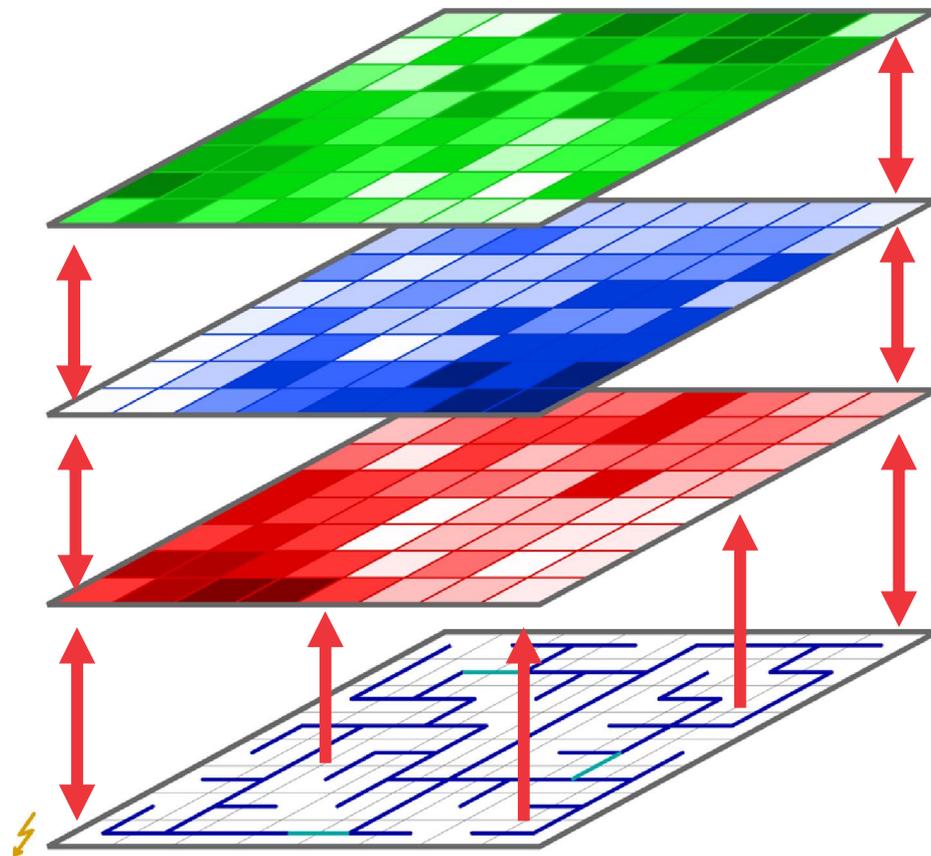
Industry, GDP

Healthcare

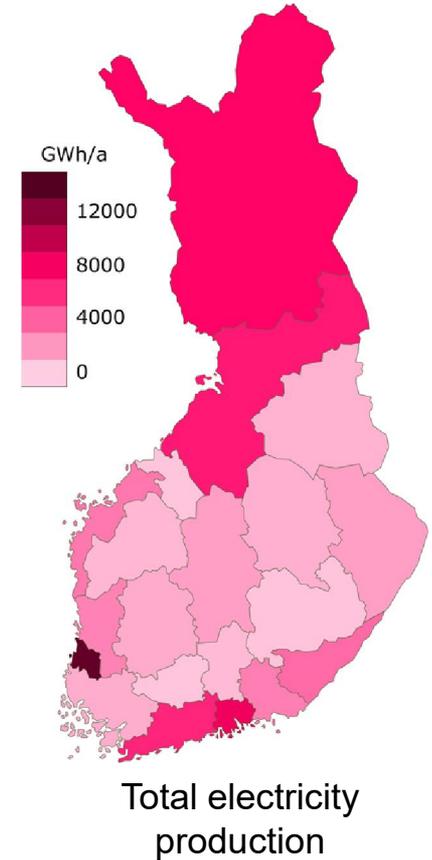
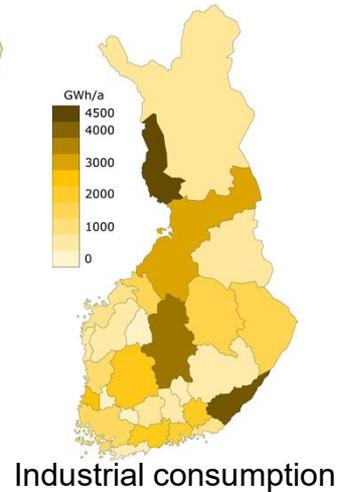
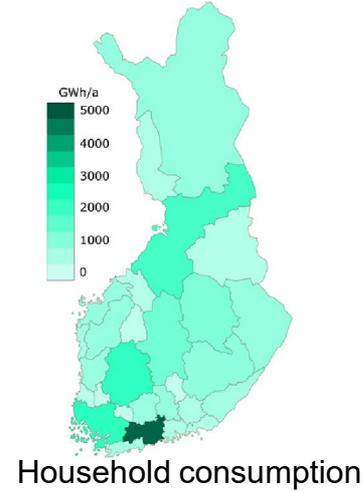
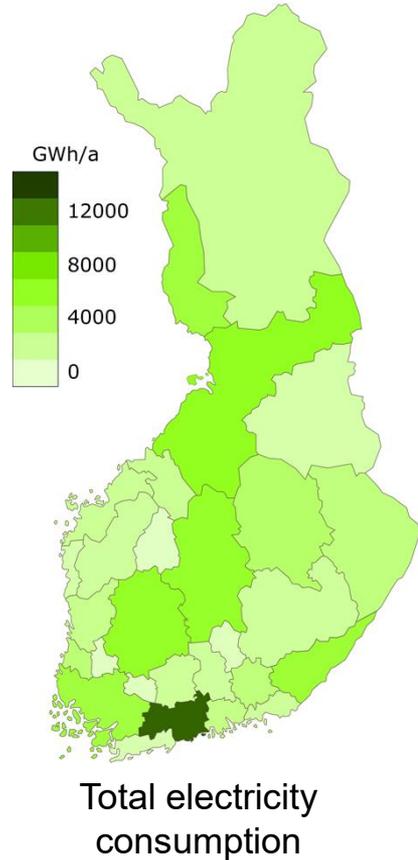
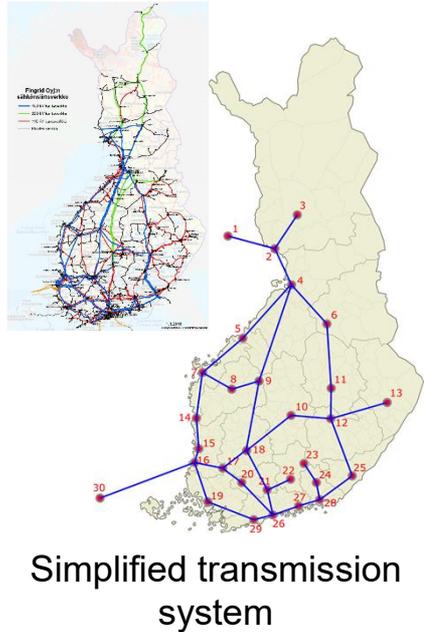
Population, age structure

Traffic

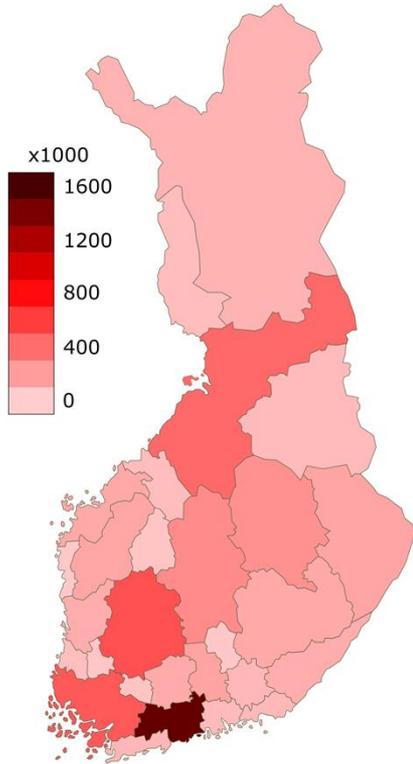
Energy system ⚡



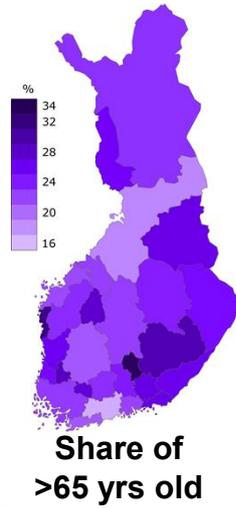
# Large-scale example: Finland



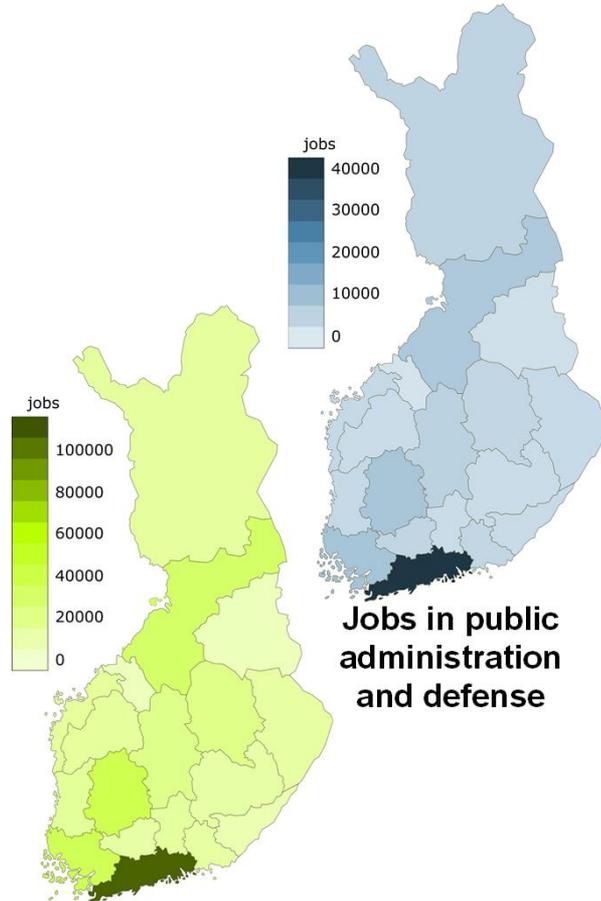
# Socio-economic layers (examples)



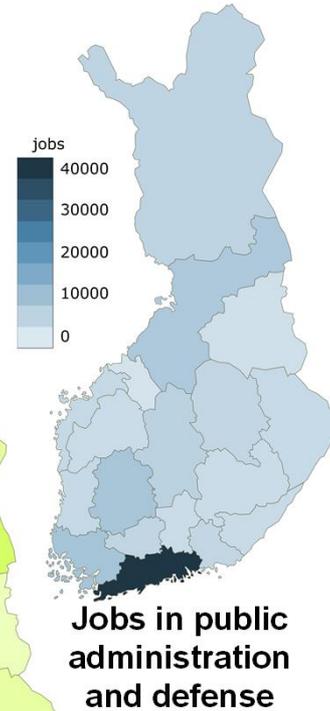
**Population**



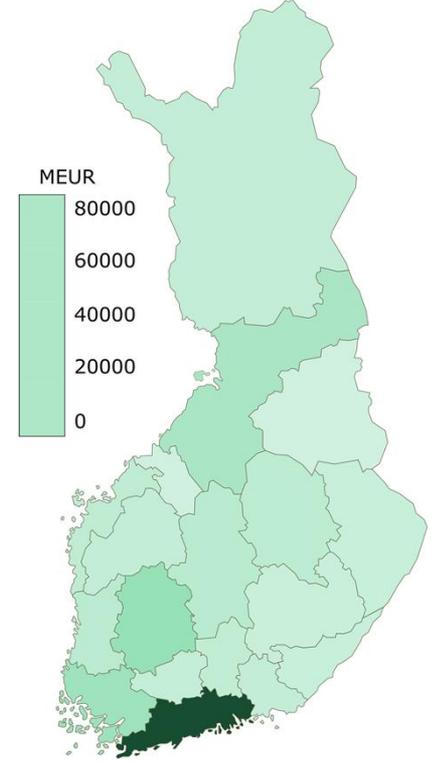
**Share of  
>65 yrs old**



**Jobs in  
healthcare sector**

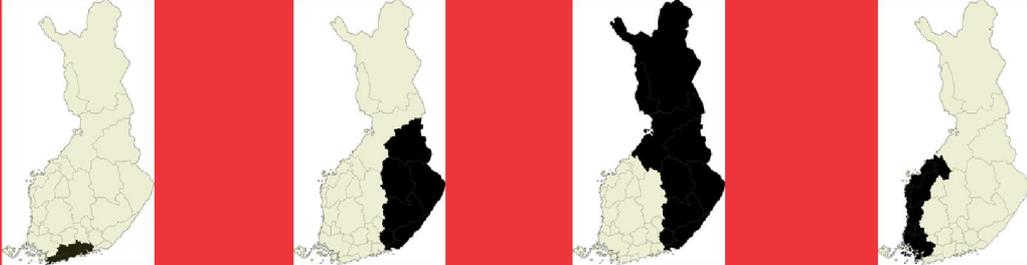


**Jobs in public  
administration  
and defense**



**GDP**

# Total black-out in a part of Finland



<b>Power consumption</b>	20%	23%	39%	21%
<b>Power supply</b>	17%	20%	42%	28%
<b>Population</b>	30%	17%	28%	20%
<b>GDP</b>	38%	15%	24%	19%
<b>Healthcare</b>	27%	18%	29%	22%
<b>Administration + Defense</b>	35%	18%	28%	17%

# Conclusions

- **Wicked disruptions cause complex & surprising consequences**
- **Better understanding of decisions in wicked situation is needed**
- **Technical performance problems cause social and economic consequences**
- **A framework is being developed to model...**
  - the socio-economic impacts from power system disruptions
  - the effects of decisions made in/for wicked situations
- *More information about the project:* **<http://wiseproject.fi/en>**

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# Thank you



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