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Technical Conference Paper

The Planning of a Gas Storage Facility

Basis for an Investment Decision

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Clausthal/Zellerfeld, Germany

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SMRI Fall Meeting Rapid City

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Possible Reasons for Gas Storage

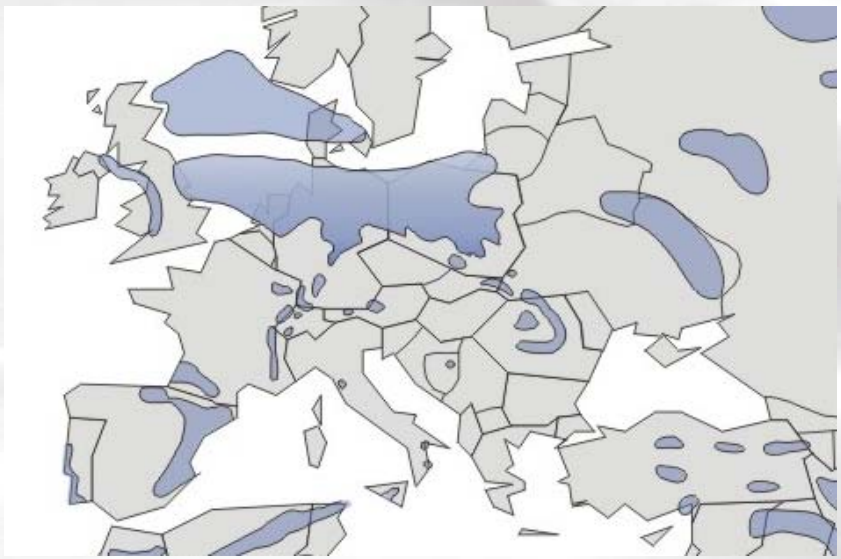
- Security of Supply (short-term / long-term fluctuations)
- Independence from External Gas Suppliers
- Pricing of Competing Energy Suppliers
- Favorable Infrastructure Boundary Conditions

Basic Data for Planning

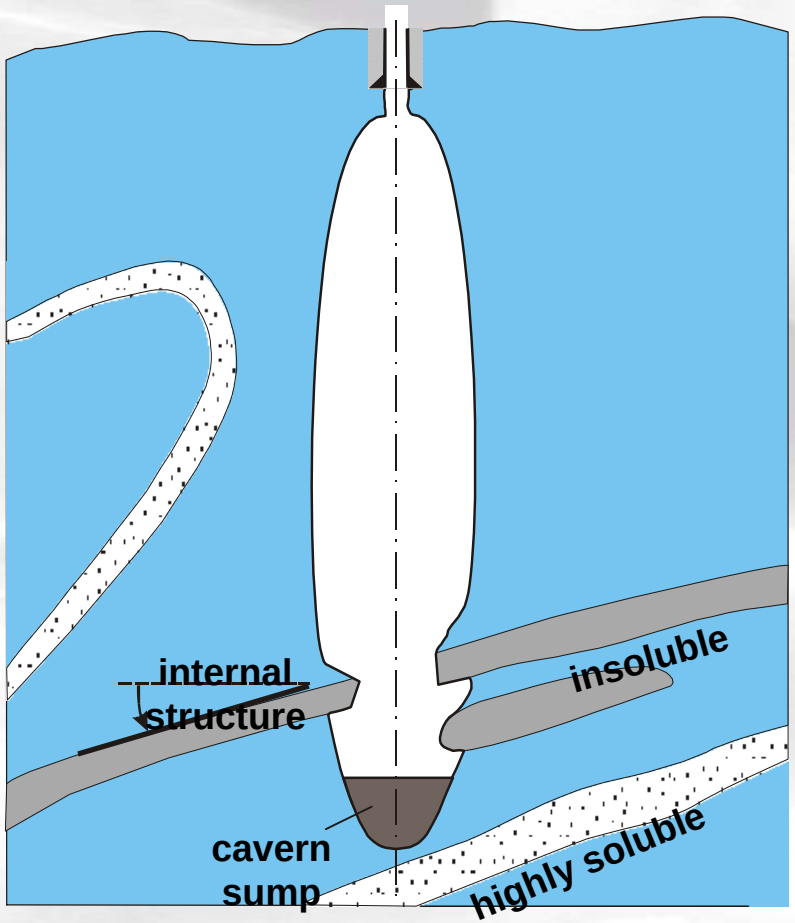
- Location
- Working Gas Volume
- Pipeline Pressure

- Concept of Storage Operation (peak shaving / seasonal storage)
  - Gas Withdrawal Rate
  - Gas Filling Rate

Location Selection



- **Size / Simplicity of Salt Structures**
- **Depth of Structure**
- **Pipeline Network**
- **Fresh Water Supply**
- **Disposal of Brine**



Geological Tasks

- Lateral Structural Setting
- Local Internal Structural Setting
- Identification of Soluble or Insoluble Layers
- Vertical Profile of Dissolution Rate
- Selection of Lithologic Intervals

Geological Tasks

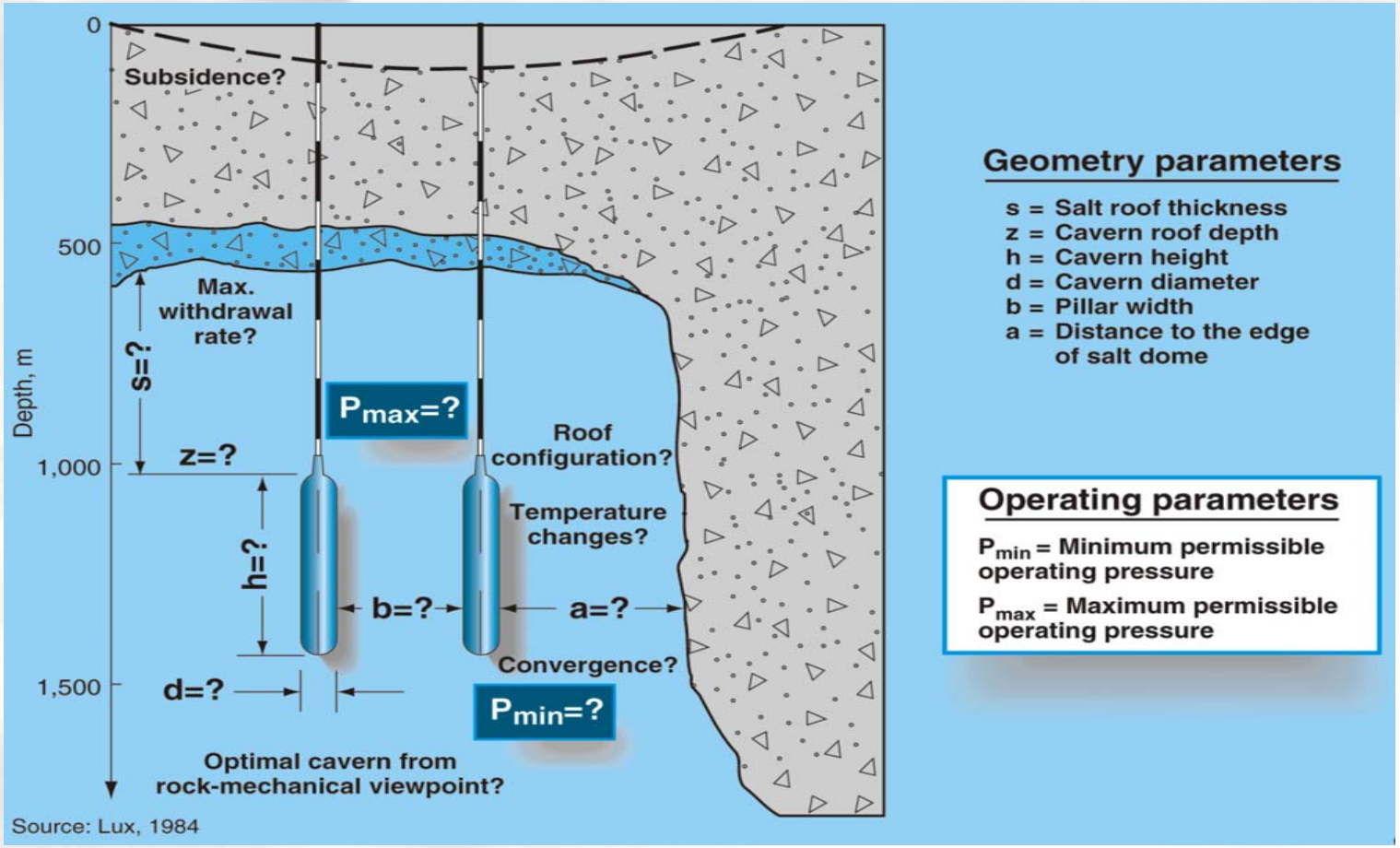
Exploration Programme:

- **Exploration Wells**
- **Gravimetry**
- **Seismic**

Higher Intensity of Exploration

➔ **Reduction of Geological Risk**

Rock Mechanics



Geometry parameters

s = Salt roof thickness
z = Cavern roof depth
h = Cavern height
d = Cavern diameter
b = Pillar width
a = Distance to the edge of salt dome

Operating parameters

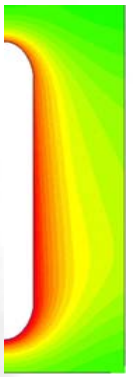
P_{min} = Minimum permissible operating pressure

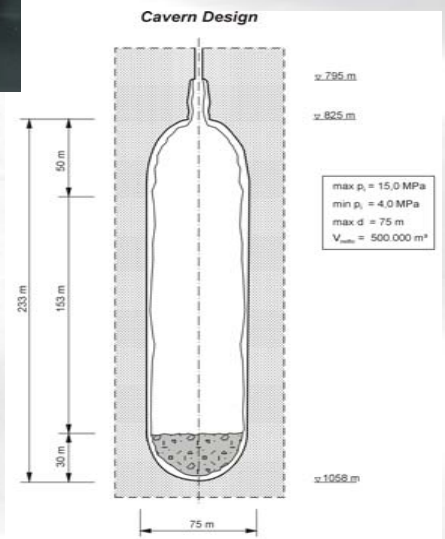
P_{max} = Maximum permissible operating pressure

Rock Mechanics

Boundary Conditions:

- **Working Gas Volume**
- **Storage Concept**
- **Withdrawal / Filling Rates**





Rock Mechanical Laboratory Tests

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Rock Mechanical Calculations

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Assessment (Stability, Usability)

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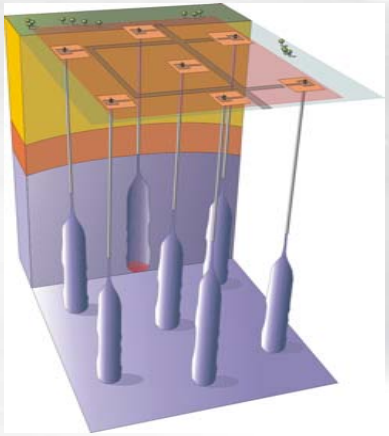
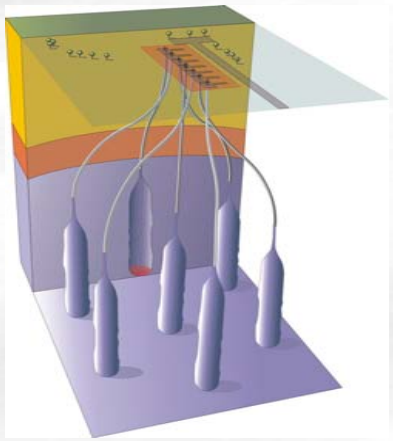
Rock Mechanical Layout (Optimisation)

Drilling



Directional Vertical Drilling

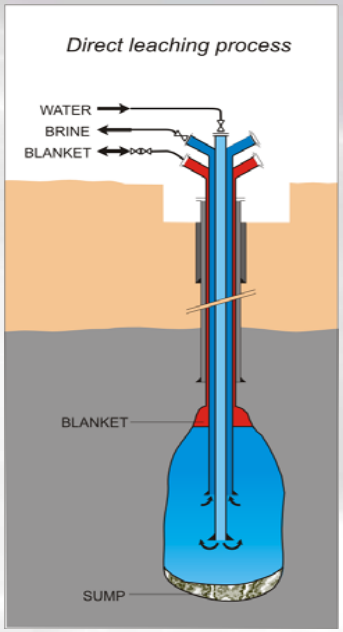
f(space; equipment; risk; cost)

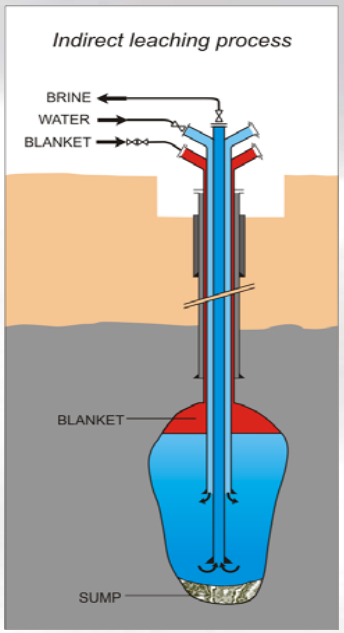


Deviated Drilling

Basis: Geological Planning

- Casing Schemes
- Facility Specifications
- Sampler Service
- Coring Programme
- Mud
- Sampling
- Cementations





Solution Mining

Leaching Method

Leaching Plan (e.g. multistep leaching)

Leaching Steps

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Leaching Simulation

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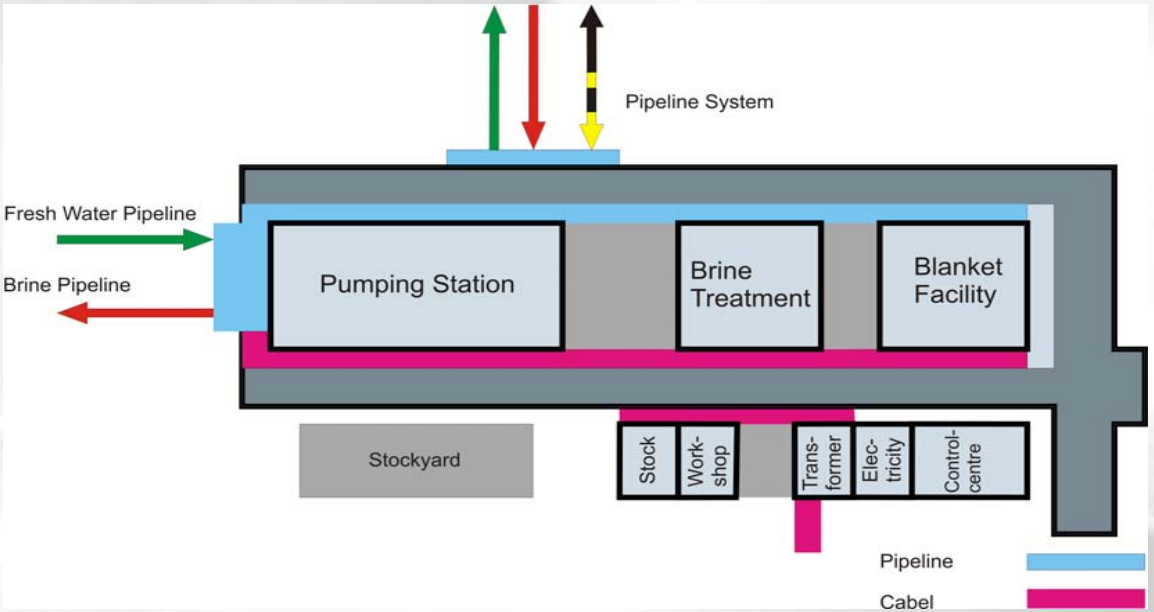
Leaching Concept

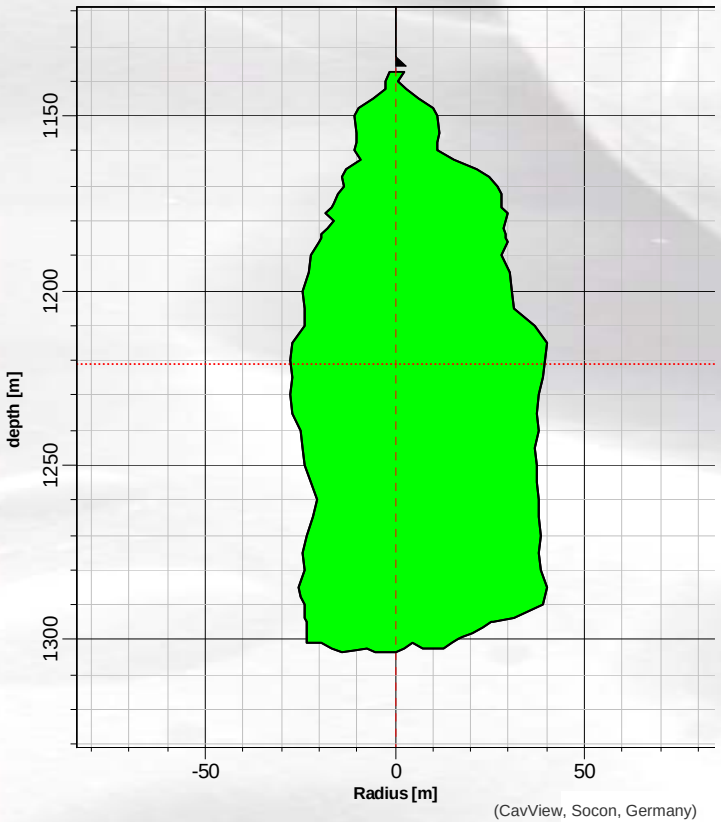
Leaching Plant



- Number of Simultaneously Leached Caverns
- Fresh Water Supply
- Brine Disposal (additional use)
- Operation (automatic; manual)
- Type of Blanket (oil; N_2)
- Structural & Civil Engineering
- C&I

Comparison of Leaching Rate and Time

Leaching Process



Monitoring of Leaching Process

- **Physical Values**
- **Chemical Values**
- **Blanket Interface**

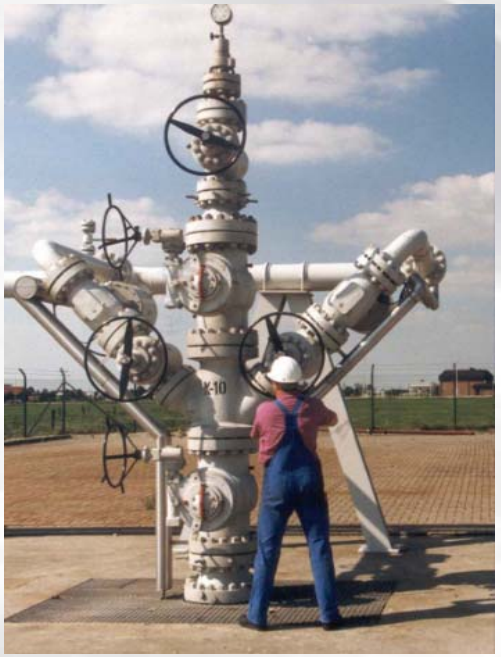
Sonar Surveys

Work Over Activities

➔ **Modification of Leaching Process**

Completion and Gas First Fill

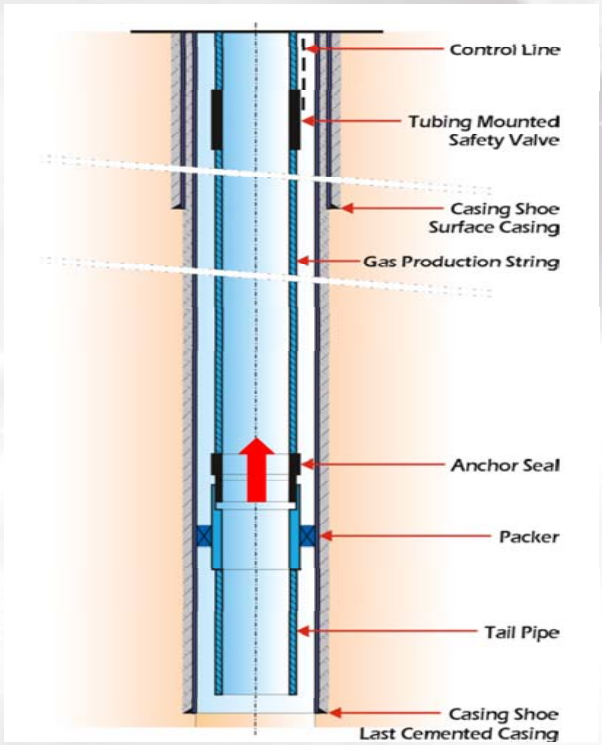
Completion = Conversion from Leaching to Gas Operation

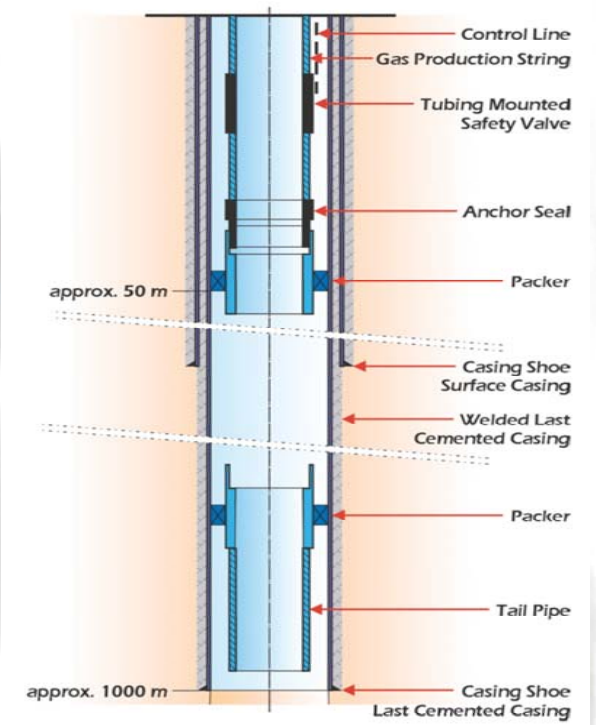


- **Removing of Leaching Strings**
- **Installation of Gas Storage Equipment (Production Tubing; Gas Wellhead)**
- **Well Integrity Test**
- **String for Brine Displacement**
- **Sonar Survey**
- **Subsurface Safety Components**

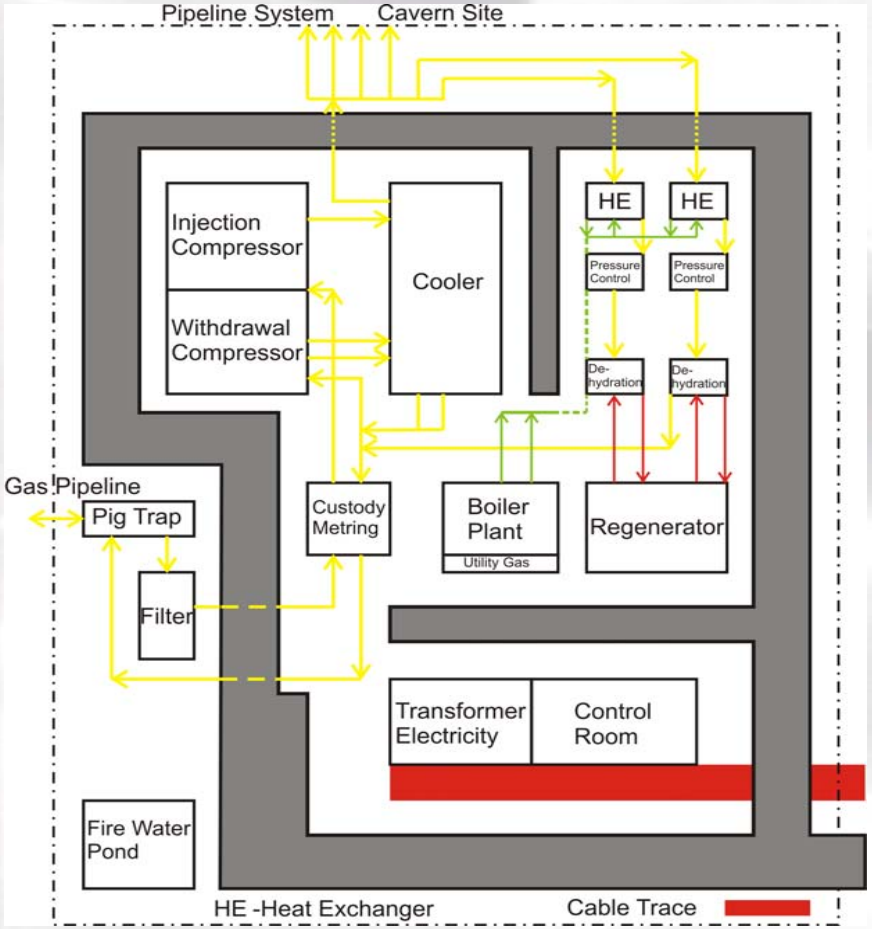
Completion Alternatives (example)

with **or** **without** **Production String**





Surface Facilities / Gas Storage Plant



Crucial Parameter: Operation Mode

- **Time Pattern**
- **Injection / Withdrawal Rates**

Injection / Withdrawal with / without Compressor

- **Reciprocating Compr.**
- **Centrifugal Compr.**

Dehydration

Technical + Economical Optimisation

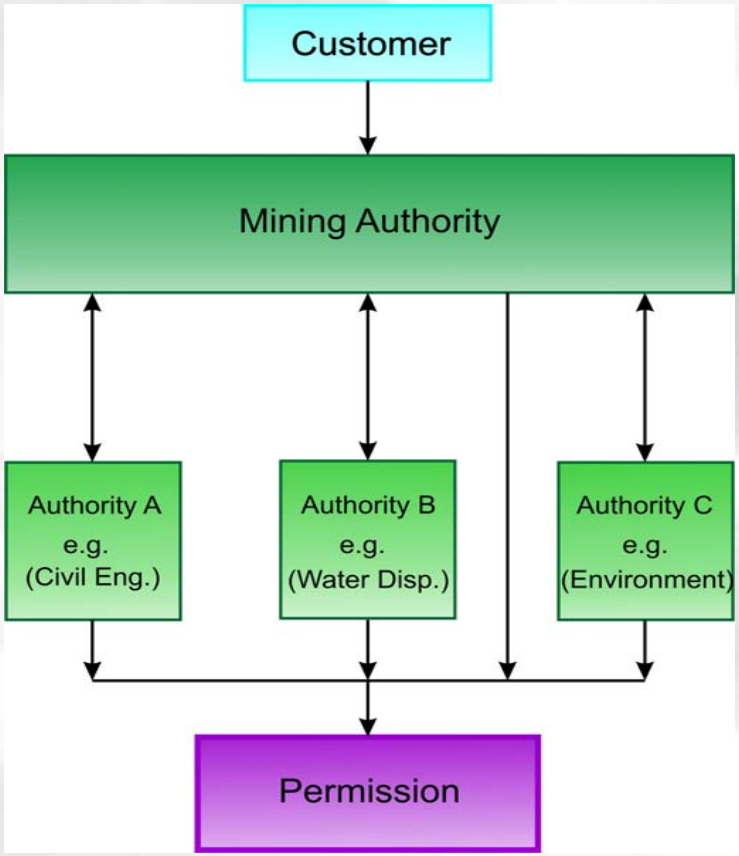
Authority Engineering

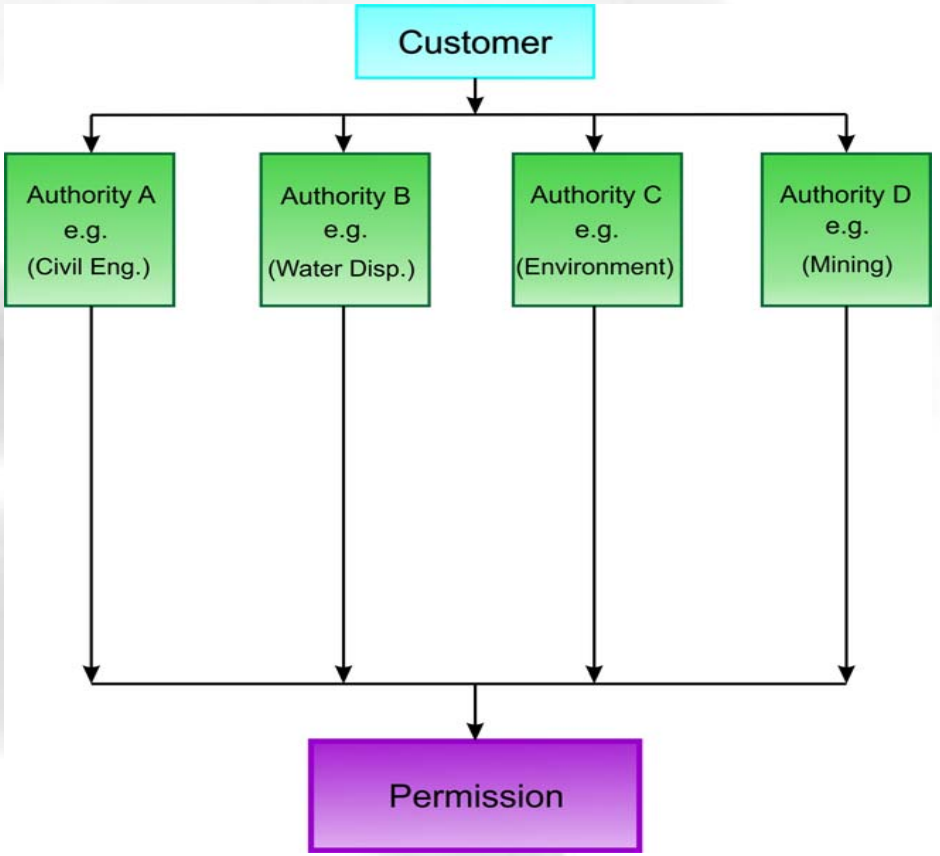
State Concession for Extraction

Approval Procedure

- **Regional Planning Procedure**
- **Nature Conservation**
- **Operating Plans**
- **Application for Leaching**

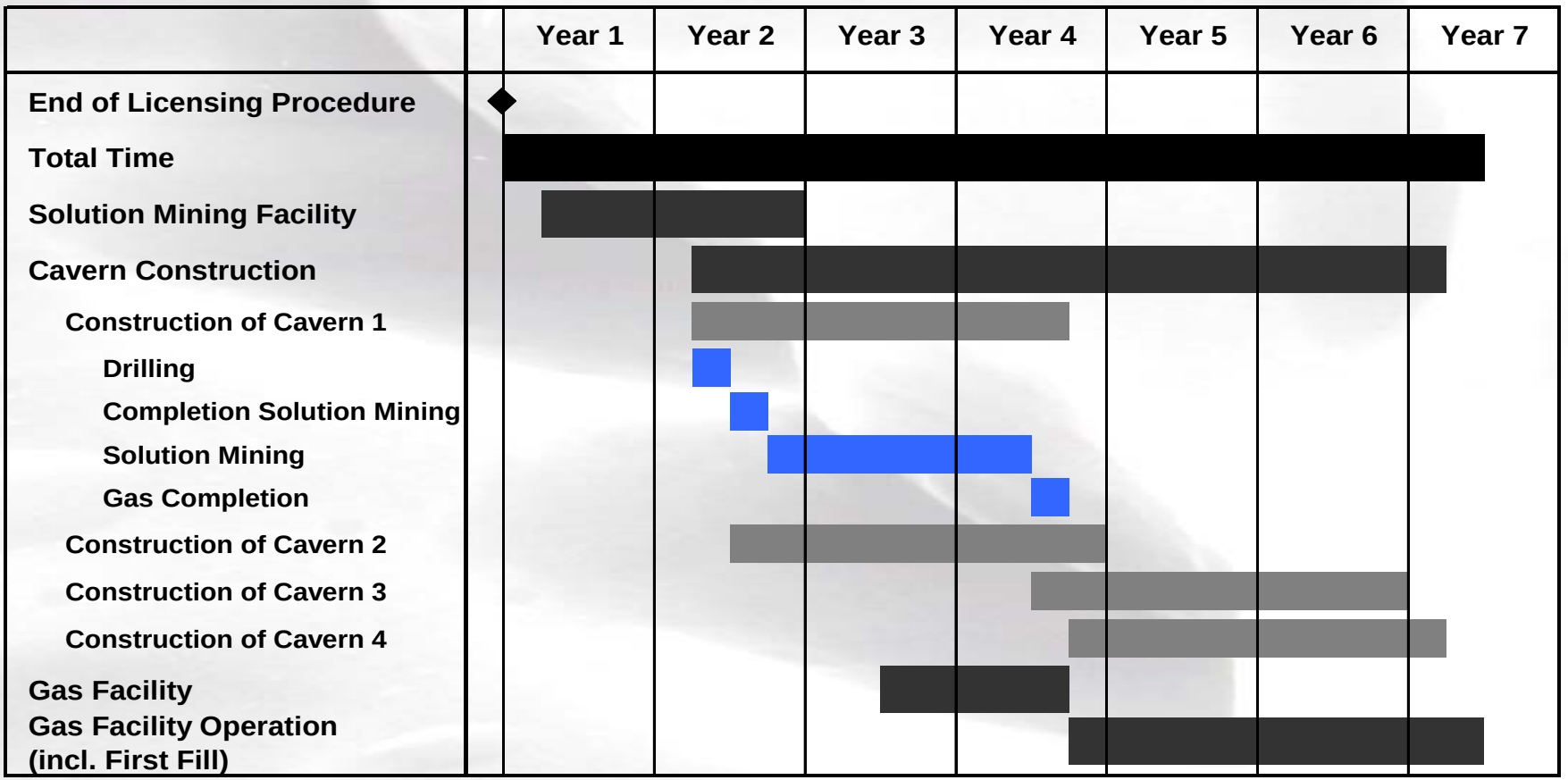
Examples for Authority Engineering





Time Schedule

Planning and Construction of Storage Facility (4 Caverns)



Apportioning of Costs