SESSION II: Pop-Up Talks

Special Presenter: **John G Rees**, NERC
1) **Dennis Konadu**, University of Cambridge
2) **Ian Temperton**, Ian Temperton Consulting
3) **Alexandra Collins**, Imperial College London
4) **Julien Harou**, University of Manchester

Specialist: **Liz Varga**
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Foreseer - UK
Energy-Land-Water interactions

Dennis Konadu, University of Cambridge
System independencies – Energy & Environment
## No-regrets energy system pathways?

<table>
<thead>
<tr>
<th>Resource</th>
<th>Core MARKAL</th>
<th>Higher Renewable</th>
<th>Higher CCS</th>
<th>Higher Nuclear</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>BAU Yield</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAU crop composition</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>50/50 Crop composition</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
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<tr>
<td>High Yield improvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAU crop composition</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>50/50 Crop composition</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td></td>
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<tr>
<td>PAU</td>
<td></td>
<td></td>
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<tr>
<td>High Coastal</td>
<td></td>
<td></td>
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<tr>
<td>High Inland</td>
<td></td>
<td></td>
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<tr>
<td>Integrated CCS</td>
<td></td>
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</tr>
</tbody>
</table>

### Key: Impact designations

#### Land
- **Low**: Maximum land for energy crops equal or less than currently unused arable land
- **Medium**: Up to 10% of UK land area
- **High**: Above 10% UK land area

#### Water
- **Low**: Lower than or up to current actual abstractions level
- **Medium**: Up to 100% increase in 2010 abstraction for thermal generation
- **High**: Above 100% increase in 2010 abstractions for thermal generation

Konadu et al. (2015) GEC
Land for bioenergy

Some pathways could cause land use stress

**Current (2010)**
- 0.4% of UK agricultural land is used for bioenergy crops

**Lowest impact - Higher Renewables**
- Requires between 7% and 10% of UK agricultural land area.
- Has a combination of considerable reduction of primary energy demand and a lower share of bioenergy.
- More diversified strategy to end use sector decarbonisation.

**Highest impact - Higher Nuclear pathway**
- Requires between 26% and 61% of the UK’s agricultural land area.
- Has the highest share of indigenously sourced bioenergy.
- Mainly used to decarbonise transport and industry in the form of liquid from

*Comparison of current and projected impact of bioenergy cropping on land UK distributions by 2050 under different scenarios of crop yield and composition: (a) BAU Composition & BAU Yield; (b) BAU Composition & Increase Yield; (c) BAU Composition & Increase Yield (d) 50-50 Composition & Increase Yield*
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Observations on investment decision making under uncertainty in clean energy

Ian Temperton
Corporate investment decision making remains unsophisticated

- Boards, executive and investment committees do not make investments under uncertainty and certainly don’t have aleatoric risk…
  - ... despite always living in uncertain times
- Most investment decisions rely on
  - IRR analysis...
  - ...with a hurdle rate...
  - ...which is arbitrarily set above WACC...
  - ... and which is always exceeded in all investment assessments
- Sensitivity analysis is as good a measure of uncertainty as you get ...
  - ... but in case that turns out to be useful we always have the red dotted box
Theories of uncertainty are probably more useful in explaining corporate behaviour than informing it

**Agency theory**
- Short term incentives / long term investments
- Information asymmetries
- Herding

**Behavioural impacts**
- Anchoring (always use a red box)
- Confirmation bias
- Excessive discounting
- Loss aversion

**Real options**
- Delay (and more analysis) not rejection
- Entry and exit costs
- Short term focus
- (BTW people don’t generally buy options)
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Incorporating Uncertainty into Evidence Syntheses

Experiences Gained from the UK Department for Environment, Food and Rural Affairs

Presented by: Dr Alexandra Collins
Date: 10th February 2016
Uncertainty in Policy Making

Risk

Implications

“Uncertainty is an uncomfortable position. But certainty is an absurd one.”

— Voltaire

Success rate

Influencing factors

Success
Problem Statement

• Evidence syntheses of increasing importance
• Evidence Investment Strategy
• CSA requirement for Evidence Statements
• How to review evidence to reduce uncertainty?
• How to measure uncertainty?
• How to communicate uncertainty?
Methods Reviewed

Table 1. Likelihood Scale

<table>
<thead>
<tr>
<th>Term*</th>
<th>Likelihood of the Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtually certain</td>
<td>99-100% probability</td>
</tr>
<tr>
<td>Very likely</td>
<td>90-100% probability</td>
</tr>
<tr>
<td>Likely</td>
<td>66-100% probability</td>
</tr>
<tr>
<td>About as likely as not</td>
<td>33 to 66% probability</td>
</tr>
<tr>
<td>Unlikely</td>
<td>0-33% probability</td>
</tr>
<tr>
<td>Very unlikely</td>
<td>0-10% probability</td>
</tr>
<tr>
<td>Exceptionally unlikely</td>
<td>0-1% probability</td>
</tr>
</tbody>
</table>

* Additional terms that were used in limited circumstances in the AR4 (extremely likely — 95-100% probability, more likely than not — >50-100% probability, and extremely unlikely — 0-5% probability) may also be used in the AR5 when appropriate.

IPCC reports

The Report Card has simplified the assessments to provide an overall confidence level of high (H), medium (M) or low (L). Low confidence results are still based on evidence and still reflect expert judgment.

MA Ecosystem Assessments

LWEC report cards
Methods Reviewed

**Evidence Statements**

All evidence statements adhere to the following format:
- **Title:** main evidence statement followed by information from supporting studies.
- **Studies:** First author, date of publication, quality rating of study, country, study took place, sample size of study, intervention duration/length of follow-up, intervention details, main (relevant) study findings.

**Population Level Change**

Evidence Statement 1: Population Level Change in Mass Media Interventions to Increase Walking

There was inconsistent evidence from 2 studies on the effectiveness of mass media interventions (which included paid advertisements [TV, radio, cable, newspapers], billboards/posters, public relations, educational activities, and community participation), delivered in the community. Increasing population levels of walking for leisure or travel in adults up to one year post intervention. One RCT study (Wimbush 1997 [1]) showed no effect on walking (the represent of data in this study was poor) and one CS study (Wray 2005 [2]) showed a small, but positive effect on walking.

Wimbush 1997 (CA [2] UK n=3475, 12 months) [40 second TV advert supported by a telephone helpline]. No change in number of days spent walking for at least 30 minutes: mean of 4.26 days in 1995 and 4.13 days in 1996, no significance statistic.
## Combining Quality Assessments

<table>
<thead>
<tr>
<th>Category</th>
<th>Study Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Quantitative experimental <em>e.g.</em> Before-after experiments, randomised control trials, non-randomised control trials</td>
</tr>
<tr>
<td>B</td>
<td>Quantitative observational <em>e.g.</em> before-after observations, case-controls, cohort studies, correlations</td>
</tr>
<tr>
<td>C</td>
<td>Qualitative studies <em>e.g.</em> interviews, expert elicitation</td>
</tr>
<tr>
<td>D</td>
<td>Economic studies <em>e.g.</em> cost-benefit/effectiveness/consequence studies</td>
</tr>
<tr>
<td>E</td>
<td>Reviews <em>e.g.</em> literature reviews, systematic reviews, reviews of randomised control trial</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>++</td>
<td>All or most of the methodological criteria appropriate for the study type have been fulfilled <em>low risk of bias</em></td>
</tr>
<tr>
<td>+</td>
<td>Some of the methodological criteria appropriate for the study type have been fulfilled and those criteria that have not been fulfilled or not adequately described are thought unlikely to alter the conclusions <em>risk of bias</em></td>
</tr>
<tr>
<td>–</td>
<td>Few or no methodological criteria have been fulfilled. The conclusions of the study are thought likely or very likely to alter <em>high risk of bias</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Evidence from many studies classed as + and/or 1 or more studies classed as ++</td>
</tr>
<tr>
<td>Medium</td>
<td>Evidence from one or more studies that have been classed as at least +</td>
</tr>
<tr>
<td>Low</td>
<td>Evidence from a small number of studies or studies classed as –</td>
</tr>
<tr>
<td>Contested</td>
<td>Evidence that differs in its conclusions (present the class for each study/evidence)</td>
</tr>
</tbody>
</table>
Where To Find Out More

- Confidence statements
  - [https://connect.innovateuk.org/web/jweg](https://connect.innovateuk.org/web/jweg)
  - Defra intranet
  - Environment Agency
  - Natural England

- Weight of evidence approach
  - Paper with CSA in progress
Thank You

- Alexandra.Collins@imperial.ac.uk
- www.imperial.ac.uk/people/alexandracollins
- @AlexMaryCollins
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Planning water regional water resources investments in East Anglia

Julien Harou, Evgenii Matrosov,

2/10/16, Imperial College London Risk & Uncertainty Workshop
Project scope

• Multi-company strategic water resource planning project for East Anglia
• Focus on the challenge of growth, sustainability reductions and climate change
• Consider future supply options including: reservoirs, strategic transfers, aquifer storage and recovery, water reuse, desalination
1st Phase: Build WREA regional system simulation model (IRAS-2010)

- Models surface water system
- Groundwater and demand aggregated into RZ level
- Simulates 60 years in 8 seconds with a weekly time-step
Proposed options modelled in WREA simulator

- 5 desalination options
- 5 reuse options
- 2 reservoir options
- 1 artificial recharge scheme
- 2 transfers from existing reservoir
- 38 unique supply to demand transfer links
Planning analysis

• Multi-criteria search under multiple scenarios
  – Incorporates multiple performance criteria
  – Finds designs that are robust given future uncertainty

• Robust decision making
  – Characterise vulnerabilities of selected plans
## WREA model performance metrics

<table>
<thead>
<tr>
<th>Performance Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating costs</td>
<td>total operating costs of simulations</td>
</tr>
<tr>
<td>Capital costs</td>
<td>Annual capital costs of portfolios</td>
</tr>
<tr>
<td>Supply deficit</td>
<td>total supply deficit summed over all RZ’s</td>
</tr>
<tr>
<td>Total weeks with level of service 1 (LOS1) failures</td>
<td>number of weeks of LOS1 failure summed over all reservoirs</td>
</tr>
<tr>
<td>Maximum duration of LOS1 failures</td>
<td>longest consecutive number of weeks of LOS1 failure summed over all reservoirs. Maximum duration metrics demonstrate system resilience.</td>
</tr>
<tr>
<td>Total weeks with levels of service 3 (LOS3) failures</td>
<td>number of weeks of LOS3 failure summed over all reservoirs</td>
</tr>
<tr>
<td>Maximum duration of LOS3 failures</td>
<td>longest consecutive number of weeks of LOS3 failure summed over all reservoirs</td>
</tr>
</tbody>
</table>
More reuse and less reservoir use

No Reuse and more reservoir capacity

Reservoir Capacity (MI/day)

Desalination Capacity (MI/day)

Reuse Capacity (MI/day)

More reuse and less reservoir use

No Reuse and more reservoir capacity

Supply Deficit (MI/year)

Capital Costs (M£/year)

Operating Costs (M£/year)
Relative performance of selected portfolios

Maximum LOS1 Failure Weeks (Resilience)
- Baseline
- Low Deficit
- High Reliability
- Cost Efficient
- High Performance

Total LOS1 Failure Weeks (Reliability)

Maximum LOS3 Failure Weeks (Resilience)

Total LOS3 Failure Weeks (Reliability)
Vulnerabilities of the ‘Cost Efficient’ portfolios

<table>
<thead>
<tr>
<th>Scenario/Dimension</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand increase</td>
<td>&gt;5%</td>
<td>&gt;0%</td>
</tr>
<tr>
<td>Reduction in winter hydrology</td>
<td>17%</td>
<td>&gt;42%</td>
</tr>
<tr>
<td>Reduction in summer hydrology</td>
<td>45%</td>
<td>&gt;49%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Failure Density</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>92%</td>
<td>69%</td>
</tr>
<tr>
<td>2</td>
<td>60%</td>
<td>28%</td>
</tr>
<tr>
<td>Total</td>
<td>79%</td>
<td>97%</td>
</tr>
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