Uncertainties around Carbon Capture and Storage: Lessons from historical analogues

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SPRU-Science and Technology Policy Research

University of Sussex, UK

Sustainable Energy Speaker Series

Carleton University, Ottawa, 22nd Feb 2012

UKERC

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- group of 14 academics and 12 PhD students focusing on energy policy, economics and systems
- Long tradition of energy / sustainability research at SPRU
- funding from several public research councils, government, industry, NGOs
- Interdisciplinary: economics, policy analysis, innovation studies
- New teaching programme: MSc in Energy Policy for Sustainability
- ***Main interest: how to govern the transition towards more sustainable energy systems***

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WHY THE INTEREST IN CCS?

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UK Climate Policy Context

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- Climate Change Bill commits government to 80% carbon emission reduction by 2050
- ‘holy trinity’: nuclear, offshore wind, carbon capture and storage
- Department for Energy and Climate Change (DECC) established Office of Carbon Capture &Storage: ‘*accelerating the deployment of CCS in the UK*’
- CCS: ambitious plans for deployment of 30GW by 2030; deployment of 3GW/year from 2020 on

Context for CCS in the UK

UK deployment in 2030 and 2050

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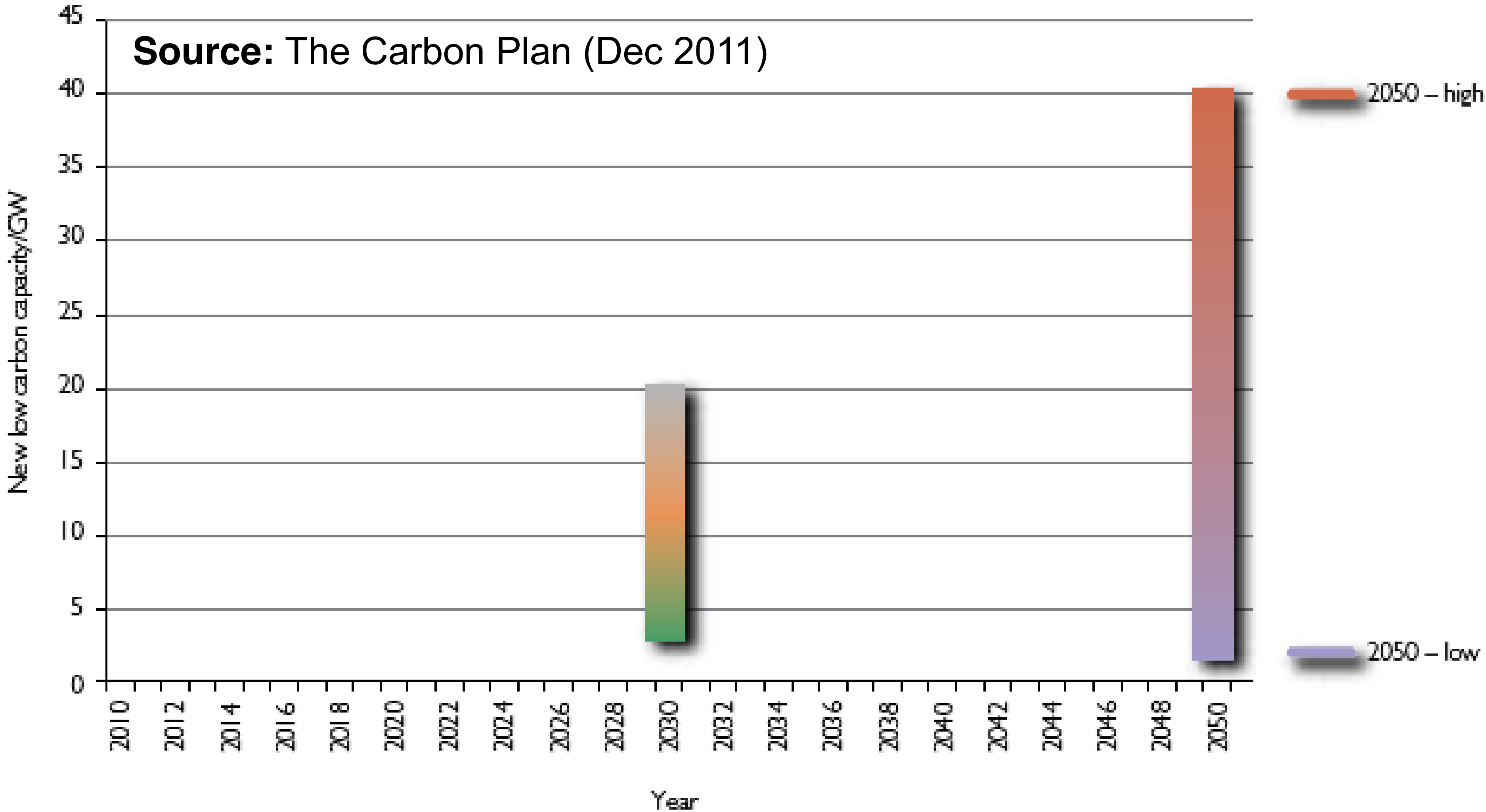

Context for CCS in the UK
A possible global picture

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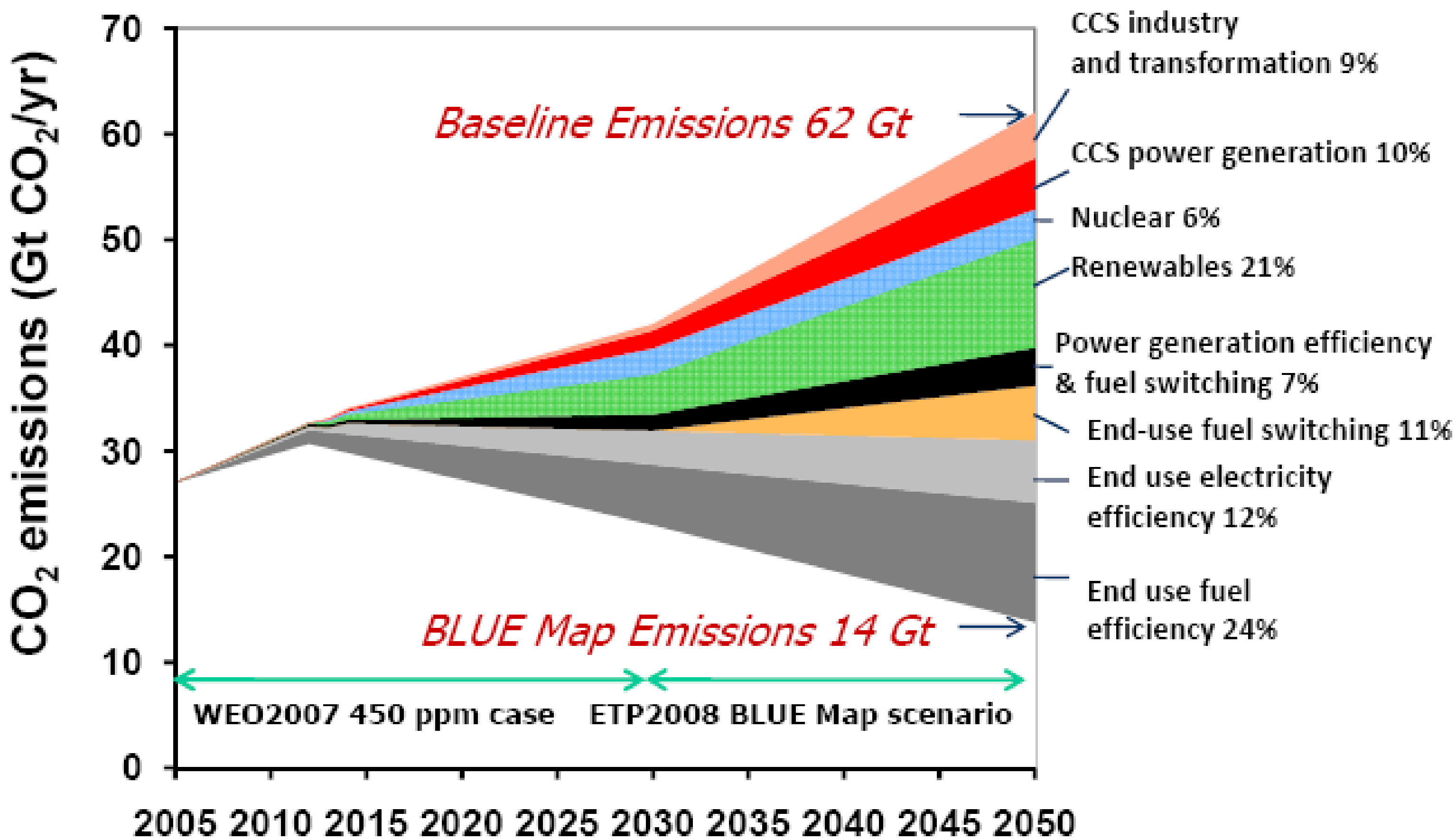

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Source: IEA

UK policy context for CCS
Some brief history …

- UK government took a long time to commit to CCS demonstrations: many years to convince the Treasury
- Builds on history of debate on ‘clean coal’ demonstrations dating back to the 1990s
- Demonstration announced in 2007 budget following consultancy study
- Initial plan for one demonstration expanded to 2-4 demonstrations (included in Coalition Agreement)
- Competition for demo 1 long and ultimately unsuccessful in its primary aim (i.e. to fund one!), but resulted in two FEED studies; unclear how demo 2-4 will be funded

North Sea Fields
CARBON FREE ELECTRICITY
UK Gas Grid
Natural Gas
H₂O
Reformer & Carbon Capture
Natural Gas
UK Electricity Grid
Hydrogen Power Station
Oil
Hydrogen
Miller Field
Cancelled
Produced Oil
CO₂
Enhanced oil recovery with long term CO₂ storage in rock formation


Cancelled

UK policy context for CCS

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Despite the fact that all the parties have worked extremely hard on the first carbon capture and storage demonstration project at Longannet, we have not been able to reach a satisfactory deal …

[W]e now know that commercial-scale CCS projects are technically viable and are likely to be financially achievable. We also know more about the best way to procure these first-of-a-kind projects

Chris Huhne, 19th Oct 2011

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OUR RESEACH

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Context

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Research project: ‘CCS: Realising the Potential?

- Looks at key uncertainties around CCS and how they might be resolved or managed
- aimed to inform UK government policies on CCS
- UK Energy Research Centre project, led by Prof Jim Watson, University of Sussex; partners: University of Edinburgh, Cardiff University, Imperial College
- project started in April 2010; project ends: March 2012

Project overview
Aims and objectives

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- **To inform UK government policies** by helping the policy community to understand the conditions for successful commercialisation
- **To advance knowledge for technology appraisal.** Using case studies of past innovations to develop a robust generic approach to the appraisal of emerging, uncertain low carbon technologies.
- **To contribute to UKERC's research programme.** Independent expertise on the role of CCS in future energy systems, and on innovation processes and policies

Four key questions

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1. What are the key uncertainties for CCS technologies?

2. How can these uncertainties be analysed effectively?

3. What can experience from history tell us about the likely extent and nature of these uncertainties?

4. Drawing on this evidence, under what conditions are CCS technologies likely to be ‘financeable’ in the UK?

Aim of Work Package 1

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• to develop an assessment framework which covers the main dimensions of uncertainty the development of CCS technologies face

• this includes potential methods of assessing these uncertainties

• novelty lies in looking at these uncertainties in the round and identifying interlinkages

How uncertainties were identified

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- systematic review of social science literature on CCS, wider innovation studies as well as technology assessment literatures

- engagement with project steering group

- 14 stakeholder interviews (utilities, engineering consultancies, finance, insurance, legal experts, regulator and policy makers)

7 CCS uncertainties identified

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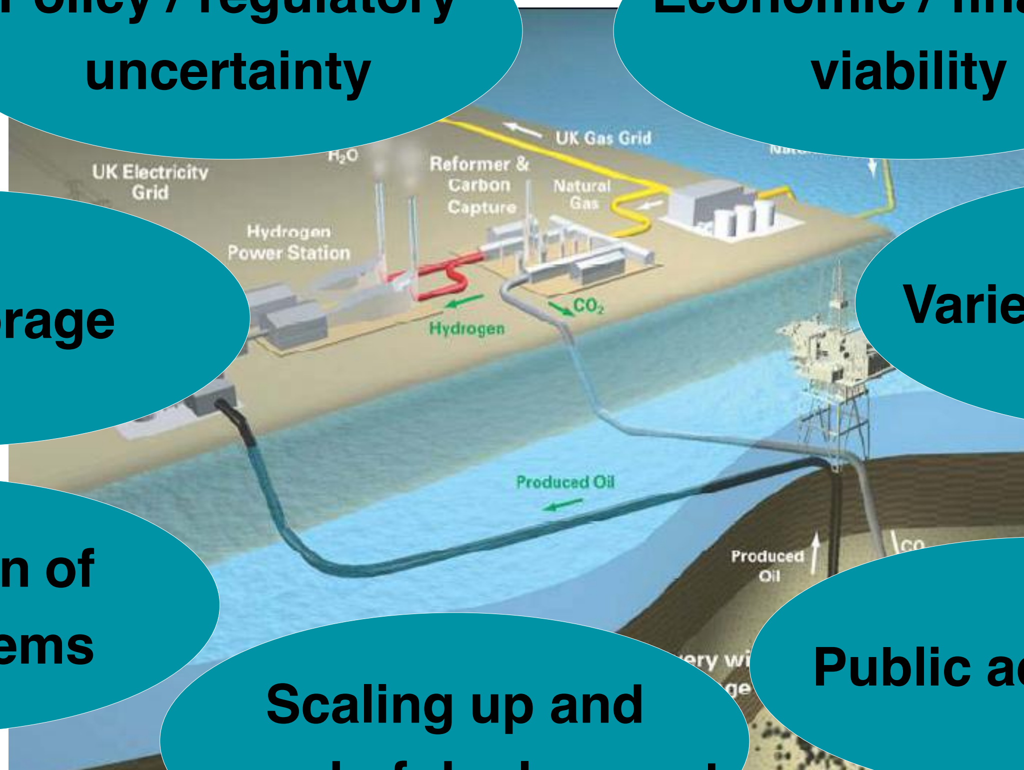

Policy / regulatory uncertainty

Economic / financial viability

Safe storage

Variety of pathways

Integration of CCS systems

Scaling up and speed of deployment

Public acceptance

Interlinkages across uncertainties

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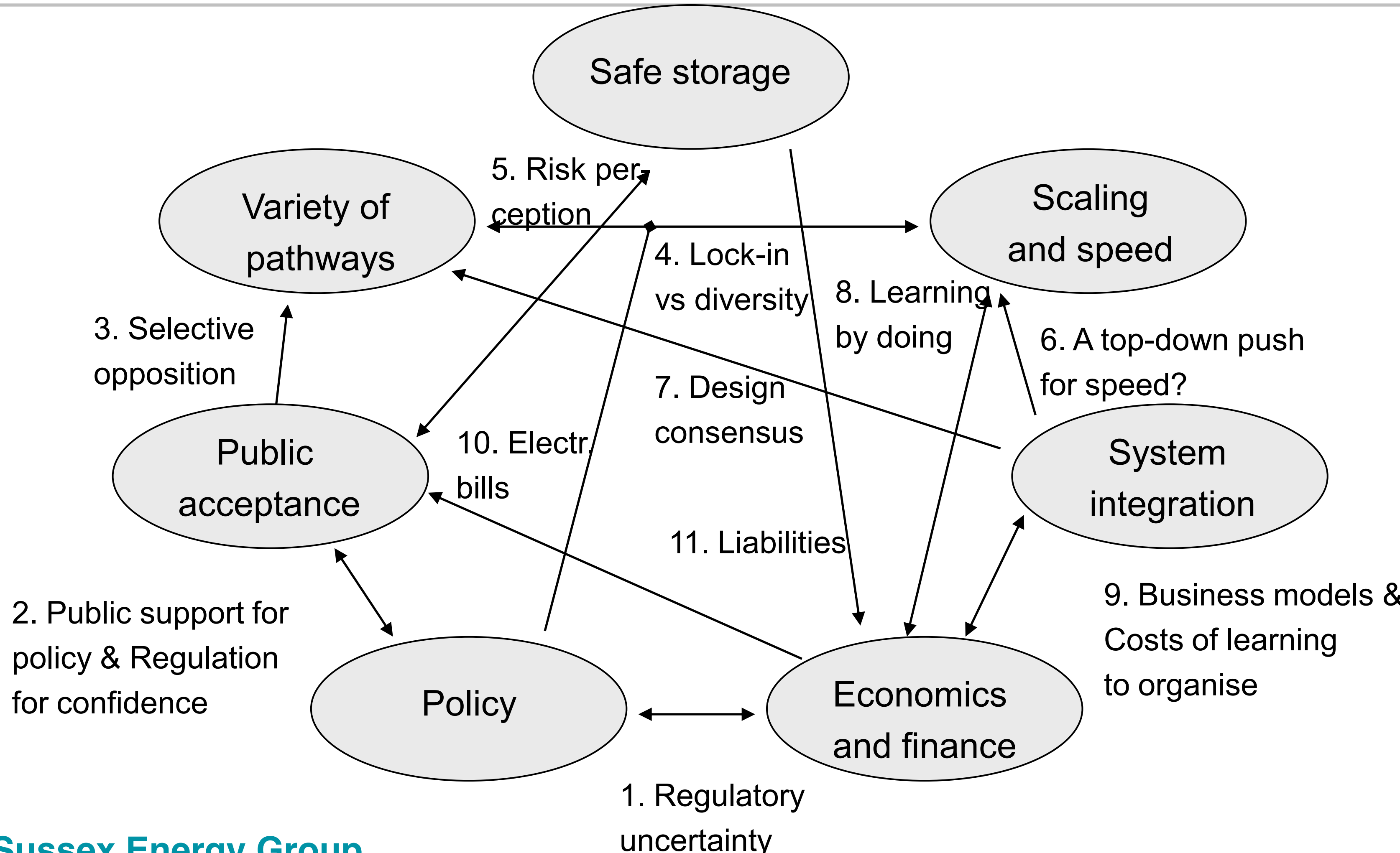

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Examples of assessment criteria used

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Policy, political and regulatory uncertainty:

- Nature of legal/regulatory framework to share risks/liabilities
- Role of subsidies and other forms of financial/economic support
- Roles of other forms of policy support
- Extent of political commitment/legitimacy

Economic and financial viability:

- Costs, including assessment of quality of cost data
- Key financial risks and ‘financeability’; sources of finance
- Role of subsidies and other forms of economic/financial support
- Extent of disagreement about costs and risks

Work Package 2:
Analogue Case Studies

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- uncertainties are being explored by looking at partial, historical analogues of other technologies, regulatory frameworks, etc

- each of the cases is used to study at least one uncertainty; e.g. radioactive waste management → 'safe storage'

- mainly based on secondary literature, documentary evidence, some quantitative data, stakeholder interviews

→ looking at these historical analogues is hoped to yield insights into how uncertainty has been reduced/obstacles overcome in these cases and which actors played a crucial role in these processes

List of case study analogues

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Partial analogue	Uncertainties
French nuclear power programme	Variety of pathways
UK nuclear waste management	Safe storage
FGD in the USA	Scaling up; Econ & financial
The UK ‘dash for gas’	Scaling up
UK natural gas grid development	Integration; Public acceptance
Landfill waste in the UK	Econ & financial
FGD in the UK	Policy

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Gas infrastructure development (I) (drawing on work by Wendy Marsden)

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- Useful analogue since CCS will also involved building new pipelines or other infrastructures to transport carbon
- case study focuses on recent UK experience with building natural gas pipelines to connect LNG terminals (2000-2010), underground gas storage and above ground LNG storage
- analysis looks at local residents and their acceptance of/resistance to concrete projects
- new pipelines undergo public consultation and environmental appraisal, but do not require local planning consent; consent from Secretary of State

Gas infrastructure development (II) (drawing on work by Wendy Marsden)

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- e.g. Milford Haven project: faced public opposition to planning applications for above ground installations and disruption of construction; introducing delays but didn't change route nor abandon project
- several challenges and appeals to High Court
- some cancelations of projects due to local resistance (e.g. Welton Gas Storage Project)
- Key differences: public profits more directly from existence of new gas pipelines/storage/LNG terminals?; safety concerns (natural gas flammable cf carbon)

Nuclear waste management (I) (drawing on work by Matt Gross)

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- useful analogue for CCS since both technologies involve burying 'waste' products underground for very long periods
- public nuclear attitudes highly depend on whether or not a permanent, safe storage solution is believed to exist
- 'best' strategy for dealing with nuclear waste was long contested in the UK (cf e.g. Germany and US)
- initial attempts for selection of deep underground repository site (Institute of Geological Sciences report; Nirex) failed because of local opposition and general lack of trust in process (science/expert driven approach)

Nuclear waste management (II) (drawing on work by Matt Gross)

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- CoRWM: deep disposal, interim storage and 'community volunteering'; broad consultation and stakeholder engagement
- transparency and process (incl. deliberation, maintaining dialogue) is key to public acceptance
- greater levels of trust in information from NGOs and scientists than government; better information = more acceptance (?)
- key differences: carbon storage will take place offshore; carbon more benign than nuclear waste; nuclear waste issue could be 'parked' initially; military connection of nuclear

Lessons for CCS? (I)

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- both cases show that public acceptability issues provided key challenges to the technologies and their governance
- nuclear case: concerns about waste management important for site selection (NIMBY) as well as overall acceptance of technology; gas infrastructure case: mainly NIMBY concerns
- CoRWM: good example of building trust and enabling meaningful engagement with stakeholders and the wider public (cf consultations on new nuclear): *could this model be used to advise on safe carbon storage?* Disputed! ‘Safest site’ versus stakeholder process; cost versus safety

Lessons for CCS? (II)

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- If in case of CCS 'community volunteering' approach not possible, *how to effectively consult offshore stakeholders (fisheries, shipping, etc)* might be a key issue
- gas cases demonstrate a pattern of local rejection overruled by Secretary of State: *model for CCS for some?*
- legal challenges, public opposition, public inquiries leading to some delay or cancellation of some gas infrastructure projects: *does CCS in the UK face similar prospects without appropriate public engagement?* (see Dutch experience)
- importance of trust, transparency and accountability

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FGD deployment in the USA (I) (drawing on work of Nils Markusson)

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- Economic and financial viability: FGD good analogue for carbon capture as emission reduction technology producing a by product of limited value
- Covers the early period of deployment in the USA (1960s-70s)
- Emissions performance standard introduced in 1971 by the EPA following initial demonstrations in late 1960s
- Led to litigation / protracted battles with industry
- Costs rose 5-fold between 1968 and 1978, due to unforeseen technical difficulties: costs subsequently fell significantly
- High costs could be passed on to consumers by utilities
- Subsequent regulation in 1979 effectively mandated FGD

FGD deployment in the USA (II) (drawing on work of Nils Markusson)

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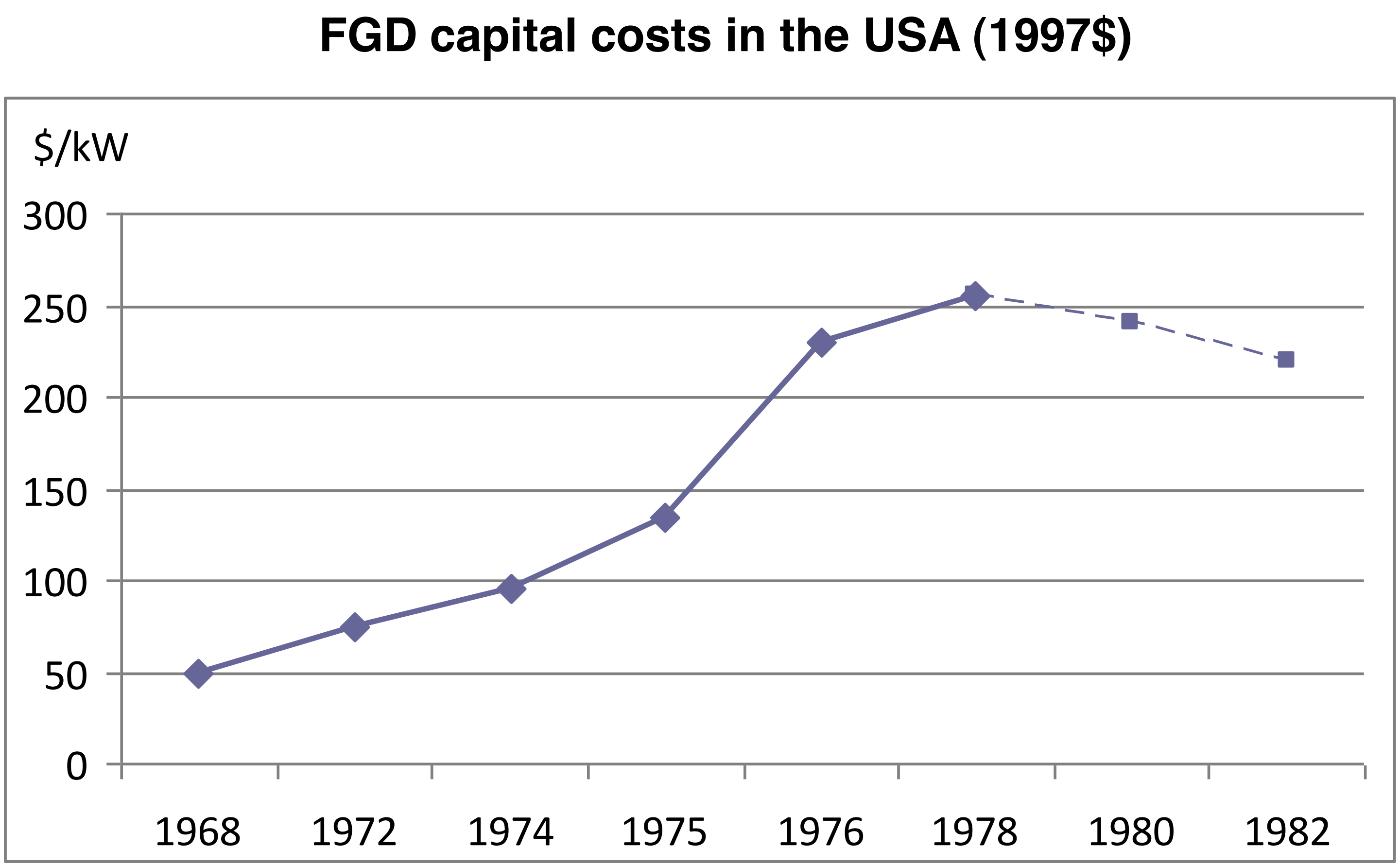
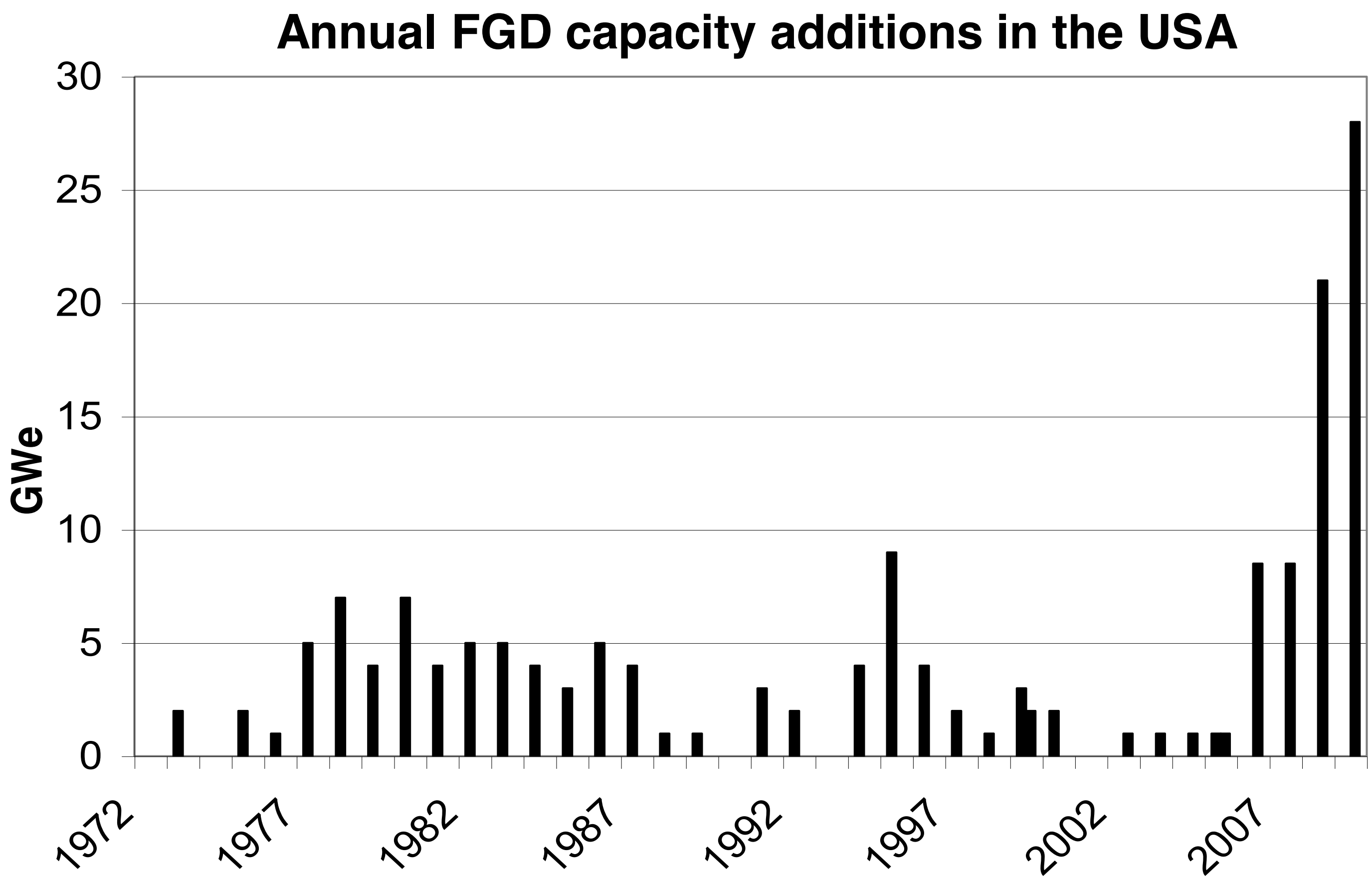


FGD deployment in the USA (III) (drawing on work of Nils Markusson)



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Lessons for CCS?

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- Technology forcing was important in FGD in the USA: prerequisites included technical expertise in the EPA and prior operating experience with large scale plants
- UK liberalised market and alternative low carbon investments make this approach more difficult for CCS
- Regulation one of policies to support FGD (also R&D support and ETS)
- Rapid development led to technical problems which were resolved (this is common!). Likely to be a feature of CCS
- Global markets smoothed demand for equipment suppliers: but how much should the UK rely on this for CCS?

Conclusion

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- looking at other technologies which are similar to CCS in some respects can provide useful insights into some of the uncertainties around CCS
- the analysis highlighted the interplay of technical, social, political and economic features
- historical lessons need to be drawn with care
- lessons do not necessarily produce ‘ready-made’ policy recipes for success but should be rather used to ask critical questions about CCS development, deployment and governance

Next steps

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- synthesising lessons across all 9 case studies
- identifying and updating linkages across uncertainties
- exploring some of the uncertainties further by developing a variety of different future CCS deployment pathways
- finalising analysis of current UK CCS policy and financiability of CCS

Thank you!

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For more information:

Markusson, N., **Kern, F.**, Watson, J., Arapostathis, S., Chalmers, H., Ghaleigh, N., Heptonstall, P., Pearson, P., Rossati, D. and Russell, S. (2012) 'A socio-technical framework for assessing the viability of carbon capture and storage technology', Technological Forecasting and Social Change, http://www.sciencedirect.com/science/article/pii/S0040162511002769#fn0005

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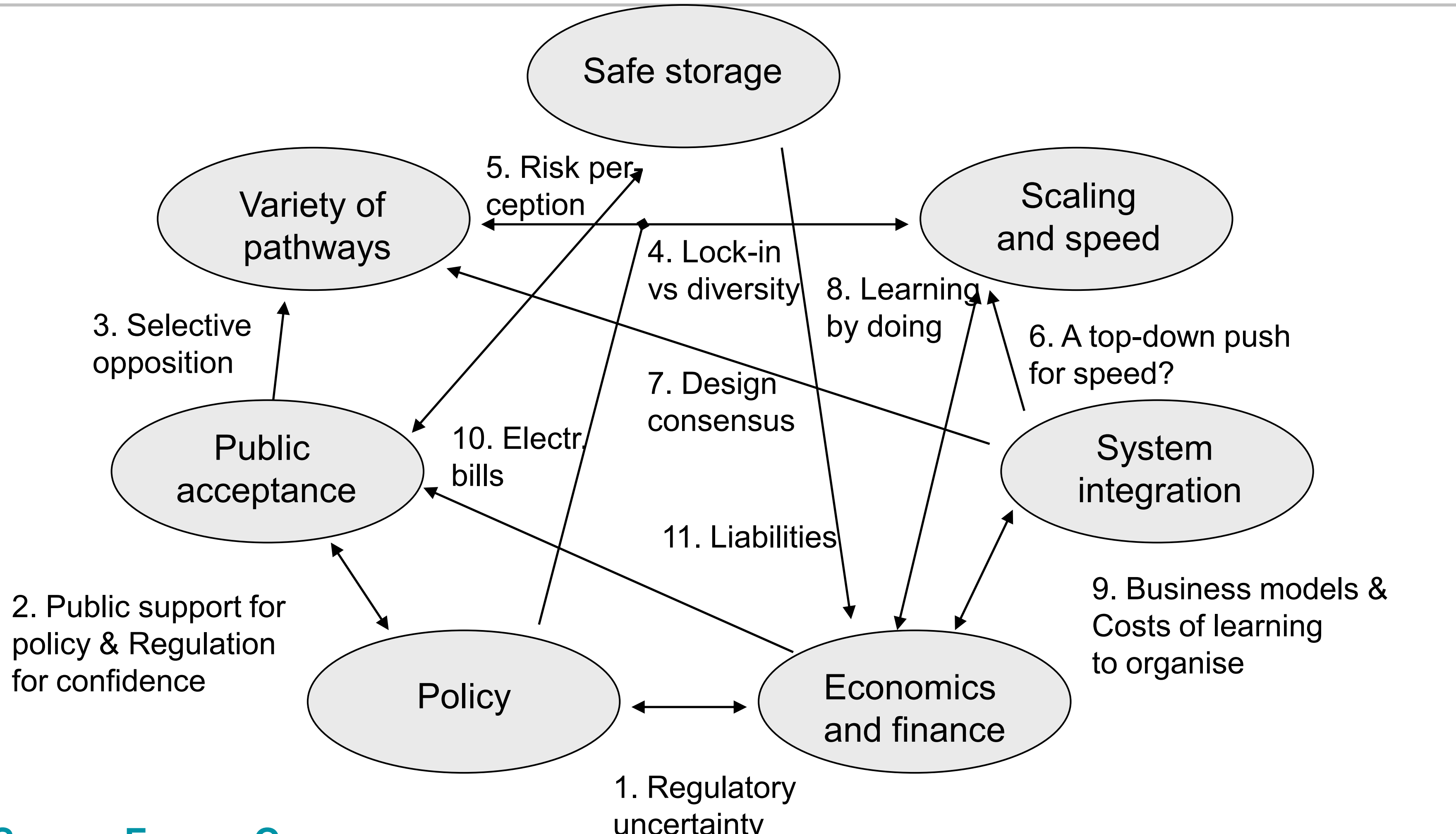
Interlinkages between uncertainties



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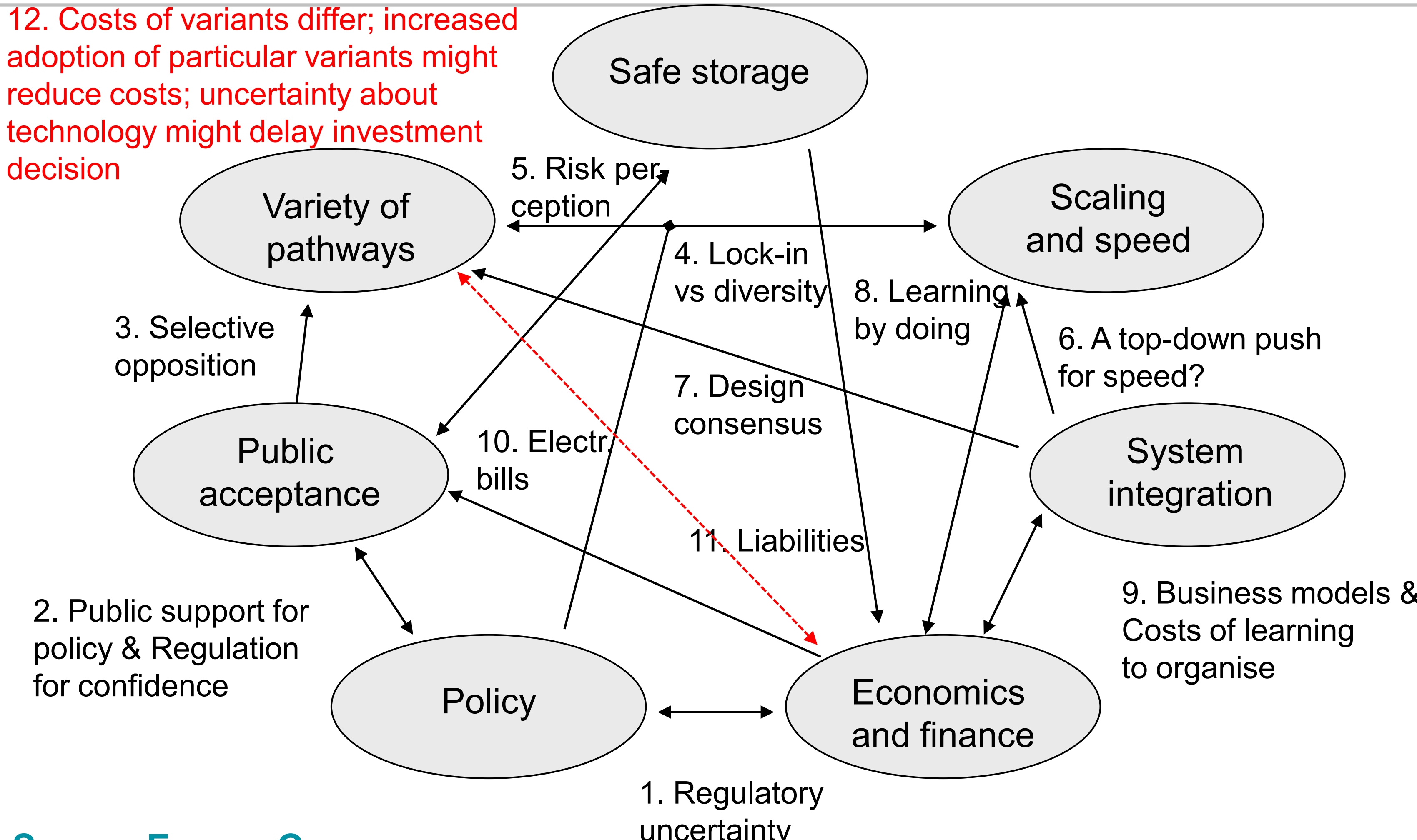

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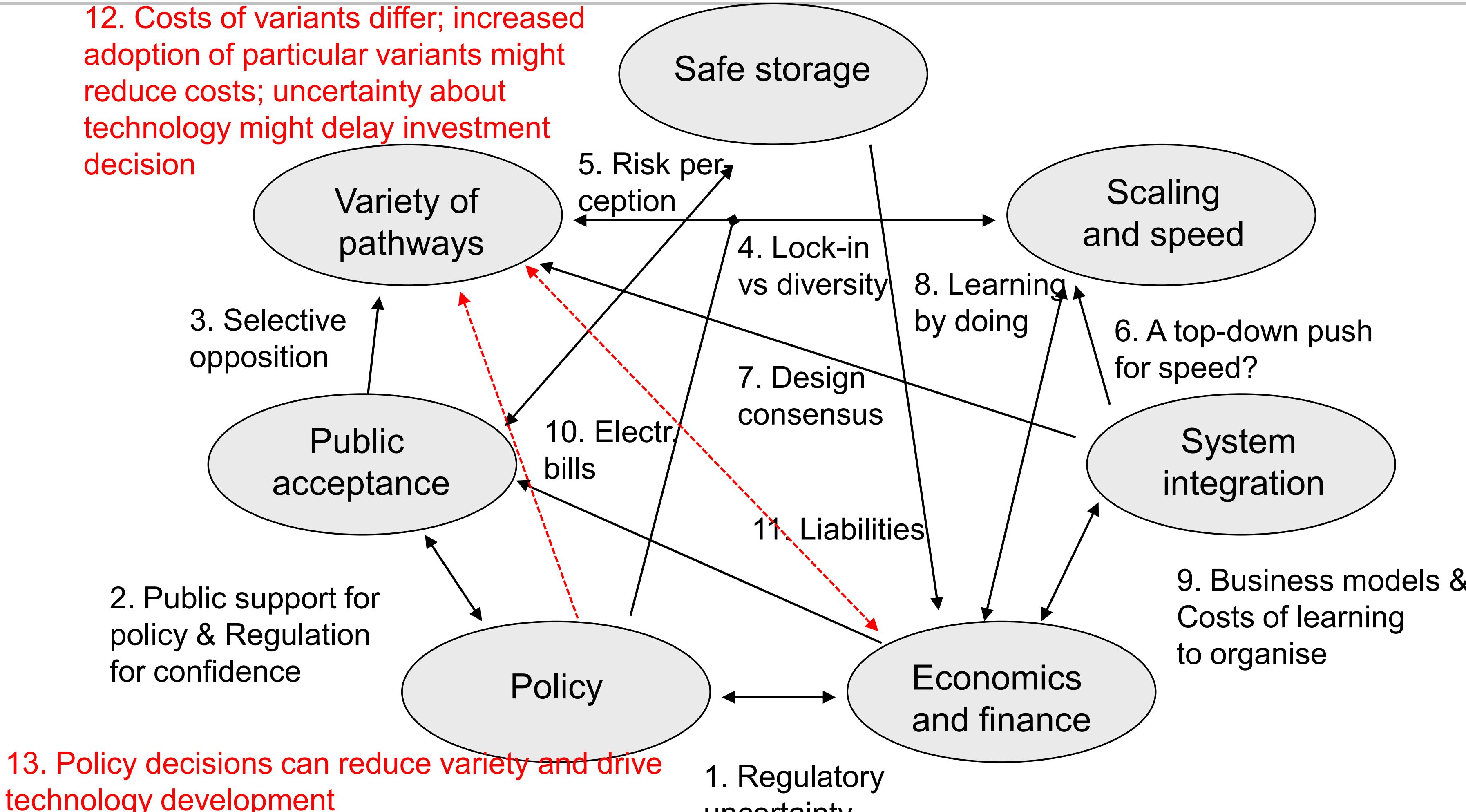

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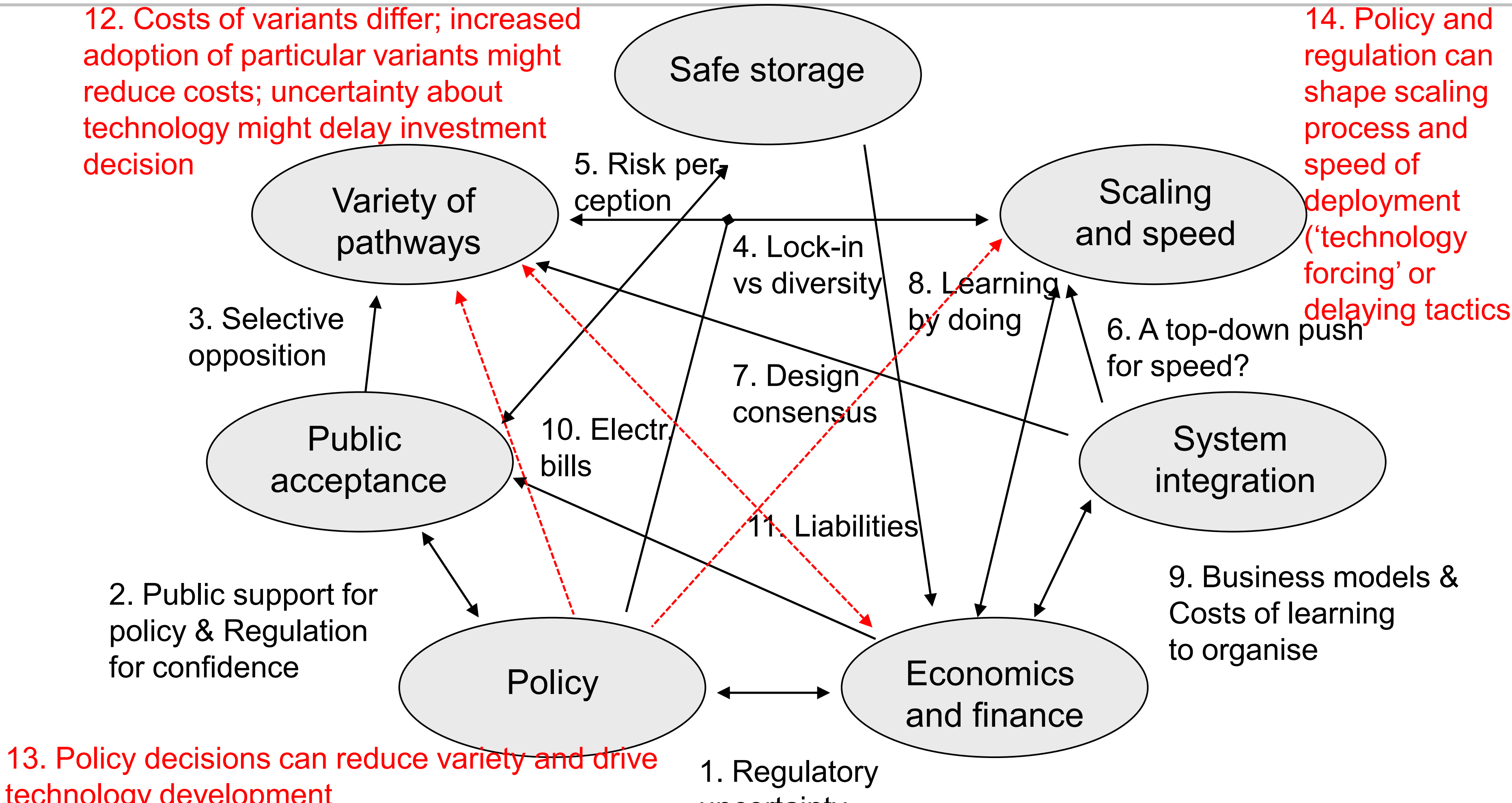

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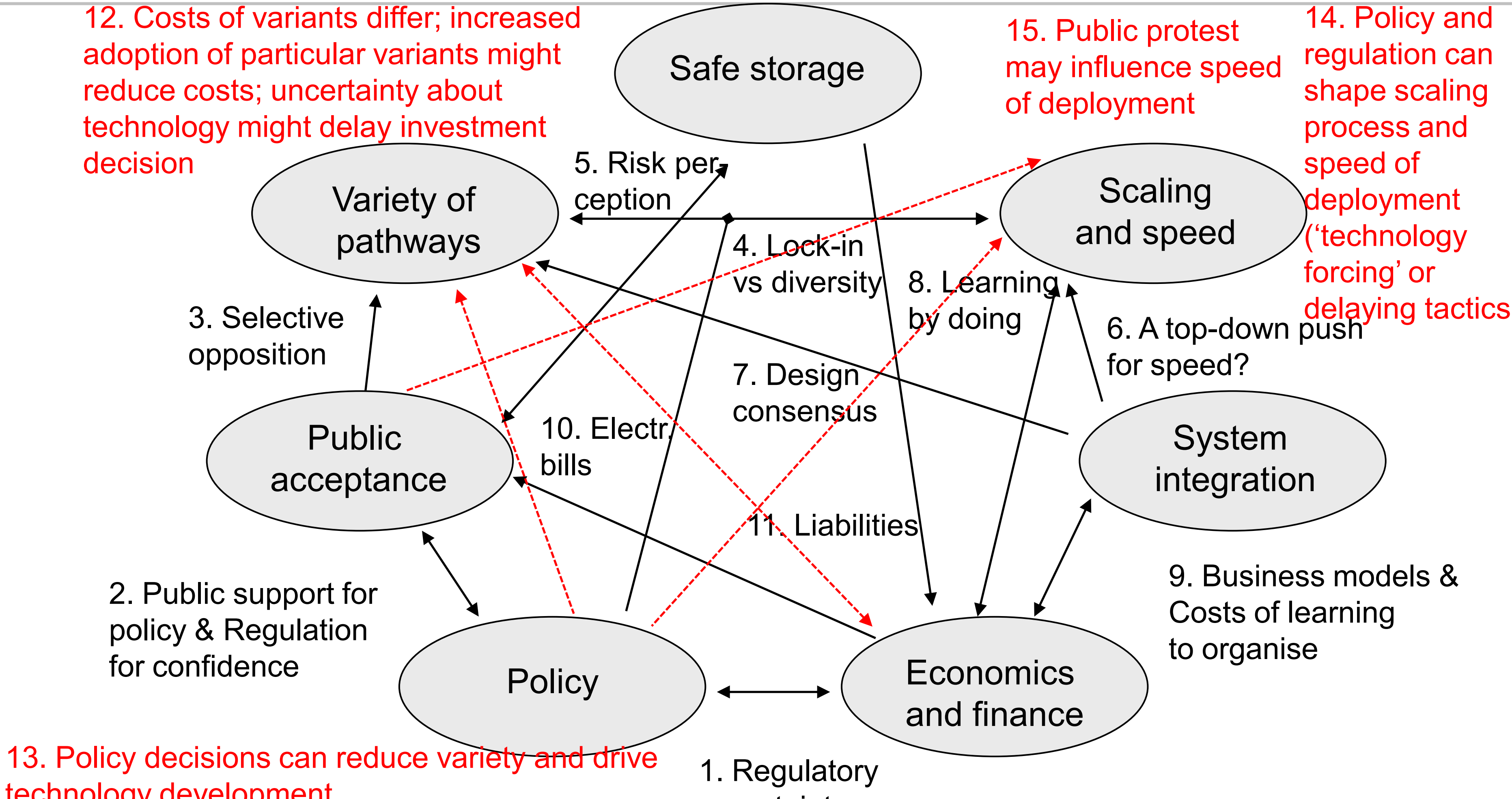

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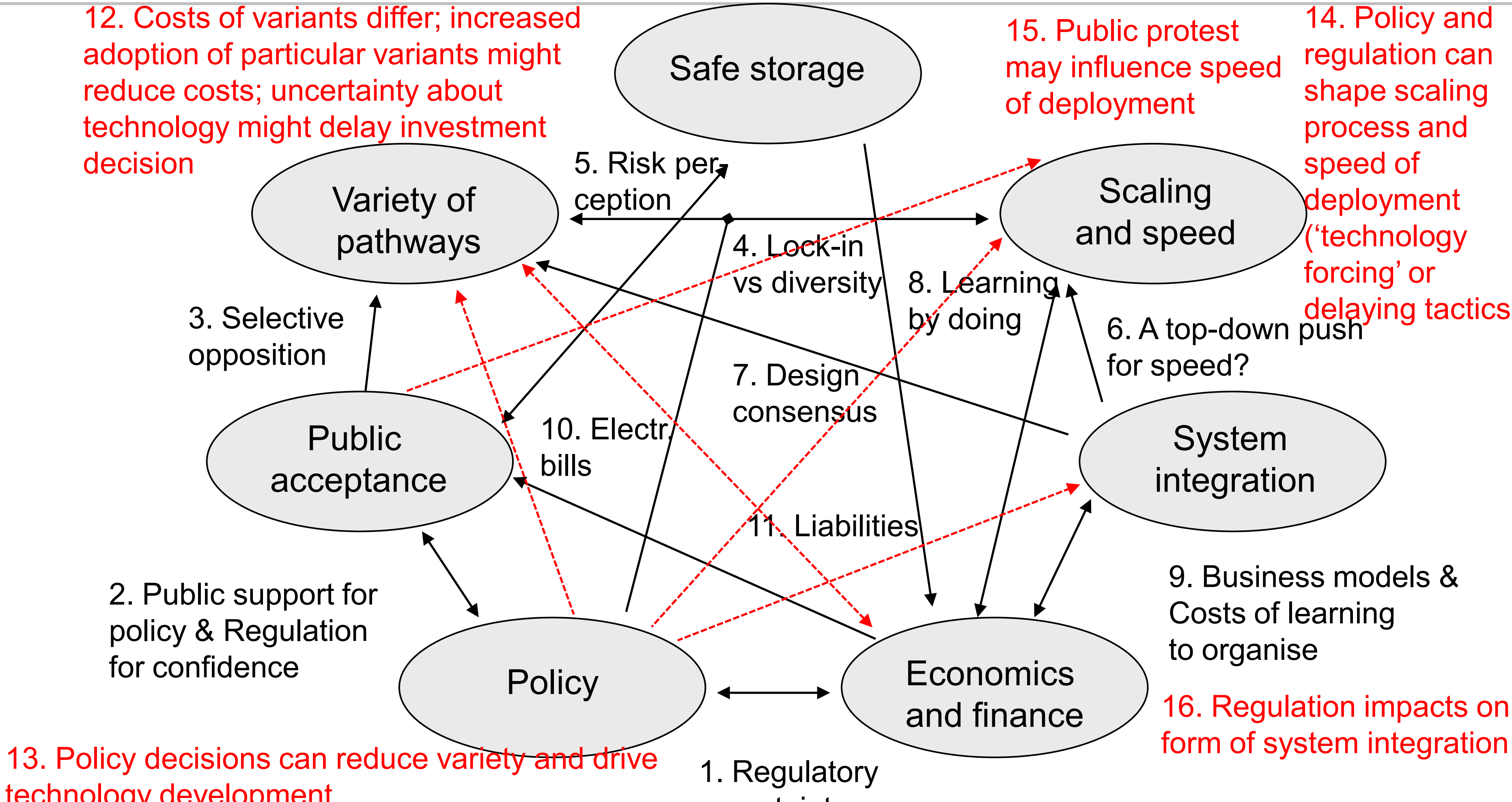
Interlinkages between uncertainties



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