



PPSDM Jakarta, November 2nd, 2017

# Company decision-making for geothermal projects

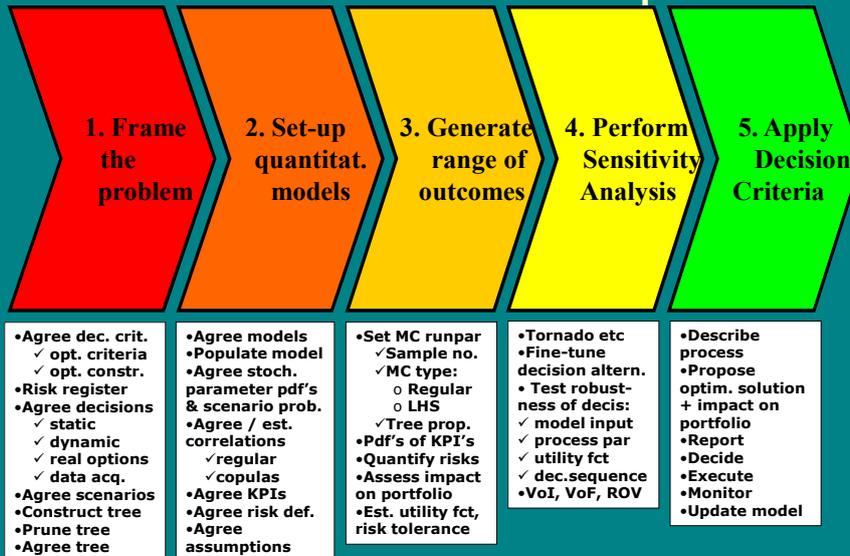
(GEOCAP course 1.07)

## Topic: Framing the Problem

Lecturer - Ir. Christian Bos

Public document (GEOCAP-2016-REP-TNO-1.07-xx)

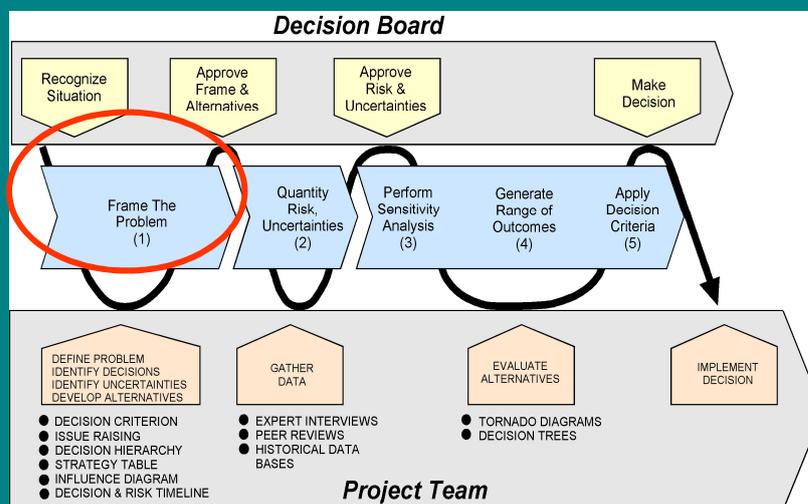
### D&RA - 5 main steps



26/10/2017



## The D&RA Process



26/10/2017



3

## Framing the problem (1)

1. Brainstorm with multi-disciplines
  - **Establish inventory of risk factors ("risk register") and business drivers**
    - **Qualitative only, no ranking yet**
    - **Highly multi-disciplinary: needs moderator to allow less vocal team members to speak up**
2. Construct graphs of:
  1. **x=Probability of Risk-factor vs. y=Adverse impact on "Value"**
    - **Qualitative: estimate hi/med/lo standard deviation**
    - **Initially, non-specific definition of "value"**
    - **Position risk-factor in quadrant**
  2. **x=Manageability of Risk-factor vs. y=Adverse impact on "Value" : "to which extent do we control the risk-factor?"**
    - **Ditto**
3. Move risk-factors relatively within quadrants
  - **Relative positioning & ranking of risk-factors**

26/10/2017



4

## Framing the problem (2)

4. Repeat steps 1 and 2, but now per KPI-group
  1. LT economics (e.g. reserves, opex)
  2. ST economics (e.g. capex, production next 5 years, 1 yr)
  3. HSE
  4. Construct graphs of:
    1. x=Probability of Risk-factor vs. y=Impact on "Value"
    2. x=Manageability of Risk-factor vs. y=Impact on Risk-reduction
5. Move risk-factors relatively within quadrants
  - Relative positioning & ranking of risk-factors
6. Using charts, agree how to translate risk-factors into "discrete uncertainties" (scenarios) OR "decision alternatives"
  - High manageability -> decision
  - Low manageability -> discrete uncertainty (scenario)
  - Low impact, low probability -> discard initially
  - Very high impact, very low probability ("train wrecks") -> discard initially

26/10/2017



5

## Ranking risk-factors in terms of Impact

- Probability versus Impact



26/10/2017



6

# Further refinement of risk factors + group scores

- Split risk-factors (model input parameters) in smaller groups and score relative importance of risk-factors for each KPI

| Ranking criteria        | occurrence |
|-------------------------|------------|
| Complexity (commercial) | 4          |
| Reserves                | 4          |
| NPV (incred)            | 3          |
| Flexibility             | 2          |
| HSE costs               | 2          |
| IRR (incred)            | 2          |
| Confidence              | 1          |
| Maximum exposure        | 1          |
| Modification reduction  | 1          |
| PI ratio                | 1          |
| Robustness              | 1          |
| Capex                   | 1          |

26/10/2017



7

Per main decision alternative, make inventory of importance of risk factor relative to pertinent KPIs

| KPI →                 | NPV        | IRR | Early prod. | Max. exposure | ΔUR       |
|-----------------------|------------|-----|-------------|---------------|-----------|
| Risk factor ↓         |            |     |             |               |           |
| Prod. start-up        | Life cycle |     | Short term  |               | Long term |
| Commercial Complexity |            |     |             |               |           |
| HSE-costs             |            |     |             |               |           |
| Capex-facilities      |            |     |             |               |           |
| Drillex               |            |     |             |               |           |

- Uncertainty in .... may have a .... (pos/neg) impact on KPI  
 - Use e.g. ---, --, -, 0, +, ++, +++

26/10/2017



8

# Important: consistently and clearly distinguish (terminology)

- Value drivers or risk factors
    - Uncertain model input data that have material impact on KPIs (initially qualitative estimate of sensitivity)
  - Optimization criteria
    - KPIs ("Key Performance Indicator", i.e. uncertain model output data, e.g. NPV, next year's average daily production, etc.
  - Boundary conditions or constraints
    - Internal/external conditions that define frame within which to optimise KPIs
  - Decision alternatives – you control this
  - Scenarios - you do not control this; scenarios describe uncertainties, e.g. in fiscal regime, steel price, etc.
- Threat to understanding each other!
- Be explicit and precise
  - Use clear **terminology** for risk, scenario, decision, driver, risk factor, hurdle rate, constraint, assumption, etc. Link terms to workflow!!

26/10/2017



9

# Example Tampen (NCS)

| alternatives          | New PF        | Local DBL 3x | Local-DBL-3y | Brent        | Area DBL 6a | Area DBL 6d | Area DBL 6e | Snorre SA | Snorre TP |
|-----------------------|---------------|--------------|--------------|--------------|-------------|-------------|-------------|-----------|-----------|
| <b>Value drivers</b>  |               |              |              |              |             |             |             |           |           |
| reserves              | +,+,+         | ++           | +,+          | +            | +,+,+       | -,,-,-      | +,+         |           | +,+,+     |
| capex                 | -,,-,-,-,-,-  | +,+,+,+      | +            | -,+          | +,+,+       | +           |             | +         | +         |
| opex                  | +,+,+,+,+,+,+ | -,,-,-,-,-   |              | -,+          | -,+         | +,+,+,+,+,+ |             | +         | +         |
| <b>Threats</b>        |               |              |              |              |             |             |             |           |           |
| HSE                   | +,+,+,+,+,+,+ | -,,-         | -,,-         | -,,-,+       | -,+         | +,+         |             | +         |           |
| Commercial complexity | -,,-,-,-      | +,+,+        | +,+,+        | -,,-         |             |             |             |           |           |
| <b>Opportunities</b>  |               |              |              |              |             |             |             |           |           |
| Flexibility           | -,,-,+        | +            |              | -,,-,-,-,-,- | +,+         | -,,-,+      | +,+         | +,+,+     | +,+       |
| Miscible flood        | +,+           |              |              | -,,-,-,-,-,- | +,+         | -,,-        | +,+         |           |           |
| New technology        | +             |              |              |              |             |             |             |           |           |

26/10/2017



10

## Inventory of risk factors (or value drivers)

- Initially, no need to distinguish continuous and discrete uncertainties (later)
- $\Delta(\text{Value})$  vs.  $P(\text{risk factor})$  plot may be done for each different KPI rather than for a lumped "value" definition
  - Meaningful to split at least into LT and ST KPIs.

26/10/2017



11

## Train Wrecks

- As a rule of thumb an event could be considered a train wreck
  - if it had a probability of occurrence in the time period considered of less than 10%
  - and a magnitude sufficient to move the P50 of the forecast distribution outside of the P10/90 range.
- Events with a probability lower than 1% are usually ignored.
- Cataloguing train wrecks is a creative brain storming exercise and these guidelines are designed to avoid the "Suppose a meteorite crashed into the platform, just as a nuclear submarine was passing?" type of suggestion.



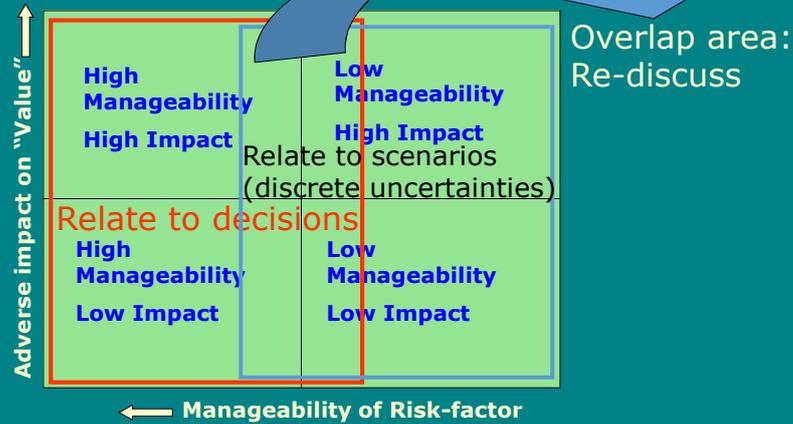
26/10/2017



12

## Ranking risk-factors in terms of manageability

### • Manageability versus impact



26/10/2017



13

## Constructing tree

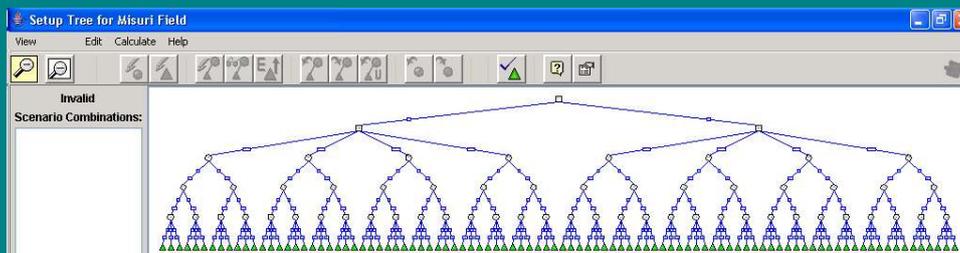
- Select from "Probability versus Impact" plot which risk factors to include in "Manageability versus Impact" plot.
- Select from "Manageability versus Impact" plot which decision and scenarios to be modelled.
- Discuss which other decisions to be included.
- Discuss which risk factors to be modelled as discrete / continuous uncertainties.
- Prune tree by removing invalid / less meaningful scenario/scenario or scenario/decision combinations

26/10/2017



14

# Pruning the tree (1)



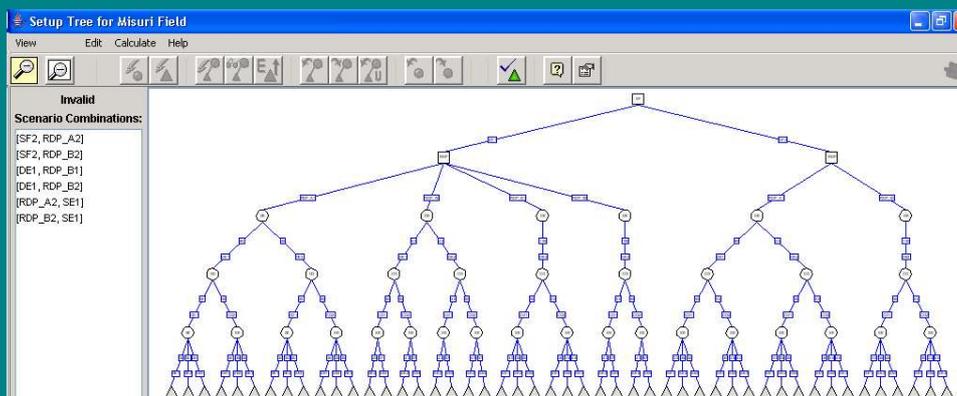
• 96 end-nodes

26/10/2017



15

# Pruning the tree (2)

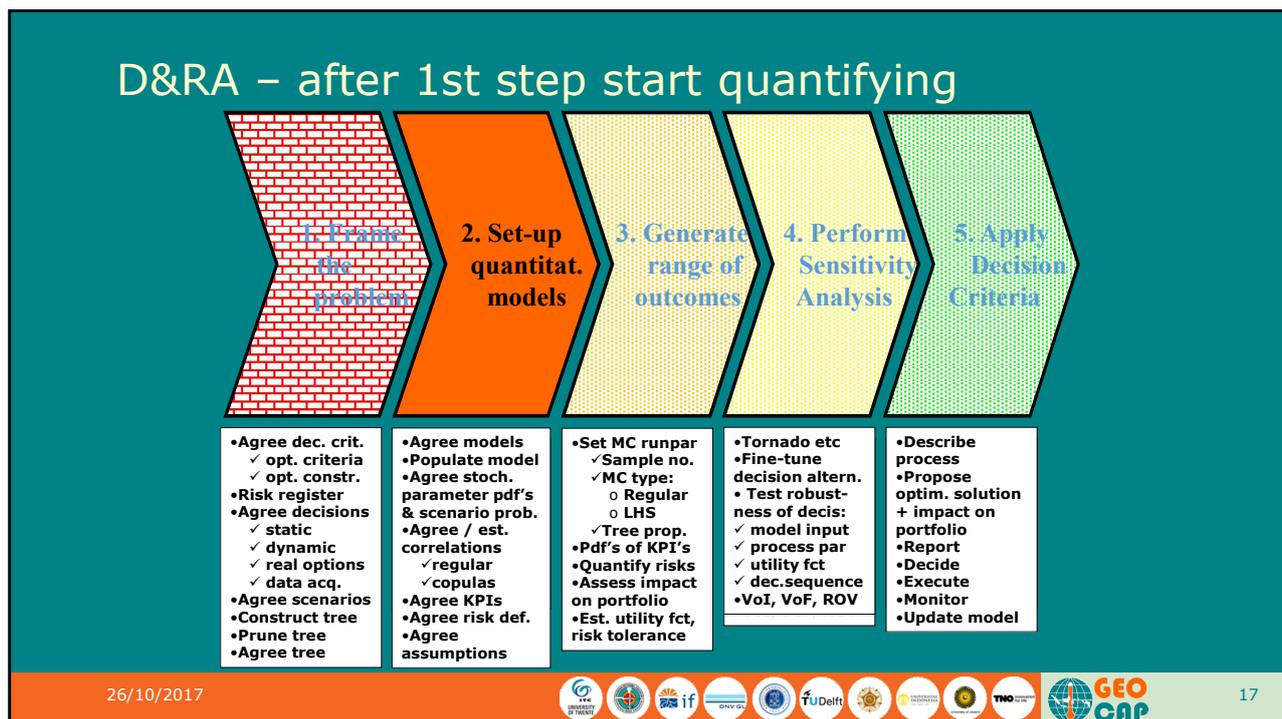


• 48 end-nodes : reduced by half

26/10/2017



16



17

## Case study

- Specify up to "three most important" Value Drivers:
  - **Reservoir : Water & Gas injection, cheaper wells, miscible injection**
  - **Market: Company specific differentials and market balance, product prices**
  - **Frame conditions: Tax, licence concession, drill access in the vicinity**
  - **Infrastructure: Opex reduction, Capex reduction, residual value**
  - **Technology: Cheaper and lighter separation, Water treatment, Low NO<sub>x</sub> turbines**
  - **HSE: emissions requirements: produced water, NO<sub>x</sub>**

26/10/2017



18

## Value drivers

- **Financial & Operational Targets**
  - ✓ Return on capital employed
  - ✓ Production
  - ✓ Exploration and development costs USD/bbl
  - ✓ Production Costs USD/bbl
  - ✓ Other Economic Indicators
- **Invested equity / suppliers**
  - ✓ Equity in field
  - ✓ Equity in surrounding infrastructure and onshore facilities
  - ✓ Equity in surrounding fields
  - ✓ Usage of services : contractors, rigs and shipping
- **"Corporate"**
  - ✓ Company Owners
  - ✓ Corporate Business strategy – regional & international
  - ✓ Safety: People and Environment
  - ✓ E&P + Downstream : Net buyer or seller?
  - ✓ Business view on implementing new technology
  - ✓ Corporate Identity: Business culture & current "voyage to a future"
  - ✓ View on sustainable development

26/10/2017



19

## Project Screening Methodology

- Parameters
  - **Economic**
    - NPV before tax  $k= 7\%$
    - NPV after tax  $k= 8\%$
    - PI-ratio = NPV per invested \$
  - **HSE Requirements for all alternatives**
  - **Sensitivities (high / low significant assumptions)**
  - **Risk Evaluation**
    - Economic
    - Commercial complexity
    - Risk Register
    - Qualitative
  - **Long term Flexibility (10 – 20 years)**
    - Market / Price
    - Technological Advancements
    - New Reserves
  - **Other?**

26/10/2017



20

## Case: Economic Parameters & Assumptions

- Inflation: 2,0 %
- Prices:
  - **OIL 17 USD / BOE**
  - **GAS 0,09 USD / Sm<sup>3</sup>**
  - **NGL 160 USD / Ton going east, and 135 USD /Ton going west. Due to USD 16 logistics penalty at XYZ.**
- Transport / extraction tariffs Country X 0,04 USD / Sm<sup>3</sup> GAS, and 92 USD / Ton NGL
- Transport / extraction tariffs Country Y 9.4 USD / Sm<sup>3</sup> fluids, and 0,03 USD / Sm<sup>3</sup> Gas, no NGL tariff.
- Environmental tariffs
  - **CO<sub>2</sub> 18 USD Fixed from 01.01.2005 →**
  - **NO<sub>x</sub> 2.5 USD / KG 2005 →**
  - **VOC Increasing from 3-13 cents/BBL2003-08, and 5 cents/BBL 2009→**
- Decommissioning:
  - **Country X : Plugging year after production stop, removal starts year after that and takes 4 years for xx and yy, two years for abc and def, and one year for the sub sea templates.**
  - **Country Y : Assumed to pay none of the costs for decommissioning the infrastructure on the Y-side.**
- Tax assumption; Country X tax regime and full tax position.
- Cut off criteria: Maximised NPV after tax.
- During the construction period, 25% of the operational investments in the RNB are used in all the alternatives
- Full transportation tariffs for the "small" overshooting volumes from nearby field Q back to pipeline P.

26/10/2017



21