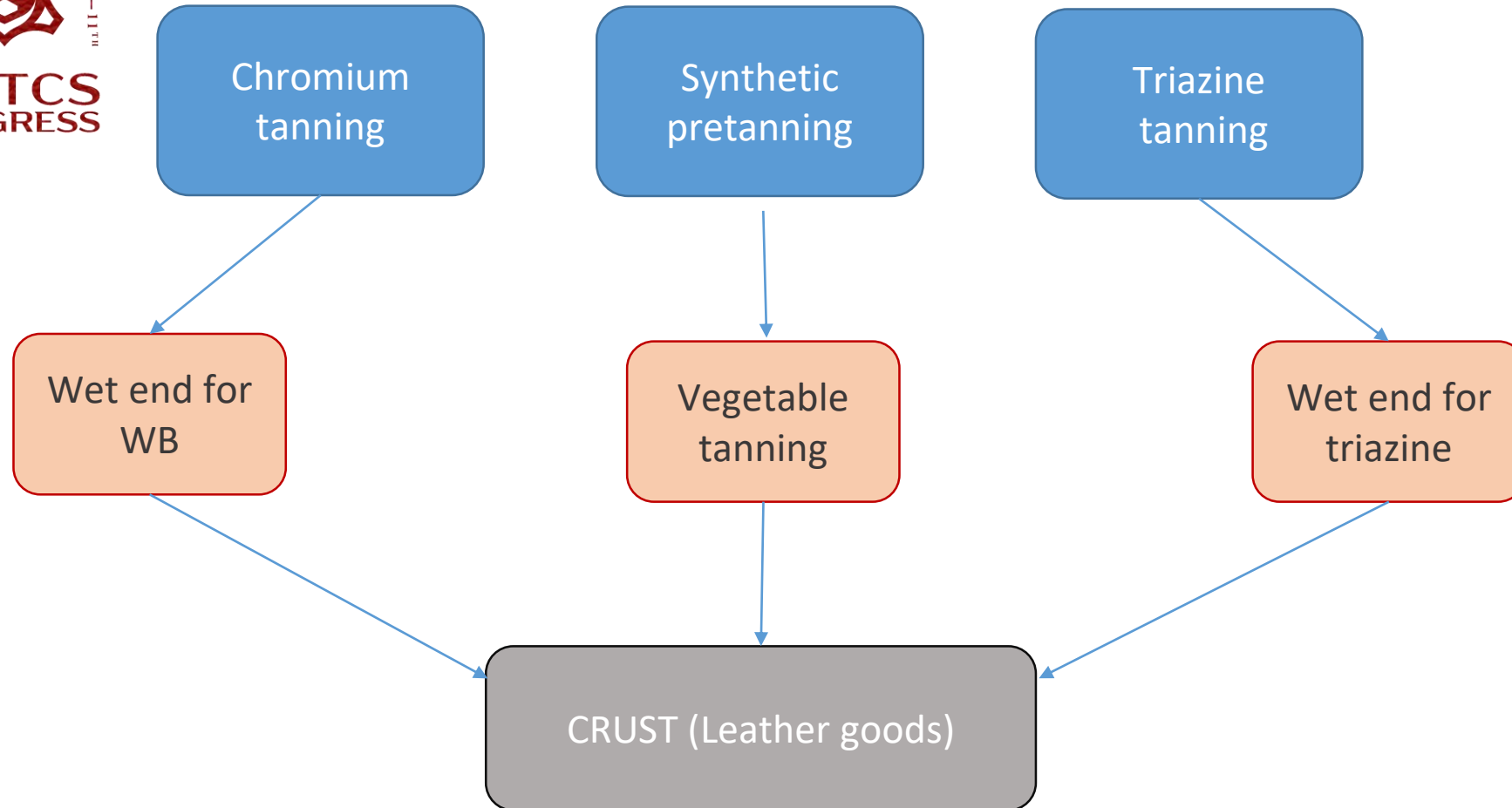


# Environmental Impact Analysis of Different Leather Tanning Methods to Optimize Eco-Friendly Process Selection

[Agnès Thomasset, Stéphane Benayoun](#)

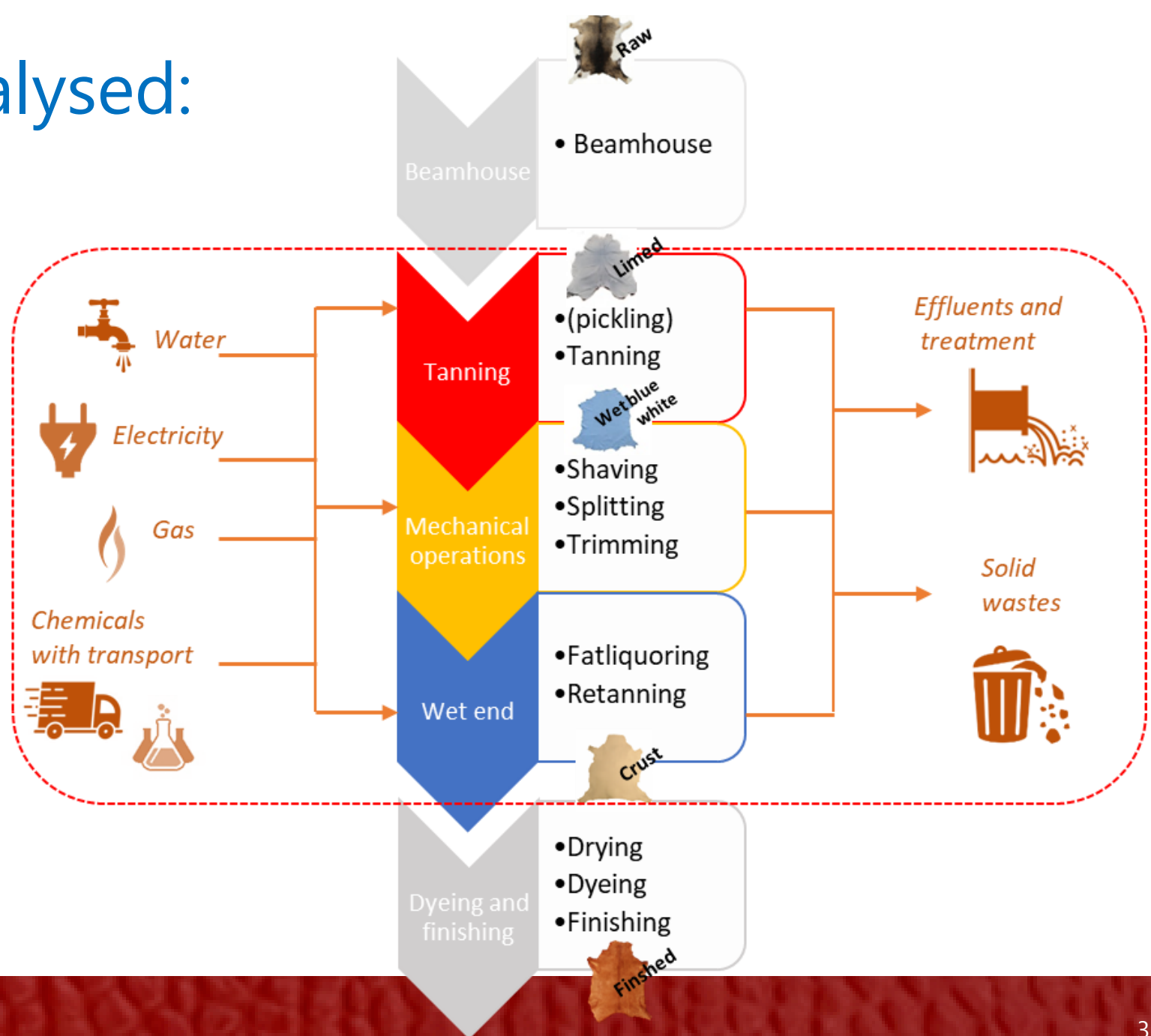
# Methodology:



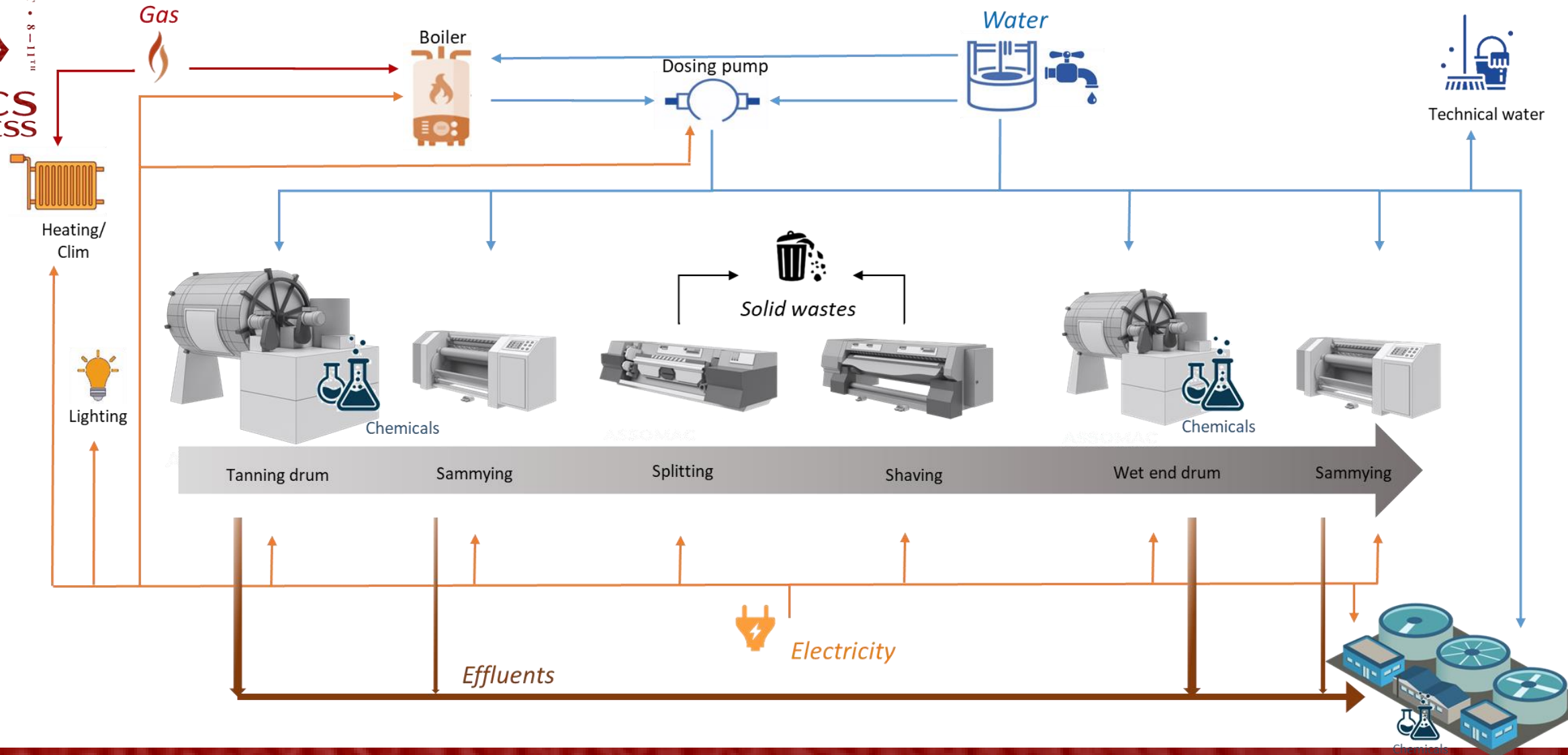
Laboratory  
(CTC- platform)  
5 industrial  
plants in Europe

Data base: EF 3.1  
Method: EF 3.1  
Software: SimaPro  
9.6.0.1

# System analysed:



# Analysed flows:



# Primary data collection:

> 3,500 raw data / site (avg.)  
 ≈ 18,000 raw data over 3 years

600 datasets → unit processes  
 (LCA inventories)

Tableau collecte données

D6	C	E	F	G	H	I	J	K	L	M	N	O	P
52	Tannage	71,04	51,79	51,58	46,68	47,75	51,39	50,01	-	49,74	51,21	52,99	-
53		-	-	-	-	-	-	-	-	-	-	-	-
54		7,10	5,18	5,16	4,67	4,77	5,14	5,00	-	4,97	5,12	5,30	-
55		0,15	0,11	0,11	0,10	0,10	0,11	0,10	-	0,10	0,11	0,11	-
56		0,82	0,60	0,60	0,54	0,55	0,60	0,58	-	0,58	0,59	0,61	-
57		0,18	0,13	0,13	0,12	0,12	0,13	0,13	-	0,12	0,13	0,13	-
58		0,65	0,47	0,47	0,43	0,44	0,47	0,46	-	0,46	0,47	0,49	-
59		0,07	0,05	0,05	0,04	0,04	0,05	0,05	-	0,05	0,05	0,05	-
60		0,08	0,06	0,06	0,05	0,05	0,06	0,05	-	0,05	0,06	0,06	-
61		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
62	Retannage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
63		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
64		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
65		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
66		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
67		50,97	37,16	37,01	33,50	34,26	36,87	35,88	-	35,69	36,75	38,02	-
68		39,21	28,58	28,47	25,77	26,35	28,36	27,45	-	27,45	28,27	29,25	-
69		39,21	28,58	28,47	25,77	26,35	28,36	27,60	-	27,45	28,27	29,25	-
70		78,42	57,17	56,94	51,53	52,71	56,73	55,20	-	54,90	56,53	58,50	-
71		0,24	0,17	0,17	0,15	0,16	0,17	0,17	-	0,16	0,17	0,18	-
72		0,12	0,09	0,09	0,08	0,08	0,09	0,08	-	0,08	0,08	0,09	-
73		0,08	0,06	0,06	0,05	0,05	0,06	0,06	-	0,05	0,06	0,06	-
74		0,12	0,09	0,09	0,08	0,08	0,09	0,08	-	0,08	0,08	0,09	-
75		-	-	-	-	-	-	-	-	-	-	-	-
76		0,04	0,03	0,03	0,03	0,03	0,03	0,03	-	0,03	0,03	0,03	-
77		0,16	0,11	0,11	0,10	0,11	0,11	0,11	-	0,11	0,11	0,12	-
78		0,12	0,09	0,09	0,08	0,08	0,09	0,08	-	0,08	0,08	0,09	-

</

## Secondary data choice:

Energy, waste treatment, transport: EF3.1/Ecoinvent database

Chemicals:

Recipes analyzed from available databases: Ecoinvent, PEFCR

Supplier data obtained for certain chemicals:

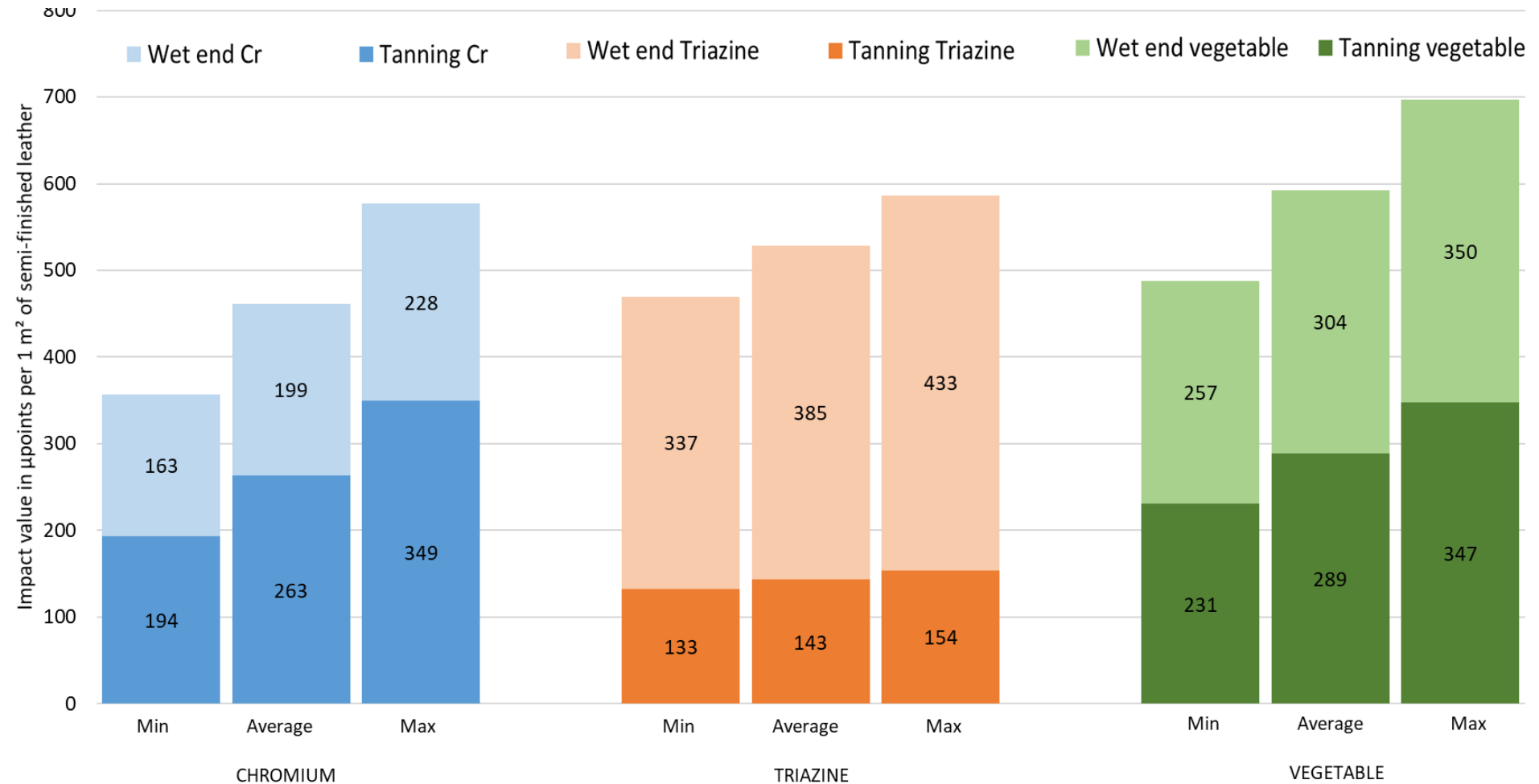
- Triazine
- Phenolic synthetic tannins
- Polyaldehyde synthetic tannins
- Sulfonated synthetic tannins



PEF

# LCA results: overall impact/m<sup>2</sup> (single score)

Averaging all bovine sites does not allow ranking tanning processes by single score



# LCA results: impact/m<sup>2</sup> by main categories

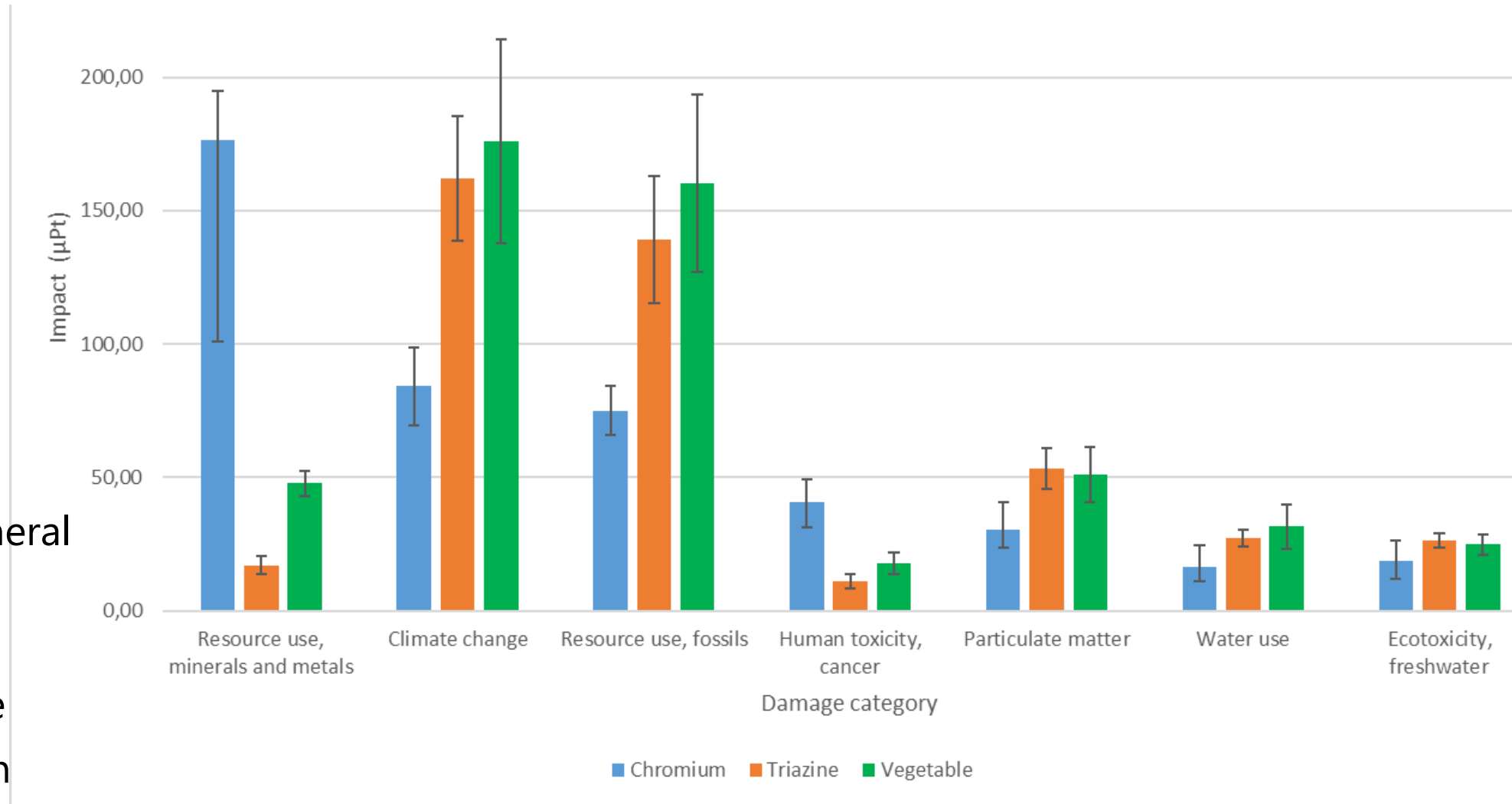
## Chrome

→ lowest impact on climate change (carbon footprint) & fossil resources

→ Higher impact on human toxicity & mineral resources

## Vegetable vs. Triazine

→ no clear distinction possible

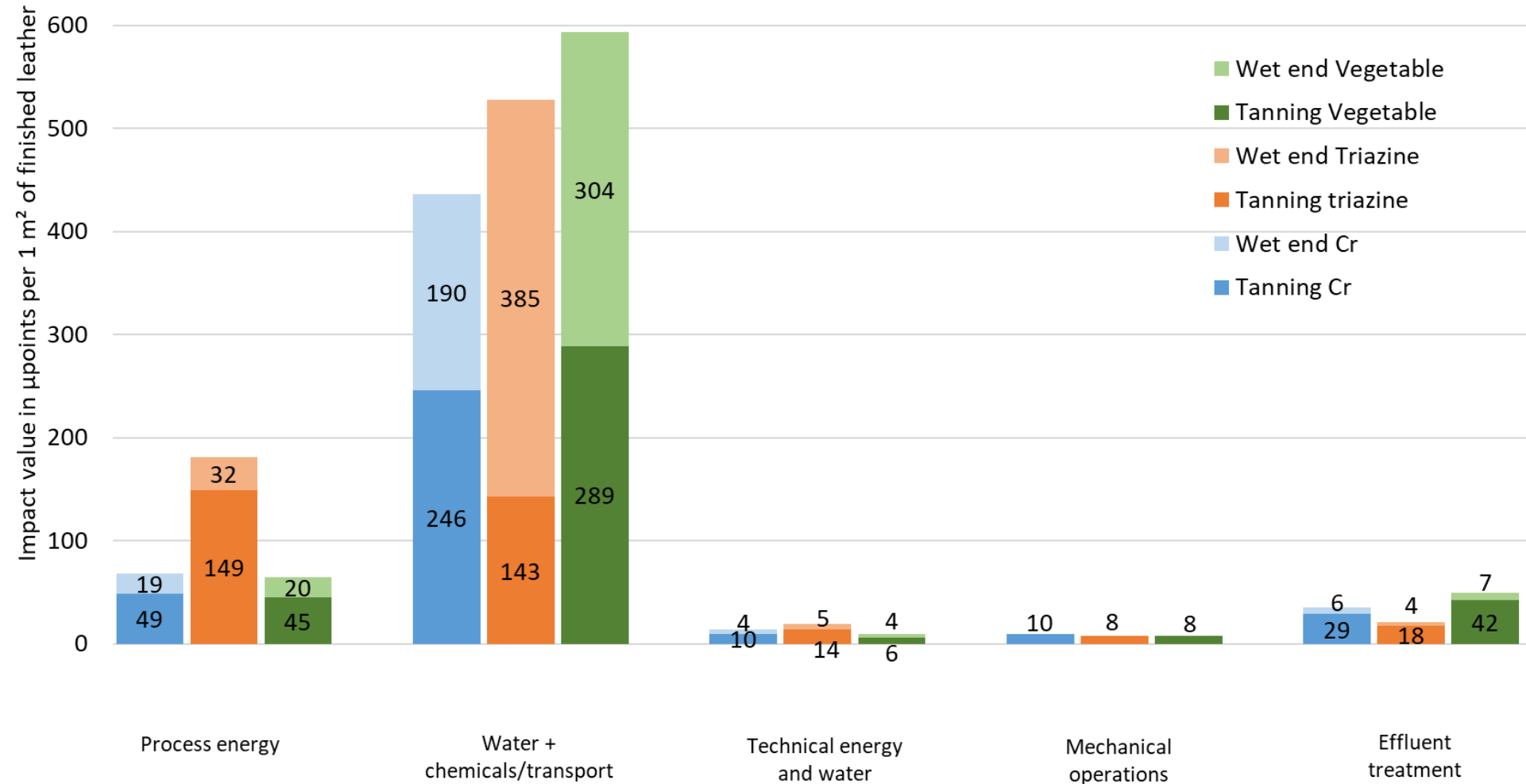




# LCA results: impact/m<sup>2</sup> by sub-process

Process bath  
 (water + chemicals)  
 → highest impact  
 ≥70% (lab)  
 86–89% (industry)

Next: process  
 energy & effluents



## Sensitivity Analysis:

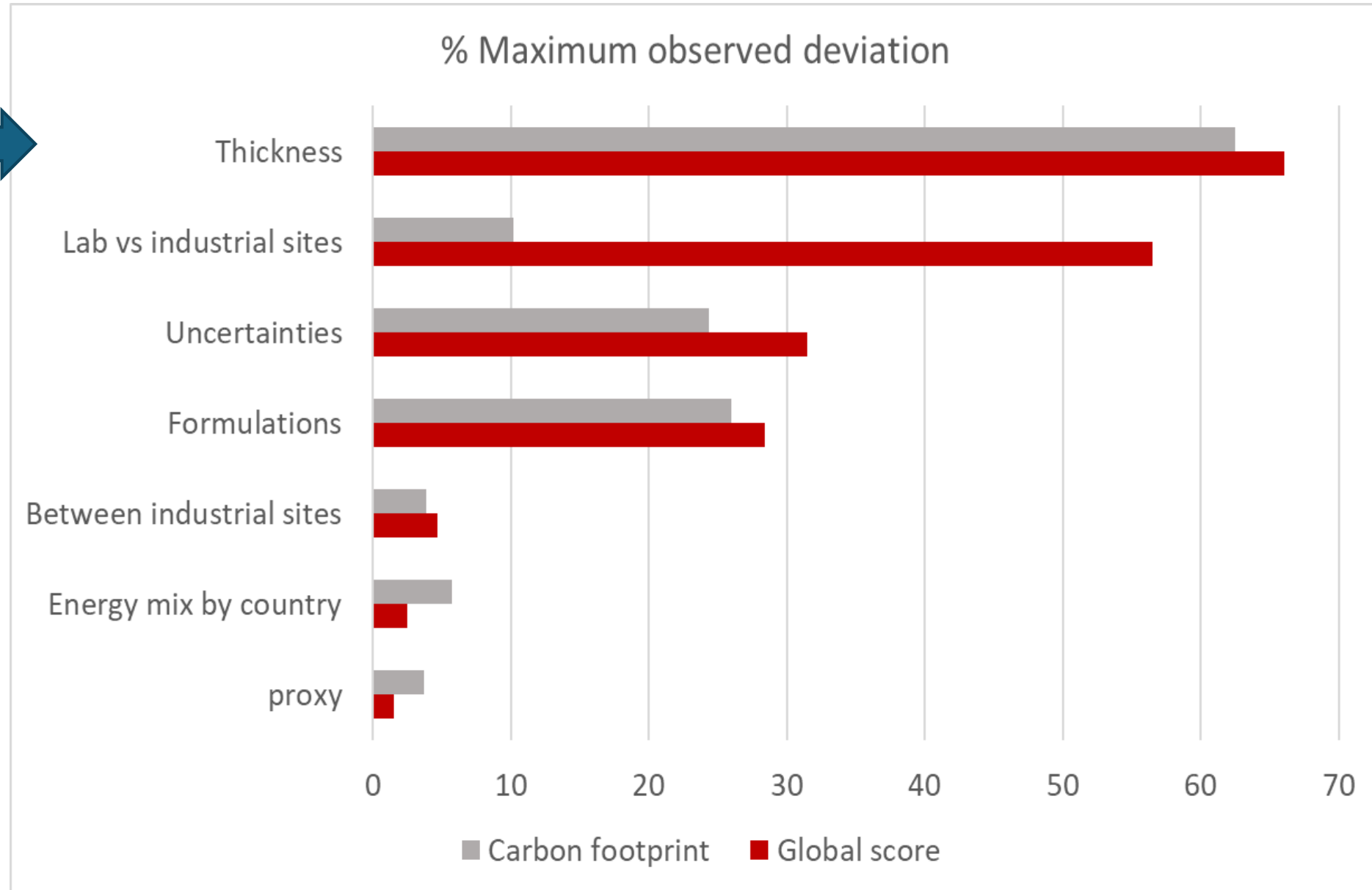
Simulations	LCI data	Energy mix	Formulation	Leather thickness	Equipment (site)	Levels tested
<b>S1</b>	Varied	Fixed	Fixed	Fixed	Fixed	Proxy vs. primary data for tannins
<b>S2</b>	Fixed	Varied	Fixed	Fixed	Fixed	France / China / Brazil
<b>S3</b>	Fixed	Fixed	Varied	Fixed	Fixed	System-specific formulations
<b>S4</b>	Fixed	Fixed	Fixed	Varied	Fixed	1.2 mm to 2.2 mm
<b>S5</b>	Fixed	Fixed	Fixed	Fixed	Varied	Different European industrial sites
<b>S6</b>	Fixed	Fixed	Fixed	Fixed	Varied	Laboratory vs. industrial

## Uncertainty Analysis:

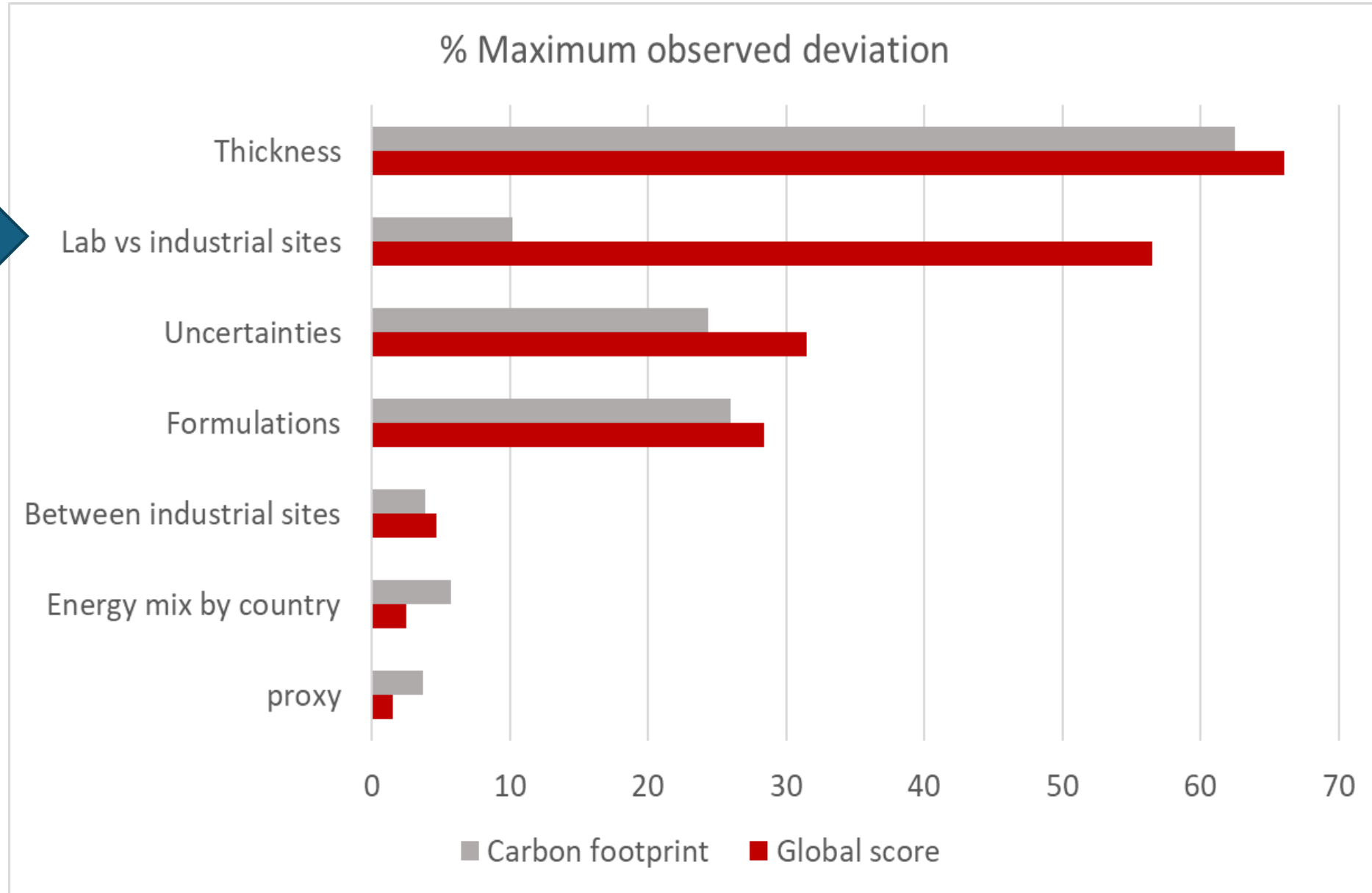
⇒ Monte Carlo method – Uncertainty assessment of data



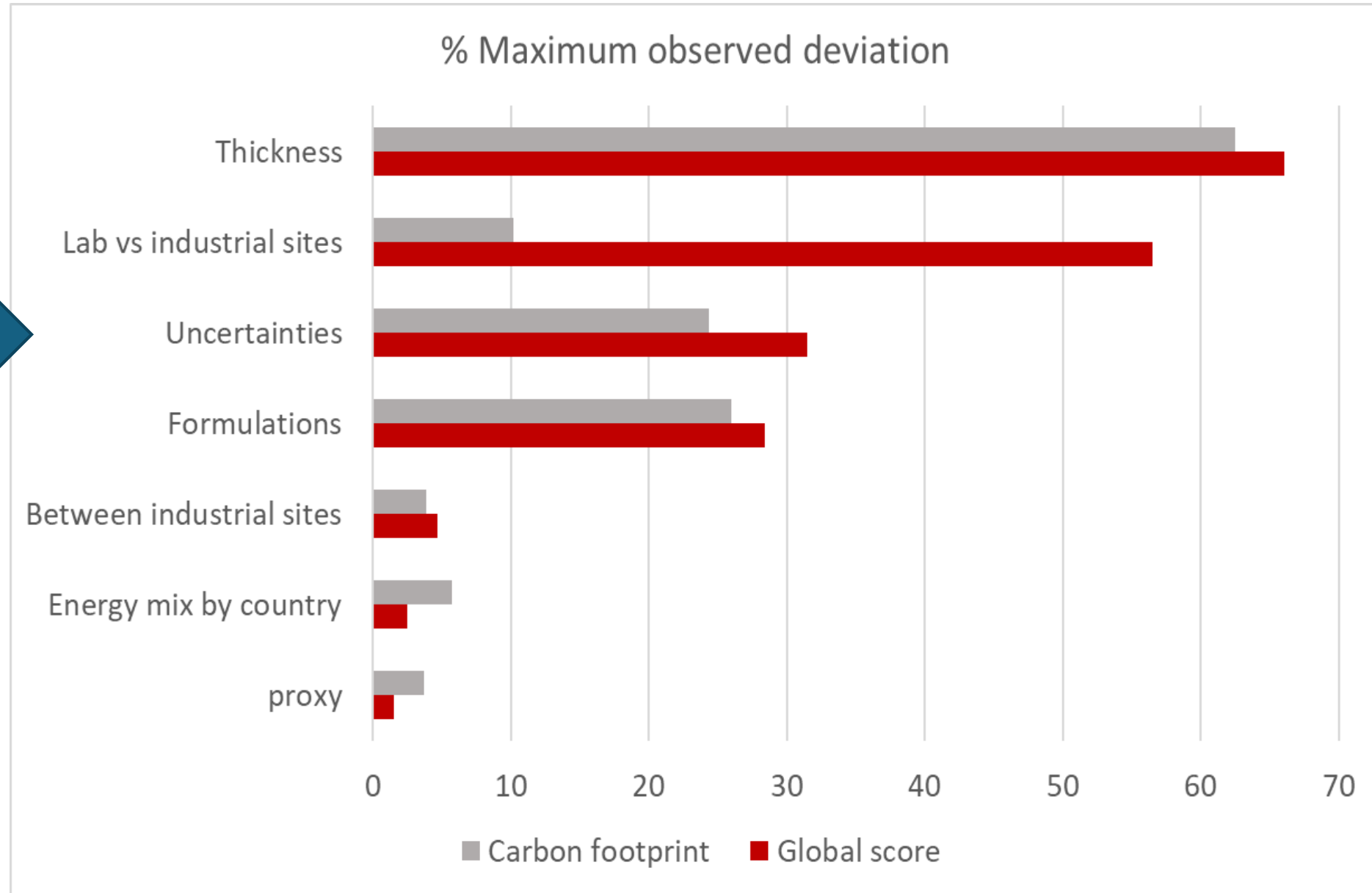
- Thickness = main influencing factor
- Process bath impact  $\propto$  hide weight (kg) thickness
- Linear relationship (if same splitting/shaving practice)



Lab equipment ≠  
representative of  
industrial energy  
optimizations

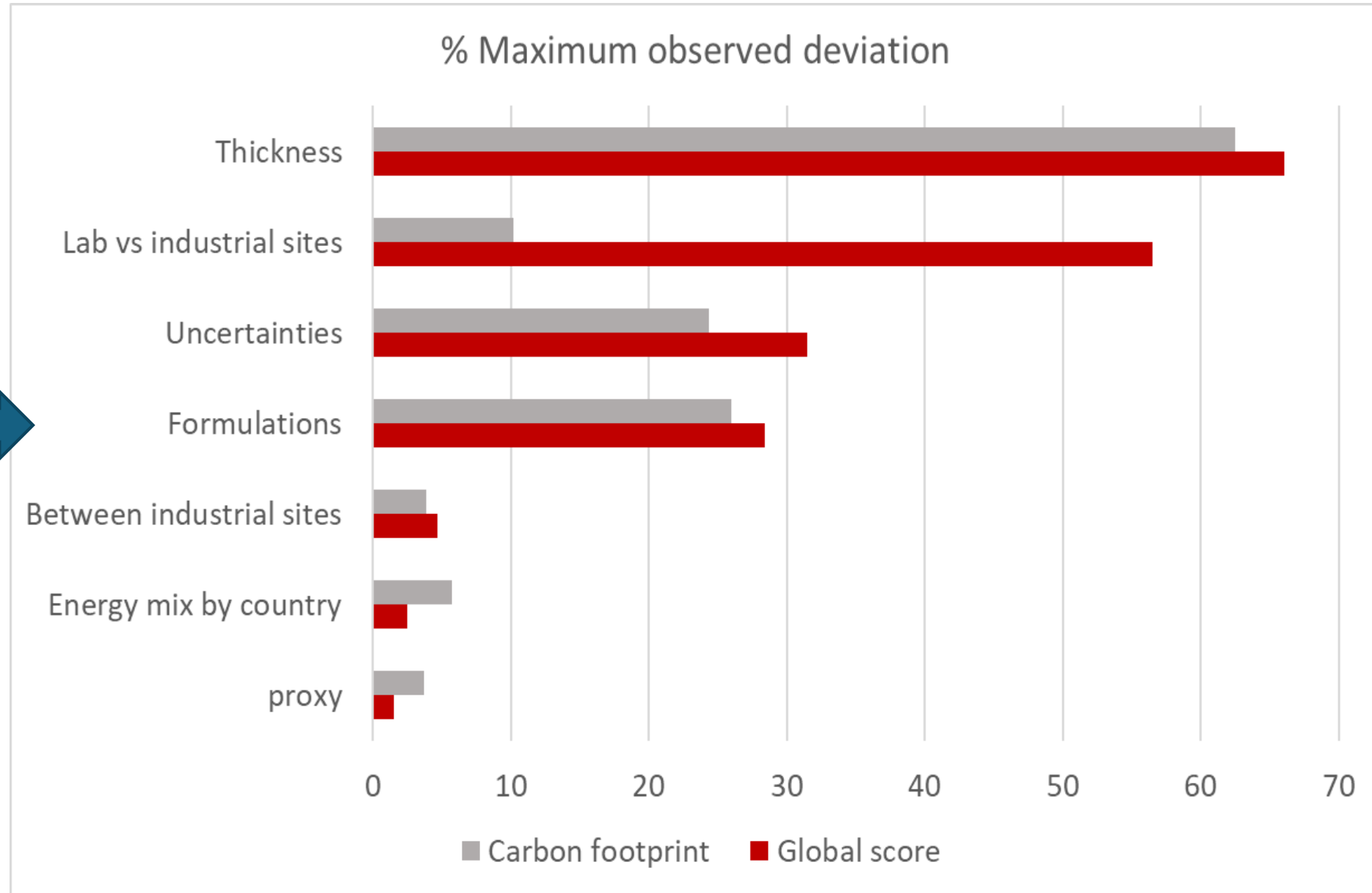


Data-related  
uncertainties =  
25–30% gap  
(hardly  
reducible)

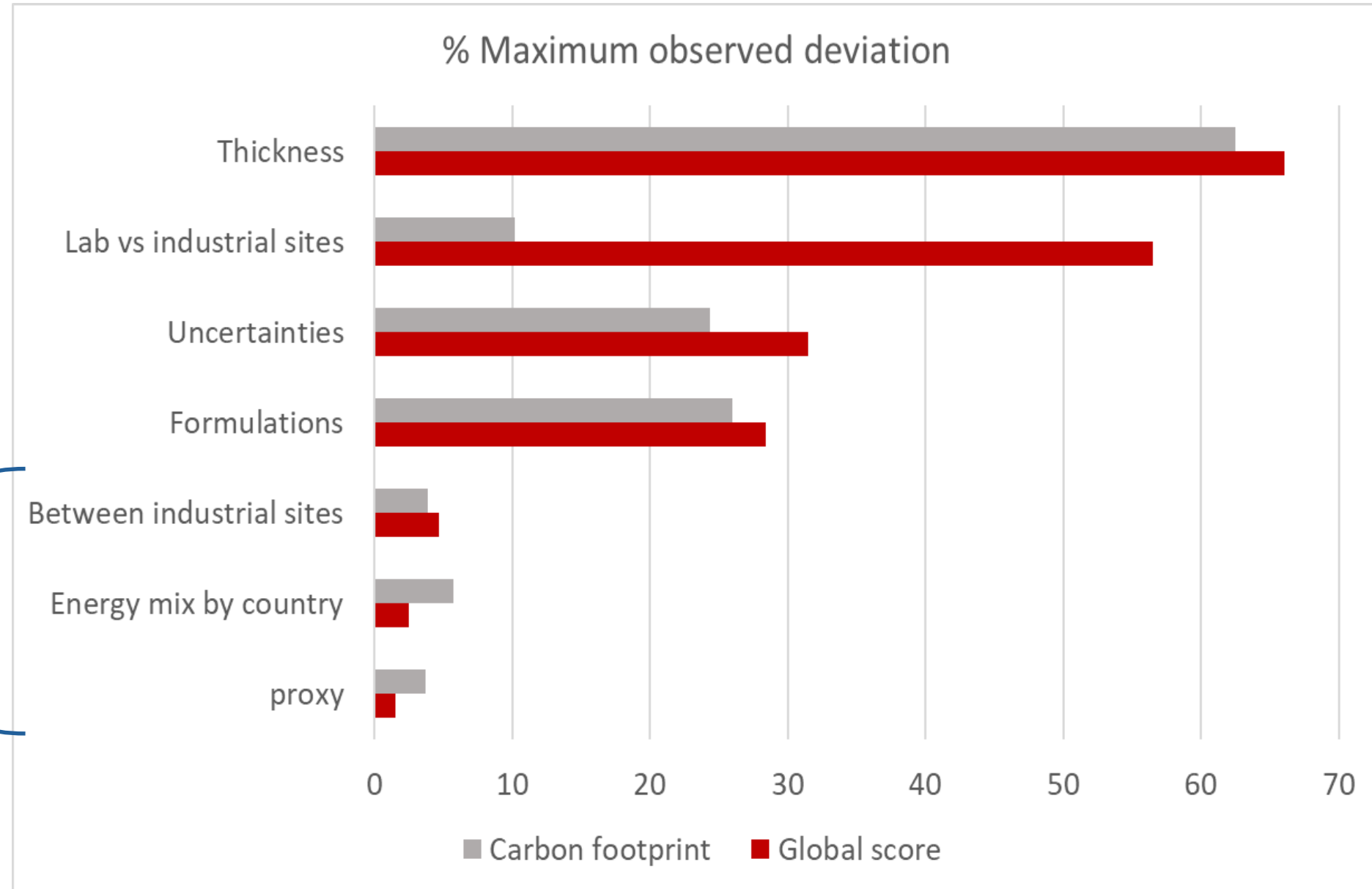


Formulation  
 diversity →  
 important  
 variability factor

(even within one  
 product type, e.g.  
 leather goods)



Minor variability  
factors  
(in this study)



## Conclusions

- No universally “better” tanning (carbon vs. toxicity)  
→ depends on environmental priorities
- Variability factors identified:
  - Eco-design levers
    - Thickness
    - Formulations
  - Methodological limits:
    - Lab vs. industry
    - Data uncertainty

## Recommendations for Leather LCAs

- Comparability (use / thickness / durability)
- Transparency (chemical inputs & processes)
- Reliability (sensitivity & uncertainty analysis)





**Thank you for your attention**

