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Making better
Appraisal & Development Decisions
Using Decision Risk Analysis
& Value of Information

Pete Naylor

Society of Petroleum Engineers
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Aims of this presentation

- To introduce Decision Risk Analysis (DRA)

- To provide an understanding of 'value of information' (VOI) analysis
  - When?
  - Why?
  - How?

# What is Decision Risk Analysis?

- A structured process to help stakeholders optimise their decision making in the face of risks & uncertainties
- Involves a combination of
  - Facilitation
  - Modelling
- Term first used by Ron Howard in 1966
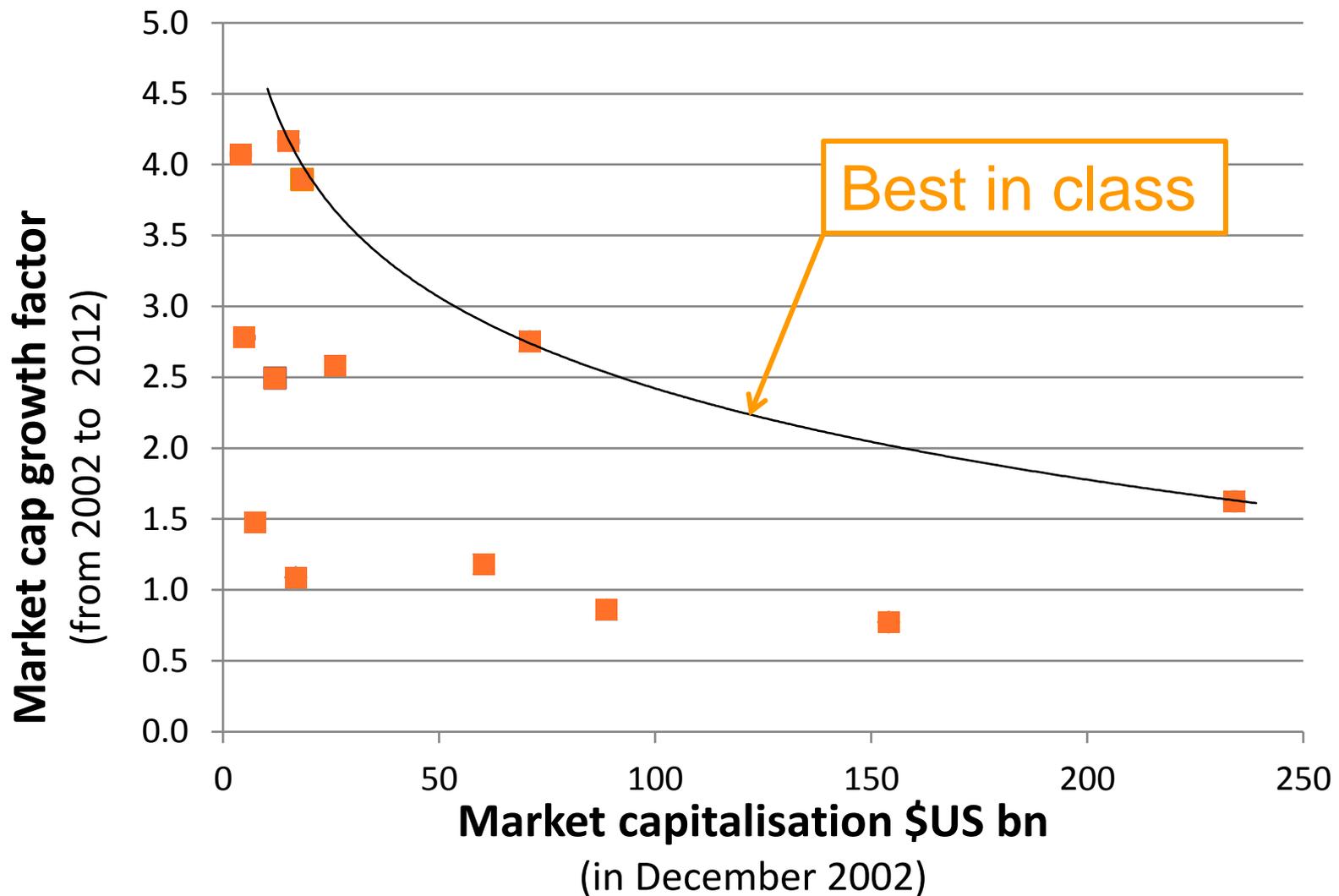
What is Decision Risk Analysis?

- A structured process to help stakeholders optimise their decision making in the face of risks & uncertainties
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Why is DRA not used more widely?

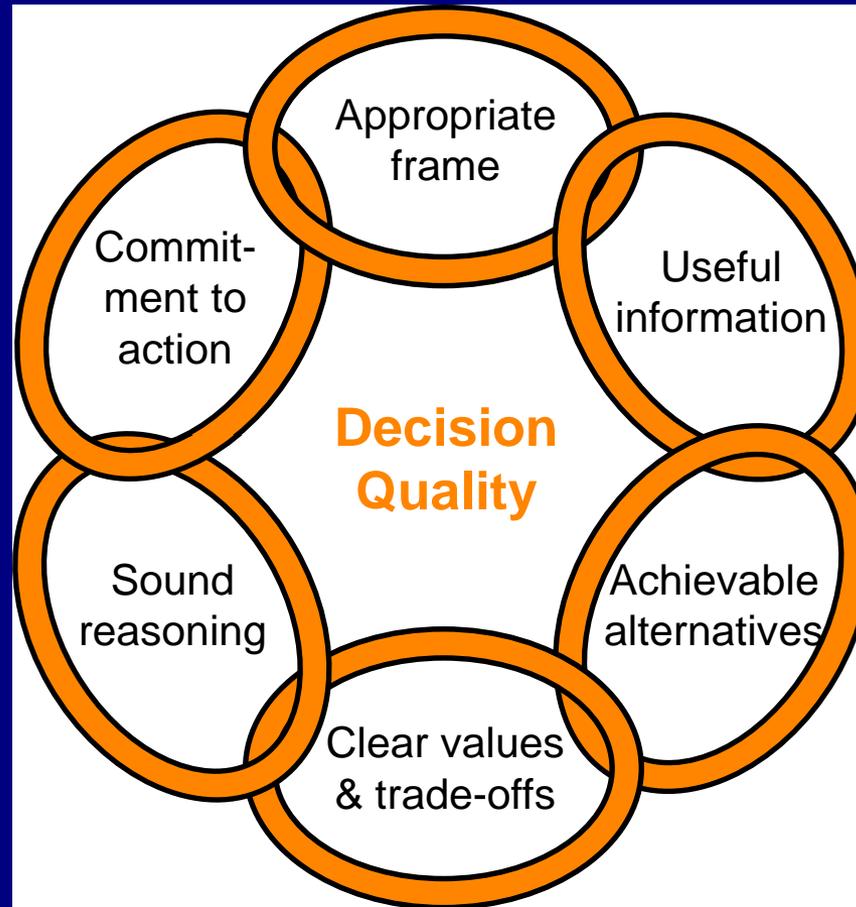# Barriers to using DRA
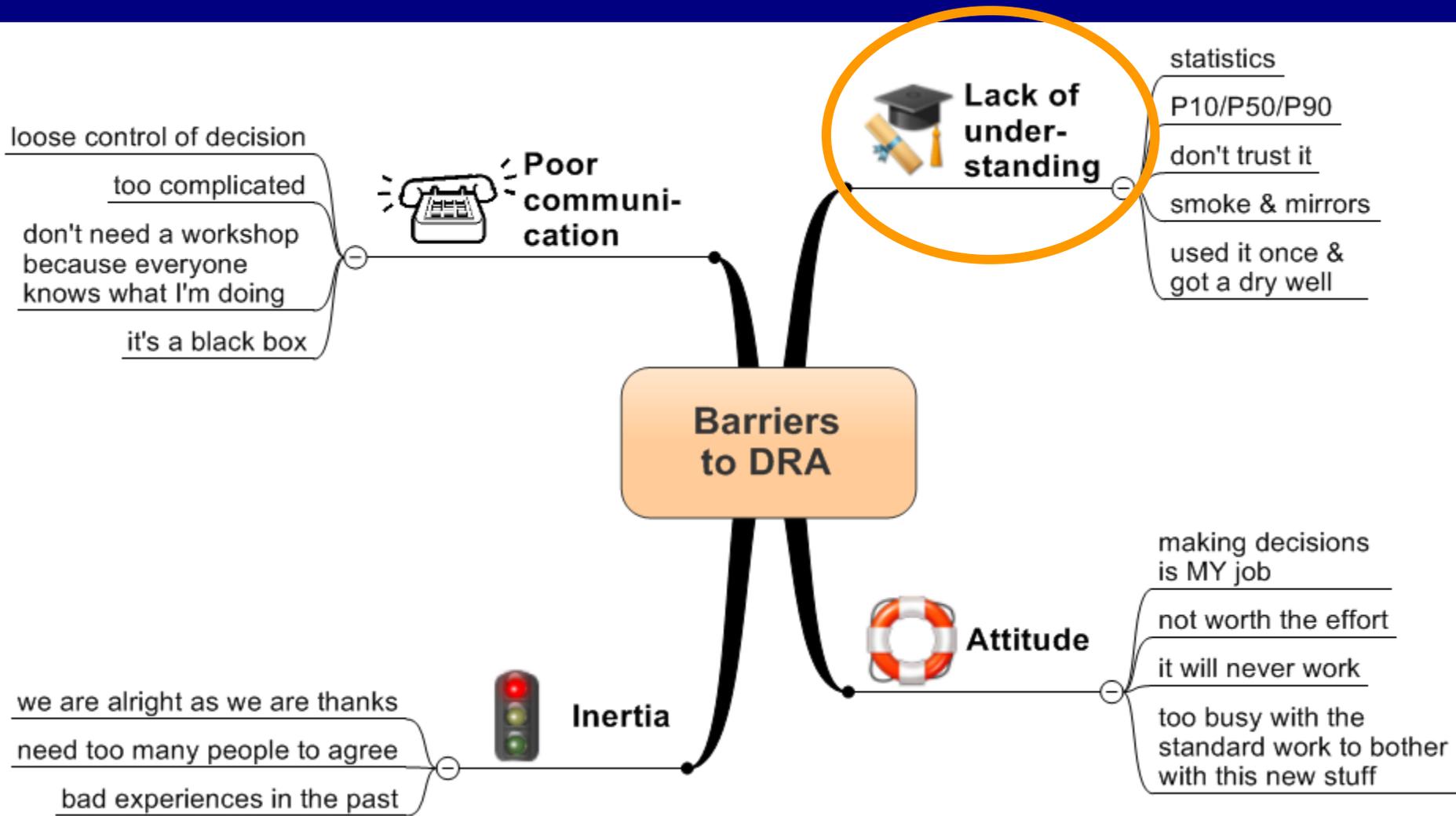
How can you deliver superior performance…?

…focus on delivering Decision Quality

A great answer to the wrong question is useless

Secure consensus amongst stakeholders

Allow for risks & uncertainties correctly

Too complex for intuition?

If there is only one choice then there is no decision

Appropriate frame

Commit-ment to action

Useful information

Decision Quality

Sound reasoning

Achievable alternatives

Clear values & trade-offs

Eg: early production vs NPV

A range of decision making approaches are available

- Voting
- Threat/benefit log
- Weighted ranking
- Absolute ranking
- Probability x impact ranking
- Cost/schedule risking
- Value of information analysis
- Fully integrated asset modelling

Qualitative

Increasing effort

Quantitative

When might VOI analysis be valuable?

- Facing multiple decision options
- Outcomes are uncertain
- Opportunity to acquire additional information
- Information costs money and/or time

Is the additional information worth the cost?

Why might VOI analysis be valuable?

- The additional information might reduce future uncertainties
- The best decision option might change in the light of the new information

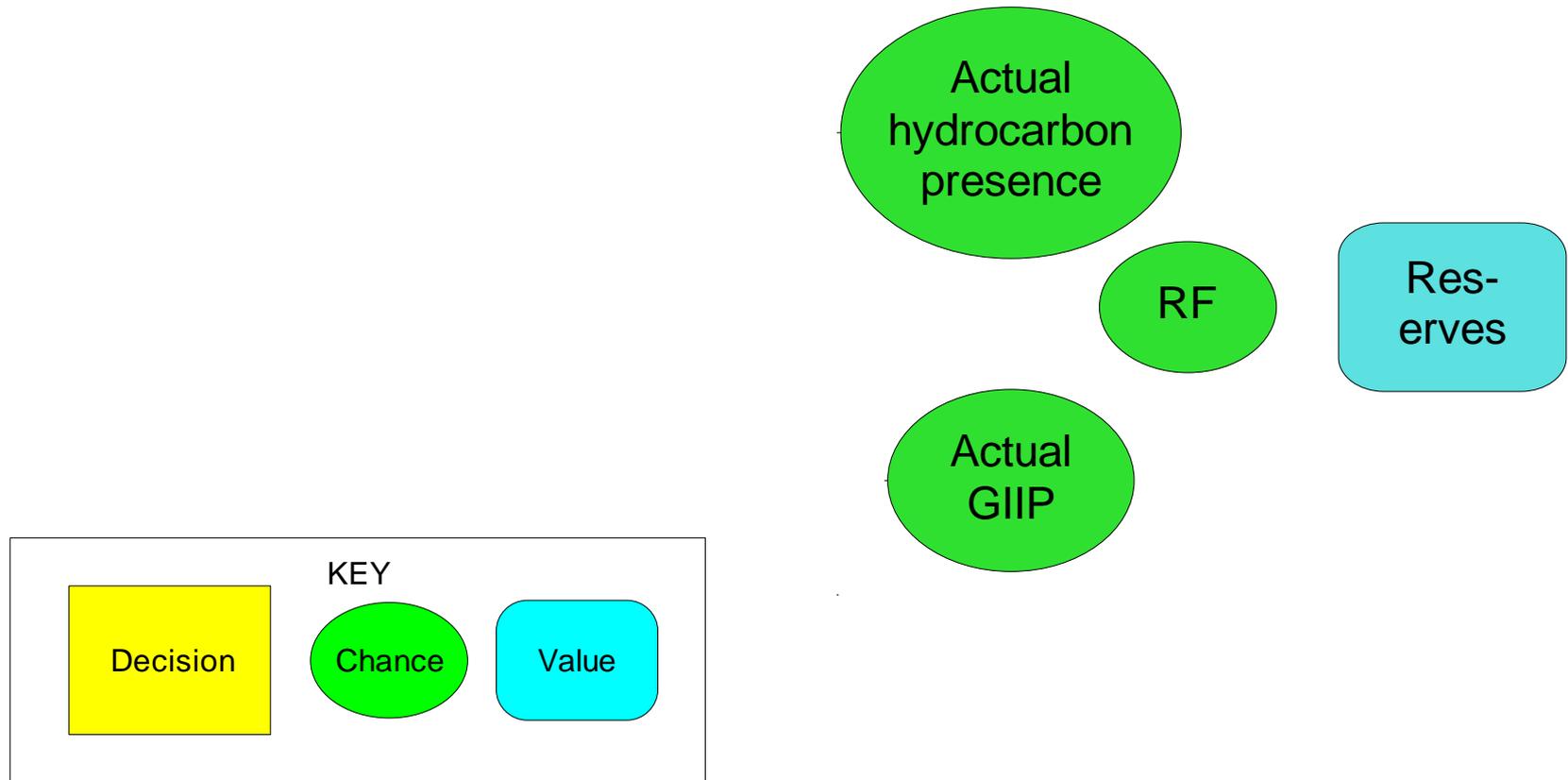If no decisions change, think carefully about acquiring the new information

Key questions

- How much does the information cost?
  - Acquisition, analysis, delay to development
- How reliable is the information?
  - Will the measurement fail?
  - False results (imperfect information)?
- How useful is the information?
  - How significant is the parameter(s)?
  - What difference will the information make?

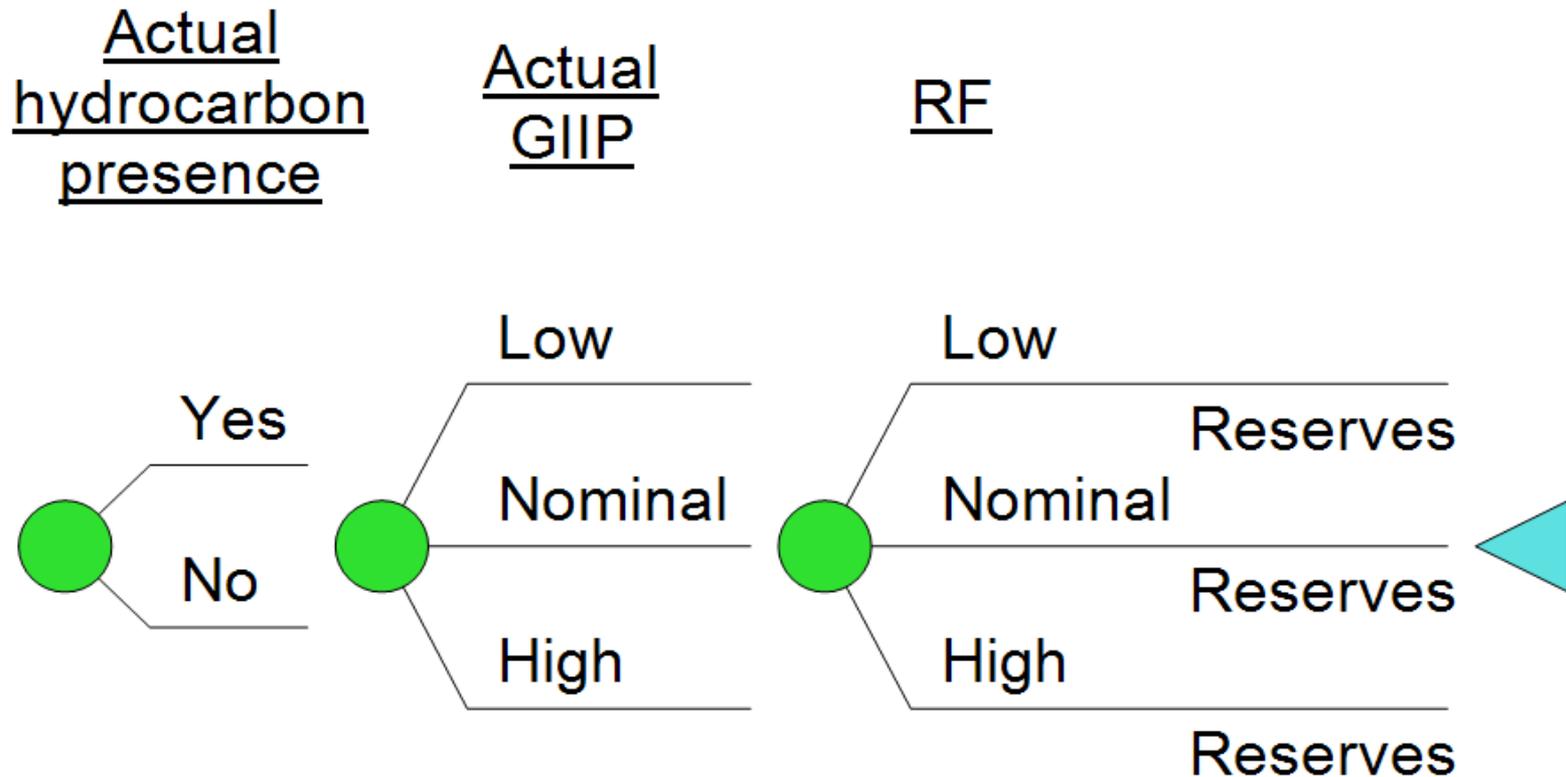# How do I undertake a VOI analysis?

- Case example
  - Should an appraisal well be drilled in the North Extension?
  - Should the North Extension be developed?

- A new user took < two hours to learn the software & complete this analysis
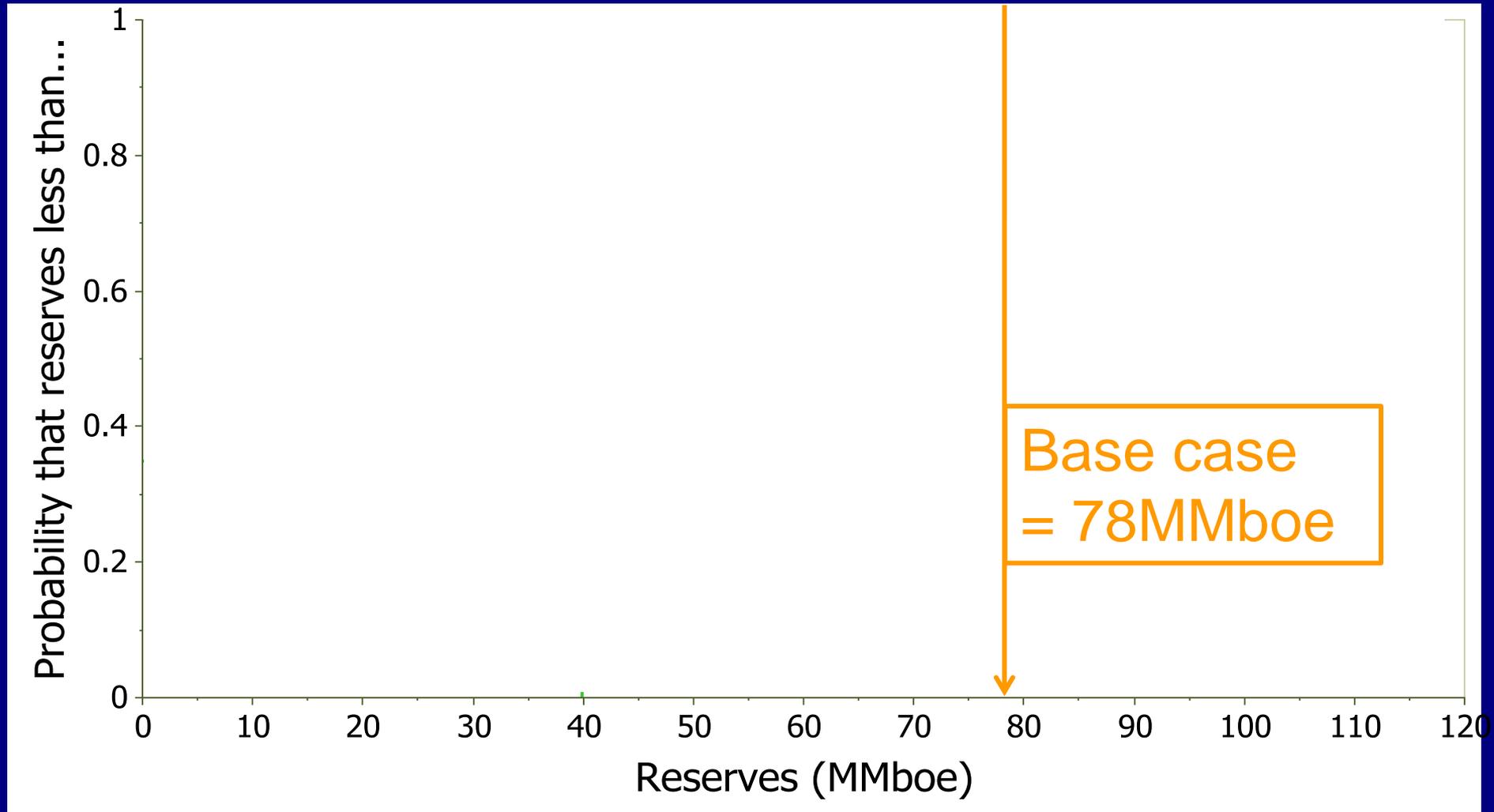
Influence diagram

Actual hydrocarbon presence

RF

Res-erves

Actual GIIP

KEY

Decision

Chance

Value

Lays out the components of the frame

Decision tree

Actual hydrocarbon presence	Actual GIIP	RF

Yes

No

Low

Nominal

High

Low

Nominal — Reserves

High

Reserves

Reserves

Reserves

Reserves = Presence * GIIP * Recovery Factor

Base case: Yes + Nominal + Nominal

15

Base case: reserves for North Extension

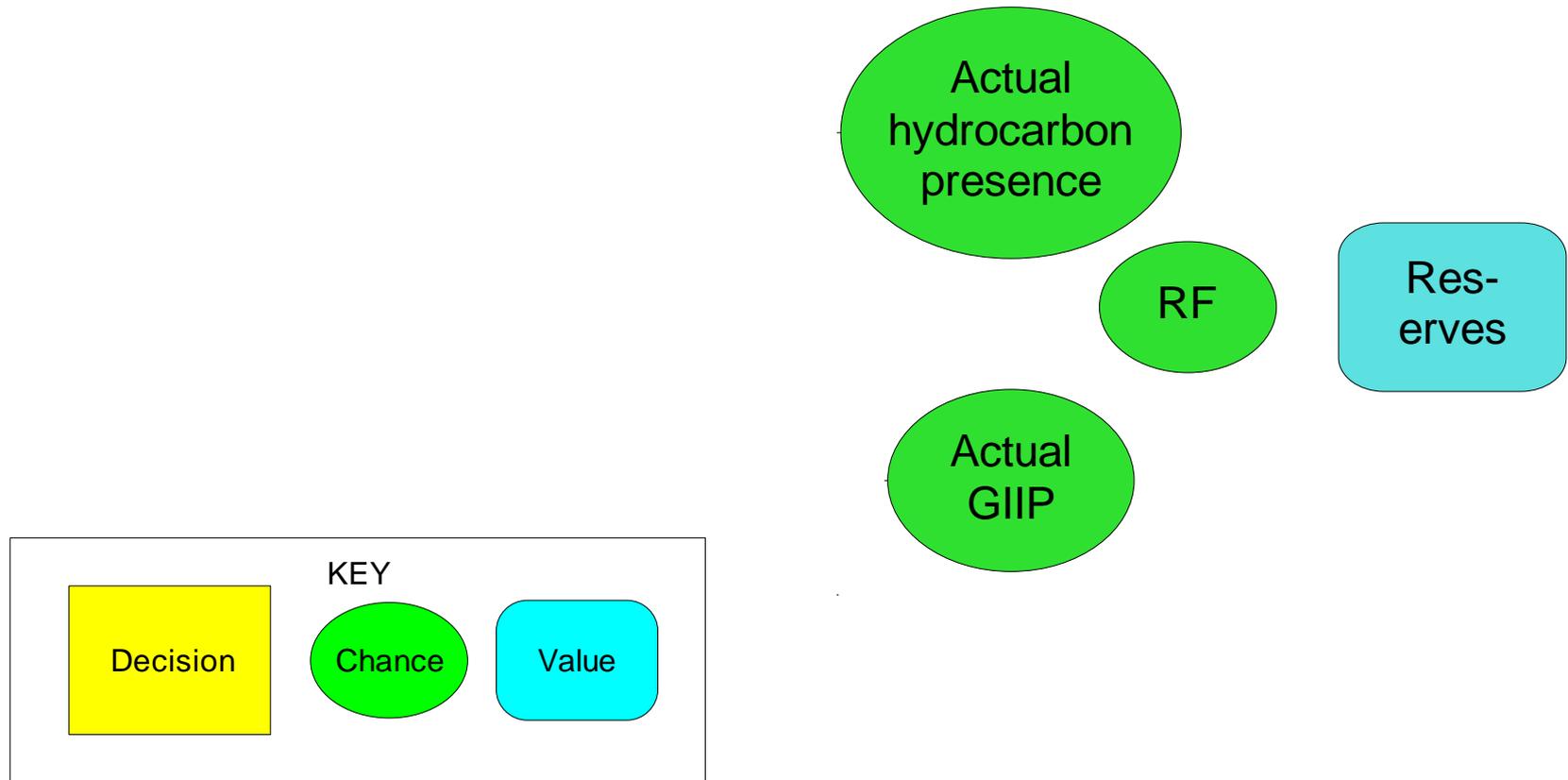Probability that reserves less than…

Base case = 78MMboe

Reserves (MMboe)

This should not be the basis of your business case

Risk profile: reserves for North Extension

Probability that reserves less than...

— Develop_now

Probability of no hydrocarbons is (1-0.65) = 0.35

Expected value = 40MMboe

Base case = 78MMboe

Reserves (MMboe)
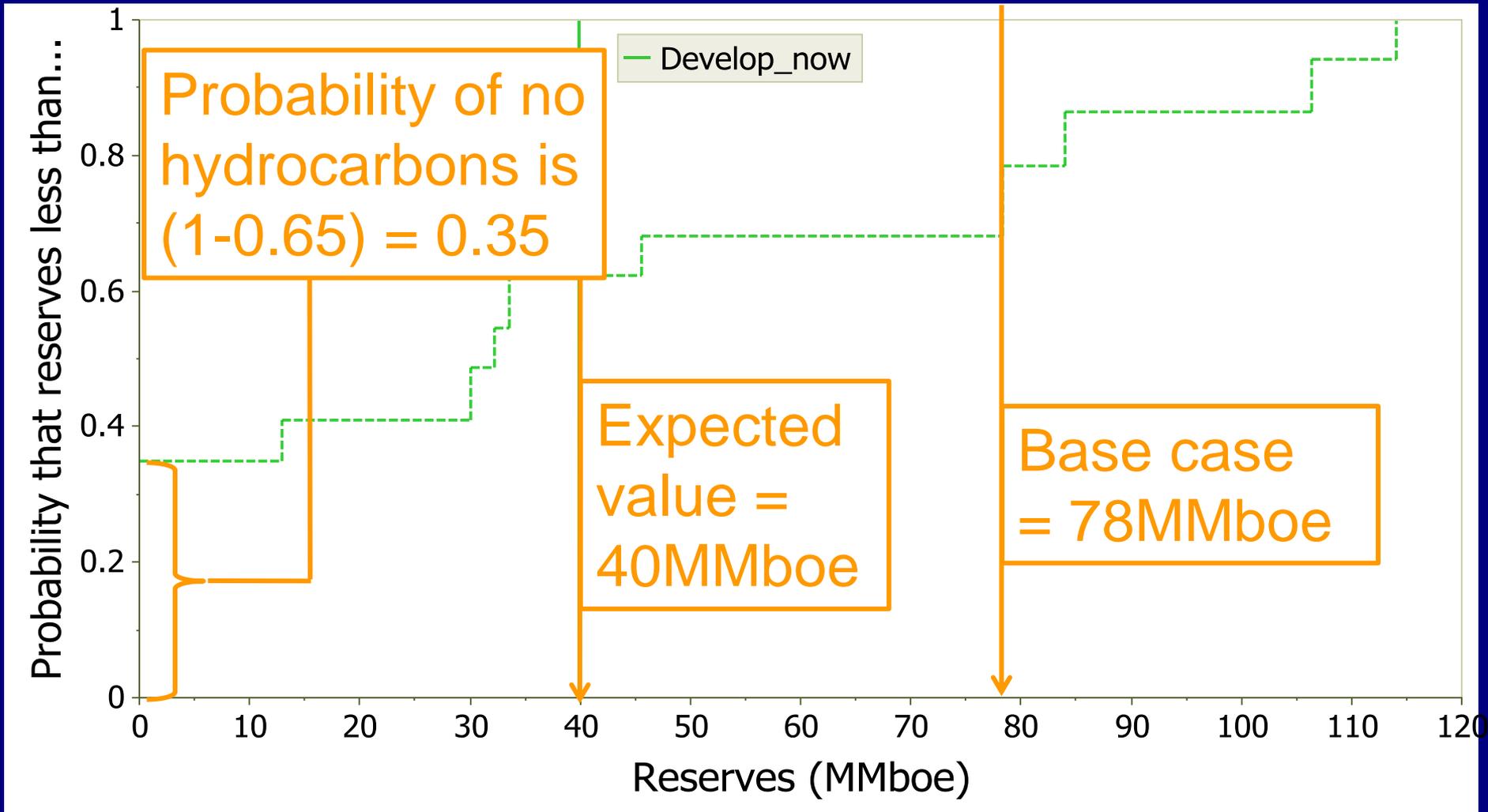
Illustrates the range of possible reserves

Influence diagram

Actual hydrocarbon presence

RF

Res-erves

Actual GIIP

KEY

Decision

Chance

Value

Influence diagram extended to include appraisal

Conditional probabilities: hydrocarbon presence with perfect information
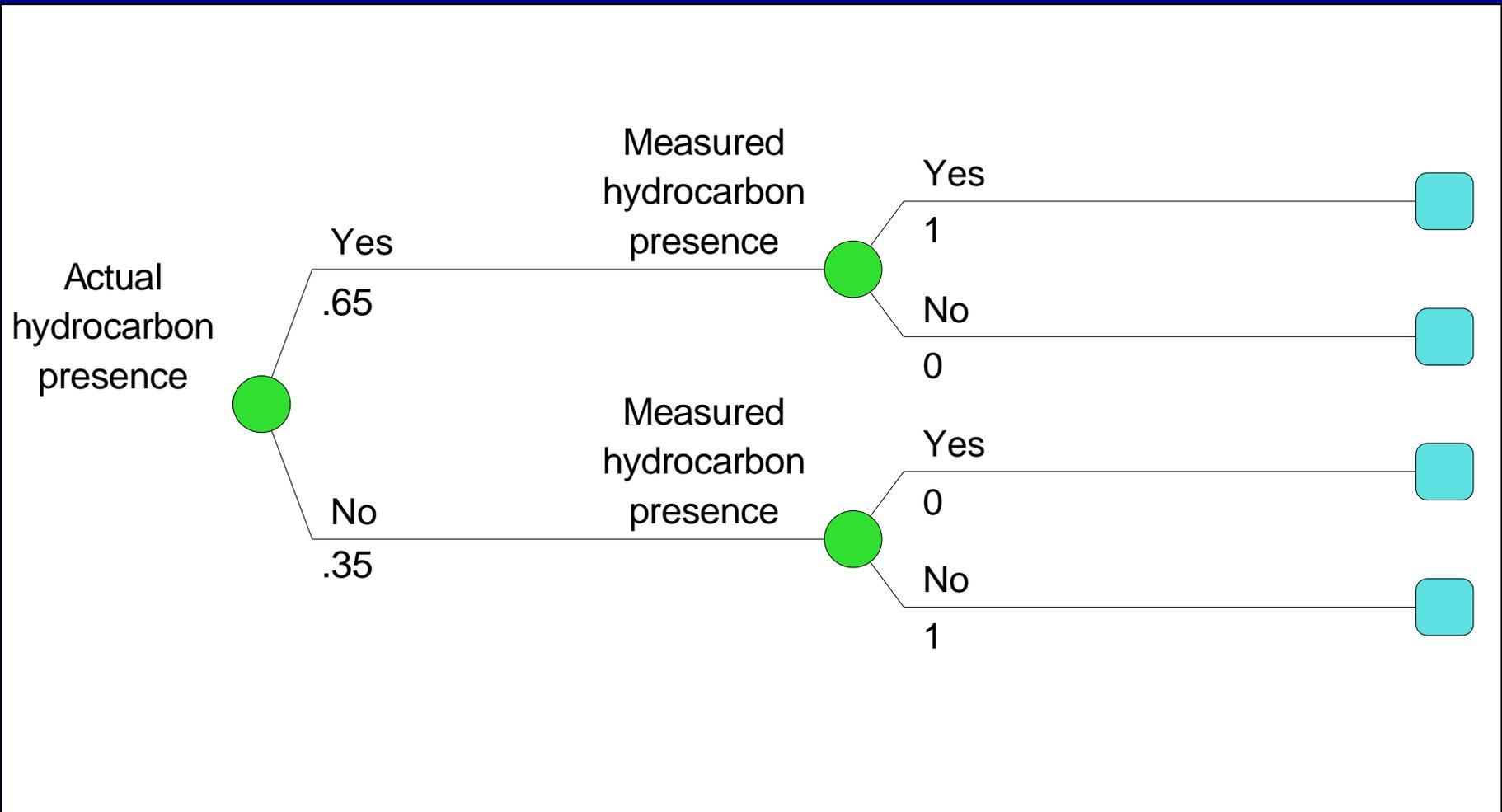
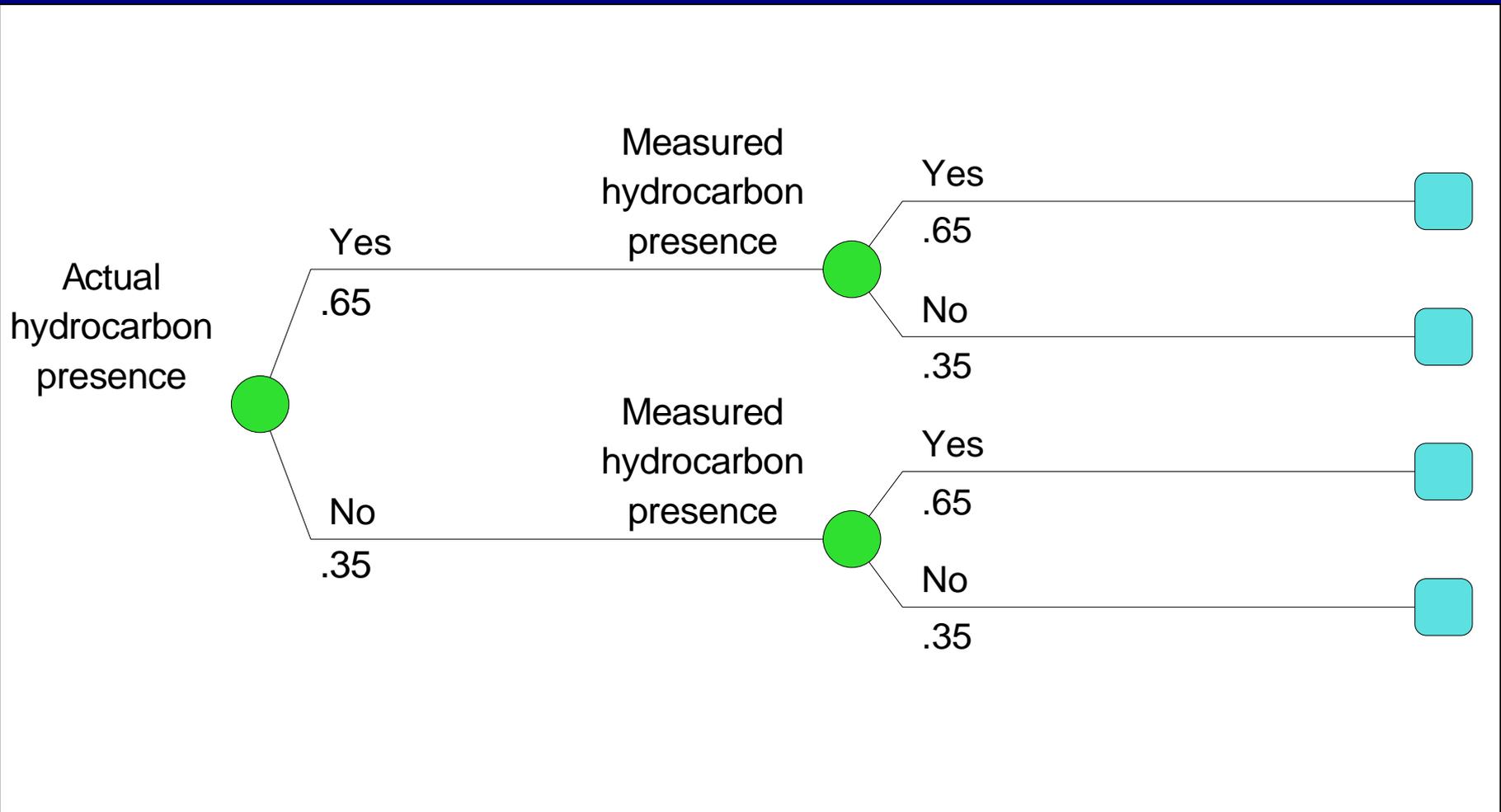Captures the reliability of the measurement

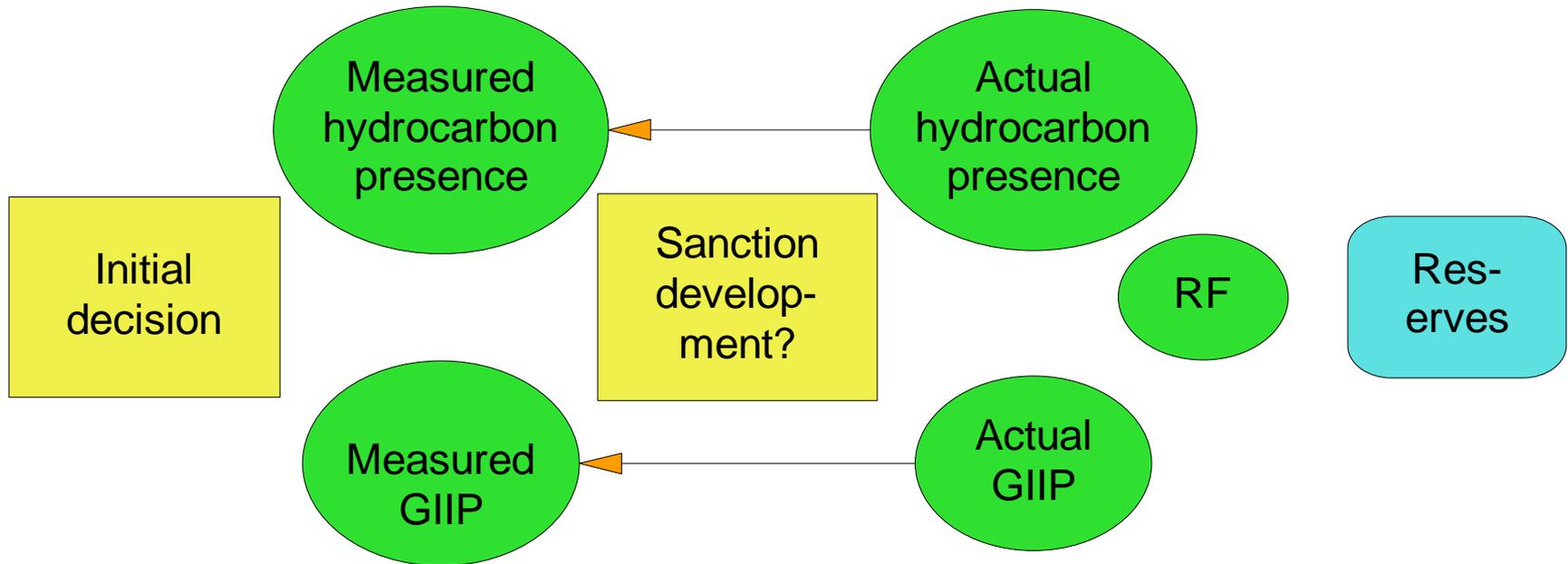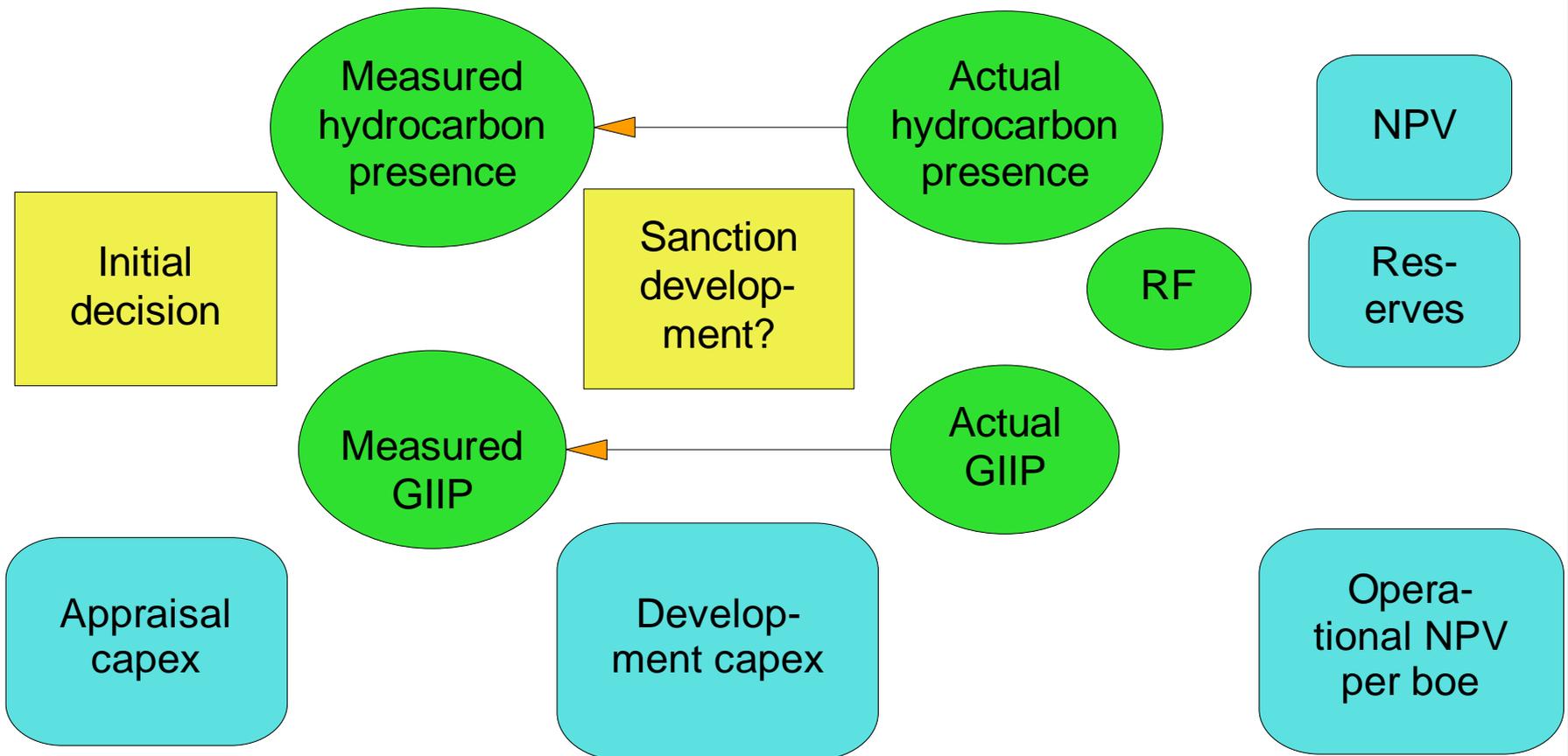# Conditional probabilities: hydrocarbon presence with imperfect information

Actual hydrocarbon presence

Yes .65

No .35

Measured hydrocarbon presence

Yes .8

No .2

Measured hydrocarbon presence

Yes .05

No .95

Conditional probabilities: hydrocarbon presence with no information

Influence diagram

Influence diagram
extended to include economics

Net Present Value = Reserves*(OpsNPV/boe)-capex
Which decision options give the best NPV?

Decision tree
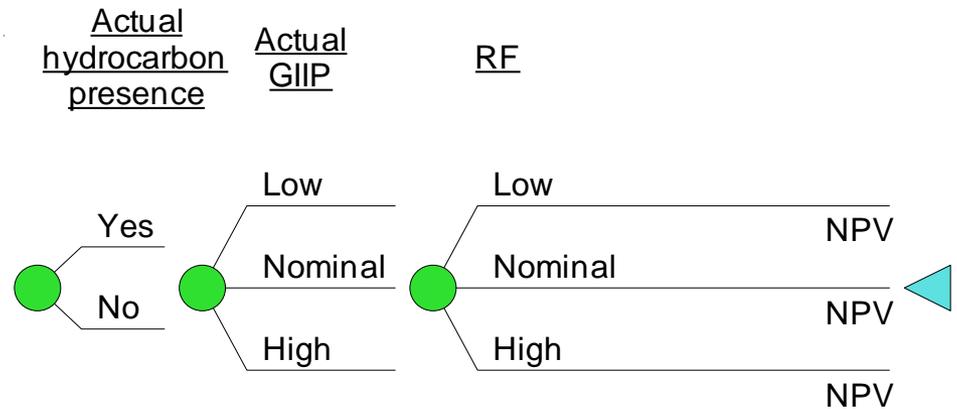
Decision tree
extended to include appraisal

| Initial decision | Measured hydrocarbon presence | Measured GIIP | Sanction develop-ment? | Actual hydrocarbon presence | Actual GIIP | RF |

Appraise — Yes / No
- Low
- Nominal
- High

Sanction development? — Yes / No

Actual hydrocarbon presence — Yes / No

Actual GIIP:
- Low — RF Low — NPV
- Nominal — RF Nominal — NPV
- High — RF High — NPV

Develop

Sanction development? — Yes / No

Actual hydrocarbon presence — Yes / No

Actual GIIP:
- Low — RF Low — NPV
- Nominal — RF Nominal — NPV
- High — RF High — NPV

Walk_away
- Yes — NPV
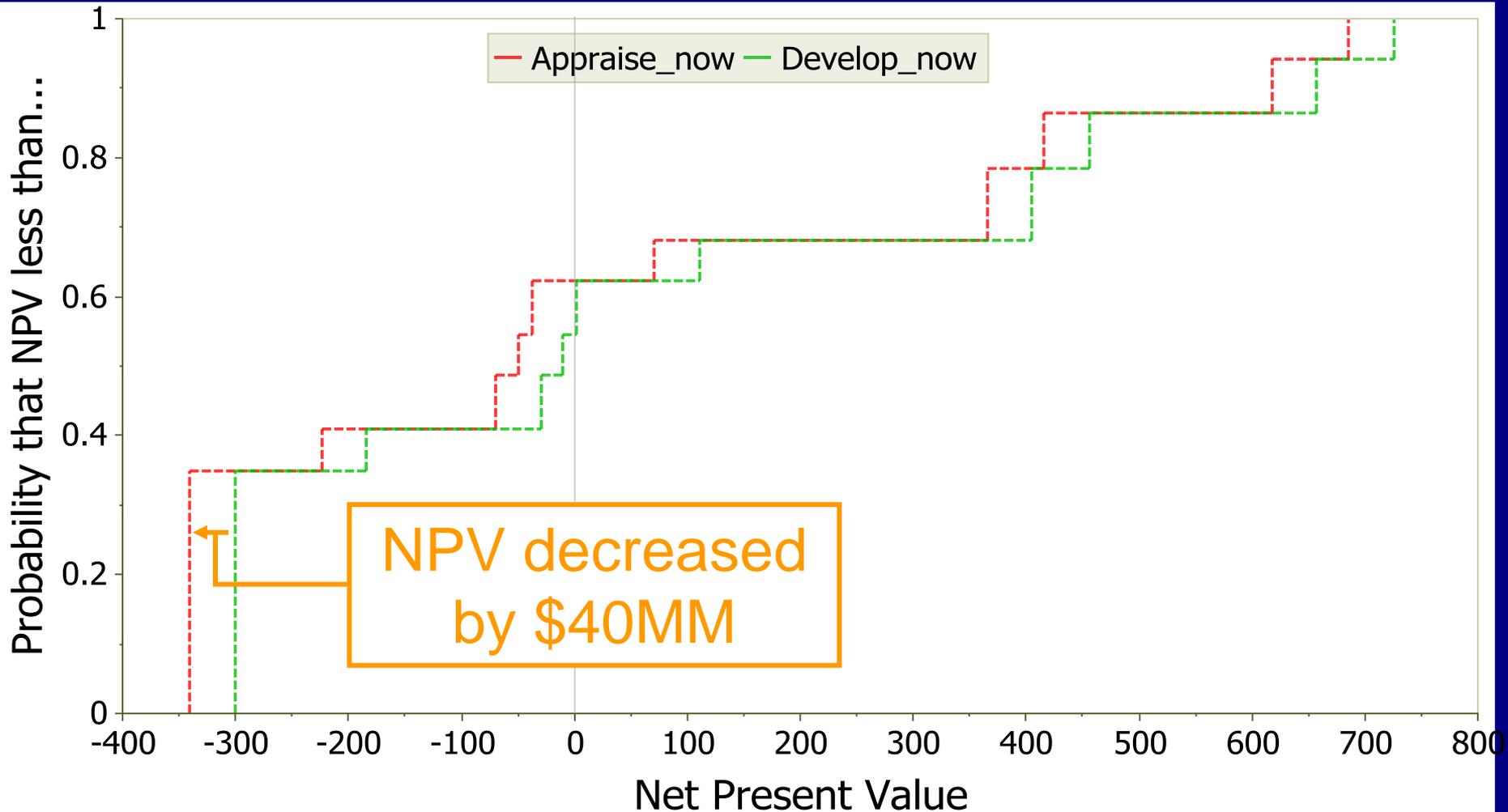- No — NPV

Captures the time order of events

NPV risk profile: develop now
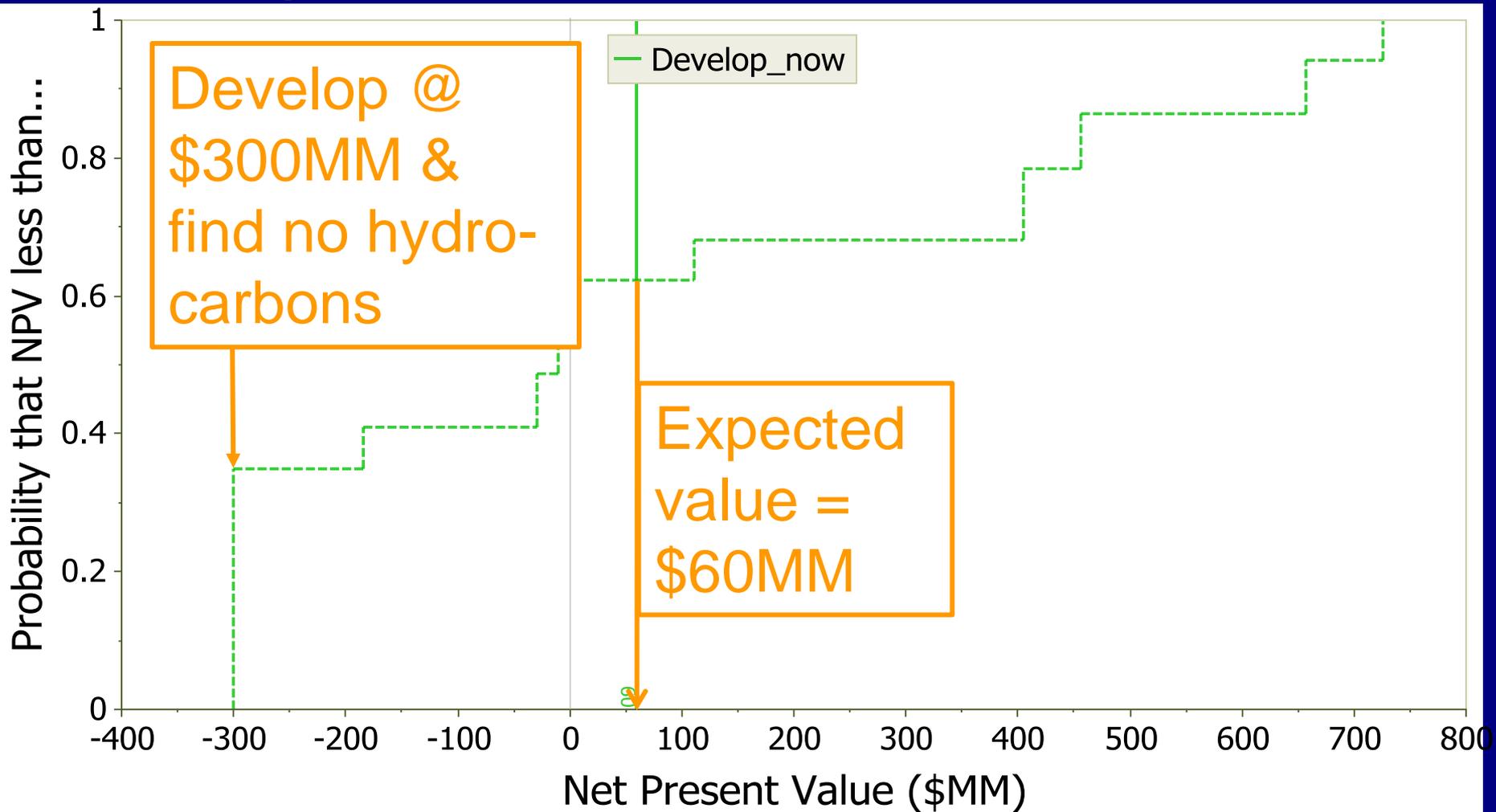
Illustrates the range of possible NPVs

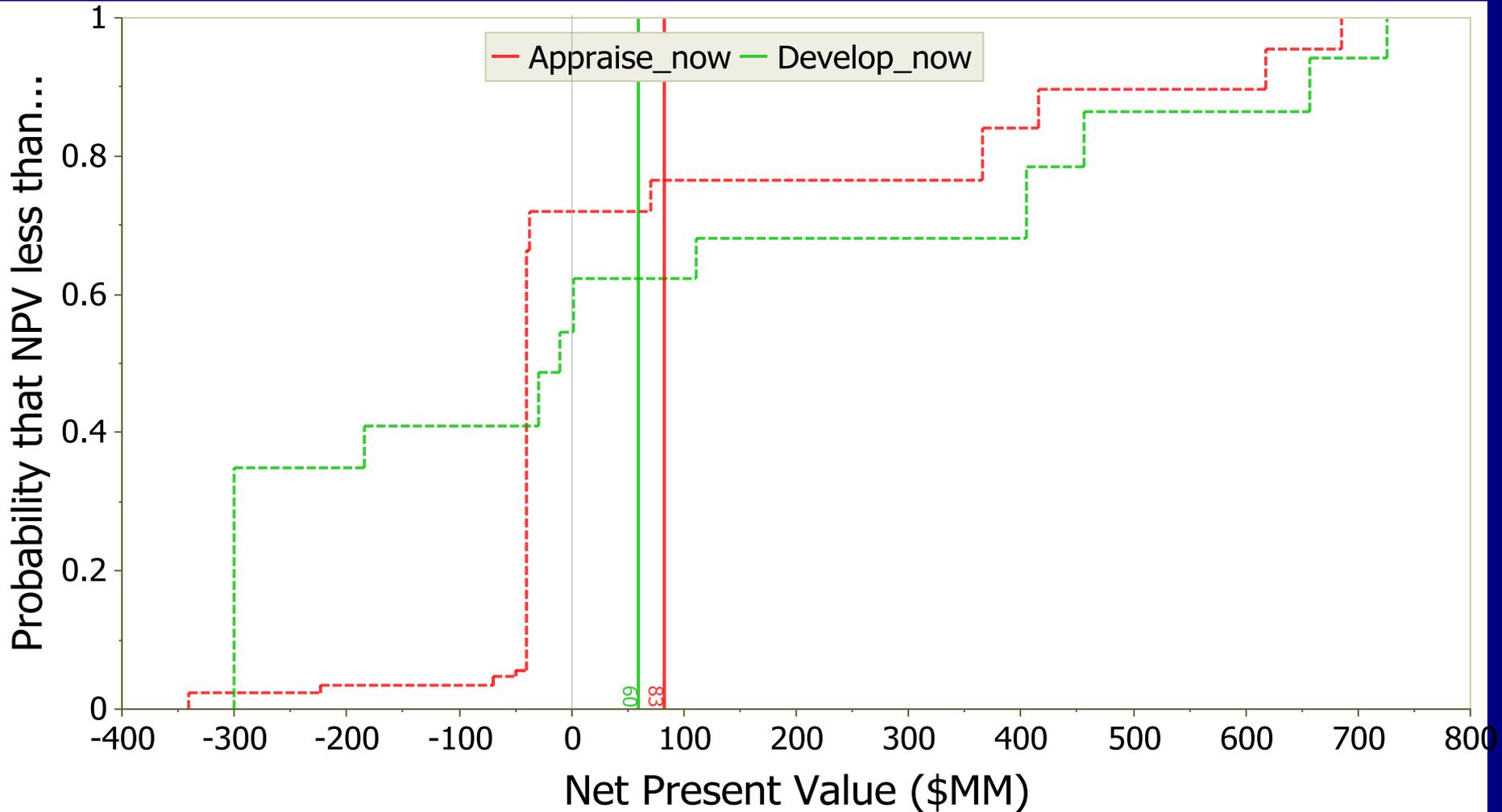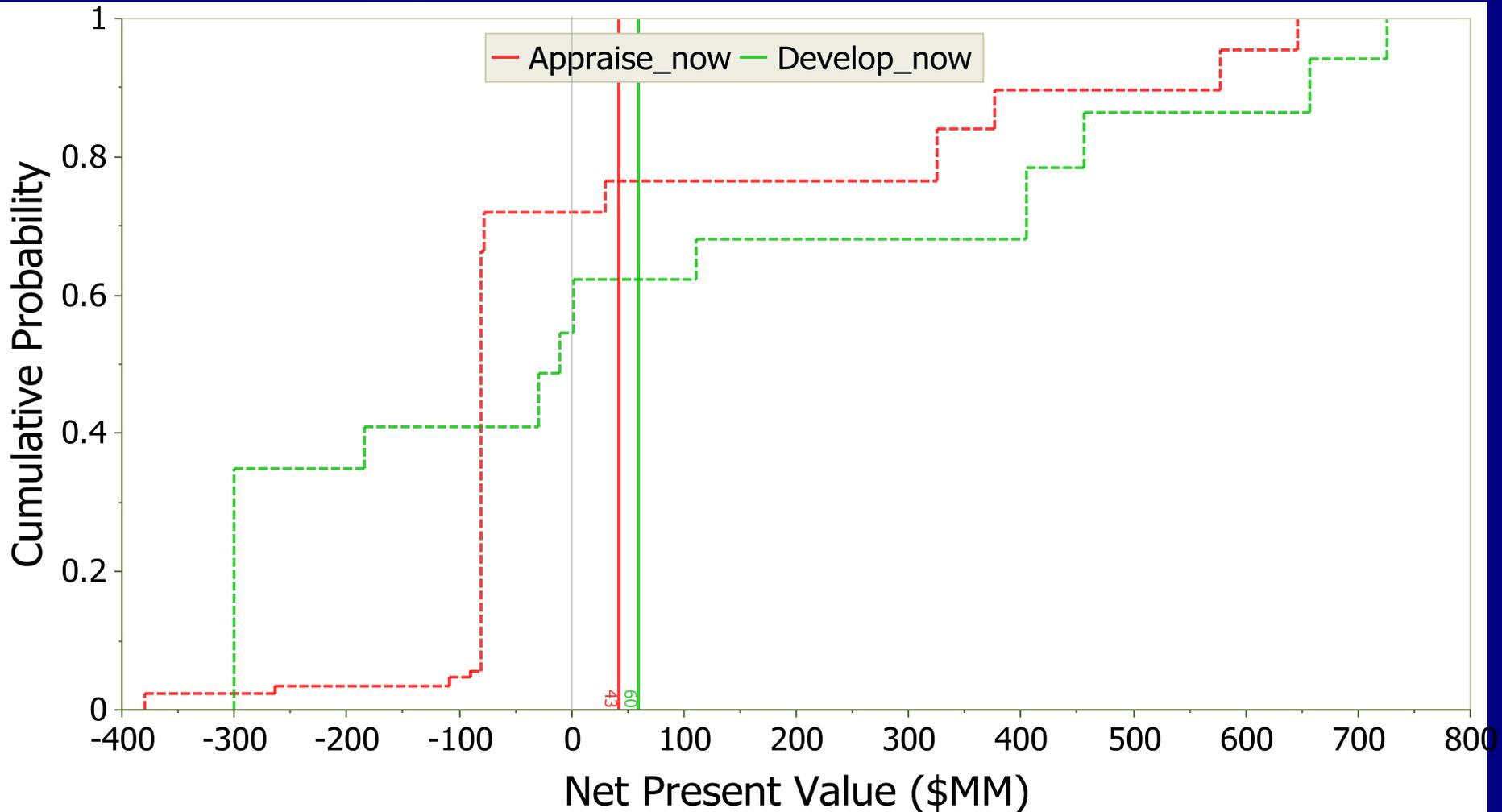# NPV risk profile: appraise, no information

NPV risk profile:
appraise, perfect information
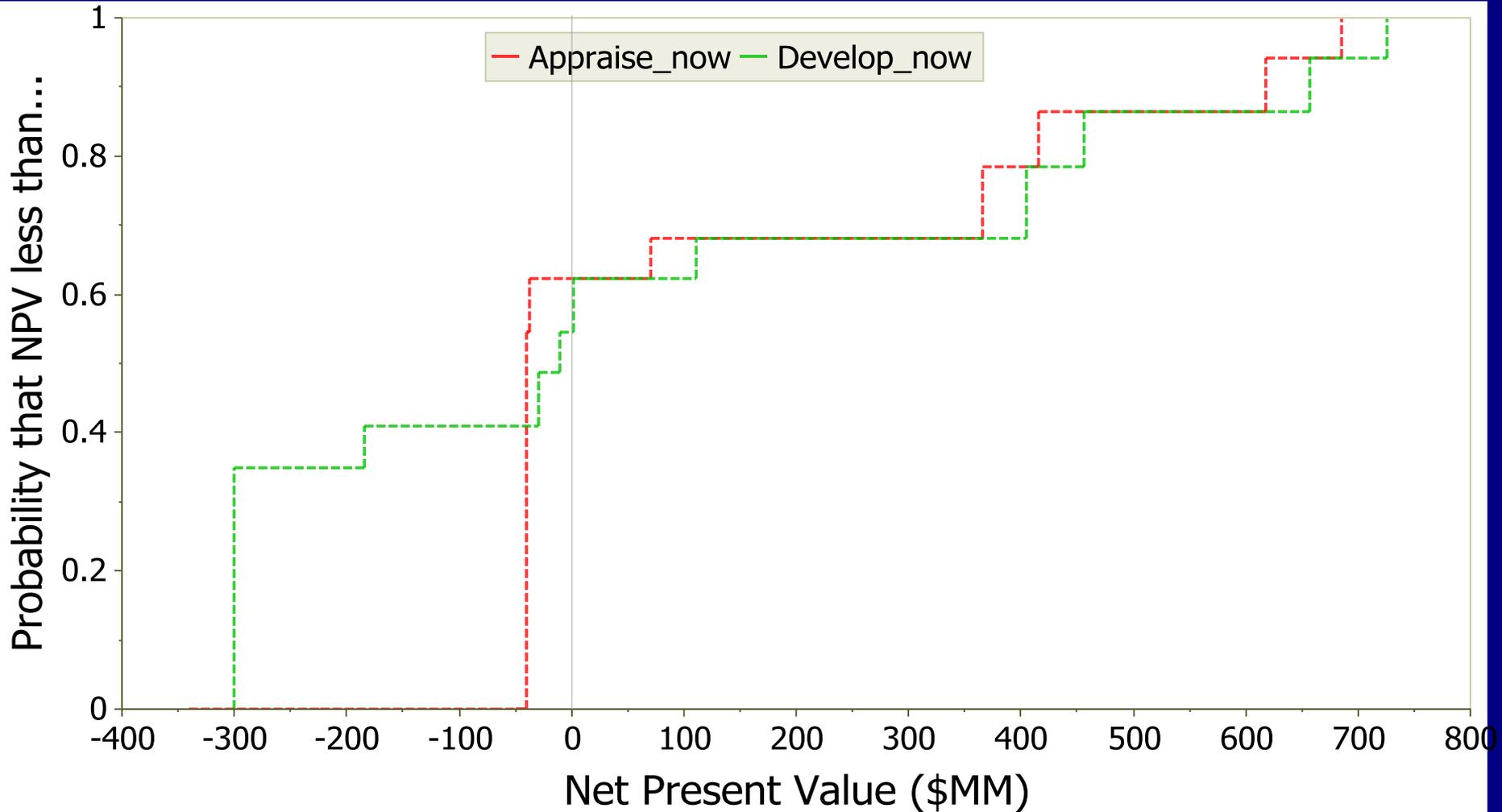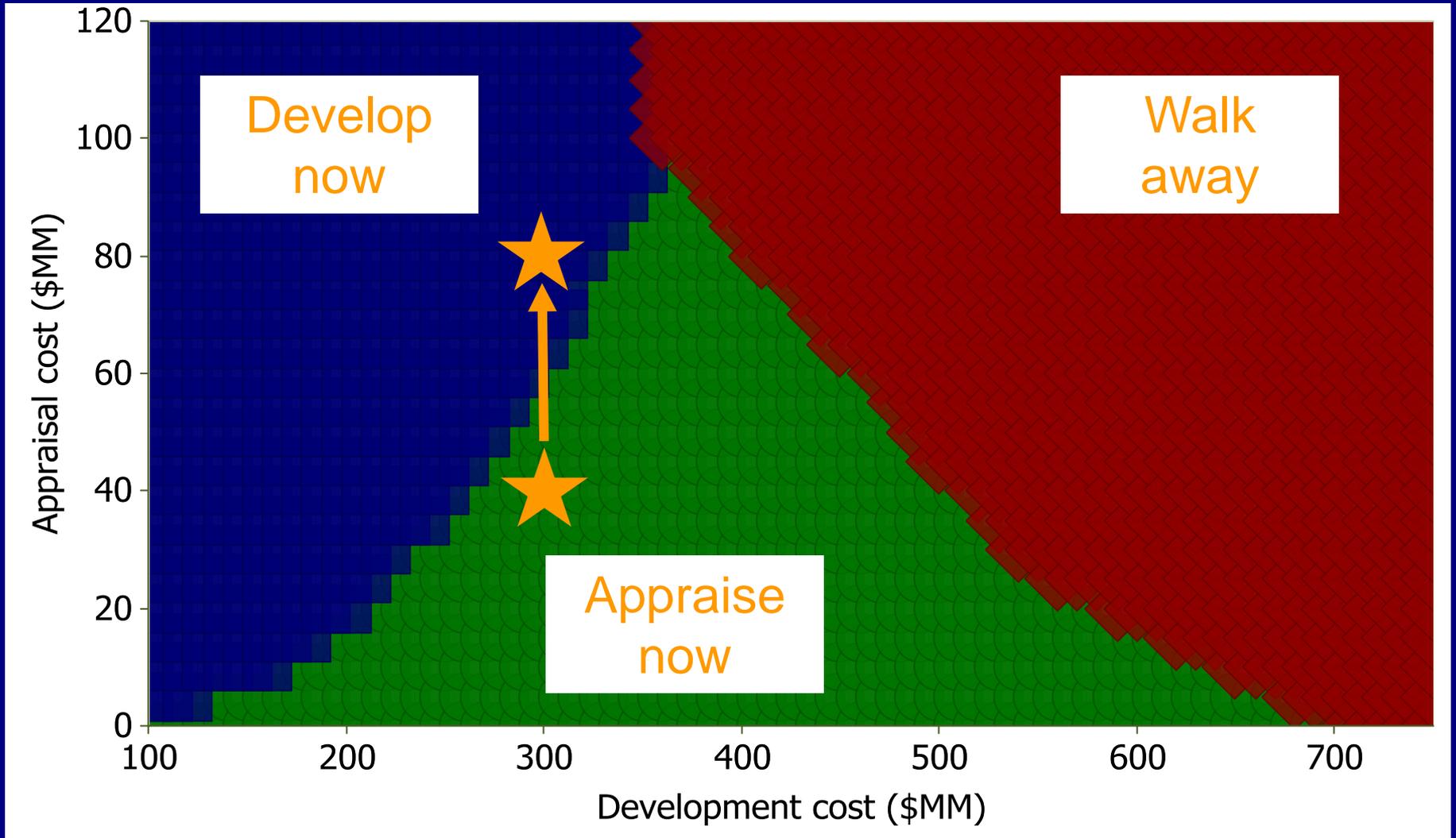
NPV risk profile: appraise, imperfect information

Risk appetite: which choice would you make if appraisal cost $80MM?

What NPV would you sacrifice to avoid downside? 31

Two-way rainbow diagram

Develop now (blue region)

Walk away (red region)

Appraise now (green region)

Y-axis: Appraisal cost ($MM) — 0, 20, 40, 60, 80, 100, 120
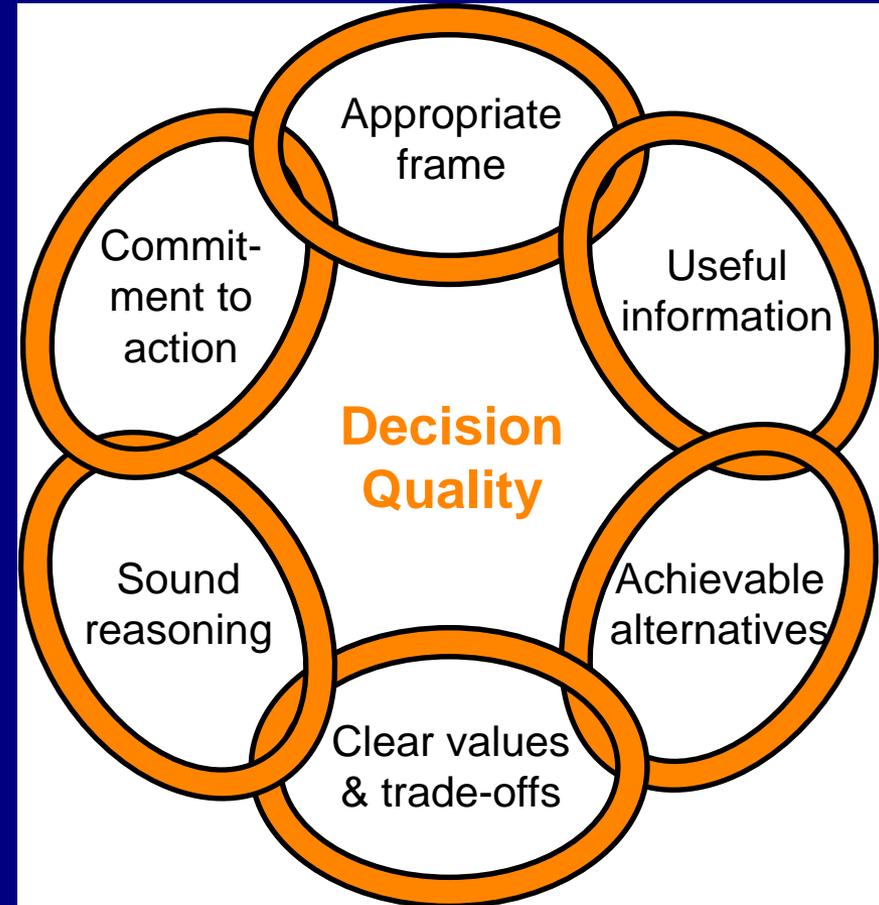
X-axis: Development cost ($MM) — 100, 200, 300, 400, 500, 600, 700

Green is where appraisal gives highest expected NPV

Summary: Decision Risk Analysis

- DRA can help you optimise not just satisfy

- Select an appropriate decision making approach

- Focus on delivering decision quality

Appropriate frame

Useful information

Commit-ment to action

Decision Quality

Achievable alternatives

Sound reasoning

Clear values & trade-offs

Summary: Value of Information (1)

- When?
  - Facing a number of decision options
  - Outcomes are uncertain
  - Opportunity to acquire additional information
  - Information costs money or time
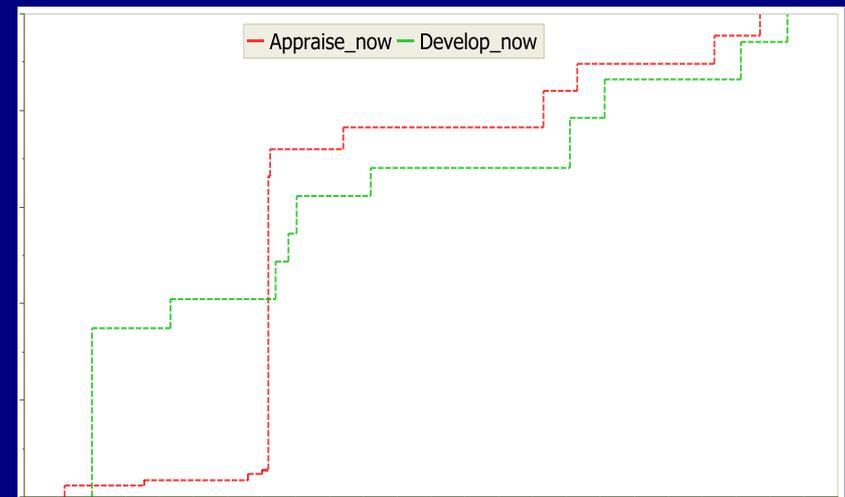
Summary: Value of Information (2)

- Why?
  - Additional information might reduce future uncertainties
  - Best decision option might change with new information
- How?
  - Invest two hours and get a Decision Analyst to show you how

Appraise_now — Develop_now
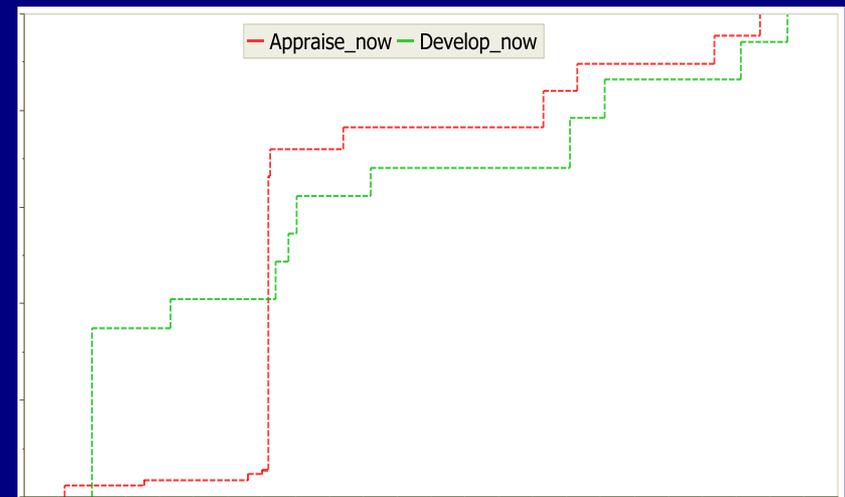
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