

# Impact of energy transition on process safety in conventional energy facilities

Dr Mark Scanlon, CChem  
MEI, Head of HS&E Good  
Practice, Energy Institute

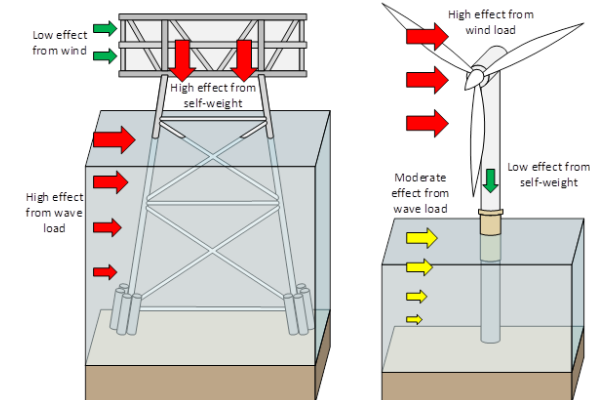
# Context: The Energy Transition Challenge

- Net zero emissions (NZE) by 2050 target
  - Nations and organisations responding
  - Energy system paradigm shift required in 25 years
  - Rethink and deliver – generate, store, transmit, distribute and use energy
- Comparison to first industrial revolution – 100 years
- Last 25 years: LNG, shale gas, biofuels, electrification
- Some winners, some ‘rabbit holes’, uncertainty (no offtakers?)
- And maintain existing assets (PS leadership)



# Context: Energy Transition Challenge

- Transition expected to be chaotic
  - Multiple opportunities and impacts in parallel
- Not just about technology – need to address changing climate



# Future Technological Requirements for NZE 2050

- Initial abatement through existing technologies and demand-side measures
- Innovative technologies required post-2030:
  - Application at scale
  - And rapid adoption



# Process Safety Management (PSM)



- Process safety management of change (MoC) critical to manage new major accident hazards (MAH) to protect people and the environment (MATTEs):
  - Adapting conventional industry operations (e.g. refinery feedstocks (e.g. waste-to-fuels), repurposing assets)
  - Introducing innovative technologies

# Process Safety Management (PSM) *continued*



- Raises questions regarding energy transition PSM impacts (... rest of presentation):
  - What are the potential process safety impacts?
  - Are PSM principles applicable, and if so, what are the priorities?
  - Are process safety standards and practices ready?
  - Future regulation of lower carbon businesses



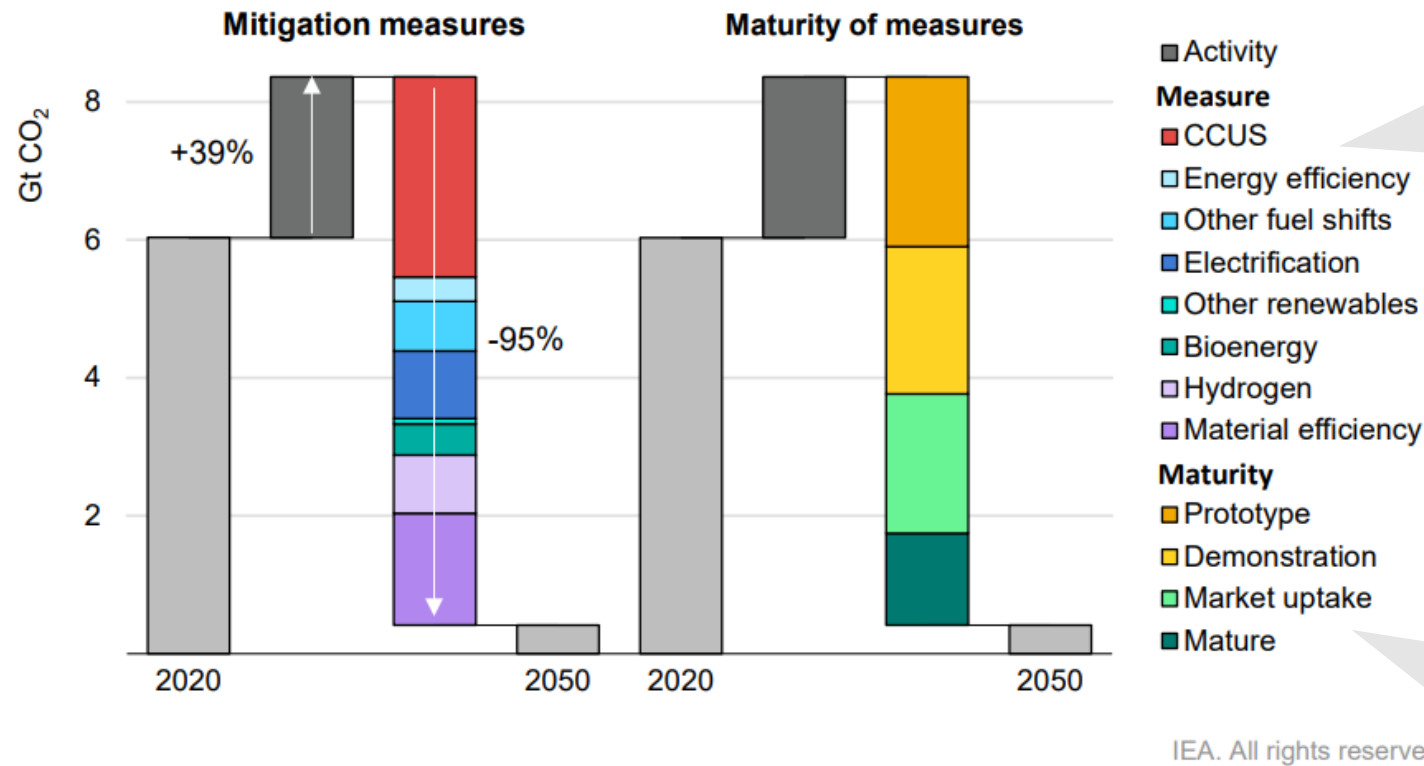
# Energy Transition already in progress

- But the energy transition has already been happening:
  - Decommissioning
  - Blending biofuels in gasoline, diesel
  - Carbon capture plants adoption
  - Increasing renewable electricity production
- But expect greater pace and more technology diversity ... next slide



# Example Decarbonisation Options – Heavy Industries (e.g. steel and cement manufacture)

Figure 1.6 Global direct CO<sub>2</sub> emissions reductions in heavy industries by mitigation measure and current technology maturity category in the Net Zero Emissions by 2050 Scenario



Multiple technologies required – PS impacts (plant complexity, several hazards)?

But only some technologies mature – iterative deployment over decades



# Net Zero/Process Safety Workshop Insights



- November 2023 industry engagement workshop, hosted by TÜV Rheinland:
  - ‘What is Process Safety Leadership’s role in managing risk during the transition to net zero?’
  - Delegates from diverse industry backgrounds, mainly UK based
  - General theme of uncertainty (e.g. governmental policy)



# Workshop: New Hazards and Risk Assessment

- New technologies introduce new hazards, e.g.:
  - Industrial-scale battery energy storage systems (BESSs) – fire hazard
  - Ammonia reimagined as a marine fuel – LoC toxicity hazard (research need)
- Risk assessment techniques largely suitable:
  - Need for minor adjustments to address climate change impact (Natural Hazards Triggering Technological Disasters (Natechs))



# Workshop: Recognised Good Practice (RGP) Shortfalls

- Physical impacts of climate change, e.g. Natechs
- Multi-site hazard study development (interfaces in clusters)
- Innovative technology engineering controls
- Ensuring new companies use guidance



Courtesy: HyNet <https://hynet.co.uk>

# Workshop: Key Process Safety Leadership Challenges



- MoC – speed and complexity
- Leadership PSM competency concerns: existing organisations and new entrants
- Understanding risks within organisations
- Collaboration necessity across sectors
- Commercial sensitivities may impair adequate knowledge sharing

# Process Safety Standards Readiness

- Industry collaborative organisations developing new standards, and amending existing portfolio
- Energy Institute's standards development process:
  - Initially *ad hoc* approach
  - Later strategic approach: workshop identified priority areas:
    - hydrogen
    - CCUS
    - power systems



# EI Process Safety Standards Developed, in Progress and Planned

- Early focus on process safety in decommissioning projects
  - Later, subsea pipeline decommissioning, structural integrity management of decommissioned offshore structures
- Hydrogen legislation mapping ('safety cases'), then skills, asset integrity MoC for infrastructure repurposing, and corrosion management
- CCUS: revised hazard analysis and plant design (first published 2010/2013) and for 2025 LoC hazard analysis study for offshore installations





## Amendment of Existing EI Standards



- EI has portfolio of existing process safety standards (~75 No.), as well as for portfolios for asset integrity, human factors, and energy transition-ready portfolios for hydrogen, power systems and CCUS
- ~50 No. process safety standards generic – no amendment required for energy transition or research studies
- ~25 No. being reviewed for adaptation for energy transition. E.g., for process safety, recently published:
  - EI 3015 ('EI 15'): hazardous area classification of gaseous hydrogen and liquid hydrogen
- EI Process Safety Committee reviewed portfolio for potential adaptation and prioritised top three titles
- Significant effort to revise all pertinent standards

**Adapting  
priority  
existing EI  
publications  
for the energy  
transition**

- *Guidance and toolkit for training on emergency decision making in loss of containment incidents (1<sup>st</sup> ed., 2017)*
- *Guidance on passive fire protection for process and storage plant and equipment (1<sup>st</sup> ed., 2017)*
- *Guidance on applying inherent safety in design: Reducing process safety hazards whilst optimising CAPEX and OPEX (2<sup>nd</sup> ed., 2014)*

## Adapting priority existing EI publications for the energy transition

### Methodology:

- Keeping the original table of contents (ToC), extend the chapters with updated information relating to the energy transition globally
- Highlight the main aspects/challenges and relevant information by adding key findings relating to the new technologies or substances (e.g. fuels)
- Update the current case studies presented in the publications by including energy transition-related international events, such as losses of containment (LoC)
- Working Group provides direction and review drafts
- Engaging wider stakeholder community (e.g. users of standards)

***Guidance and toolkit for training on emergency decision making in loss of containment incidents (1<sup>st</sup> ed., 2017)***

- Examples of changes:
  - Refer to the energy transition and expand to include low carbon substances.
  - Add a description of the challenges of energy transition.
  - Incident types: Update in terms of storage and processes related to carbon fuels.
  - Understanding and competence: Update to reflect the need for competence related to renewables and new processes.



Courtesy US CSB  
Chevron Richmond Refinery #4 Crude Unit, Richmond,  
California August 6, 2012. Report No. 2012-03-I-CA  
January 2015

***Guidance and toolkit for training on emergency decision making in loss of containment incidents (1<sup>st</sup> ed., 2017) continued***

- Example MoC issues:
  - Update range of loss of containment (LoC) events.
  - Are there any different or additional measures for new substances and processes?
  - Emergency response (ER) training: are there different/additional requirements, such as response time, how to respond to specific hazards from low carbon fuels, etc?

***Guidance on  
passive fire  
protection for  
process and  
storage plant  
and equipment  
(1<sup>st</sup> ed., 2017)***

- Examples of changes:
  - Focus on loss of containment (LoC) events
  - Adapt for low carbon and non-carbon substances, including biofuels, H<sub>2</sub>, NH<sub>3</sub>.
  - Consider extending application to BESSs.
  - Example MoC issues: Consider small H<sub>2</sub> molecule easily diffusing through small gaps in PFP materials to protected material. Potential for H<sub>2</sub> embrittlement of protected carbon steel?





***Guidance on  
applying  
inherent safety  
in design:  
Reducing  
process safety  
hazards whilst  
optimising  
CAPEX and  
OPEX (2<sup>nd</sup> ed.,  
2014)***

- Examples of changes:
  - Emphasise the need for leaders to understand the impact of new technologies and their associated hazards in order to be familiar with the potential inherent safety strategies to be applied.
  - Clarify application to cover storage and handling of all low carbon and non-carbon fuels.
  - Consider whether different/additional if additional considerations are required relating to low carbon and non-carbon fuel systems in all phases of the design process.
  - Consider different range of applications, e.g. novel marine fuels, bulk shipping of CO<sub>2</sub>.
  - Consider 'brownfield' design, e.g. for repurposing assets.
  - Better consider environmental impacts, as well as safety.

# Who guards and is developing net zero standards?

- A complex picture, with multiple organisations working in parallel and lacking high-level coordination. Some operate at different TRLs. They include:
  - Research councils, regulators (e.g. OFGEM) and governmental funding applied mainly to academia, academia hubs (e.g. Ocean RE-Fuel, IDRIC, Mari-NH3), consultancies and technology developers (e.g. Net Zero Technology Centre)
  - Trade associations (H2 Council, EIGA, EEMUA, BCGA)
  - Professional bodies (IGEM, EI)
  - Standards Development Organisations (e.g. ISO TC/197 and TC/67)
  - IEA for HAC and separation distances
  - Skills bodies (e.g. Cogent, E&U Skills, ECITB, Opito)




Storage of anhydrous ammonia under pressure in the United Kingdom

! Needs revalidation  
– published 1986

# Future Regulation of Lower Carbon Businesses

- Health and safety (and environmental) legislation, regulation and regulators contribute to PSM assurance
  - GB has HSE and several environmental regulators
- HSE established Net Zero Hub to assess impacts to facilities and operations it regulates from:
  - the energy transition
  - climate change
  - HSE's ten-year strategy

A black and white thought bubble with a tail pointing towards the left, containing text.

'Enable industry to innovate safely to prevent major incidents, supporting the move towards net zero'

# Lower Carbon Business Regulation



- Onus on duty-holders to demonstrate safety ('safety case')
- EU directives and goal-setting legislation largely applicable, but:
  - EU Offshore Safety Directive limited scope for CO<sub>2</sub>/H<sub>2</sub> offshore
- Environmental regulators' focus:
  - MATTEs
  - Adapting to climate challenges (extreme weather and Natechs)
- HSE and environmental regulators engage in standards development – industry benchmarks
- Caution with new technologies and new duty holders, now part of the energy system:
  - E.g. flammability hazard in anaerobic digestion plants

## Key 'Take-Aways'

- A safe ('process safe') energy transition is required
- Process safety leadership remains important
- Timely communication of risks (pace of change)
- Adaptation of PSM frameworks (for energy transition complexity)
- Availability of comprehensive knowledge in standards (new hazards, risks, and control measures)
- ..... while operating within business uncertainty

Reflecting on the presentation title ‘Impact of energy transition on process safety in conventional energy facilities’:

- There are many potential impacts brought about by the energy transition
- Some ‘standards’ are available to assist in enabling and assuring good PSM; but there is much work in progress, and more work is required, including research, before codifying into standards



# Acknowledgements



Gaynor Woodford, Sustainability Lead – TÜV Rheinland, and Laszlo Komaromi, Senior Technical Officer – Energy Institute, who documented insights from industry engagement at the TÜV Rheinland Process Safety Management Workshop and Conference ‘What is Process Safety Leadership’s role in managing risk during the transition to net zero?’ (Edinburgh, November 2023).

Dr Zsuzsanna Gyenes, AMIChemE, Director – Global Industrial Safety Solutions Ltd.

Thank You

# Impact of energy transition on process safety in conventional energy facilities


Dr Mark Scanlon, CChem  
MEI, Head of HS&E Good  
Practice, Energy Institute

**Thank you.**

**Questions?**

[mscanlon@energyinst.org](mailto:mscanlon@energyinst.org) 

[www.energyinst.org](http://www.energyinst.org)

 Follow us:  
@EnergyInstitute

 Join us:  
Energy Institute