

Ministerie van Klimaat en Groene Groei



Policy on induced seismicity in the Netherlands

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Sustainable use of the subsurface

now and in the future

- > <u>Important role for the subsurface</u> From production to storage
 - Gas production
 - 1/3 of current energy consumption
 - Production in NL before import
 - Gas storage
 - Geothermal energy
 - Salt production and storage
 - Raw material
 - Strategic independence
 - Reliable availability
 - Hydrogen storage
 - Energy transition
 - CO₂ storage





Risk in the Energy Transition



*source: Letter to Parliament, November 4th 2022 Dealing responsible with safety and health in the energy transition (Dutch: verantwoord omgaan met veiligheid en gezondheid in de energietransitie)



Policy principle 1 & 2: Responsible

The new energy system is equally safe and healthy as the current

1. High level of safety and health

- Define safety norms (LPR 10⁻⁵)
- The residual risk is acceptable
- Transition period for new activities

2. <u>Risk assessment and uncertainty</u>

- Uncertainty as part of risk
- Quantitative methods versus qualitative methods
- Precaution
- Monitoring and progressive insight → knowledge increases → incorporation in policy





Policy principle 3 and 4: Expeditious

Room for experimentation, learning from incidents, apply new insights

- 3. Help innovation and knowledge enhancement
 - Guidelines (if policy or regulation is missing)
 - Room for innovation (allow pilots under certain conditions)
 - Monitoring (to reduce uncertainty)
 - Knowledge increase, knowledge sharing, knowledge programs

4. Drawing lessons from incidents

- Incidents are inevitable and damage needs to be compensated
- Lessons learned → reduce probability of resurrence, possible reduction of effects
- Not emotions but facts as basis for lessons and improvements
- Open sharing of information (by everyone)
- Process improvements in risk assessment methodologies





Policy principle 5 & 6: Interconnected

Act as one government and in connection with society

5. Dialogue and open communication

- Active, open and transparent
- Balanced: societal importance, risks and downsides
- In context: in comparison to other risks (natural gas)
- Considerations: perceptions and acceptance of risk
- Perspective for actions (e.g. joint fact finding)

6. <u>Combining public interests</u>

- If necessary, solve bottle necks
- Broad consideration of public interests of energy (clean, affordable, reliable, safe, etc.)
- Collaboration on all levels (national regional local)
- Evaluation of the policy principles



March 2025, Schatzalp seismicity workshop

Seismic risk policy

Risk policy principles

- 1. Define the level of safety and health
- 2. Assessment and uncertainty
- 3. Innovation and knowledge enhancement
- 4. Drawing lessons from incidents
- 5. Open communication
- 6. Combining ambitions

Actions

- 1. LPR < 10^{-5}
 - how to define the norm for activities with little/no induced seismicity?
- 2. Reduce uncertainties
- 3. Research programs, independent research
- 4. Parliamentary inquiry Groningen gas production
- 5. Open accessible data, open accessible knowledge
- 6. Seismicity risks due to different activities are dealt with in a similar matter



Uncertainty*

* In seismic risk analysis

F

- > Limited data availability
 - 3-D insight in the deep subsurface
 - Seismicity data coverage
- > Deep subsurface
 - Presence of faults
 - Characteristics of layering
 - Stress conditions in subsurface
 - Stress changes due to activities

Focused in areas of oil and gas production

	P	bor	Moderate	Good	l to excellent
Data examp	le	10 10 10 10 10 10 10 10 10 10 10 10 10 1			
Seismi	c risk an	alysis			
 Relaseis 	ation bet micity	ween deep s	subsurface	activitie	s and
Description	Small num	ber of events	(Groningen	gas fields	orizon identifica easy and faults seismic resolut
- P e	hysical mevents, pr	odelling => r edictions beyo	nagnitudes and calibrate	and occur ed period	an be identified Confoise
> Rela	ation bet	ween s <mark>eis</mark> mi	icity and g	round m	ovemen
– P	GA/PGV m	odel for t <mark>he w</mark> ho	le of the Neth	erlands	
 Reladar 	ation bet nages/ris	ween groun ks	d moveme	nt and	
– E	xtending s	tudies for the G	roningen gas f	ield into otl	her areas
		2 ser l			
		for	Legend Gas fields Gas field Producing gas field AT Undeveloped gas field CK	s Aol	
			Depleted gas field Temporanily abaondoned gas field Depleted oil and gas field Underground storage RB		
		Kilometer	RO	Consisten are field and exactly	

Source: seismic hazard and risk assessment, report TNO and EBN, November 16th 2023

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Decreasing uncertainty by increasing seismicity data 2024-2028

Extension of the seismic network goal: observe magnitudes \geq 1,5 with local densification (M \geq 1) around activities in the deep subsurface

Source, KNMI dec 2024

March 2025, Schatzalp seismicity workshop

Source, KNMI report 2024

Decreasing uncertainty by increasing seismic data coverage

scant

Filling in the blanks:

- New 2D seismic lines
- Reprocessing old seismic data
- Research wells

Decreasing uncertainty by research

KEMprogramma.nl

GeoKennisNL

Task 42 underground hydrogen storage

Mining activity versus H&R type	Seismic hazards and	Subsidence hazards and	Environmental	
Oil and gas reservoir production	Groningen	KEM-02, KEM-04, KEM- 05, KEM-08, KEM-09, KEM-14, KEM-19a, KEM- 19b, KEM-24a, KEM-24b, KEM-34, KEM-36	KEM-19a, KEM-19b	KEM-18, KEM-19a KEM-19b
	Small gas fields	KEM-07	KEM-16a	KEM-16b
	Oil fields			
	Methane cyclic storage	KEM-01, KEM-48	KEM-48	KEM-48
	Hydrogen cyclic storage	KEM-39		
Underground storage in porous reservoirs	Production water injection	KEM-24a		
	CO2 storage	KEM-27, KEM-39	KEM-27	KEM-27
	Conventional doublet systems	KEM-06, KEM-15	KEM-06	KEM-06, KEM-18
Geothermal reservoir energy production	Enhanced Geoth. Systems (EGS)	KEM-06	KEM-06	KEM-06
	Shallow caverns (<750m)		KEM-17	
Salt cavern development and production	Deep Caverns (>750m)		KEM-16a, KEM-17, KEM- 26	KEM-13
	Methane cyclic storage			
	Oil strategic storage	-		
Underground storage in caverns	Hydrogen cyclic storage	KEM-28	KEM-28	KEM-28
	Nitrogen cyclic storage			
	Compressed Air			
	Wells	KEM-31		KEM-13, KEM-18, KEM-28
Mining infrastructures	Installations	KEM-31		KEM-33
	Pipelines	KEM-31		
Coal mining domains and infrastructure	Limburg			

H&R measures vs H&R type	Seismic risks	Subsidence risks	Environmental
			risks
Public HRA instruments	KEM-03, KEM-10, KEM-	KEM-03, KEM-16a, KEM-	
	34	16b, KEM-47	
Public monitoring systems	KEM-11, KEM-27		
Public norms, TL systems and mitigating			
actions			

Legend	5 = high	3 = medium	1 = low
	Priorities and KEIM research projects		

March 2025, Schatzalp seismicity workshop

Seismic risk policy

Risk policy principles

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- 2. Assessment and uncertainty
- 3. Innovation and knowledge enhancement
- 4. Drawing lessons from incidents
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Ongoing action points

1. LPR<10⁻⁵

Risk analysis methods are developed and refined

2. Extension of seismic monitoring netwerk, seismic data coverage

3. Knowledge program effects of mining, GEOKennisNL

4. Groningen seismicity => learning and drawing lessons

5. Knowledge is shared (website KEM, DEEP-NL, nlog.nl EPOS-NL) open publications, source codes, Geological Survey of the Netherlands (PIO, BRO)

6. Seismicity risks due to different activities are dealt with in a similar matter

Questions?

Safe and responsible use of the subsurface

> Safe:

- Risk analysis => mining law
 - Subsidence risk
 - Seismicity risk
 - Environmental risk
- > Responsible:
 - Socially responsible
 - Avoid damages occurring
 - Importance of the energy transition
 - Strategic independence
 - Reliable availability

- Norm LPR < 10⁻⁵

Commission Mining Damage

Balanced approach to risk combining perspectives

Induced seismicity

- Same norm for all subsurface activities (LPR < 10⁻⁵)
- Policy will be updated
- > Research is needed to:
 - enhance knowledge
 - reduce uncertainties
 - apply new insights

Seismic hazard and risk analysis in the Netherlands for deep subsurface activities

Fully probabilistic risk analysis

- > Norm LPR<10⁻⁵
- > Different typologies
- Number of buildings above the norm per year
- > Mining law satisfied
- > Unanswered: which buildings?

Geothermal heat production

Policy

- Mining law
 - Description of the expected ground movement
 - If necessary:
 - Safety risk => norm for LPR
 - Risk for damages to buildings and infrastructure
 - Risk of disrupting functionality infrastructure
 - Measures to prevent surface movement
 - Measures to prevent or limit damages due to surface movement
- License can be rejected if:
 - Unacceptable risks for safety (LPR>10⁻⁵)
 - Unacceptable damage (financial capacity)
- Lisence holder needs to take all measures that are reasonable to prevent risk and damage

Public* seismic hazard and risk analysis Groningen

* https://www.nlog.nl/broncode-groningen-modelketen

Schematic depiction of the main features of the SHRA-geothermal procedure. Blue = standard procedure₂grey =

March 2025, Schatzalp seisnicustomk procedure. Green, orange en red = possible outcomes after following the SHRA steps; November 16th 2023