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A Toolkit for Managing Sociotechnical Risk – September 2026

Prepared by: Jan/Josh/Stevan
Presented by: Josh Wickham (GPA)/Stevan (GIRA)

A Toolkit for Managing Sociotechnical Risk

We are here to launch a toolkit on Managing Sociotechnical risk in the Energy Transition.

The title of this raises two questions in my mind.

1. What is sociotechnical risk?

and

2. Why do we need a toolkit to manage it?

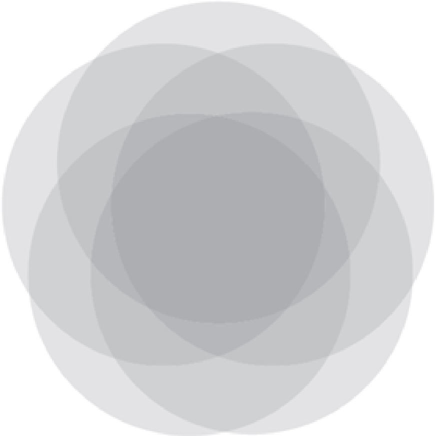
Sociotechnical risk (Macrae, 2022)

Sources of risk
are **interrelated**

They amplify,
reinforce,
interact and
overlap

Structural
sources of risk
Risks arising from interdependencies and interactions between different technical and social structures

Cultural
sources of risk
Risks arising from collective values, beliefs, norms and practices



Organisational
sources of risk
Risks arising from social processes, organising activities and human and contextual factors

Epistemic
sources of risk
Risks arising from the ways that knowledge and ignorance are constructed

Technological
sources of risk
Risks arising from the capabilities, affordances and constraints produced in and by material technologies

Epistemic = knowledge related

Stage 1 Project Summary

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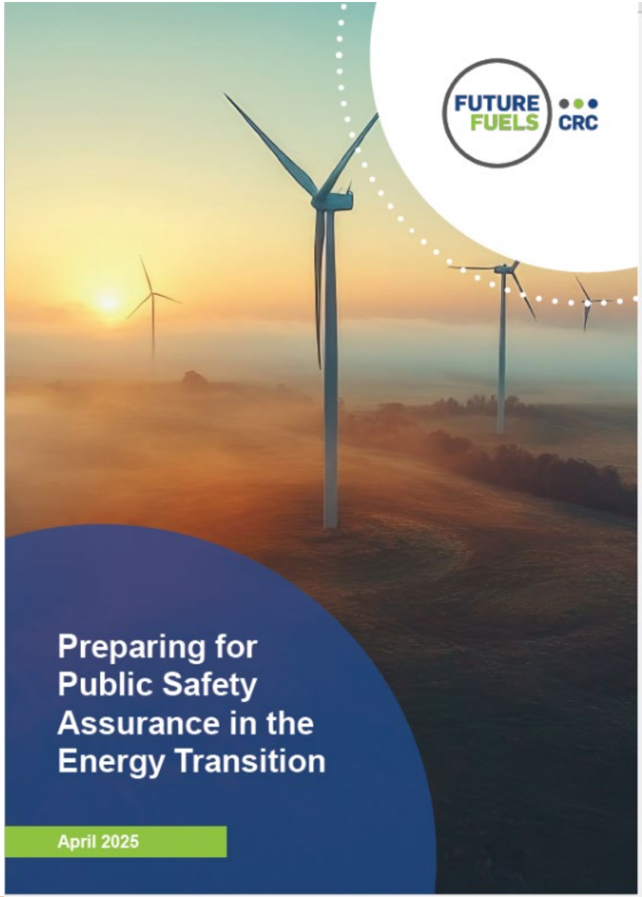
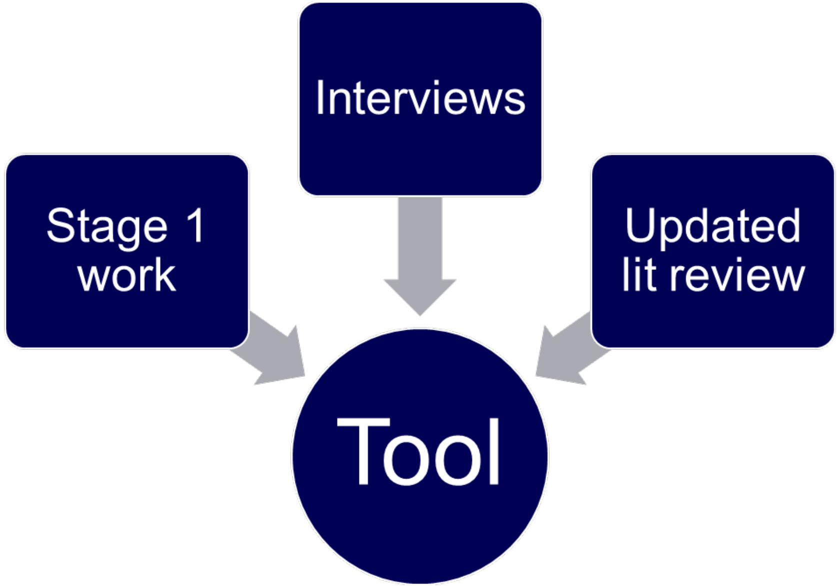
- FFCRC project RP2.3-08 Public Safety Assurance in the Energy Transition
- Literature review and accident case analysis re sociotechnical risks



Stage 2 Project Objectives

Build on stage 1 work to produce:

1. a detailed report re project lessons learned and
2. a toolkit for identification of sociotechnical risks linked to any given energy transition activity/project.



Interviews – who and what

- **25 interviews** with people who have renewable gas project experience (real world projects)
- Pipeline company people, regulators, contractors, other project proponents
- Interviews focused on:
  - Challenges related to technological maturity and availability
  - Navigation of uncertainty over the science including in relation to regulation
  - Support for knowledge development and management considering the expanding workforce
  - Impacts of political and policy pressures in relation to renewable gas projects

Toolkit style

Toolkit

- Small set of key principles for managing renewable gas project risk with a focus on what's different to BAU.
- For each principle:
  - Explain what's different
  - Set of reflective questions
  - Two or three real world examples
- Designed to make you think!
- Not designed to replace existing project risk management processes.

Principles

1. Acknowledge the uncertain environment and the impact this can have on everyone
2. Ensure individuals and organisations understand their responsibilities and have the skills to carry them out
3. Consider how different people and organisations bring different cultures to the project
4. Spend extra time on planning to achieve goals faster in the end
5. Ensure that novel technology equipment items are effectively integrated into the whole-of-plant design
6. Think about how our past experience influences our design and our way of working
7. Consider how the built facilities will be integrated into the base business technically, financially and organisationally
8. Ensure regulatory responsibilities are understood and regulator relationships are strong
9. Keep in touch with government policy shifts at all levels
10. Maximise learning from operating experience including sharing across the sector
11. Support continuing research and standards development to capture and share new knowledge

Acknowledge the uncertain environment and the impact this can have on everyone 1

Ensure individuals and organisations understand their responsibilities and have the skills to carry them out 2

Consider how different people and organisations bring different cultures to the project 3

Spend extra time on planning to achieve goals faster in the end 4

Ensure that novel technology equipment items are effectively integrated into the whole of plant design 5

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11 Support continuing research and standards development to capture and share new knowledge

10 Maximise learning from operating experience including sharing across the sector

9 Keep in touch with government policy shifts at all levels

8 Ensure regulatory responsibilities are understood and regulator relationships are strong

7 Consider how the built facilities will be integrated into the base business technically, financially and organisationally

6 Think about how our past experience influences our design and our way of working

Toolkit Design & Format

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Format of Each 11 Principles:

1. Overview statement
2. Key reflective questions
3. Two real world examples

Acknowledge the uncertain environment and the impact this can have on everyone

Working on innovative projects linked to energy transition is rewarding, and so they attract capable people. But uncertainty is the constant in today's evolving renewable gas landscape, with rapid scientific and technological advancements, shifting project scopes, and fluctuating market conditions. These changes can affect timelines and influence the morale of project personnel, particularly those involved in pre-FID stages and demonstration facilities.

Identifying risks linked to uncertainty

- Constantly shifting goal posts can result in change fatigue. What can we do to support our people and maintain clarity while still meeting evolving expectations?
- How do we keep the team motivated to stand up for safety and make difficult safety choices when there is so much uncertainty about the project going ahead? Do we have effective change management systems to ensure the final design is fit for purpose?
- With significant uncertainty over the basic science, how do we recognise when it is necessary to return to first principles to address remaining technical challenges? Are we allowing sufficient time and space to do this effectively?
- Financing and regulatory processes often require demonstrating best practice, but this becomes challenging when there are no existing facilities or benchmarks to draw on. What additional steps or evidence might be required to satisfy both financing requirements and regulatory expectations? How will you meet them?
- Delivery expectations may be set by political imperatives, not by engineering considerations. Are our schedule requirements realistic given the technical work required?
- In a tight employment market, securing and retaining skilled personnel is critical. What can we do to encourage project team members to stay in a competitive employment environment?
- Commercial pressures can drive optimistic assumptions regarding uncertain safety and reliability outcomes. Are our safety and reliability performance assumptions realistic and appropriately risk averse?

The strain of late-stage changes

In rapidly evolving sectors such as hydrogen, constant shifts in project scope driven by uncertainty around offtake and emerging market opportunities can create significant strain on teams. In one project, late-stage changes, such as scaling facility size in response to new potential customers, repeatedly redirected project efforts. While teams may initially respond with energy and adaptability, this becomes unsustainable over time.

One strategy to address this is limiting the time individuals spend in roles that are most exposed to constant change and rework.

When safety is extra hypothetical

A project environment always involves some degree of contestation where engineers need to be able to put a good case for what they think is the right choice. To be most effective, professionals need to be invested in the outcome of their work, but this becomes hard to maintain in the face of constantly shifting goal posts.

When teams believe a project is unlikely to proceed, safety considerations may be treated as theoretical rather than real, leading to less rigorous scrutiny of hazards and mitigations. It's hard to maintain chronic unease if you know in the back of your mind that the design will likely change next month.

Maintaining discipline in safety management, regardless of perceived project viability, is critical to ensuring preparedness and protecting future system integrity, people, and the environment.

Principle 1

Example Principle – Uncertainty

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Key Components of Principle

- Working on innovative projects linked to energy transformation is rewarding, and so they attract capable people.
- Uncertainty is constant in today's renewable gas landscape, with
- rapid scientific and technological advancements, shifting project scopes, and fluctuating market conditions.
- Changes affect timelines, influence the morale of project personnel, especially in pre-FID stages and demonstration facilities.

Principle 1

Questions

Example Principle – Uncertainty

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Key Reflective Questions

1. Constantly shifting goal posts result in fatigue. What can we do to support our people and maintain clarity?
2. How do we keep the team motivated to stand up for safety and make difficult safety choices when there is so much uncertainty about the project going ahead? Do we have effective change management systems to ensure the final design is fit for purpose?
3. With significant uncertainty over the basic science, how do we recognise when it is necessary to return to first principles to address remaining technical challenges? Are we allowing sufficient time and space to do this effectively?

Principle 1

Questions

Example Principle – Uncertainty

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Key Reflective Questions

4. Financing and regulatory processes require demonstrating best practice, but this becomes challenging when no existing facilities or benchmarks to draw on. What additional steps or evidence might be required to satisfy both? How will you meet them?
5. Delivery expectations may be set by political imperatives, not by engineering considerations. Are our schedule requirements realistic given the technical work required?
6. In a tight employment market, securing and retaining skilled personnel is critical. What can we do to encourage project team members to stay in a competitive employment environment?
7. Commercial pressures can drive optimistic assumptions regarding uncertain safety and reliability outcomes. Are our safety and reliability performance assumptions realistic and appropriately risk averse?

Principle 1

Real World Examples

- Toolkit also includes real-world examples:

The strain of late-stage changes

In rapidly evolving sectors such as hydrogen, constant shifts in project scope driven by uncertainty around offtake and emerging market opportunities can create significant strain on teams. In one project, late-stage changes, such as scaling facility size in response to new potential customers, repeatedly redirected project efforts. While teams may initially respond with energy and adaptability, this becomes unsustainable over time.

One strategy to address this is limiting the time individuals spend in roles that are most exposed to constant change and rework.

Safety in design

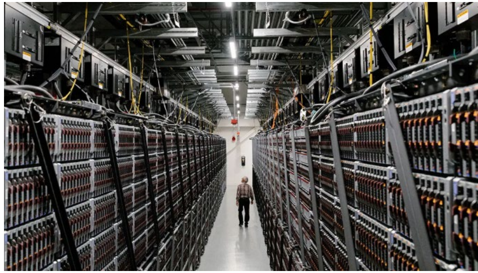
The concept of safety in design has been well adopted in the gas sector and other process industries including embedding safety thinking into concept selection.

In contrast, the early stages of some projects have focussed on project economics and technical feasibility, seeing safety as a check or an add-on to be addressed later. This has led to significant cost additions at FEED stage to address possible failure modes or worst-case consequences and how to avoid them.

This can lead to costly rework or even taking projects forward only to discover later in project execution that they cannot be safely executed.

What to leave with?

1. Toolkit is ready to be used (30-page document – hard copies here!)
2. Further information in 60-page report (expanded document)
3. Developed based on renewable gas experiences (especially pilot scale hydrogen) – core lessons can **apply to other new sectors**
4. Read and reflect, and **trial the reflective questions on your next new project**



Ensure that novel technology equipment items are effectively integrated into the whole-of-plant design

Understanding how an electrolyser or other novel equipment item functions as part of an overall plant design requires data on boundary conditions and safety and operational studies of how the entire system functions in both normal and abnormal conditions. In the renewable gas context, some vendors have not focussed strongly on this aspect of their technology development and may not fully understand the complexity and importance of system-wide studies. Inadequate management of this interface can lead to safety and reliability problems in operation.

Identifying risks linked to integration of whole-of-plant design

- An effective process safety view of a new plant requires an integrated understanding of how the entire system will operate. Are we considering safety at a system level, not just focussing on individual equipment items? Have we done a Layers of Protection Analysis (LOPA) and established Safety Integrity Levels (SIL) for instrumented risk controls? Has risk been reduced so far as is reasonably practicable (SFAIRP)?
- Do vendor contracts / relationships give us access to all the safety information we need to safely integrate each new equipment item into an overall safe system?
- Are we satisfied that operational and safety instrumented functions are separated in our design and management of change processes will ensure this is maintained in operation?
- Comprehensive safety studies require an understanding of possible failure modes which might be lacking for innovative designs with little operating track record. Do we have a good understanding of the possible failure modes of all parts of the new facility? Have we completed a comprehensive HAZOP that addresses nodes across all facilities?
- Many new facilities are bespoke, meaning that spares may not be readily available when they are needed. Have we thought about spares requirements (likely need and delivery time) and the potential impact on plant up time?
- Novel technology is rapidly evolving. How does our design take this into account?
- Does everyone clearly understand the boundaries between vendor packages and the balance of plant?

Access to vendor safety studies

HAZOP is a key safety assurance mechanism and conducting an effective HAZOP of a plant involving innovative technology requires that the entire plant is reviewed by a team that includes expertise in the new technology. Some projects have experienced difficulties in getting vendors to provide details of past HAZOP studies conducted for their equipment and/or to take part of whole of plant HAZOP studies.

This risk has been managed by ensuring contract conditions list required documents but also by building strong vendor relationships to ensure the cooperation of technical staff.

Impact on the rest of the plant

Some design contractors reported that electrolyser vendors do not always design operating and safety functions as separate within instrumentation architecture as has been standard in the oil and gas sector for decades. This becomes particularly critical when vendors retain access to operational instrumentation even after plant commissioning in order to monitor equipment performance and even make operating software updates remotely.

Managing this risk requires significant awareness on the part of design personnel including checking fundamental aspects of design that might normally be taken for granted.

Consider how the built facilities will be integrated into the base business technically, financially and organisationally

The complex and uncertain nature of renewable gas projects has the potential to create difficulties at upstream and downstream interfaces with the base business. Issues can be technical or organisational as existing systems, equipment, workforce and customers are impacted by the new facilities. Effective management makes for easier startup whereas gaps can make early operations difficult.

Identifying risks linked to base business integration

- Is everyone clear on the motivation driving the project (profit, proof of concept, other)? Does everyone share the vision?
- Does our project introduce hazards that our workforce may not be familiar with (e.g. presence of H_2S, operating completely new types of equipment)? How will they be trained to manage such hazards?
- What are the key assumptions we have made in our design about facility operations? Are there any new operational monitoring requirements to confirm our assumptions regarding plant behaviour in operations?
- Is organisational ringfencing required to meet competition regulations?
- How are those working in the base business kept up to date with new projects and what these changes might mean for them?
- How do our project plans impact existing customers, both technically and commercially? Have all potential impacts been addressed?
- Are we planning to shut down old plant and/or facilities as part of the project? Have we identified and considered all interfaces, particularly utilities?
- As we move to increasing use of artificial intelligence (AI), how does this impact our plans for renewable gas projects?

When agile meets systems

Renewable gas project teams are sometimes noted as having a different culture to base businesses - more agile and less compliance focussed. While this might work well for generating concepts and ideas, at some point the project needs to be integrated with company systems. Some projects have addressed this relatively late in project execution creating confusion and delays.

Selling renewable gas to existing customers

Existing customers who buy gas under contract can also be impacted by renewable gas projects. In addition to technical questions related to the impact of changes in the heating value of the gas supplied to them, legal paperwork may also need to be updated to ensure that new gases fall into the scope of existing sales agreements.

Changes to base plant

Some renewables projects have involved shutting down parts of base plant to eliminate carbon-intensive operations. Planning for such changes is not simple. Process plant is often highly integrated, particularly when it comes to utilities such as heating, cooling, plant air and/or plant nitrogen. Planning for some projects has come unstuck when interfaces are not understood from the start.

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