

WP 1  
TOWARDS SYSTEM  
DYNAMIC MODEL OF  
UHS BUSINESS  
ECOSYSTEM

# Results so far.

Task 1.1. Identification of critical stakeholders and topic areas of underground hydrogen business ecosystems

- The most important stakeholders of underground hydrogen business ecosystem in Finland identified

Task 1.2. Identification Of relevant future scenarios

- Scenarios drafted and to be shown later in this meeting
- Still waiting for the National Hydrogen Market Act to be published

# Main stakeholders of underground hydrogen business ecosystem in Finland



System operator/ owner	Public sector	Private sector	Third sector	Fourth sector
<ul style="list-style-type: none"> <li>- Gasgrid</li> <li>- Fingrid</li> <li>- Independent economic operator/ system operator responsible of operating the storage (Either one company as owner or jointly owned and operated by several companies)</li> </ul>	<ul style="list-style-type: none"> <li>- Regulators (e.g. Tukes, municipal and regional authorities)</li> <li>- Ministries</li> <li>- Research organizations</li> <li>- Educational institutes</li> <li>- Potential public investors</li> <li>- Safety authorities</li> <li>- Energiateollisuus ry</li> </ul>	<ul style="list-style-type: none"> <li>- H2 producers</li> <li>- H2 offtakers</li> <li>- Energy companies and utilities</li> <li>- Equipment and technology providers</li> <li>- Engineering and Geotech companies</li> <li>- Customers and end-users in various sectors (e.g. transport sector, steel industry, chemical industry, aviation sector, marine sector)</li> <li>- Logistics operators</li> </ul>	<ul style="list-style-type: none"> <li>- NGOs</li> <li>- Associations that are supporting the green transition</li> <li>- Associations that are against the land use for industrial purposes</li> <li>- Hydrogen Cluster Finland</li> </ul>	<ul style="list-style-type: none"> <li>- Communities and local citizens / industries near storage sites</li> </ul>

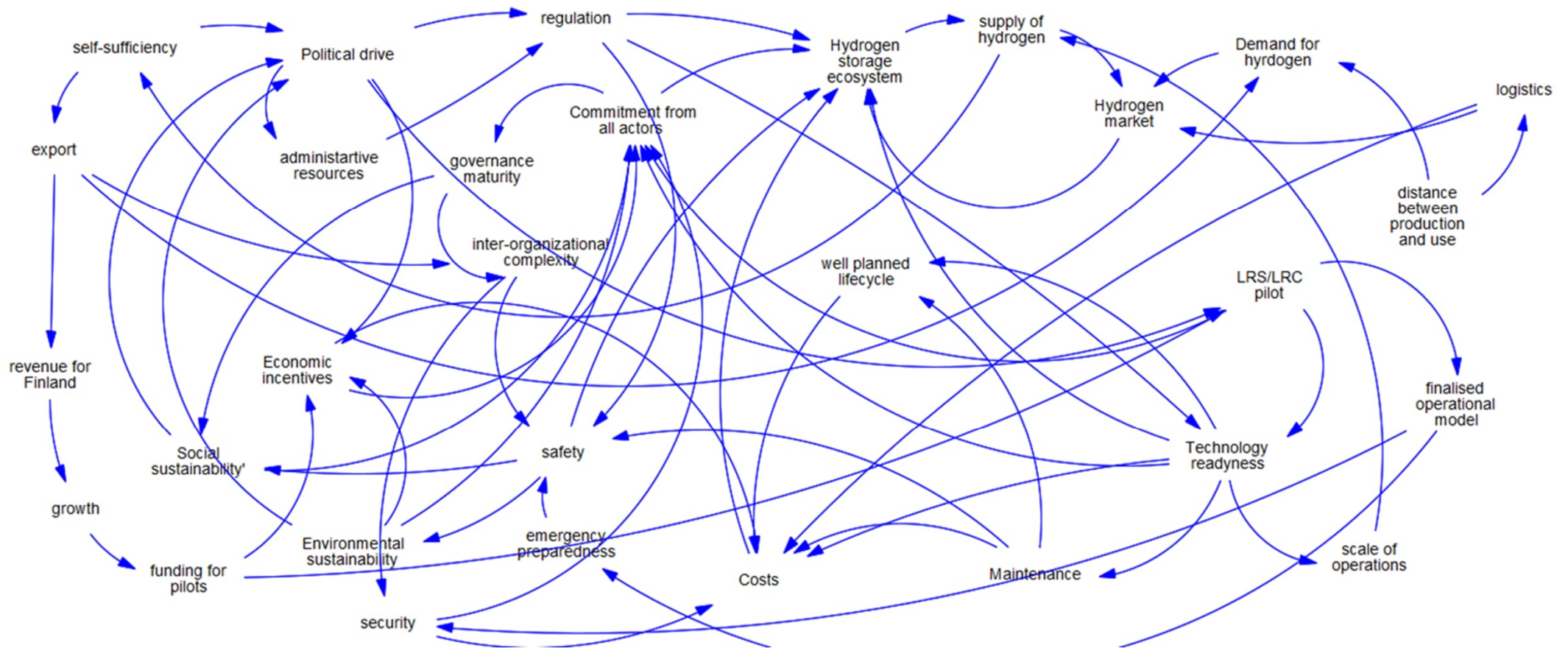
### Carriers:

- Policy and regulatory clarity
- Clear roles and responsibilities
- Availability of funding
- Geology-appropriate storage matured through R&D
- Strong industry interests and benefits seen
- Early high-quality stakeholder engagement and an ecosystem with all necessary stakeholders investing at industrial scale
- Early involvement of human and organizational factors
- Good safety culture and leadership
- Cheap electricity as well as a robust and modern electricity grid
- Desire for comfort
- Climate change and natural catastrophes -> Need for fossil-free energy
- Finland's carbon neutrality goal 2035
- Government commitment to clean hydrogen leadership
- Access to low-cost clean energy
- Well justified calculations for realistic scenarios
- Need for H<sub>2</sub> storage is significant

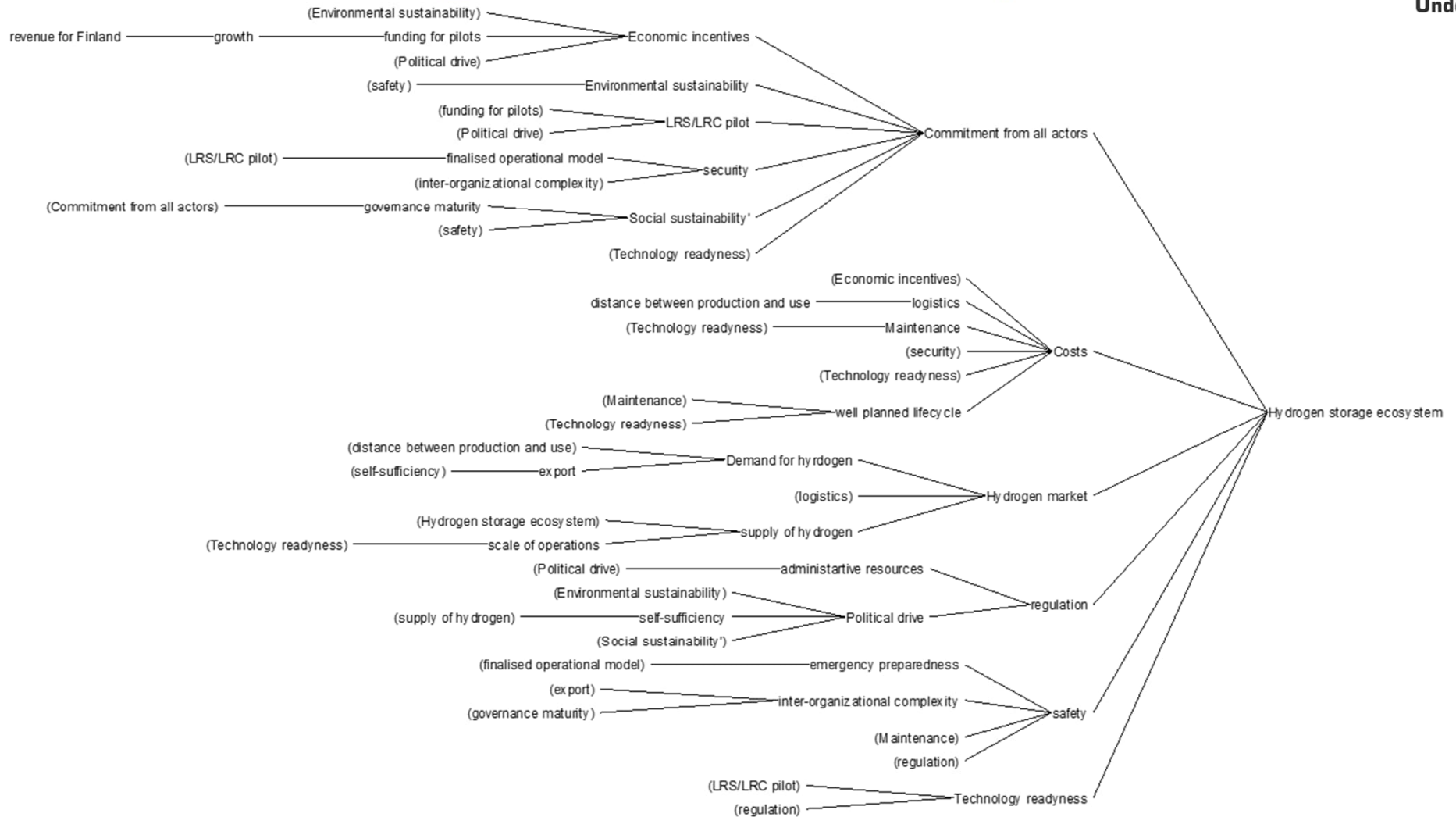
### Barriers:

- Too expensive
- Uncertainty if it is worth it
- High construction costs
- Uncertainty whether LRS is optimal vs LRC
- Profitability uncertainties
- Lack of information on technological development and required technology
- Industrial advantages not visible
- Not enough green energy production
- No political will for fossil-free transition
- Conservatism and fear of change
- Old-fashioned politics
- Unrealistic expectations and short-sighted politics
- Hurry and profit pressure causing inadequate research
- Risk structures with high safety requirements
- Insufficient time and money for research

# First step: Group Model Building



# Fishbone diagram of the ecosystem



# Archetypes of the HUG simulation model

Chicken and Egg dynamics of the  
Hydrogen market (chaotic snowball  
effect)

Hydrogen  
markets

Competition of construction  
resources dynamics (State variable  
delay)

Weakest link dynamics of  
prerequisites (Multiplicative  
formulation of lag)