

Visualisation and interpretation of uncertainty and variability in Industrial Ecology

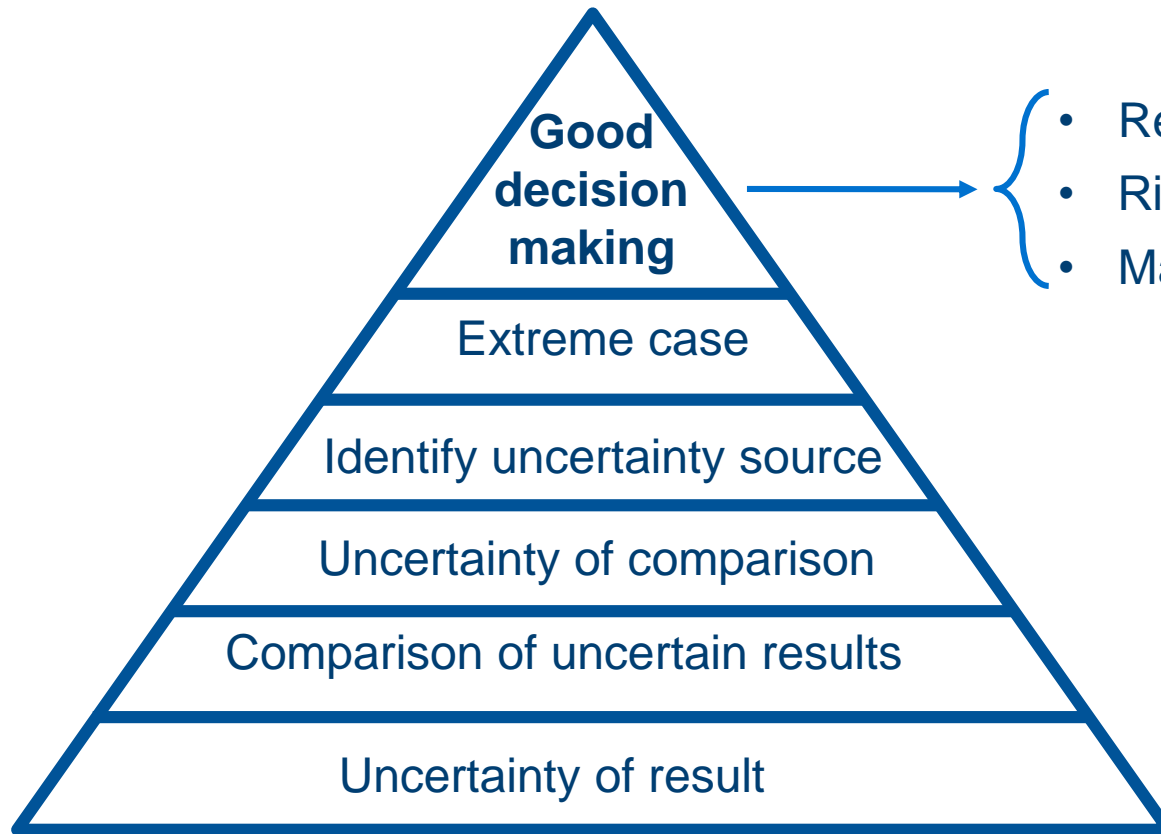
Leonardo Paoli

Resource Efficiency Collective

Outline

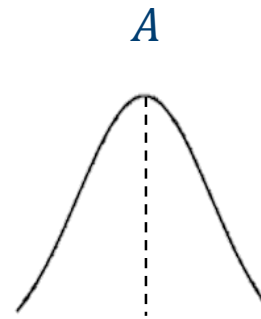
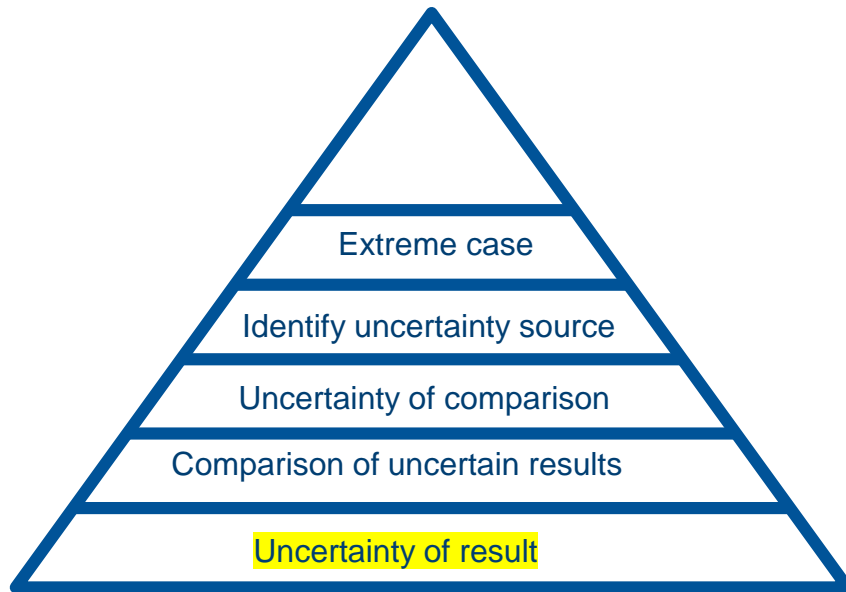
1. What can we learn from uncertainty and variability analysis?
2. Uncertainty and variability analysis insights
3. Examples of uncertainty and variability visualisation
4. Summary and Discussion Prompt

What can we learn from uncertainty and variability analysis?



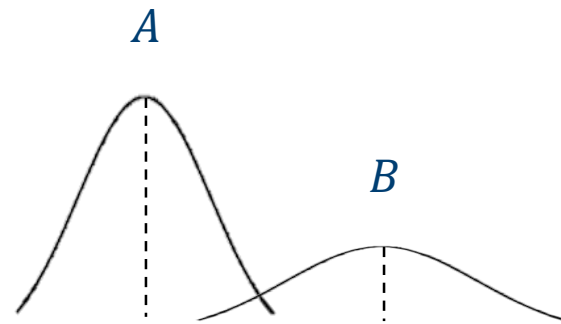
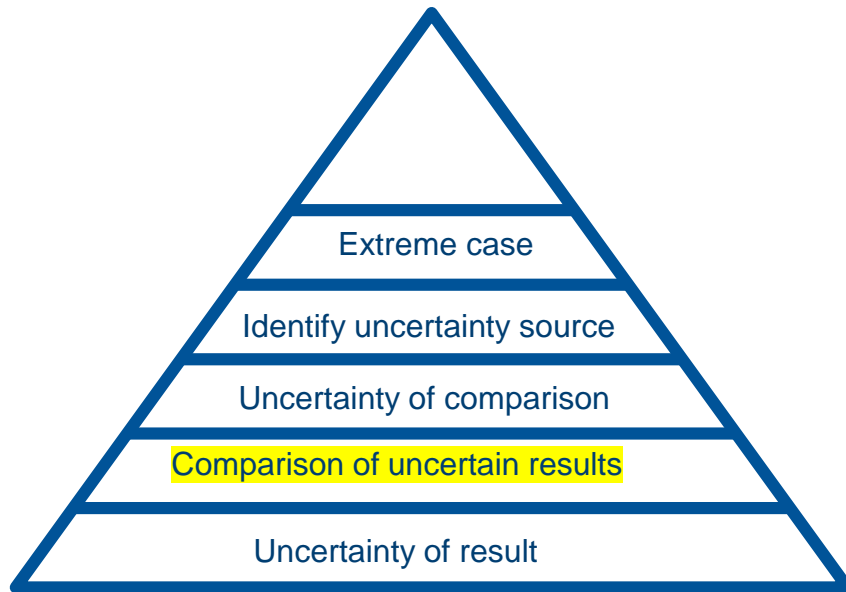
- Reliability of Results
- Risk of “bad things happening”
- Maximise information available

Uncertainty analysis insights



$$A = X_1 \pm \alpha$$

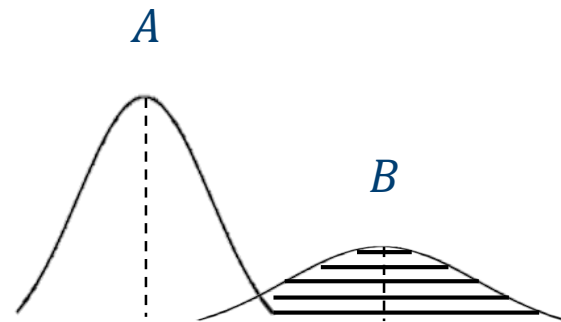
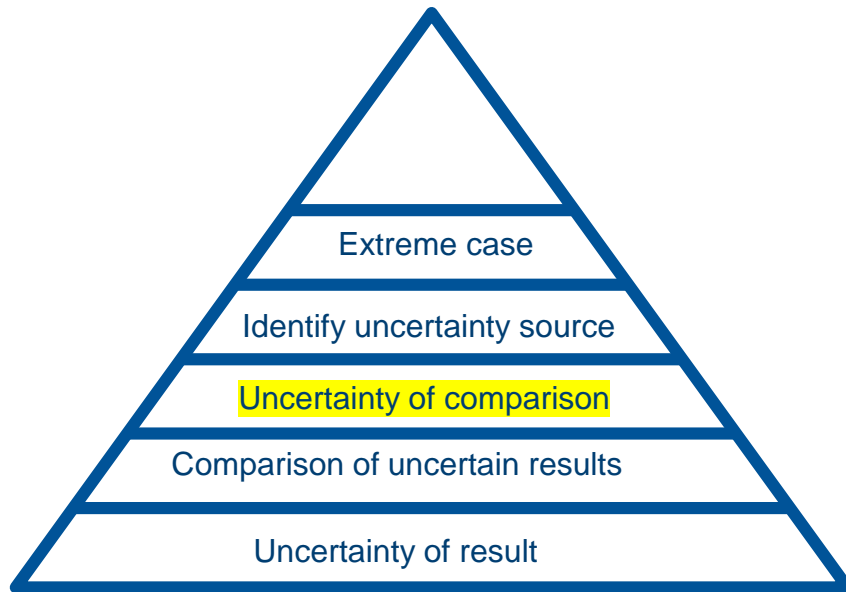
Uncertainty analysis insights



$$A = X_1 \pm \alpha \quad B = X_2 \pm \beta$$

$\beta > \alpha$ therefore B more uncertain than A

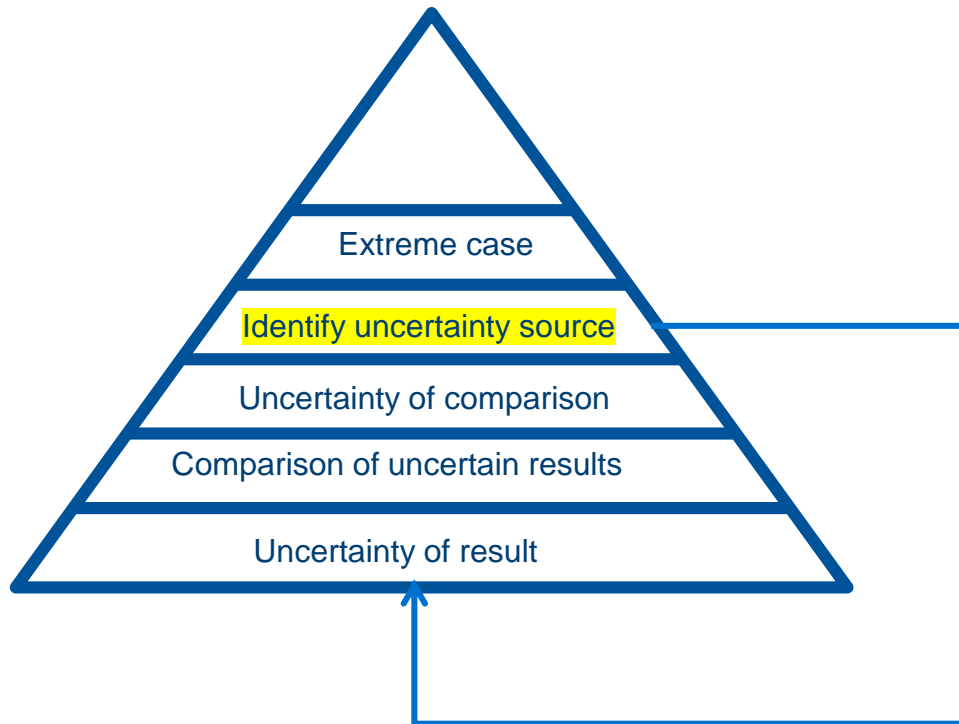
Uncertainty analysis insights



$$A = X_1 \pm \alpha \quad B = X_2 \pm \beta$$

X% probability that $B > A$

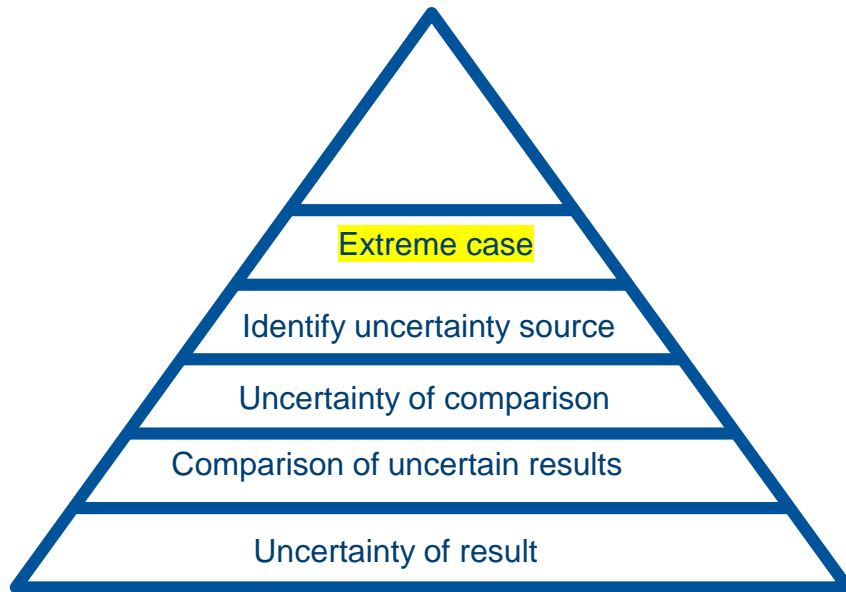
Uncertainty analysis insights



Uncertainty source

- Combination of magnitude and centrality of uncertain flow

Uncertainty analysis insights

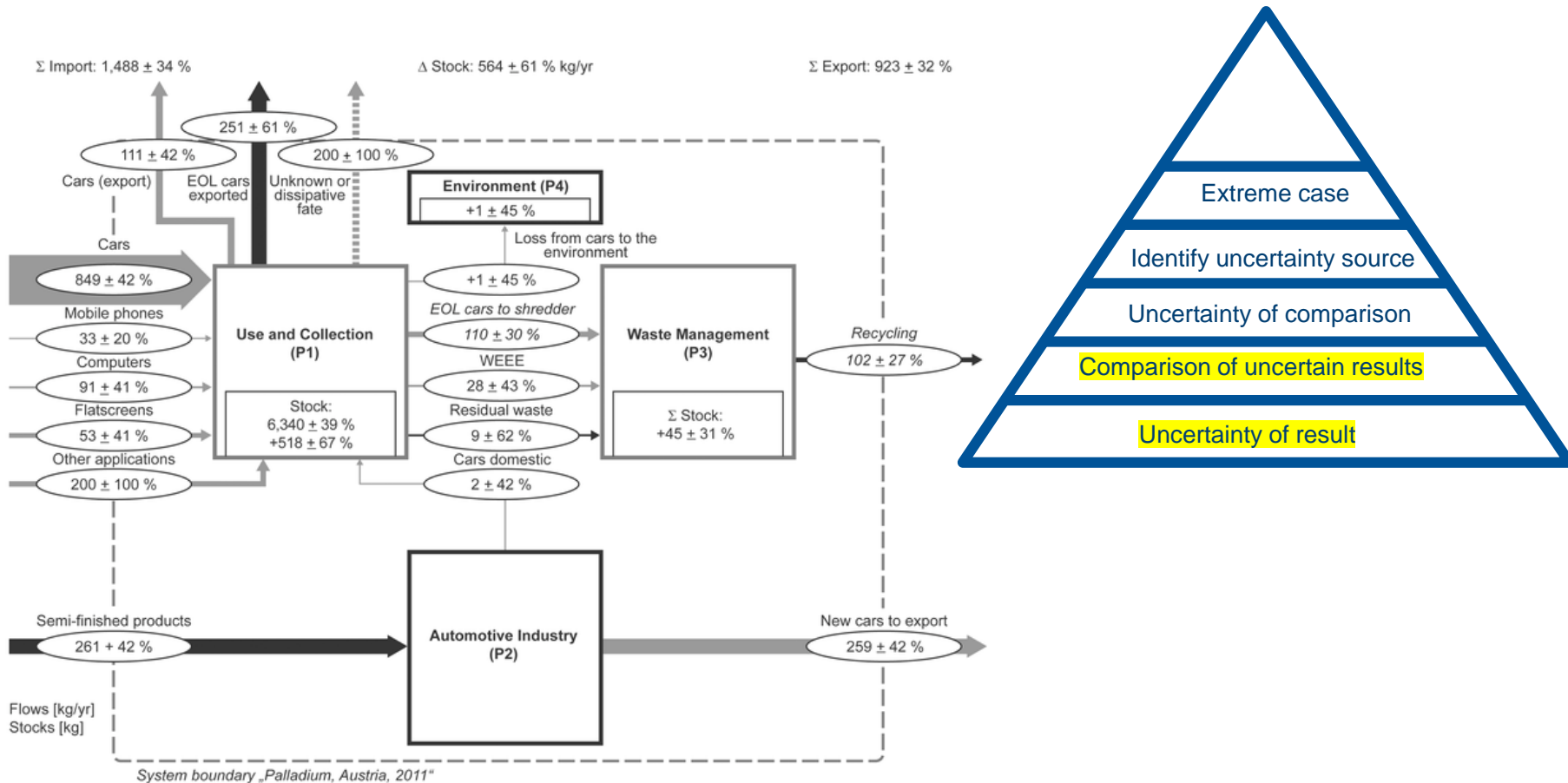


Probability of reaching

- Critical values
- Benchmarks

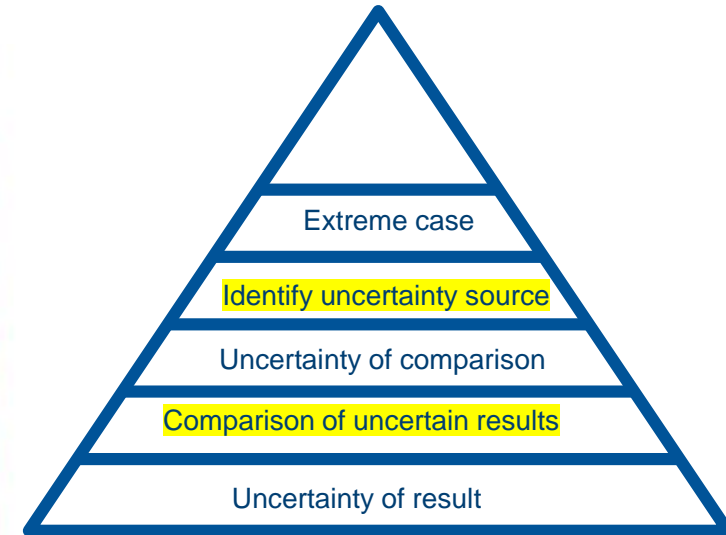
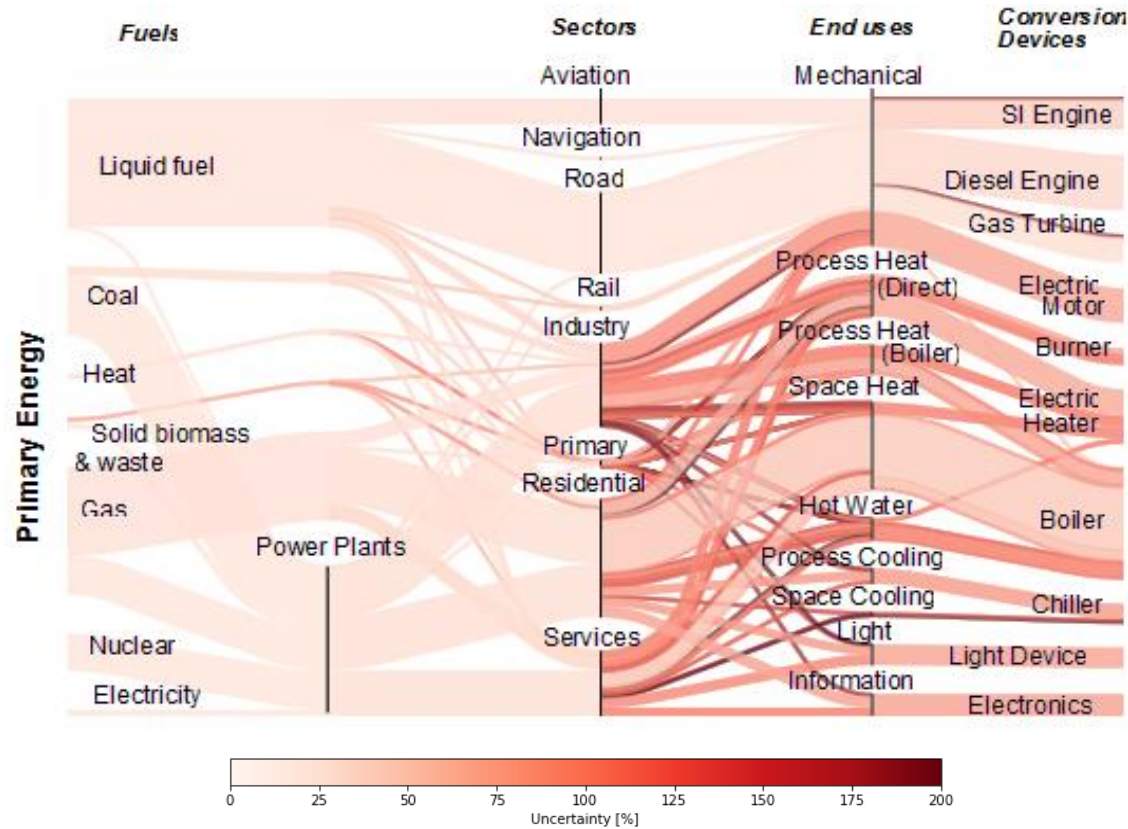
Visualising Uncertainty and Variability in Industrial Ecology

Example1 – Sankey – Material Flow Analysis



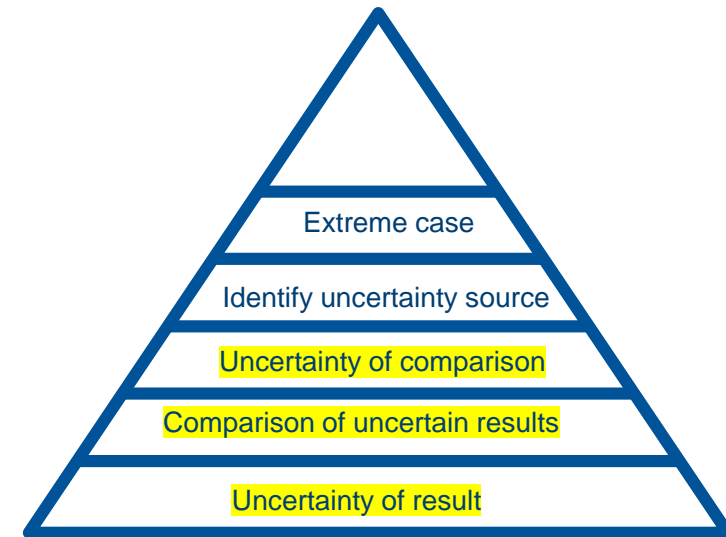
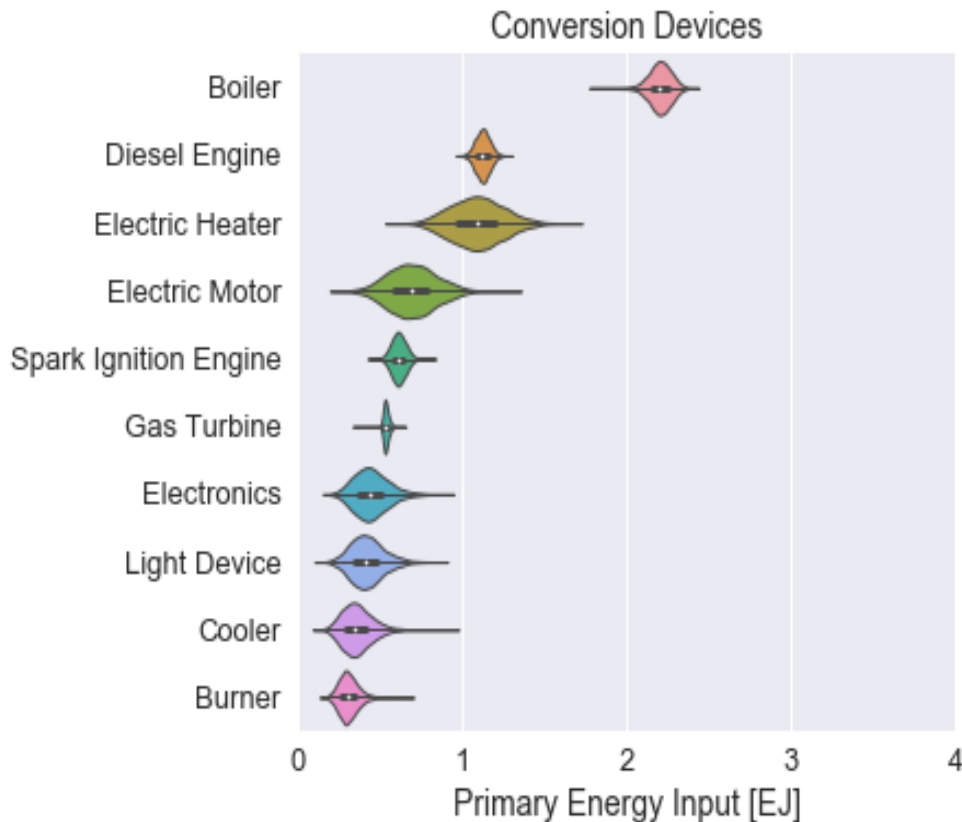
Laner, David, Helmut Rechberger, and Thomas Astrup. "Applying fuzzy and probabilistic uncertainty concepts to the material flow analysis of palladium in Austria." *Journal of Industrial Ecology* 19.6 (2015): 1055-1069.

Example 2 – Sankey – Energy Flow Analysis



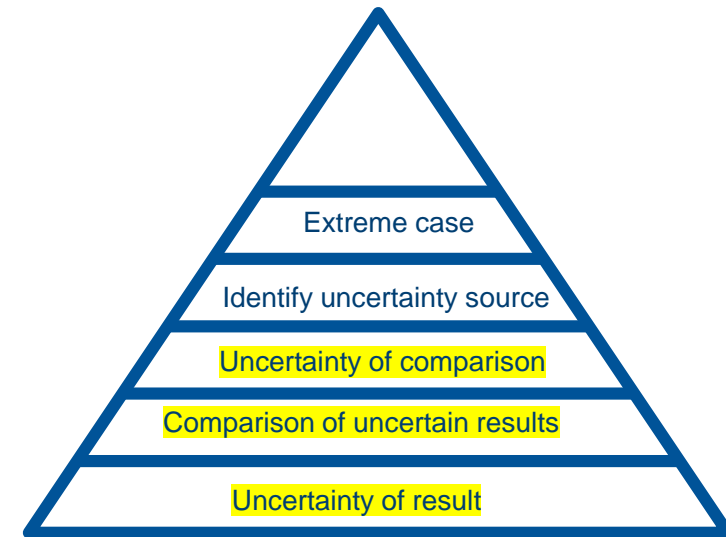
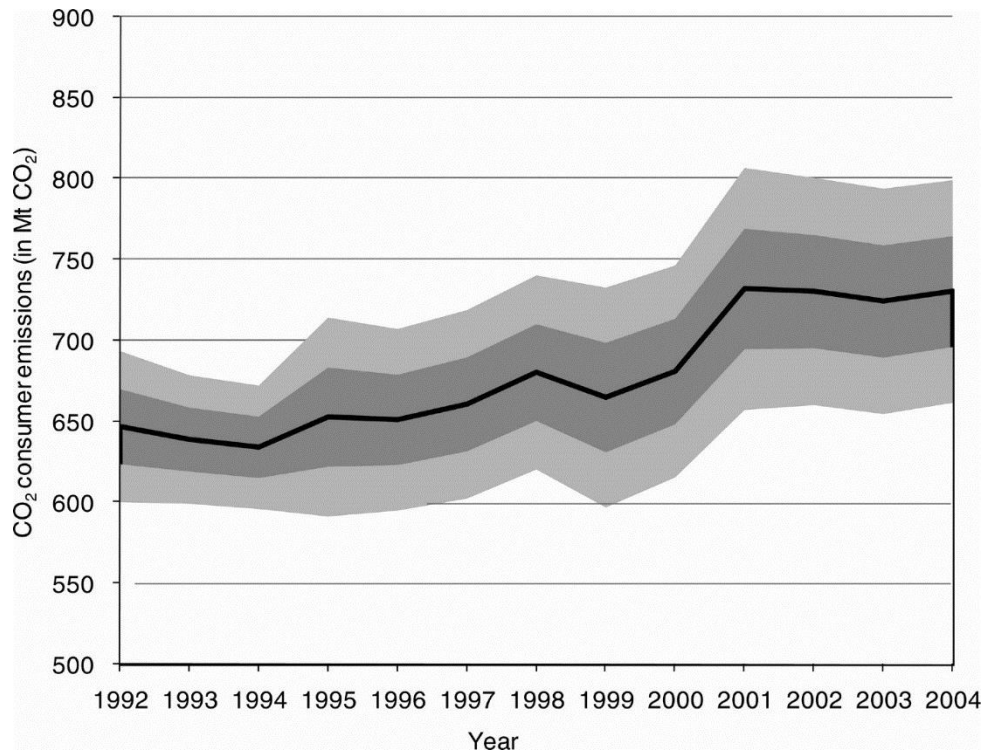
Paoli Leonardo, Lupton Richard, and Cullen Jonathan. "Probabilistic model allocating primary energy to end-use devices." *Energy Procedia* - accepted

Example 3 – Violin Plot – Energy Flow Analysis



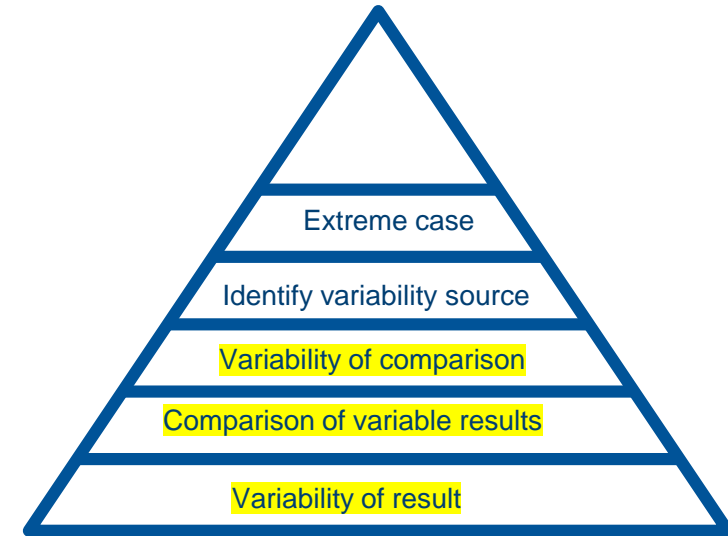
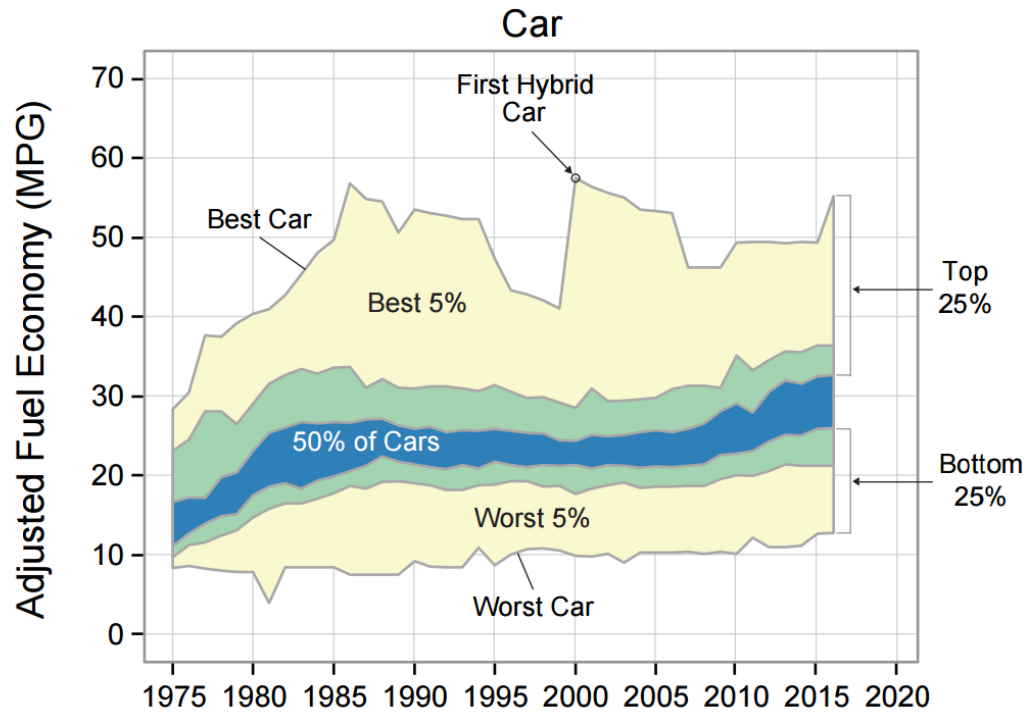
Paoli Leonardo, Lupton Richard, and Jonathan Cullen. "Probabilistic model allocating primary energy to end-use devices." *Energy Procedia* - accepted

Example 4 – Line Plot – Input Output



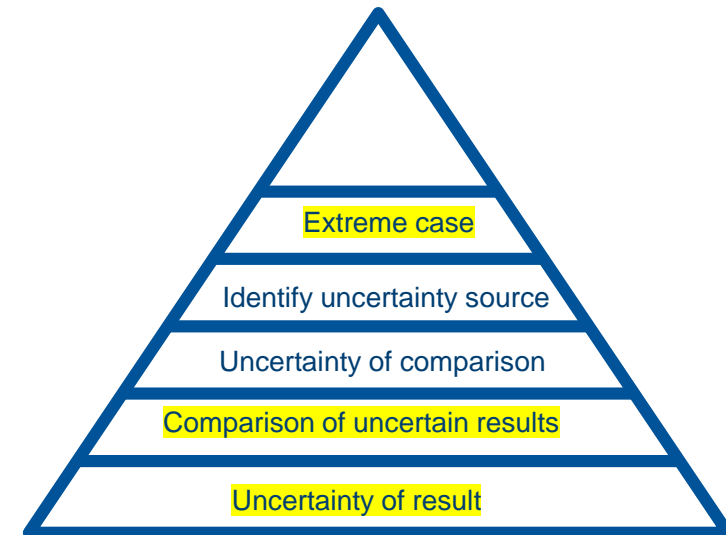
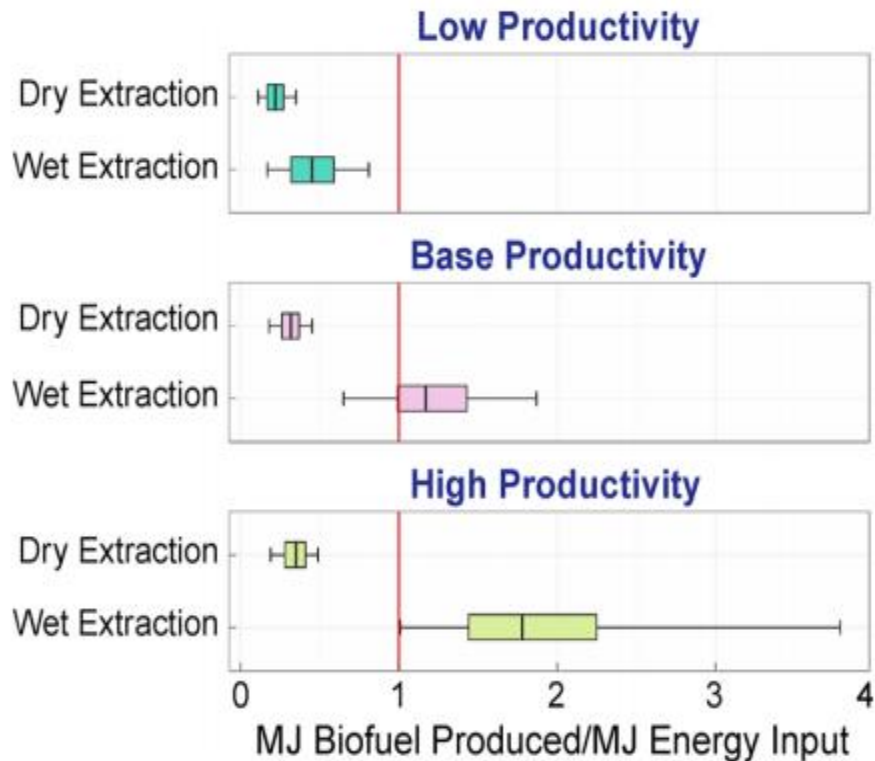
Lenzen, Manfred, Richard Wood, and Thomas Wiedmann. "Uncertainty analysis for multi-region input–output models—a case study of the UK's carbon footprint." *Economic Systems Research* 22.1 (2010): 43-63.

Example 5 –Line Plot – Variability



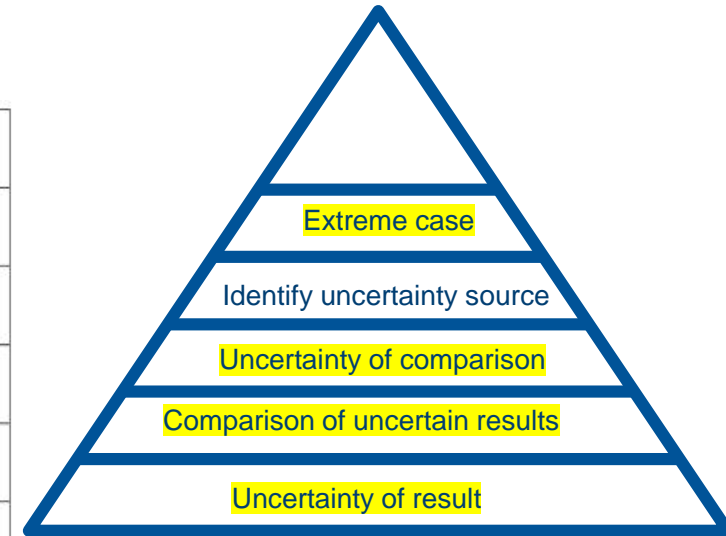
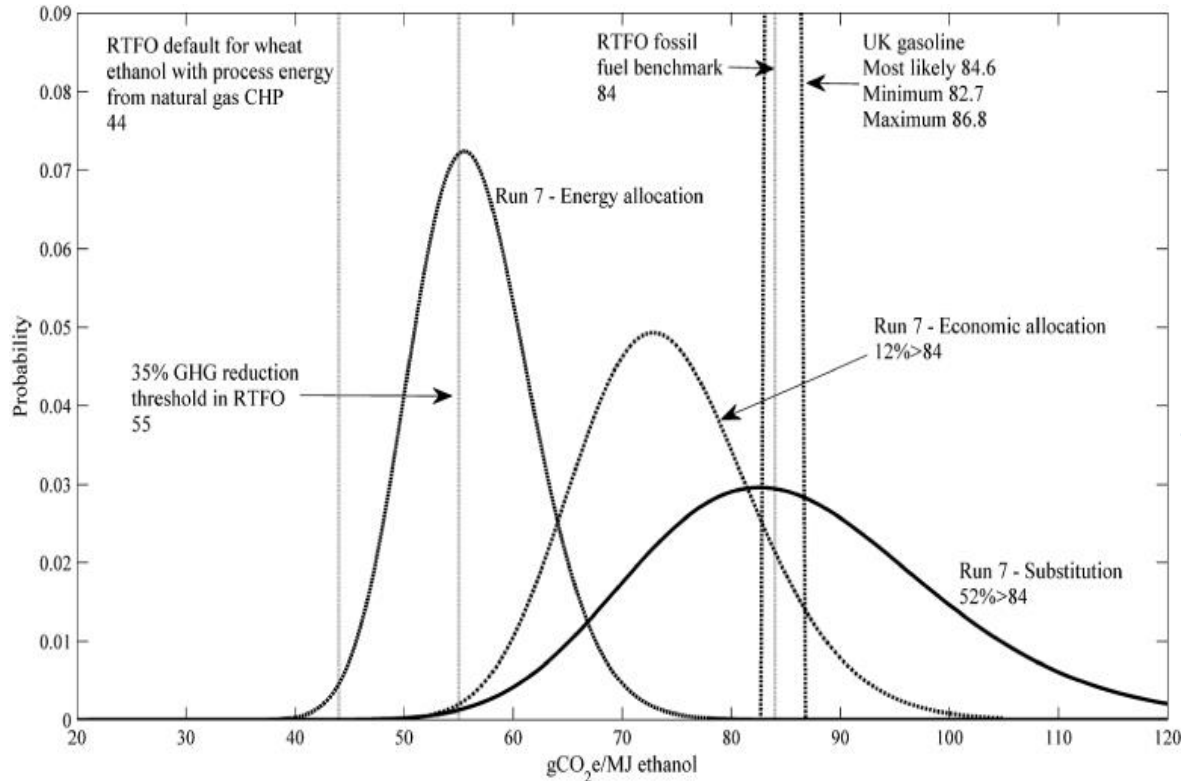
Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016, Environmental Protection Agency

Example 6 – Box and Whisker – Life Cycle Assessment



Sills, Deborah L., et al. "Quantitative uncertainty analysis of life cycle assessment for algal biofuel production." *Environmental science & technology* 47.2 (2012): 687-694.

Example 7 – Line Plot – Transport Modelling



Yan, Xiaoyu, and Adam M. Boies. "Quantifying the uncertainties in life cycle greenhouse gas emissions for UK wheat ethanol." *Environmental Research Letters* 8.1 (2013): 015024.

Summary of examples – Discussion prompt

	MFA	LCA	I/O
Extreme case		Box-Whisker	
Uncertainty of comparison	Violin	Box-Whisker	Line Plot
Identification of knowledge gap	Sankey		
Comparison of uncertain results	Sankey, Violin	Box-Whisker	Line Plot
Uncertainty of result	Sankey, Violin		Line Plot
Variability			

References