Lecture 24

Course Evaluation

Real World Examples: Challenges of handling uncertainty and complex business casing decisions

Real-world examples

1. Single variate sensitivity analysis
2. Probabilistic analysis when governing equations aren't known / haven't been mapped out
3. Financial investment decisions in context of different risk profiles
4. Financial investment decision: scoping and uncertainty challenges
5. Solar policy design
6. Detailed biogas to RNG example:
   – Challenges
   – Model structure tips

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1: Single-variate sensitivity: Hydropower example

- Simplest, most common form of analysis
- Often not grounded in probabilities
- (Excel example for hydropower feasibility analysis)
- Useful for identifying key vulnerability/ies and focusing effort on reducing them (if possible)

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2: Probabilistic analysis when governing equations aren't known: Wastewater pollution example

- Requirement to meet water quality standards
- Penalties applicable for failure to comply
- Political desire to avoid violations

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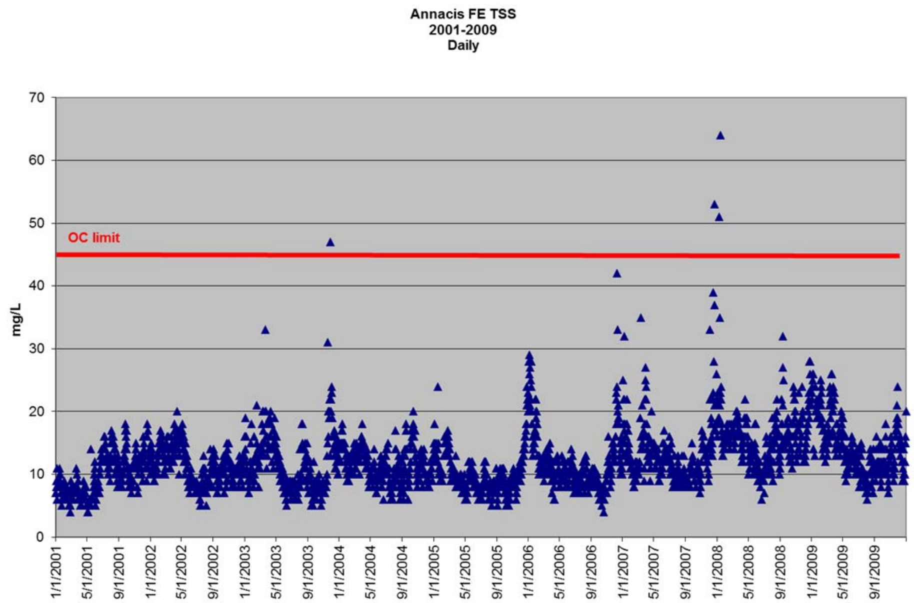
2: Probabilistic analysis when governing equations aren't known: Wastewater pollution example



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2: Probabilistic analysis when governing equations aren't known: Wastewater pollution example

- Probability of a violation occurring affected by:
  - Rainfall intensity and pattern
  - population growth
  - changes in wastewater conditions including alkalinity
  - changes in temperature and alkalinity in receiving environment
  - Other factors

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2: Probabilistic analysis when governing equations aren’t known: Wastewater pollution example

- Probability of a violation occurring affected by:
  - Rainfall intensity and pattern
  - population growth
  - changes in wastewater conditions including alkalinity
  - changes in temperature and alkalinity in receiving environment
  - Other factors
- Should additional investment be made to reduce probability of violations occurring?

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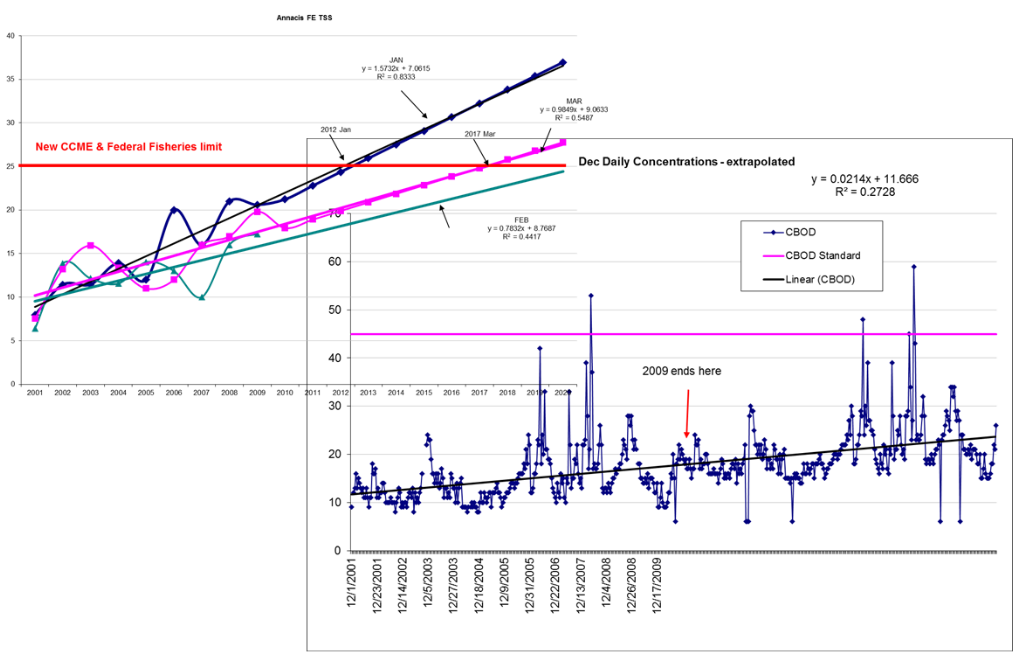
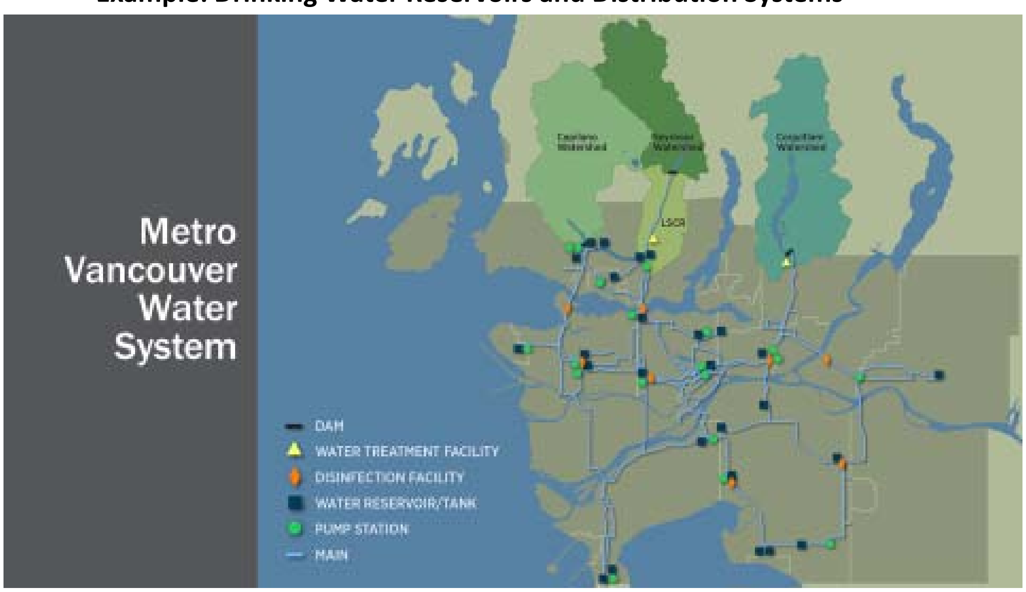
2: Probabilistic analysis when governing equations aren’t known: Wastewater pollution example



Potential break point

3. Risk Management Example

- **Example: Drinking Water Reservoirs and Distribution Systems**



3: Financial investment decisions among different risk profiles: Seismic vs climate change example

- Risk impact assessment techniques

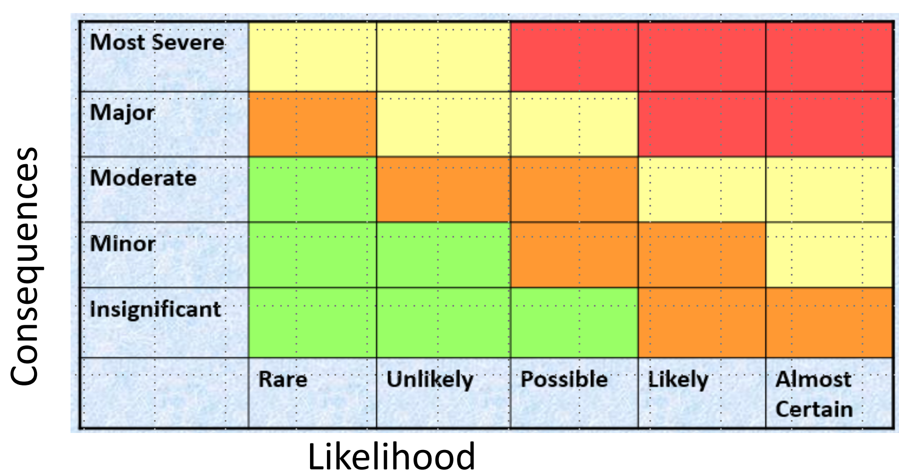
PROBABILITY THAT SOMETHING WILL GO WRONG

SEVERITY OF RISK

Category	FREQUENT Likely to occur immediately or in a short period of time; expected to occur frequently	LIKELY Quite likely to occur in time	OCCASIONAL May occur in time	SELDOM Not likely to occur but possible	UNLIKELY Unlikely to occur
CATASTROPHIC May result in death	E	E	H	H	M
CRITICAL May cause severe injury, major property damage, significant financial loss, and/or result in negative publicity for the organization and/or institution	E	H	H	M	L
MARGINAL May cause minor injury, illness, property damage, financial loss and/or result in negative publicity for the organization and/or the institution	H	M	M	L	L
NEGLIGIBLE Hazard presents a minimal threat to safety, health and well-being of participants; trivial.	M	L	L	L	L

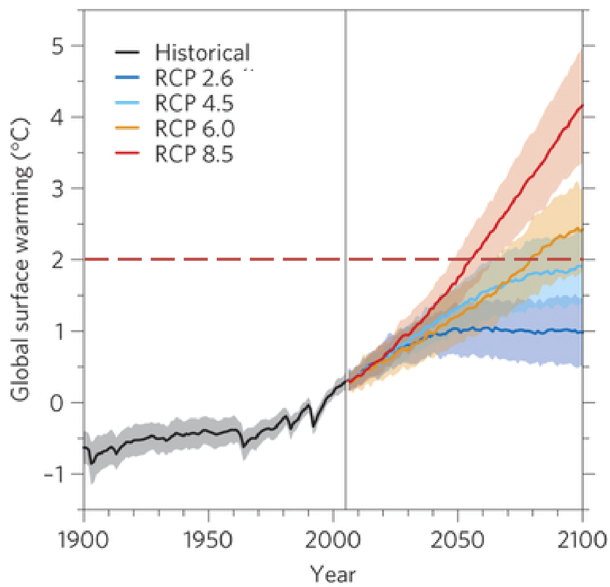
Risk Management Example

- **Evaluate two risks to these systems: climate change, and earthquakes. Where would they be located? How would you prioritize action?**



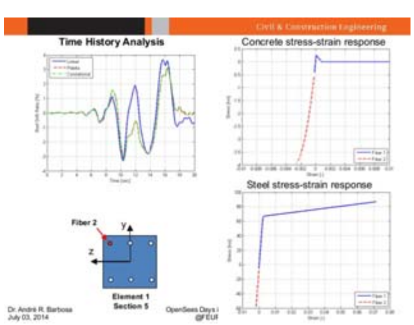
Climate change risk profile

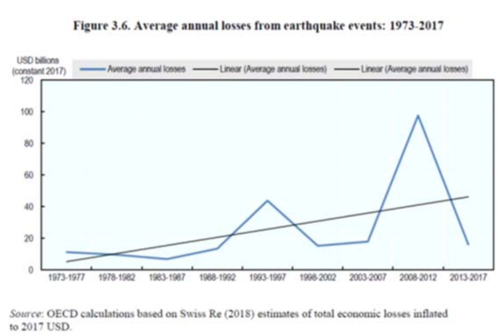
- How to establish probabilities?
- Human uncertainty, plus modelling uncertainty
- High probability, low to moderate (to high?) impact events



Seismic risk profile

- How to establish probabilities?
- Near-term low probability, high impact events
- Physical uncertainties and financial uncertainties
- Is expected value an appropriate technique in such situations?





3: Financial investment decisions among different risk profiles: Seismic vs climate change example

- How would you prioritize investments to address these challenges?

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4: Financial investment in context of probabilistic risk: Server facility example

- Need to design a new building that will host servers.
  - Fixed requirements
  - Variables under consideration?
  - Implications on costs?
  - Long term implications?
- How would you integrate this information and do a business case assessment to recommend specific servers and building cooling systems?

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5: Policy design: support for solar PV systems

- In BC, the installation of residential solar power systems usually costs between $15,000 to $30,000. Affected by: size (kW), number of solar panels, location, and whether or not a pre-existing electrical system needs modification.
- It may take years for a homeowner to financially benefit. For example, to cover the cost of a PV system large enough to offset 100% of the annual electricity demand of a home in a rural area, a homeowner may have to wait ten years.
- Therefore, to slightly compensate for the cost the provincial government of British Columbia has created a few financial incentives.
  - Local rebates and incentives
  - Provincial sales tax exemption policy
  - Net metering program (BC Hydro will purchase excess electricity generated)

What kinds of further incentives might be appropriate to encourage installation of solar PV systems?

How will businesses and homeowners assess these potential incentives in their decision making?

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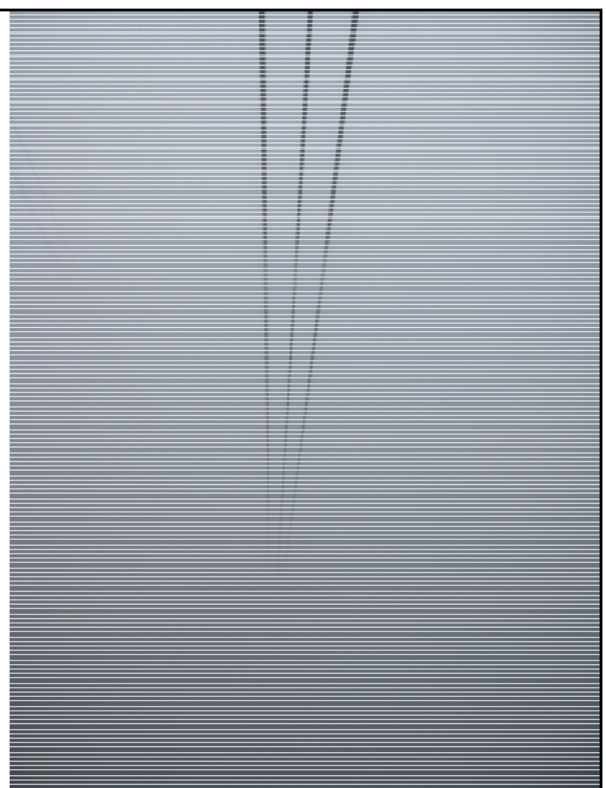
Potential break point



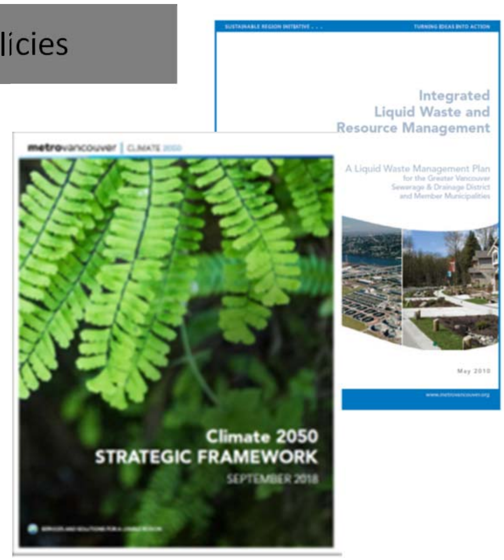
6. WWTP Biogas Enhancement to Renewable Natural Gas (RNG) Case Study

Project Overview

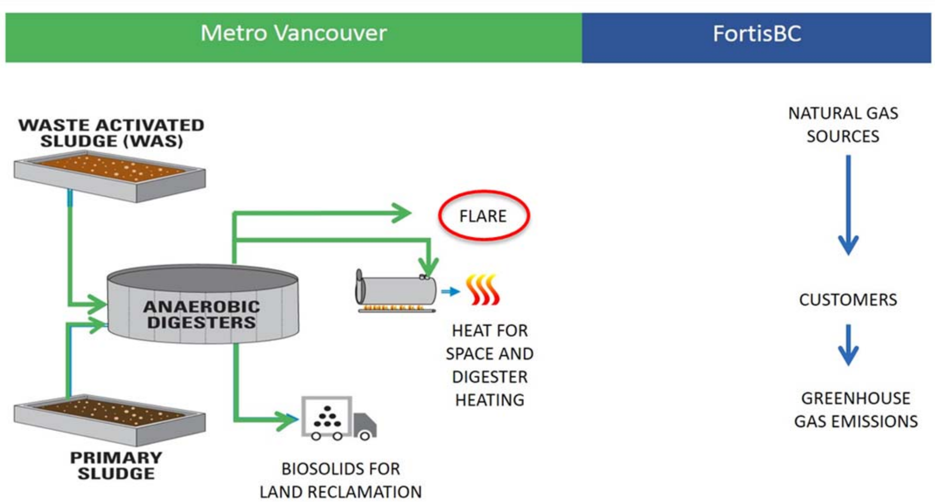
- Install biogas cleanup equipment at Lulu Island WWTP in Richmond
- Use excess digester gas beneficially by cleaning up and selling to FortisBC as renewable natural gas

Drivers: Metro Vancouver Plans & Policies

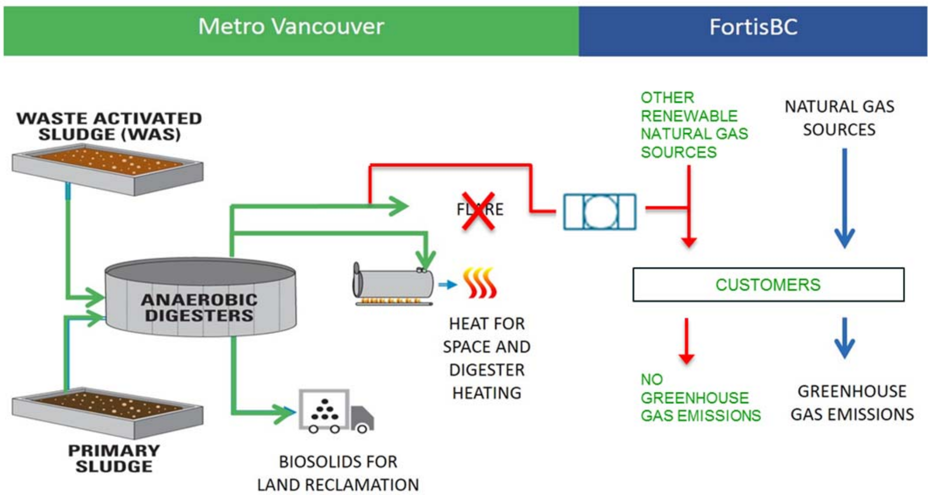
- Board Strategic Plan
- Integrated Liquid Waste and Resource Management Plan
- Climate 2050 Strategic Framework
- Energy Management Policy
- Carbon Price Policy

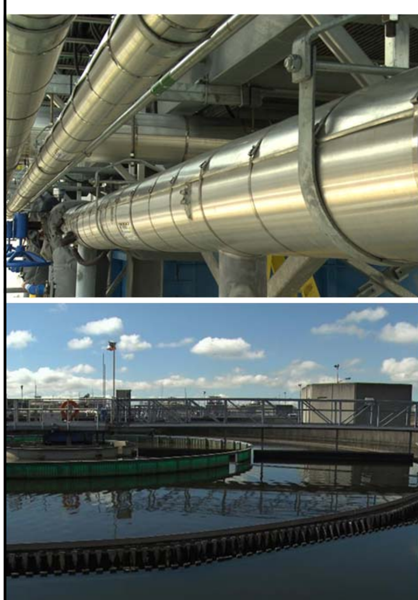


Project Schematic: Existing



Project Schematic: New





Biogas Upgrading Assessment

Concept:

- Quality requirement
- Innovative but not 'bleeding edge'

Process assessment:

- technologies reviewed
- Waterwash and Pressure Swing Adsorption (PSA)

Business Case Analysis

- 25 year equipment life
- Est $12.3M capital costs
- Initial biomethane sales $630,000 / yr
- Initial O&M costs $150,000 / yr
- Carbon price policy benefits $330,000 / yr
- Positive business case: +$5.4 million NPV

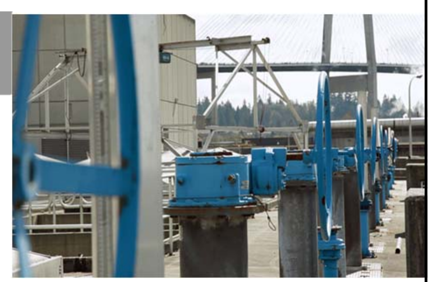
Challenges and Opportunities

Challenges:

- Partnerships
- Financial considerations
- Legal and regulatory considerations

Opportunities:

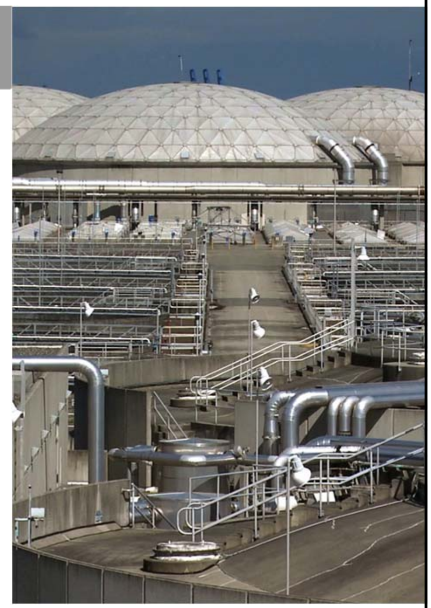
- Hands-on operational experience
- Environmental benefits
- Demonstration of innovation
- Synergies and incentives



Biogas Enhancement and Use

Enhancement possibilities:

- **Free up additional biomethane**
  - Effluent heat recovery
- **Enhance generation: Co-digestion**
  - Direct addition of energy-rich materials to anaerobic digesters, generating biogas
- **More complete digestion**
  - Thermal hydrolysis
  - Microwave-enhanced oxidation



Longer Storyline

- Biogas enhancement firm X proposed sale and implementation of unproven technology to Metro Vancouver
- Two projects in one: biogas enhancement, and cleaning of biogas for sale to FortisBC as renewable natural gas
- Multiple funding partners and agencies
- Collapsed to one project (renewable natural gas) after agreements were in place, but before construction
- Reviewed for potential cancellation multiple times, with updated estimates each time
- Completed construction last year: up and running

Challenges

- Scope challenges:
  - Appropriate sizing of equipment
  - Coordination of equipment sizing between two projects
  - "Business as Usual" other planned infrastructure additions at plant were unclear in timing and scope, yet affected these two projects

Challenges

- Costing challenges: different years, different parts of project
  - Original estimates for project by Consultant A
  - Certain specific cost elements re-estimated later by Consultant B: coordination and syncing of data use challenging
  - Other specific cost elements from Biogas enhancement technology firm X

Challenges

- Data quality and coordination challenges:
  - Parameters from a wide variety of sources, of differing quality, some more dated than others
  - No credible source for some parameters
  - Other parameters have multiple, conflicting data sources
  - Some performance parameters provided by Biogas enhancement technology firm X (information bias)
  - Forecasted driving parameters

Challenges

- Contractual and financial challenges:
  - Business case depends on sale of biomethane, but sale of biomethane depends on business case
  - Projects with NPW>0 unlikely to receive grant funding (not required)
  - Projects with NPW<0 difficult to receive grant funding (losing proposition)
  - Timing of analysis: different aspects of the project had very different equipment lives. Analyze business case over 15 years? 25 years? 30 years?

Challenges

- Conceptual/ monetization challenges:
  - Non-monetary factors mattered: greenhouse gas emission reductions. How to include?
  - Later on, these were monetized, so analysis had to be adjusted
  - In the end, they were removed again!
- Political challenges:
  - Review processes were circumvented due to political decisions

<turn to Excel>

Model Design Structure Tips

- Consistent formatting and structure across worksheets
- Document all data sources and parameters!
- Don't embed parameters in formulas! Very difficult to find or update.
- Separate parameters from model calculations if helpful for clarity
- Separate BAU calculations from alternative scenarios
- Separate physical models from economic models
- Use different worksheets for this separation, if helpful
- Legend
- Change log
- Reporting log

Detailed visit to model

- <turn to Excel>
  - Consultant A Costs
  - 2018 report
  - Parameters
  - Model
  - Legend

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