GEOCAP
Geothermal Capacity Building Program Indonesia - Netherlands

PPSDM Jakarta, October 30th, 2017

Company decision-making for geothermal projects
(GEOCAP course 1.07)

Topic: Mutual introductions & course overview

Lecturer - Ir. Christian Bos

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

Cooperating companies & universities

Universitas Gadjah Mada	University of Twente — Faculty ITC
Universitas Indonesia	Utrecht University — Faculty of Geosciences – Department of Earth Sciences
Institut Teknologi Bandung	Delft University of Technology — Department of Geo-Technology
INAGA	Netherlands Organisation for Applied Scientific Research
IF Technology	DNV GL

IND coordinator:
INAGA
NL coordinator:
ITC
Advisory board:
BAPPENAS (chair)
MEMR
RISTEK DIKTI
Min. Foreign Affairs NL
Rector ITB
Rector UGM
Rector UI
INAGA
Proposed additional members:
BADIKLAT MEMR
Badan Geology

Funded by
Ministry of Foreign Affairs of the Netherlands

26/10/2017

2

GEOCAP full courses WP1.06-1.07-1.08

Course title/focus	Target Group
1.06 - Government policy-making and decision-making for geothermal projects Energy policy framework: broader perspective of renewable energy market, role of GTE. Understanding GTE policy framework, government take + investment climate, learning + updating. Authority decision-criteria and decision-making: tendering, licensing and permitting, COD, financial closure. Also: subsidies, guarantees, govt. participation. Interaction with company decision-making.	Central govt. policy-makers, Competent Authority licensing and permitting decision-makers. Industry representatives.
1.07 - Company decision-making for geothermal projects Framing the problem. Investment Decision Analysis / Risk Analysis: methods, multi-criteria, techno-economic models (physics + discounted cash flow analysis), production forecasting, uncertainty, sensitivity analysis, risk mitigation, value of information, value of flexibility. Decision-gate process, project maturation. Corporate portfolio analysis. Multi-stakeholder analysis.	Corporate decision-makers, company engineering / corporate planning staff, company economists. Government representatives
1.08 - Environmental aspects of geothermal projects Sustainable GTE planning and decision-making in Indonesia: logic, efficiency, effectiveness, transparency and stakeholder involvement.	Government, Industries, Academicians and local stakeholders.

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Today's programme (Monday)

- Mutual introductions

- Programme overview of 7 days 5-13 Nov 2013

- Some remarks on spirit of course

- Discussion

- Questionnaire to test prior knowledge

- Lecture on DA and DQ

- Exercises

26/10/2017   4

Introduction of participants

#	Given name	Surname	E-mail	Background / function	Expectations of course
1					
2					
3					
4					
5					
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7					
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9					
10					
11					
12					
13					
14					

26/10/2017   5

Daily programme DD-DD MMM 2017
08:30- ±16:00 hrs

Day		Programme
Mo	am	Introduction(s); Geothermal energy in Indonesia GT-asset maturation cycle; DCF; Tax; KPIs; CAPM
	pm	XL exercises: DCF, CAPM
Tu	am	Uncertainty; decision tree analysis;
	pm	XL+CB exercise
We	am	Valuation, VoI, VoF, MCDA; Psychology;
	pm	Uncertainty estimation exercise; DTA and XL+CB exercises
Th	am	Framing; option valuation; what is a 'good' decision?
	pm	Intro to Geothermal Asset valuation XL model, XL+CB exercise
Fr	am	Portfolio analysis; LT vs. ST; what is a good investment climate?
	pm	XL + CB exercise; wrap-up; course evaluation form

26/10/2017   6

Essence and spirit of course

- This course is about *maximizing geothermal asset value through decision-making under uncertainty*
  - These decisions drive a company, employment, national wealth, etc.

- It discusses rather *abstract concepts* such as *(added) value*, *uncertainty*, *opportunity*, *risk*, *expectation*, *probability*, *value of information*, *decision quality,* etc. These are perhaps less concrete than physical quantities such as 'porosity' or 'resistivity' of some geological formation, or some hardware component.
  - Many technical people struggle with these abstract concepts

- Students participating in the *Company decision-making* course are therefore expected to *speak up* whenever they do not fully grasp a subject.

26/10/2017   7

Why is investing in subsurface unlike any other industrial activity?

- Technology / production forecasting uncertainty
  - Revenue uncertainty due to *technical* uncertainty (data scarcity)
- Economics / commercial complexity
  - High capex, capex & opex uncertainty
- Governance
  - Legal / fiscal / regulatory complexity
- People management
  - Staff turnaround time << asset performance
- Public acceptance (HSE&SR)
- Integration skills
  - Learning from experience

Summarizing: **committing high capex when productivity of asset is still very uncertain →**

- **High technical risk +**
- **High non-technical risk**
- **This must be balanced by high expected *Return on Investment***

26/10/2017   8

Decision analysis (DA)
ref. Wikipedia

- Decision analysis (DA) is the discipline comprising the philosophy, theory, methodology, and professional practice necessary to address important decisions in a *formal* manner.

- DA includes many *procedures, methods, and tools*
  - for identifying, clearly representing, and formally assessing important aspects of a decision,
  - for prescribing a recommended course of action by applying the maximum expected utility action axiom to a well-formed representation of the decision, and
  - for translating the formal representation of a decision and its corresponding recommendation into insight for the decision-maker and other stakeholders.

26/10/2017   9

Processes & methods to be discussed

- **Decision Gate process** – project maturation from brainwave to bankability to FID
- **DA process** – Decision Analysis, to be updated at various 'Decision Gates'
- **Framing** – Part of DRA process: defining uncertainties, decision alternatives, models, decision criteria
- **DTA** – Decision Tree Analysis: setting up a logical structure for Decisions and Scenarios
- **T2B** – Technical-to-Business: modelling technique to couple physics/technical/economics (and HSE)
- **Basic Statistics** – understanding how to model uncertainties, 'Frequentists' vs. 'Bayesians', preventing bias / psychology
- **MC** – Monte Carlo, probabilistic sampling technique for modelling KPI-uncertainties, incl. correlations
- **SA** – Sensitivity Analysis: understanding main high-impact uncertainties + what to do about it
- **Robustness** – definition of robustness: how to use this when recommending a decision?
- **CAPM & WACC** – Capital Asset Pricing Model & Weighted Average Cost of Capital: how to use in DCF?
- **DCF** – Discounted Cash Flow analysis: understanding the underlying assumptions of DCF analysis
- **HGT** – Host Government Take, tax, royalty, levies, depreciation, ring-fencing
- **MCA** – Multi-Criteria Analysis: understanding how to optimize the future in case of multi-criteria
- **VoI** – Value of Information: understanding when to propose new data acquisition
- **VoF** - Value of Flexibility: understanding when to propose flexibility-options in an engineering design
- **MPT** – Modern Portfolio Theory: better understanding the nature of risk and how the portfolio of projects determines how to assess individual project risk.
- **MSA** – Multi-Stakeholder Analysis: understanding how to make a Multi-Stakeholder project fly
- **DQ** – Decision Quality: a way to measure and monitor the quality of the decision-making process

Many other methods, e.g.
- **Real Options Valuation**
- **Complexity theory**
- **Agent-Based Modelling**
- **System Dynamics**
- **Bifurcation theory**
- **Resilience testing**
- **Etc. etc.**

26/10/2017   10

Decision-making processes (investment)

"Nothing is more difficult, and therefore more precious, than to be able to decide" - Napoleon Bonaparte

When maybe?

Need more data / info?

Inadequate process?

26/10/2017

11

Academic skills & attitude (1): be critical !

Some examples of questions you may ask yourself regularly:

- How do I know whether I adequately understand some topic?
- When do I start / can I stop questioning?
- What does it mean to have a critical attitude?
- What does it mean to be curious?
- What does it mean to think autonomously?
- What does it mean to nimbly switch between abstraction levels?
- What is relevant detail?
- When and how should I verify whether some theory is applicable to the problem in question?
- How do I formulate a question in such a way that it can be solved with the available methods?

26/10/2017

12

Academic skills & attitude (2): be critical !

- How do I show *mastery* of a subject? How do I influence the thinking process in a group?
- What should my attitude be towards class and lecturer during classes?
- How do I take responsibility for my own professional development in terms of knowledge, skills, attitudes?
- How should I engage in a group or in a F2F discussion?
- What does it mean to be Master? Professional responsibility?

- *It is hoped that the Company Decision-Making course will also contribute to these more general, but crucial requirements to demonstrate your Master level!*

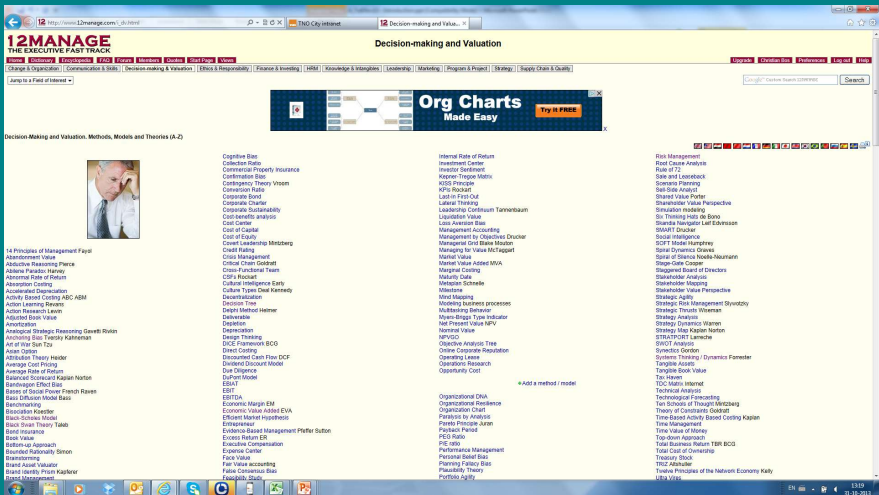26/10/2017   13

Some important attitudes

- *Curiosity*: reach beyond the limits of your current knowledge
- *Eagerness*: show that you have a strong desire to know more
- Initiative: engage with more experienced people
- *Good communication*: articulate your thoughts, and timely
- *Pro-active*: do not wait for others to guide you
- *Sharpness*: know how to question pertinently & unambiguously
- *Robustness:* your reasoning should be solid like a rock
- *Self reflection*: know what you don't know / don't understand!
- *Self-managing*: pave your own way, know and work on your weak points
- *Openness*: be receptive to other ideas, question your axioms
- *Creativity, originality*: use your imagination and knowledge to find *new* solutions. *Think out of the box*.
- *Helicopter view*: seeing relevant detail AND overview
- *Nimbleness*: switching between abstraction levels

26/10/2017   14

http://www.12manage.com/i_dv.html

Try it out!

26/10/2017

Finally

- *Company decision-making* is about
  - Operational decision support
  - Investment decision support and project maturation
  - Strategic planning
    - Department
    - Corporate
    - Partners / contractors / joint ventures / mergers / acquisitions etc.

- Economics and *Company decision-making* is where all information comes together and is upgraded to KPIs and recommendations for decision-making. It's a _language_. It is _the_ language that integrates all disciplines.

- In the end, management chooses the weights per decision-making criterion before making a decision.

26/10/2017   16

Questionnaire

Questionnaire to test knowledge of course participants prior to vs. at the end of the five-day course on "company decision-analysis for geothermal projects"

Public document (GEOCAP-2016-REP-TNO-1.07-4)

Author: Christian Bos (TNO, WP-Leader 1.07)

Date: draft v. April 12th, 2016

To: WP1.07 Course participants

Name	
Company, Organization	
Study completed	
Level achieved (BSc, MSc, PhD, MA, etc.)	
Educational institute (University etc.)	
Years of professional working experience	
Years of professional working experience related to the geothermal industry	
Did you participate in the March 28-29, 2016, pre-IIGW short course at ITB, Bandung? (Y/N)	
How many hours did you spend reading the course's syllabus prior to the course week?	

Instructions: (multiple choice) tick at each question one answer only (either a, b, c, or d). Note, if you don't know the answer with certainty, then do not tick any answer, but leave the answer open. DO NOT GUESS.

- The objective is to obtain an impression of what you have learnt after one week.
- Testing prior knowledge is the reference
- At the end of the week we will repeat this test and compare.

26/10/2017

17