SHALE
HYDRAULIC FRACTURING

MINIMISING IMPACTS ON COMMUNITIES
(Responsible & Sustainable Development)

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Company:	Atlantic Council
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ENERGY COMMUNITY IMPACTS

- Any development has risk and disturbance
- Risk determination and acceptance is critical

Community Interaction

- Supply timely open and complete information
- Technical based risk analysis

Positive

1. Development and Appraisal R&D
2. Jobs: Direct and Indirect
3. Housing: Permanent and Temporary
4. Local and National Investment
5. Energy Security
6. Source Readily Available

ENERGY COMMUNITY IMPACTS

Negative

1. Development and Appraisal R&D
2. Transportation
3. Potential environmental contamination
4. Community character
    - Noise
    - Visual
    - Emmissions

UNCONVENTIONAL RISK

- Rapid development in the energy industry
- Roll-out world-wide by operators into new plays without direct US analogues
- Numerous incidents now that have highlighted potential exploration risks
- Increasing public awareness and attention on the technology

UNCON Boom and Emerging Risk

- Exponential increase in the use of the technology
- Reduced pool of appropriately qualified personnel
- Understanding geomechanical and operational aspects is critical
- Studies ongoing at present in the US/UK looking at groundwater contamination and seismic risk during HF operations

RISK MANAGEMENT & FRACTURING

The Issue:
Pollution history associated with energy and the potential risk from hydraulic fracturing (HF).

Interested Parties:
HF risk management considerations and strategies involve everyone:

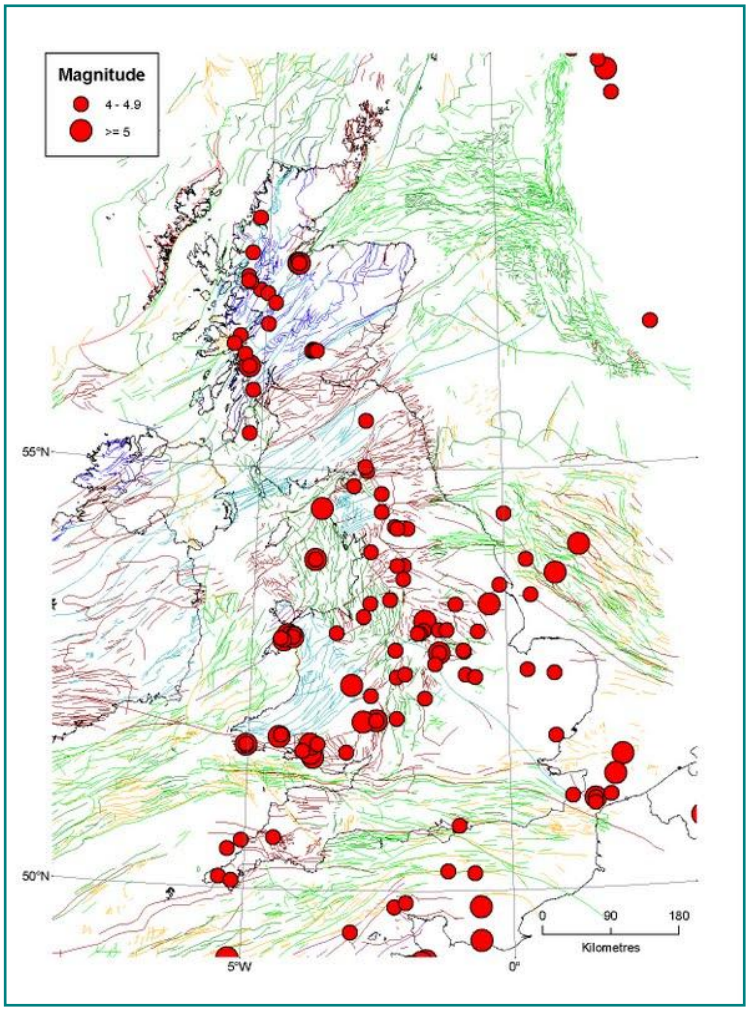
- **Energy industry**
- **Regulators**
- **Insurers**
- **Local stakeholders**
- **Other affected parties**

HAZARD PROTOCOL

Protocols exist for Geothermal industry (EGS) (Majer, 2008) of Induced Injection Seismicity (IIS):

1. Assess natural (seismic) hazard potential
2. Assess induced (seismicity) hazard potential
3. Review local laws and regulations
4. Establish dialogue with relevant authorities
5. Educate all stakeholders
6. Establish (microseismic) monitoring network
7. Update and interact with stakeholders
8. Implement procedure for Evaluating Damage

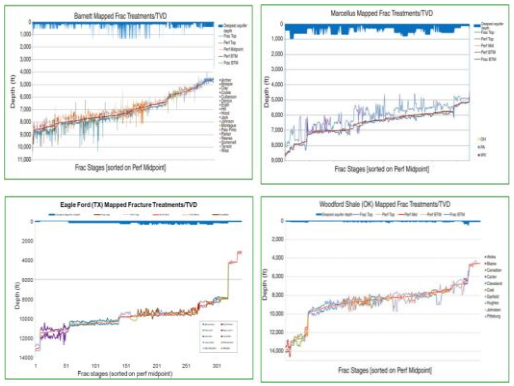
ASSESS NATURAL & INDUCED HAZARD POTENTIAL

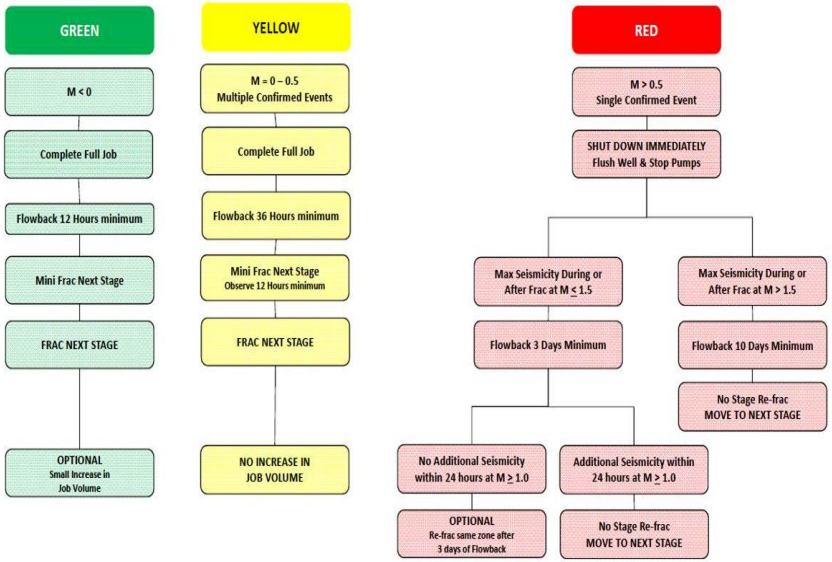


Characterise the natural seismic potential of the site and surrounding area, using public information:

- Earthquake history
  - Magnitude
  - Frequency
- Geological and tectonic setting
  - Fault sizes
  - Stress analysis
  - System geometry

ASSESS INDUCED HAZARD POTENTIAL





Analogous to mining/civil engineering

- Characterise the potential for nuisance seismicity and vibration damage
- Review geological information
- Independent estimate of maximum probable event
  - Incident rate
  - Severity
- Quantification of potential hazard to structures and buildings
- Mitigation plans required for environmental impact studies and similar regulatory reports.
- On-site periodic reviews or traffic light systems

REVIEW LOCAL LAWS & REGULATIONS

- Risk analysis and legal studies should be done of issues, identifying and assessing:
  - Induced seismicity
  - Blasting/clearing
  - Construction
  - Road noise and similar activities
- In consultation with the regulator, ensure compliance with legal requirements
- Liabilities can be based on: Trespass, Strict liability, Negligence and Nuisance
- Insurance risk needs to be determined and covered.

REGIONAL AUTHORITY DIALOGUE

Consultation with community groups and agencies:

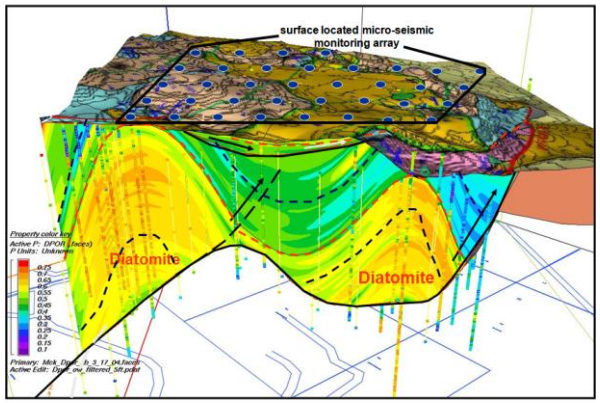
- Purpose of the project
- How the assessment will be done
- Size of site to be developed
- Expected impacts on the environment and local residents
- Long term costs and benefits (region and nationally)

EDUCATE STAKEHOLDERS

(Source Cuadrilla)

1. Regular public meetings or personal visits (population density dependent)
2. Open dialogue about relevant issues recommended
3. Training courses for stakeholders
4. Site visits

ESTABLISH A MONITORING NETWORK



(Source Microseismic)

(Source Pinnacle)

Wide range of magnitudes is desirable

- Existing Networks
- Dedicated network

Need to detect and mitigate risk to developed areas

- Radius several times the reservoir depth

Independence of monitoring equipment and analysis is important regarding claims.

INTERACT WITH STAKEHOLDERS

- Over 400 residents and stakeholders have been to our sites since February 2011
- A dedicated freephone community information line, email address and website
- Public Q&A sessions
- Many dozens of small and large meetings, engagements

(Source Cuadrilla)

Proactive updates
- Reduce public anxiety
- Put unreasonable claims in perspective

Options:
- Personal meetings of technical and consenting staff with local residents and regulators
- Public meetings
- Media coverage
- Guided tours
- Public annual operating reports
- Call-in line, web-site
- Scheduled meetings with public officials
- Newsletter or visitor centre

IMPLEMENT DAMAGE EVALUATION

Procedure for monitoring and responding to felt events should be developed

1. Assess structural damage
2. Assess environmental disturbance
3. Quantitative methods required for an accurate evaluation of any claim
4. Fair to both operator and public
5. Damage claim registration and mapping conducted by an independent organisation

REGULATOR REQUIREMENTS

Operator requirements:

- Clear policy and direction from national and local regulators and planning authorities, and coordinated roles and responsibilities.
- Business like cooperative relationship – appropriate issues raised and addressed in a timely way.
- Clear and consistent decision making criteria.
- Sensitivity to public concern is important and visible technical reassurance from regulators is also essential to manage this