# IGU
# Working Committee 2 UGS

## UGS: Achievements and trends in the field of technical efficiency, environment stability and safety

**Report Study Group 2.2 for the World Gas Conference**

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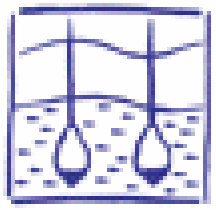
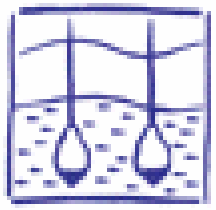


# Questionnaire analysis – basis for the study

## Questions are grouped in 5 basic parts:

1. *General Aspects*
2. *Reservoir*
3. *Wells*
4. *Surface Facilities*
5. *Safety*



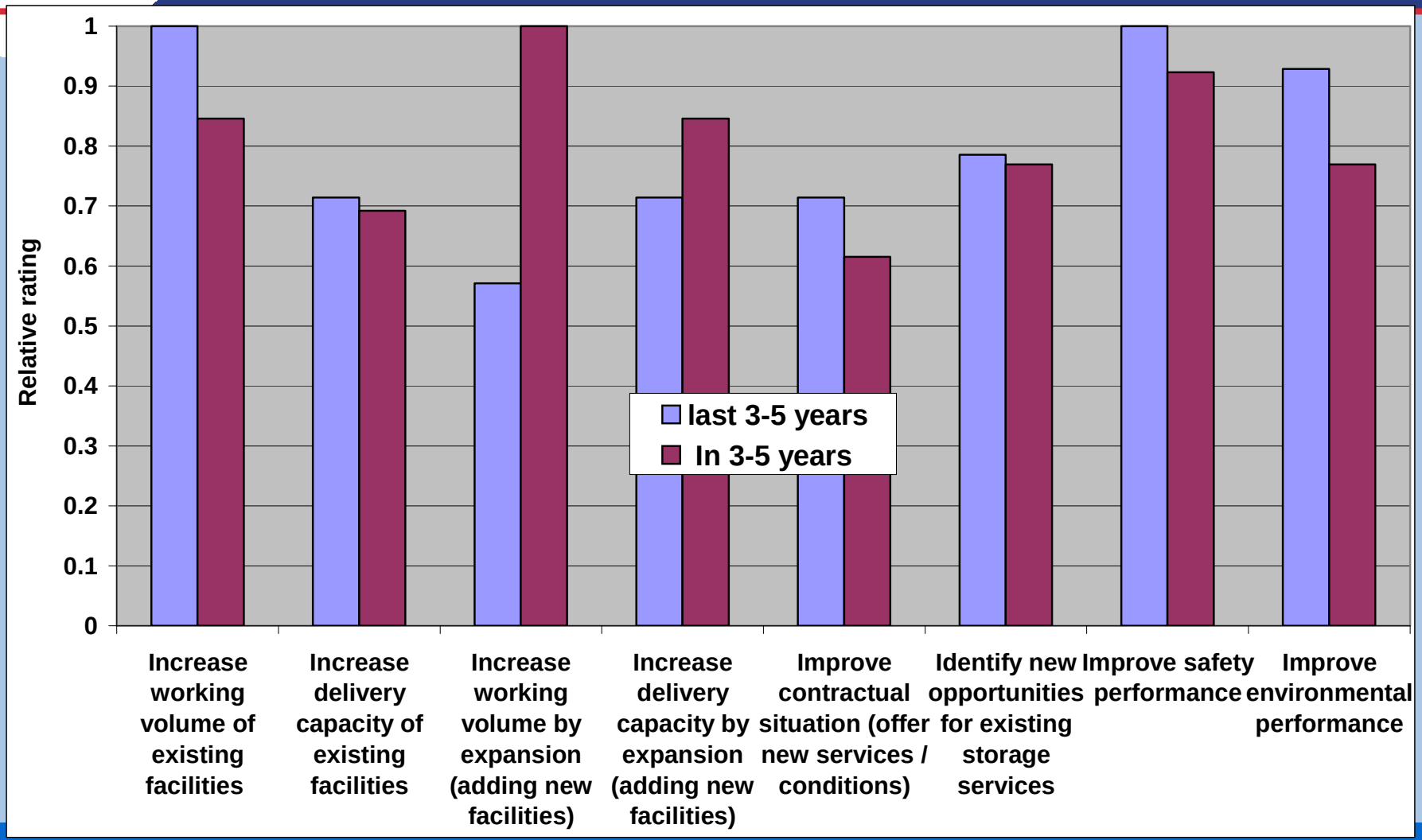
# Answers

## 20 answers from 15 countries

- **Europe :** *Austria, Croatia, Czech, Denmark, Germany, France, Italy, Netherlands, Romania, Russia, Spain, Sweden,*
- **Asia :** *Japan*
- **America :** *Argentina, USA*

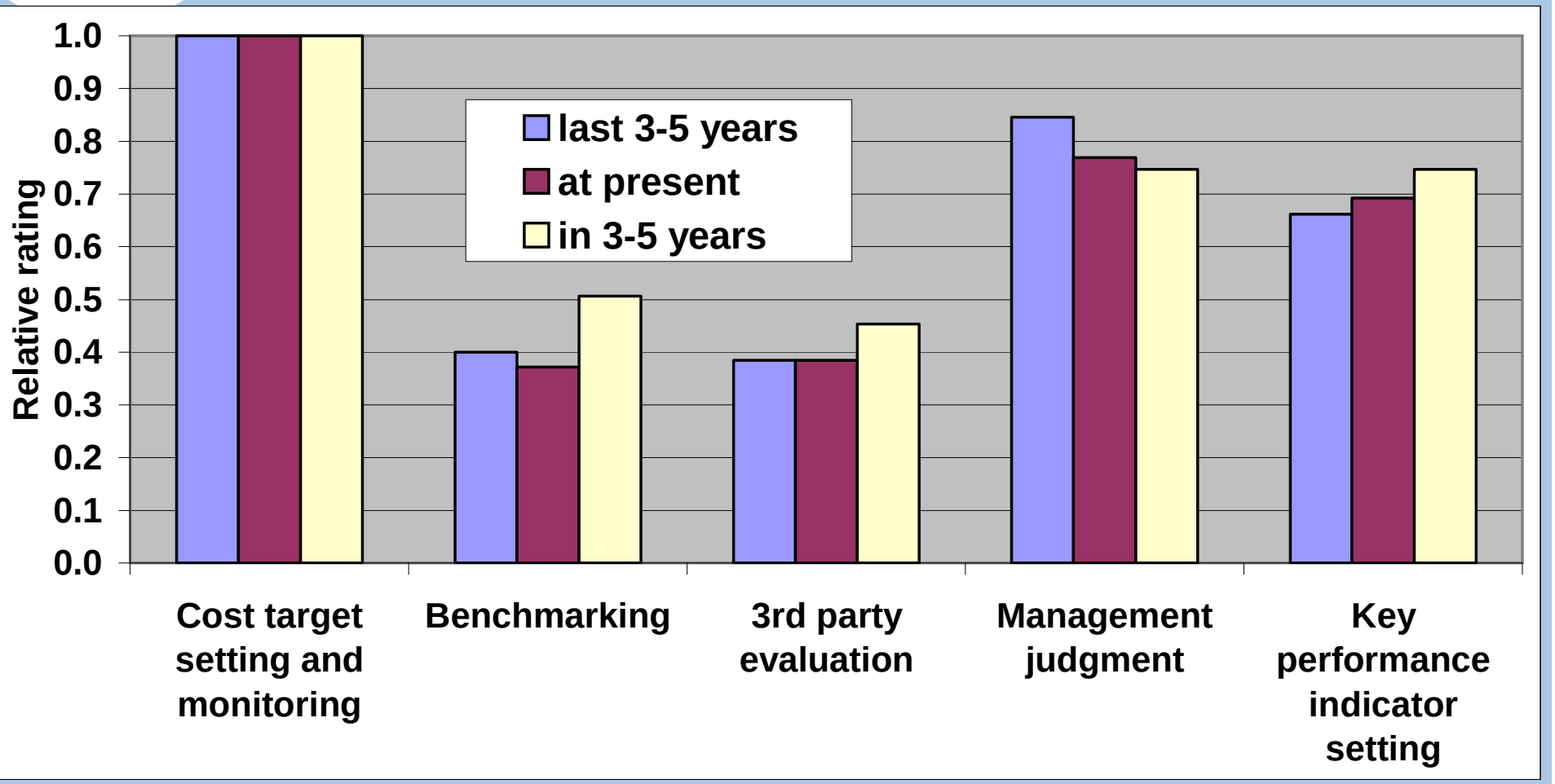
# 1 General Aspects

## 1.1 Improvements carried out on existing gas storages. Future trends



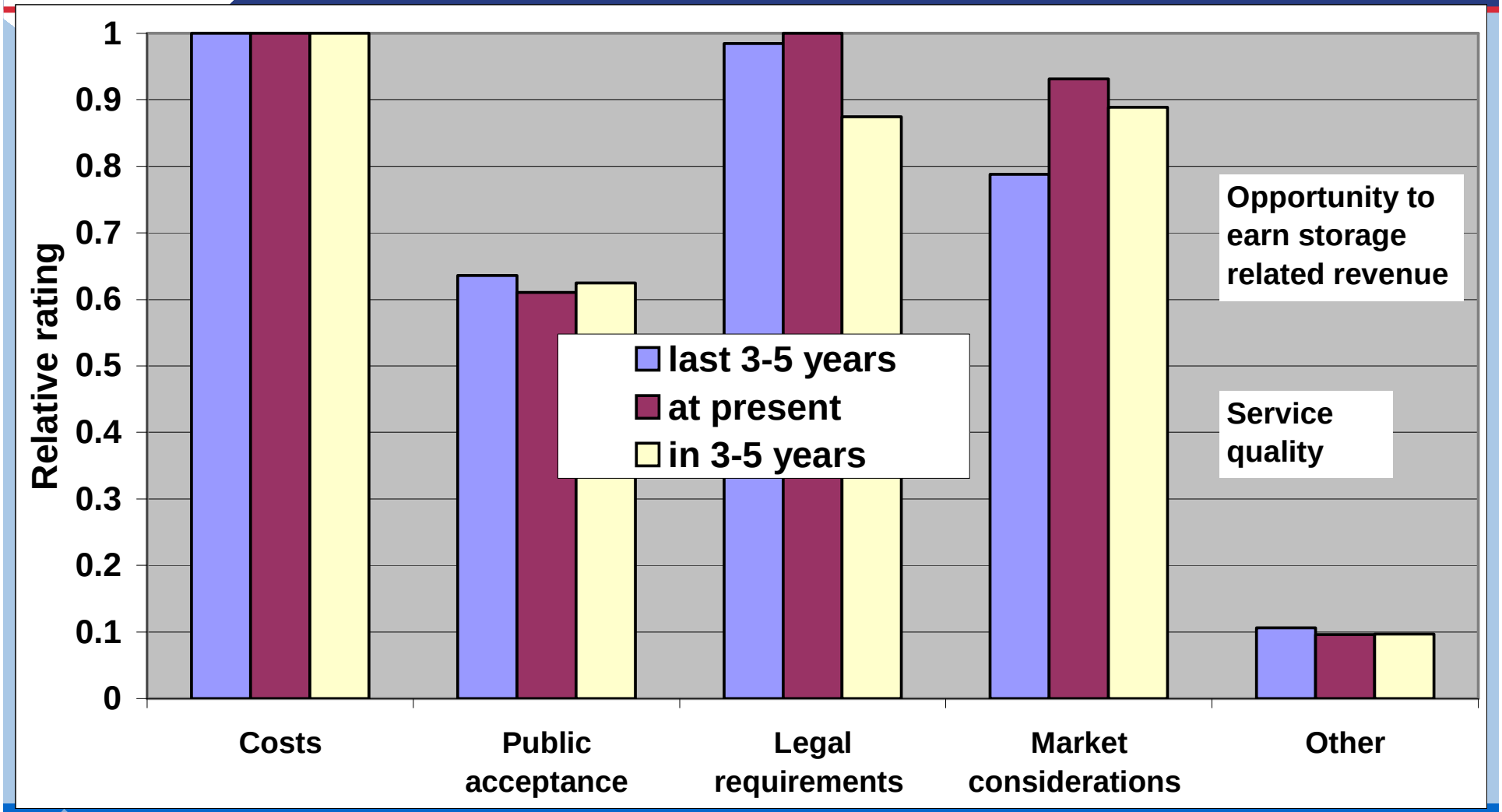
# 1 General Aspects

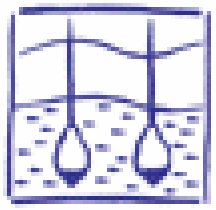
## 1.2 Techniques used to analyze the performance of storage



# 1 General Aspects

## 1.3 The most significant drivers for improvement





# 1 General Aspects

## 1.4 New techniques preferred to use in future

**The most significant new techniques:**

- $CO_2$ sequestration
- Storage in lined Hard Rock Caverns
- Storage in abandoned Mines

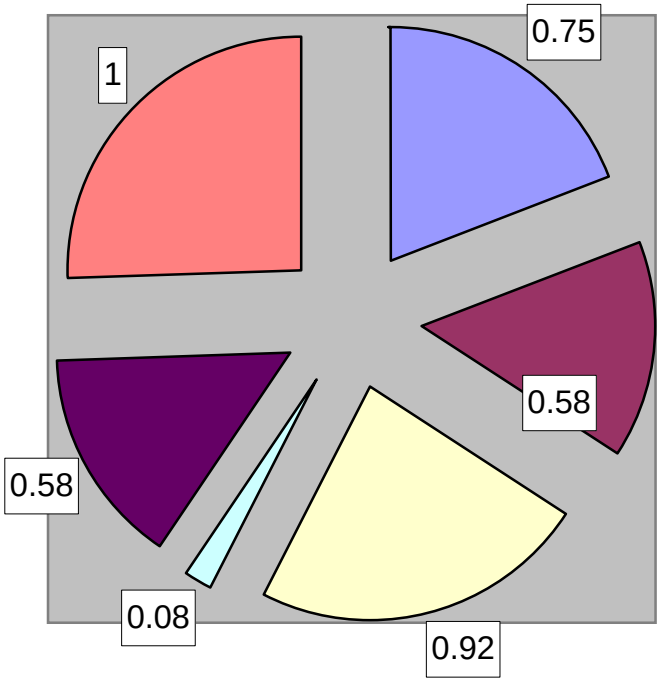
**Less significant new techniques:**

- Gas sorption into the solids
- Storage as Gas Hydrates

# 2 Reservoir

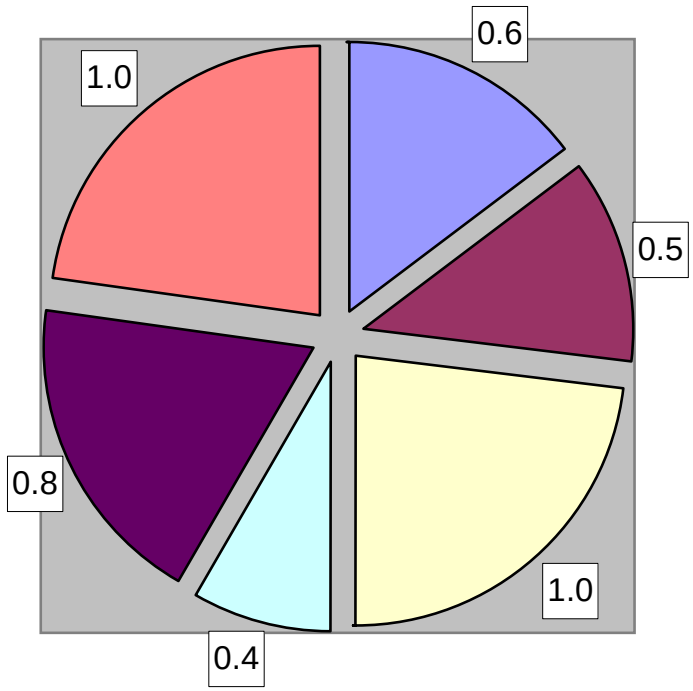
## 2.1 Definition of layer characteristics

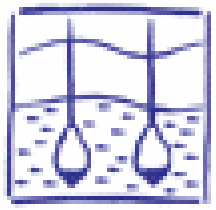
last 3-5 years




- 2D-seismic
- Reprocessing 2D-seismic
- 3D-seismic
- 4D-seismic (time lapse seismic)
- Seismic attribute mapping
- Re-interpretation

In future 3-5 years

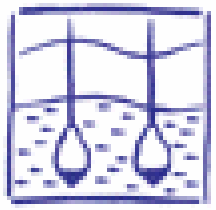




# 2 Reservoir

## 2.2 Determination of the limits for the maximum working reservoir pressure

- *Aquifer storage: maximum pressure is limited by the need to keep the gas within the structure*
- *Salt cavern storage: maximum pressure is determined by the max. pressure gradient 0.184 bar/m*
- *The maximum allowable pressure normally has to be approved by authorities*



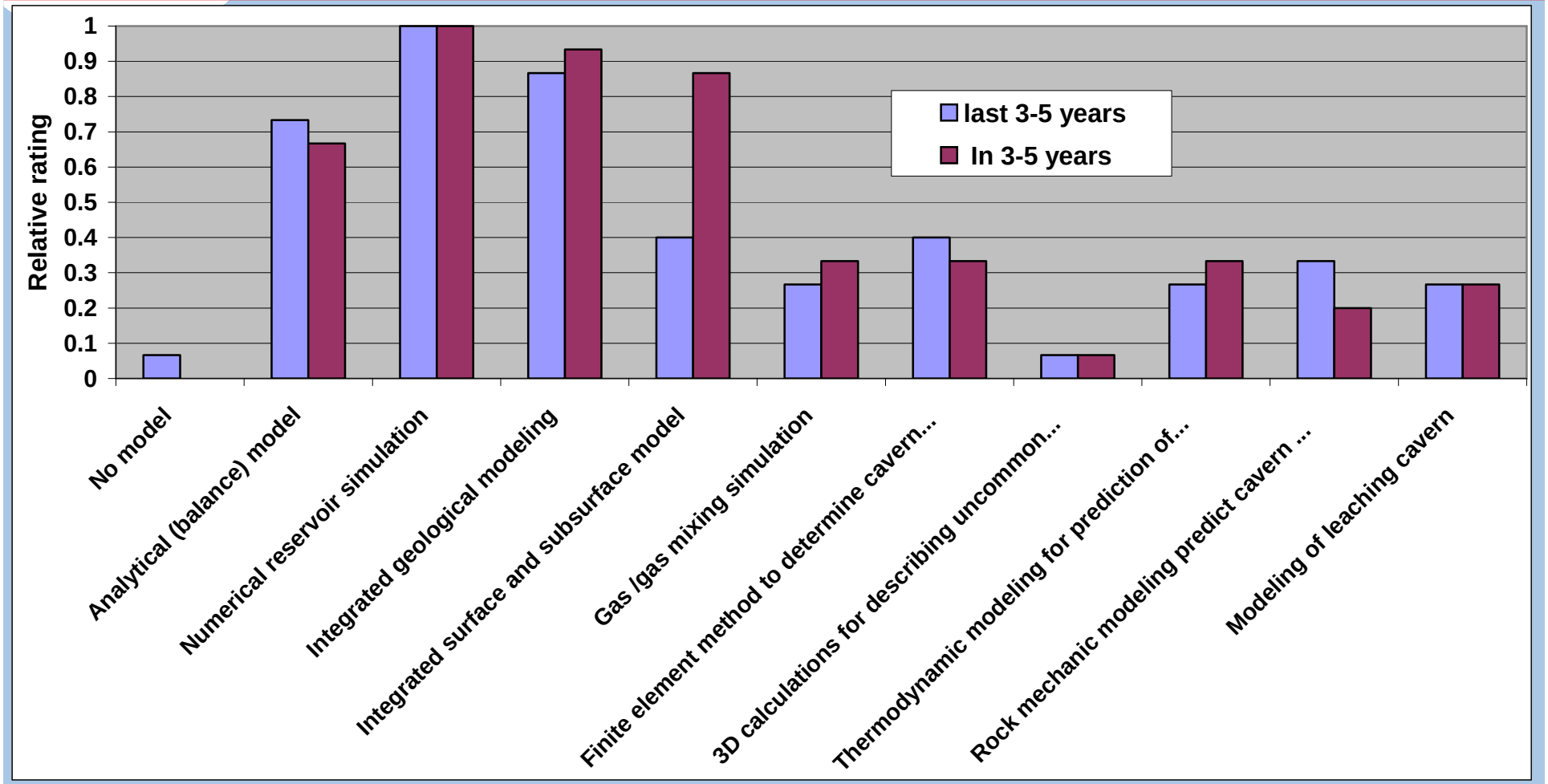
# 2 Reservoir

## 2.3 The trends for maximal allowable pressure gradient

- *UGS in aquifer the most common value is up to 1.4 times higher than level of initial pressure*
- *In Oil&gas field value of pressure gradient in almost 50% answers is equal to initial level. In rest cases, it is allowable to have up to 1.2 times more initial level*
- *In salt caverns average level allowable pressure gradient is 0.18 – 0.19 bar/m*

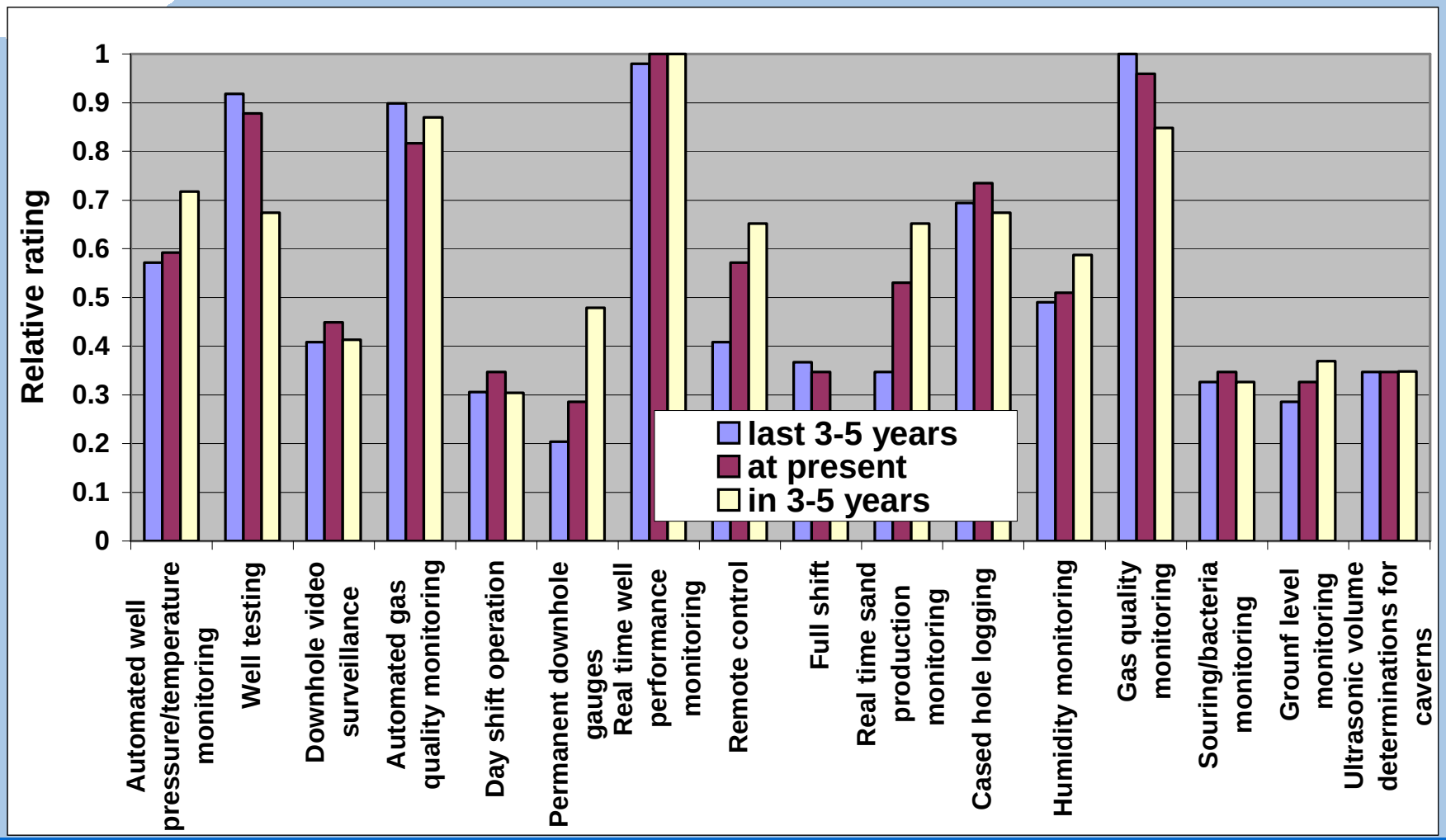
# 2 Reservoir

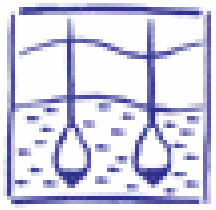
## 2.4 Type of reservoir modelling tools



# 2 Reservoir

## 2.5 Monitoring techniques used to improve geological, technical, operational safety

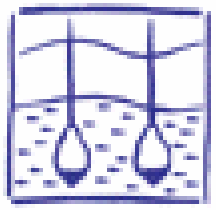




# 2 Reservoir

## 2.6 Technical measures implemented to improve the performance of the storage

| For all type of UGS | For pore storages | For caverns |
|---|---|---|
| •Reduction of pressure losses<br>•*Fast change of operational mode*<br>•*Minimizing size of cushion gas* | •*Sand control techniques*<br>• *Stimulations for skin/scale removal*<br>•*Measures used to diminish water influx*<br>• *Infill drilling* | •*Leaching of new caverns*<br>•*Enlarge existing caverns* |



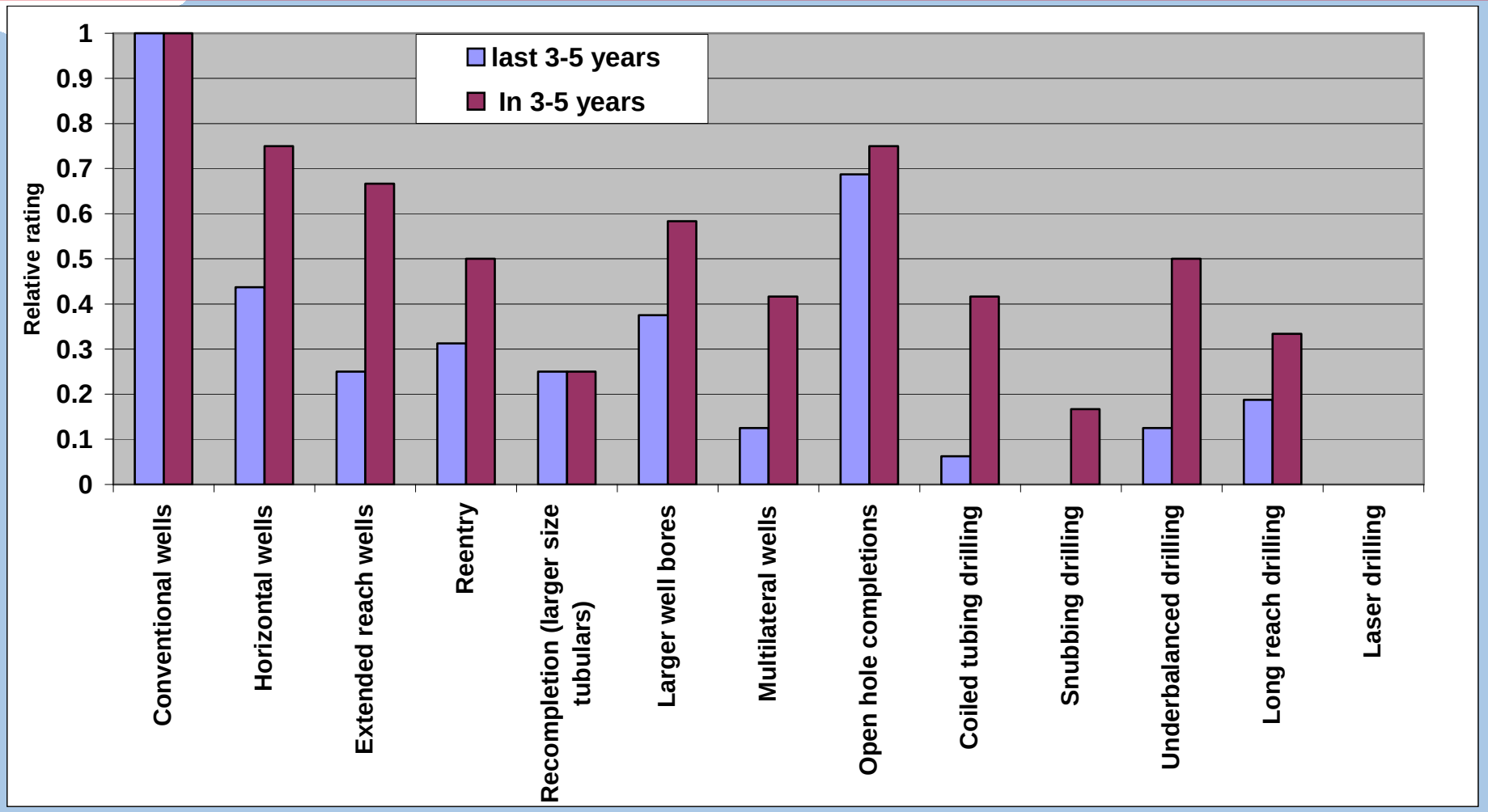
# 2 Reservoir

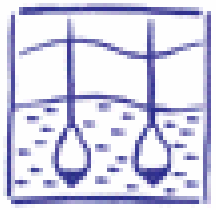
## 2.7 Measures implemented to improve th leaching of caverns

- *Enlarging existing caverns*
- *Leaching of lens shaped caverns in thinner salt layers*
- *Networking of caverns*
- *Sump sealing  Re-use leaching brine*

# 3 Wells

## 3.1 Well concepts used in UGS





# 3 Wells

## 3.2 Problems in implementing new well concepts

**Two main problems:**

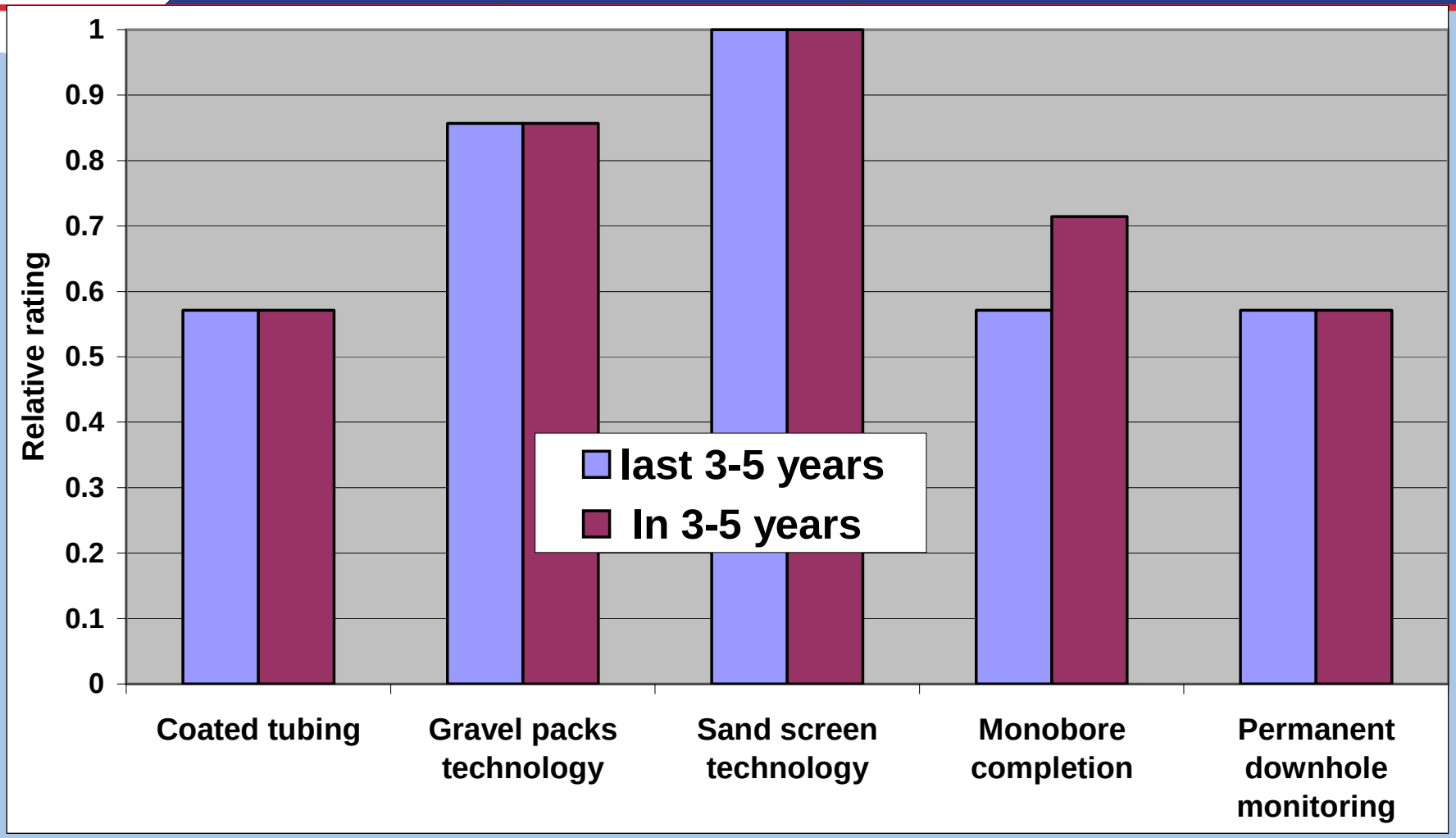
- **well bore damage**
- **cement bond quality**

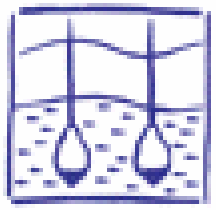
**The less trouble problems:**

- **Hole stability**
- **Sand control**

# 3 Wells

## 3.3 Techniques applied for well completion concepts





# 3 Wells

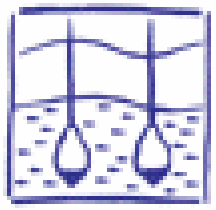
## 3.4 Stimulation technologies used for maintain and improve deliverability

**The most prevalent stimulation technologies are:**

- *Acidizing*
- *Fresh water treatments*

**Among other technologies there was mentioned:**

- *Fresh water wash to dissolve salt*
- *Hydro blast to clean out well bore fill and scale*
- *Fresh water jet washing*
- *EDTA treatments*



# 3 Wells

## 3.5 Methods using to ensure the integrity of subsurface equipment

**The most used method is:**

- ***Annulus pressure monitoring***

**Remaining measures encountered with almost equal frequency:**

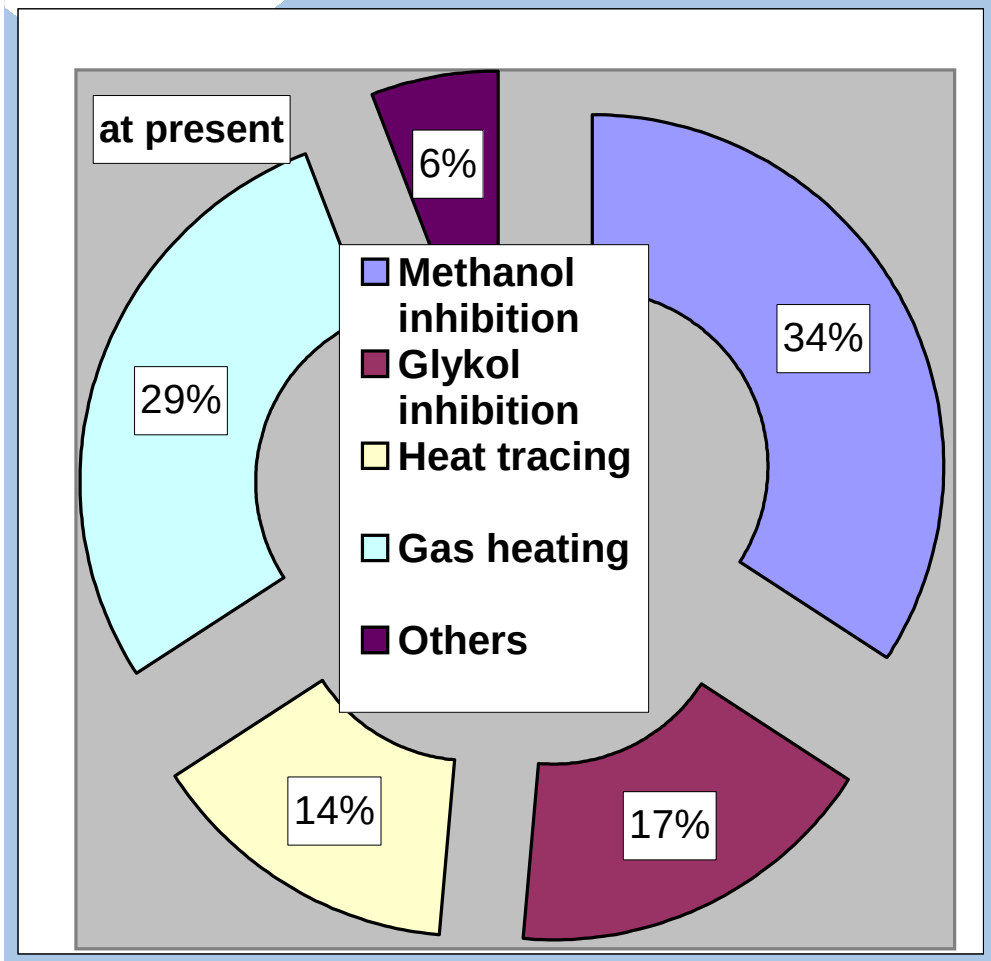
- ***Corrosion monitoring***
- ***Cathode protection***
- ***Annulus fluid level control***
- ***Regular inspection program***

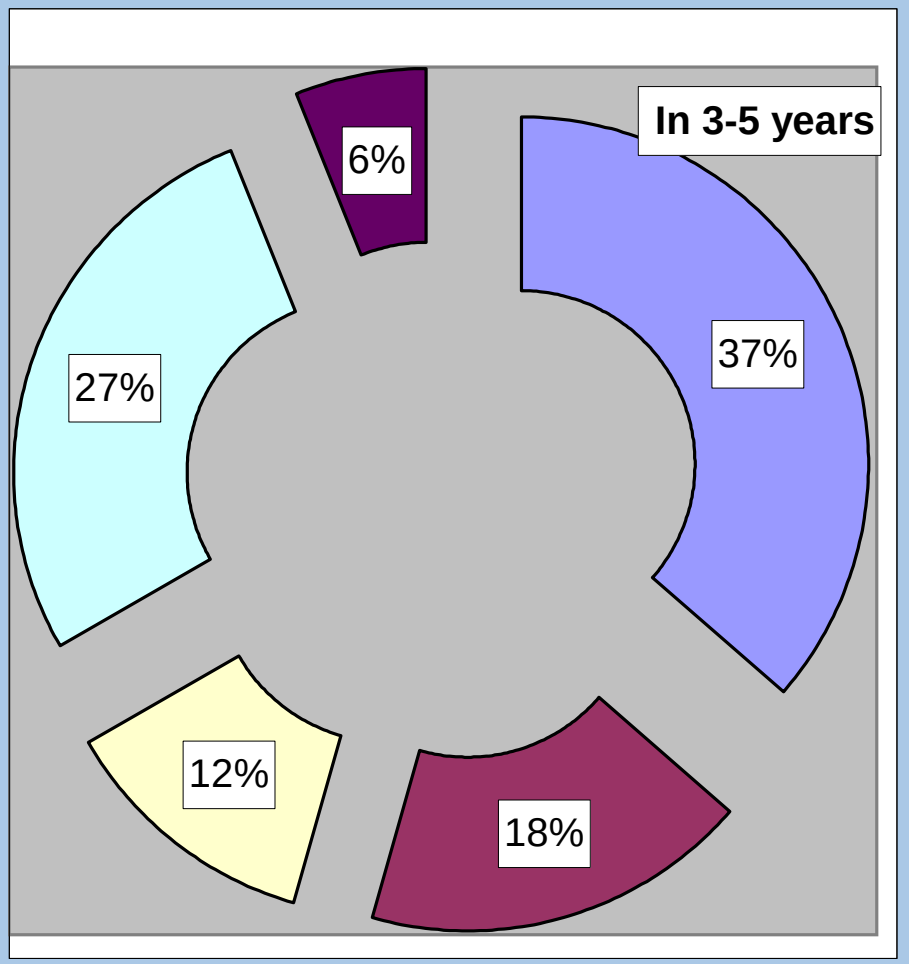
**Among other technologies there was mentioned:**

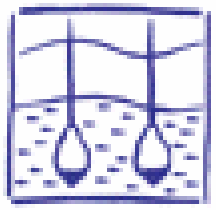
- ***Injection of biocide into the annulus***
- ***Investigating check values for Annulus fluid level control***
- ***Microvertilog, D-mag log, Neutron and temperature logs for corrosion monitoring***

# 4 Surface Facilities

## 4.1 Techniques used to avoid hydrate formation





# 3 Wells

## 3.2 Problems in implementing new well concepts

**First two places occupied by:**

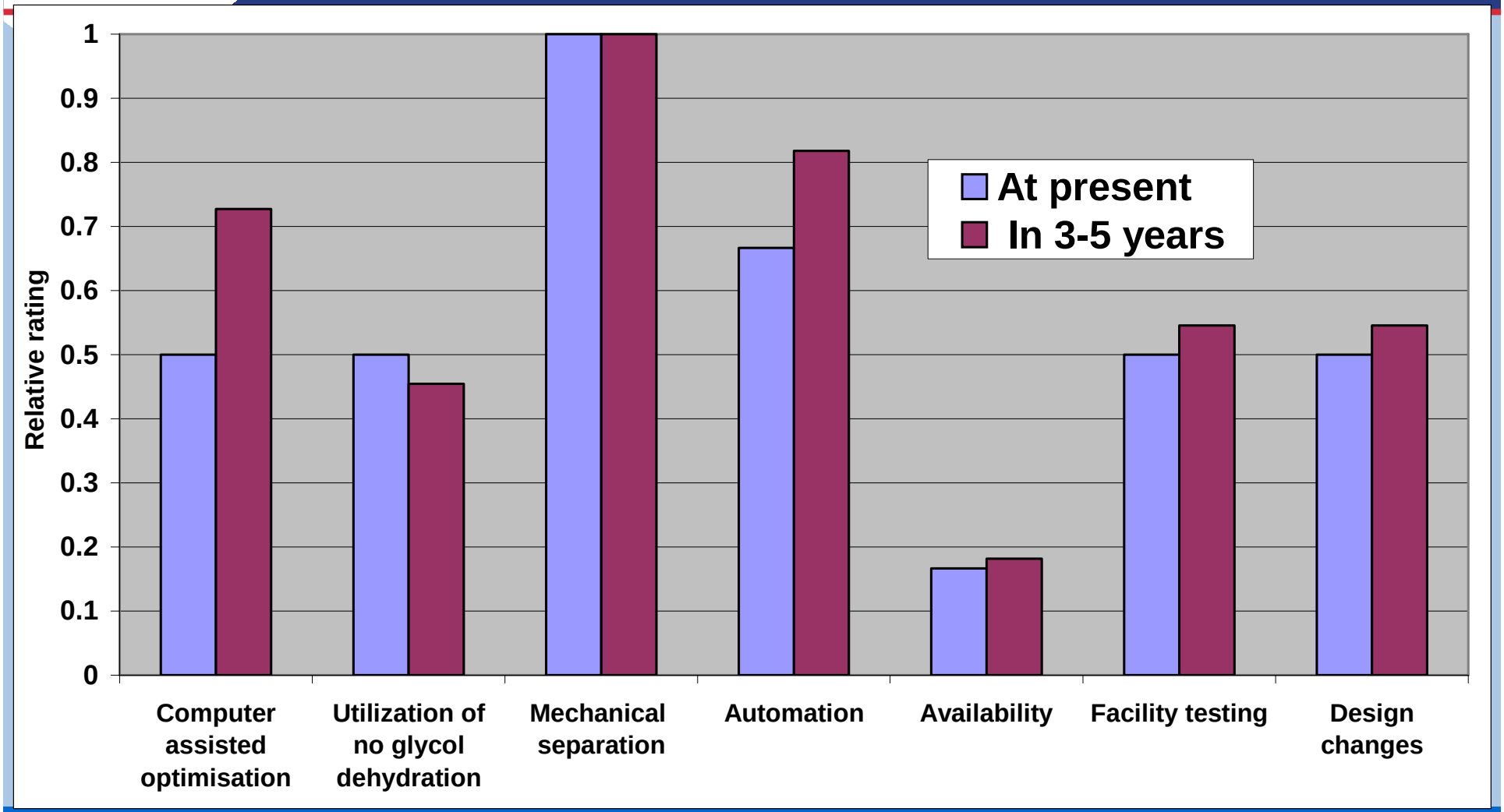
- ***Cathode protection***
- ***Wall thickness monitoring***

**Following three places occupied by:**

- ***Material choice***
- ***Chemical inhibitors***
- ***Coating***

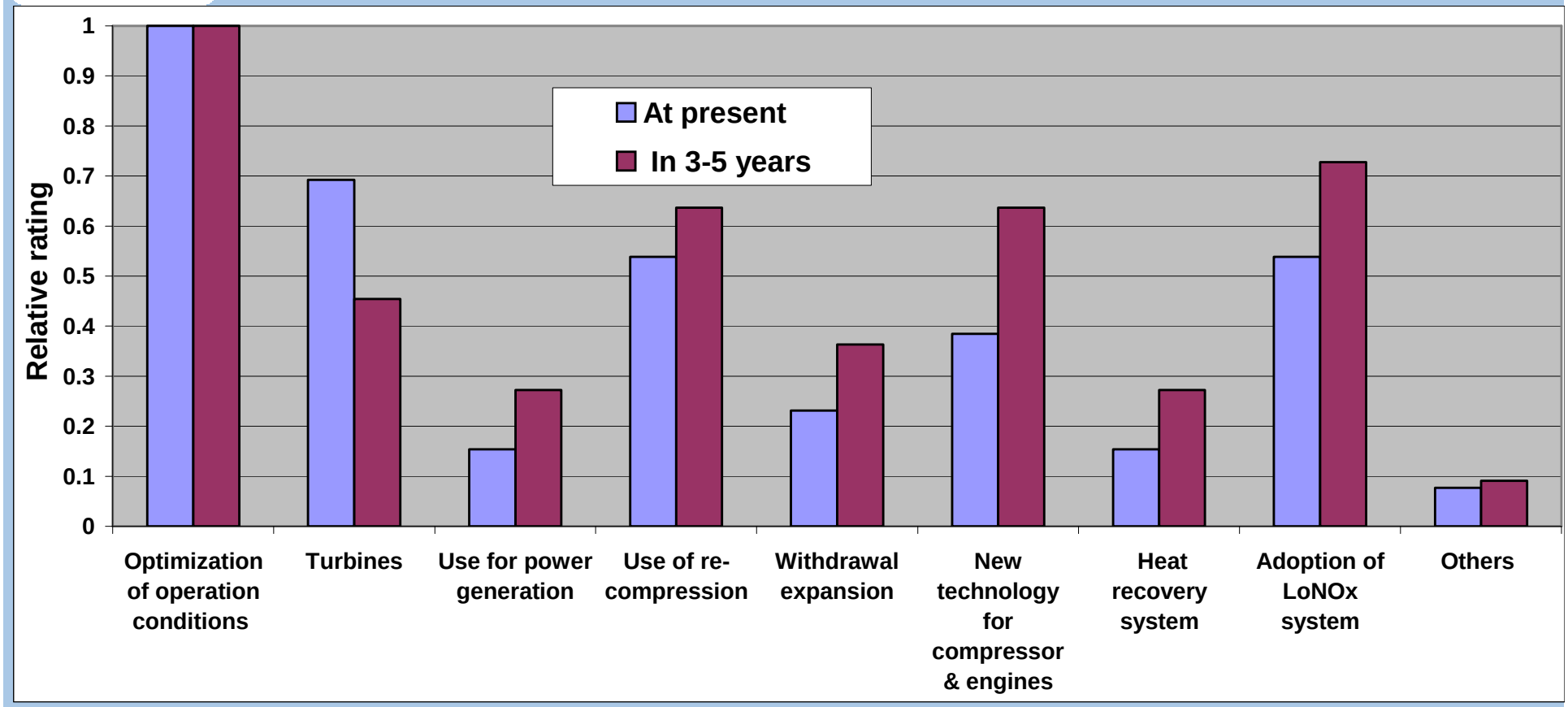
# 4 Surface Facilities

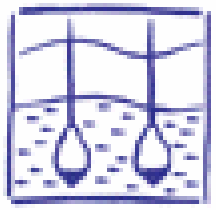
## 4.3 Technology applied on gas treatmen and gas quality management



# 4 Surface Facilities

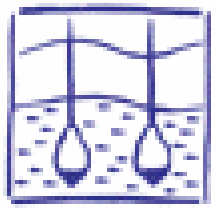
## 4.4 Improvements carried out on compression performance





# 5 Safety
## 5.1 Spectrum of technologies for safety

- *Safety studies and audits*
- *Preventive technical installations*
- *Subsurface safety valves*
- *Diagnosis of critical operations*
- *Enhanced monitoring*
- *Best knowledge of the geological situation*
- *Periodical gas inventory and control of cap rock tightness*
- *Preventive maintains*
- *Accidence analyses*



# Conclusions

- *The expansion of world gas demand will lead to a continuous increasing of storage capacity in future, and many new facilities will have to be constructed to meet future needs*

- *The analysis of data shows that gas storage technologies are being developed that allow the efficiency of UGS creation and operation to be enhanced and new market requirements to be met*