And now for something completely different: Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM)

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Fellowship: Net Zero & MuSIASEM

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- Fellowship in land use and societal metabolism
  - Work in progress
  - Ramp-up MuSIASEM while testing Scotland's Green Recovery and Net Zero goals
    - How will it happen? Walk matching talk?
    - Net zero means offsetting: afforestation and carbon capture technologies, but not my critique at this point
    - Scotland is in UK context

Fellowship: Net Zero & MuSIASEM

- MuSIASEM? *Multi-Scale Integrated* Analysis of Societal and Ecosystem Metabolism
  - To tackle system complexity
  - Assumptions
    - It's a biophysical world out there and we should analyse it that way (very suspect of economics)
    - All technologies have costs: so how track them?
    - Grammars/narrative

MuSIASEM – multi-scale, integrated

- Think: Russian dolls…
  - Successive embeddedness (vertical & horizontal)
  - Spatial/regional/national, sectoral, temporal (always ‘multi’) -
  - Holon: everything has parts and is a part of something else
  - The black box… and ‘unblackboxing’

System Metabolism and Allocations

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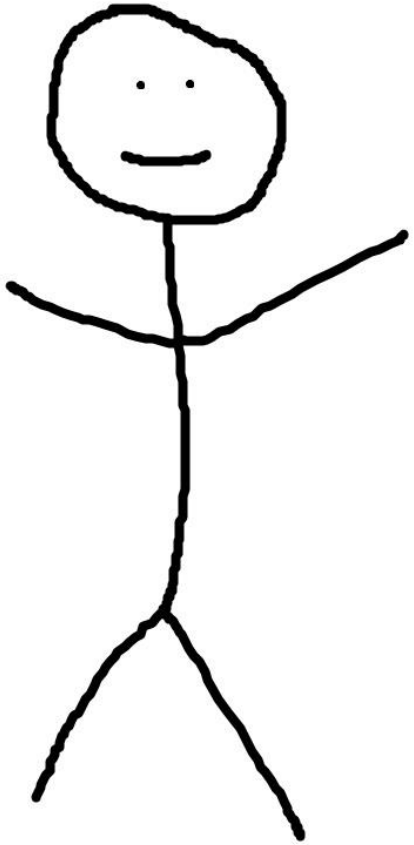
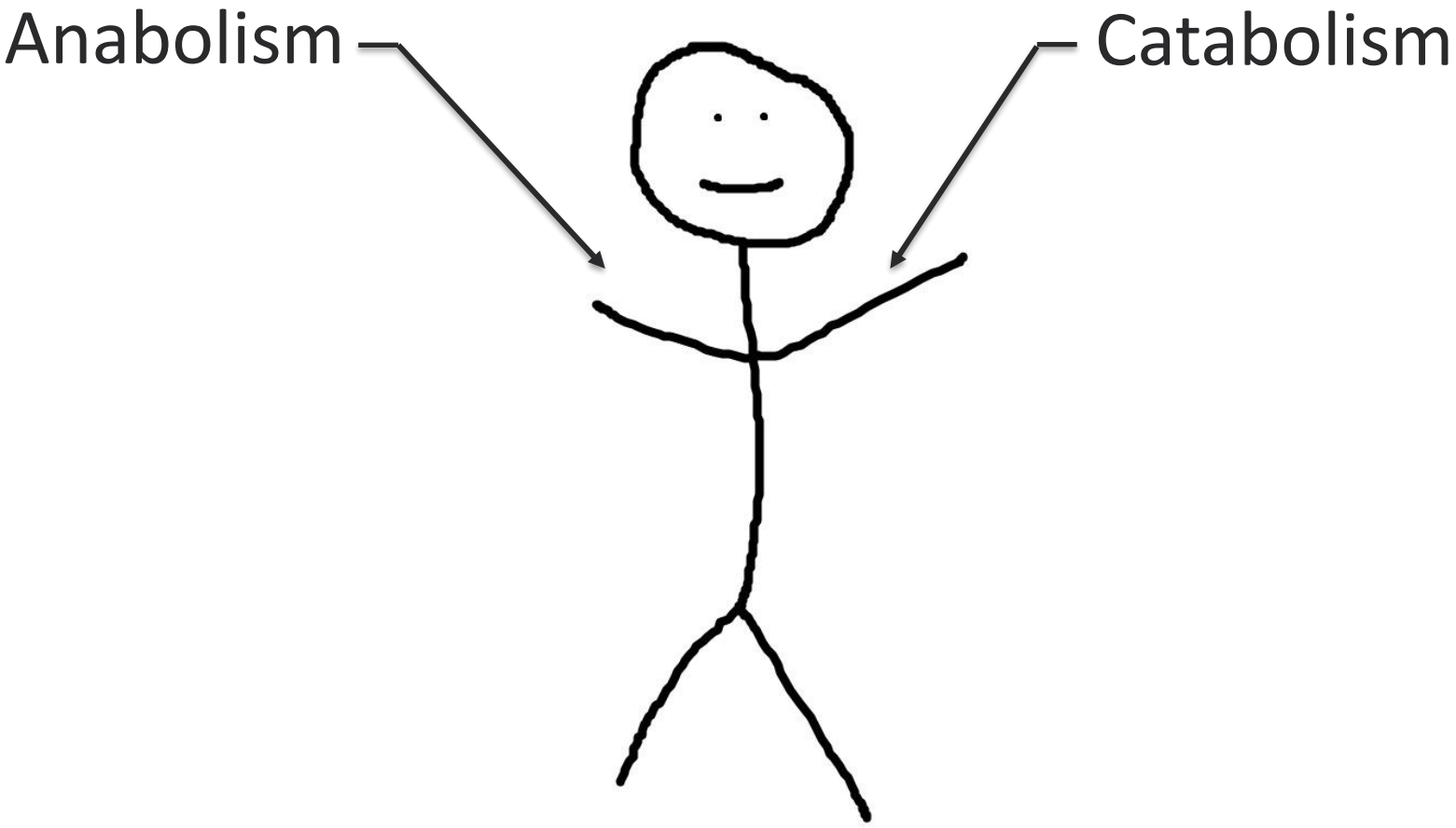
What is Metabolism?



System Metabolism and Allocations



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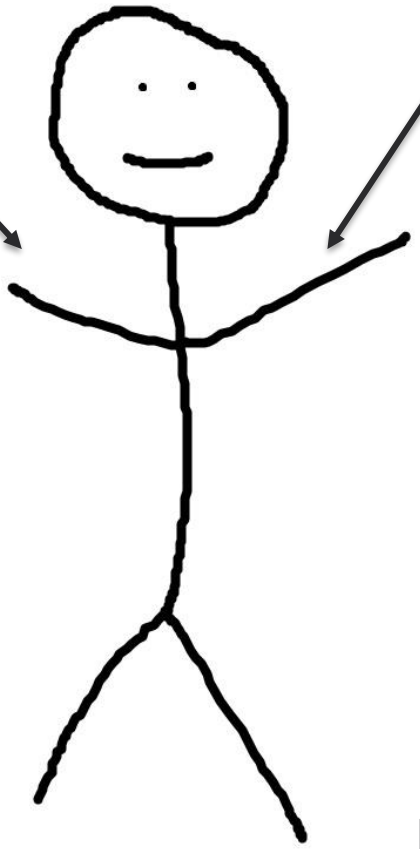


Anabolism

Catabolism

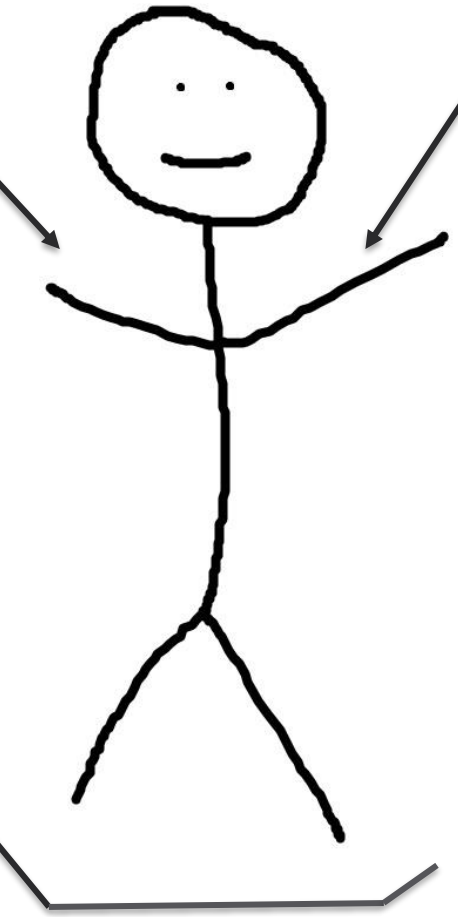
Breakdown

Energy Carriers

- Fats
- Proteins
- Carbohydrates
- Vitamins
- Minerals

Used by organs!

System Metabolism and Allocations



Anabolism

Build-up

- Daily activities
- Self-maintenance
- Reproduction

Catabolism

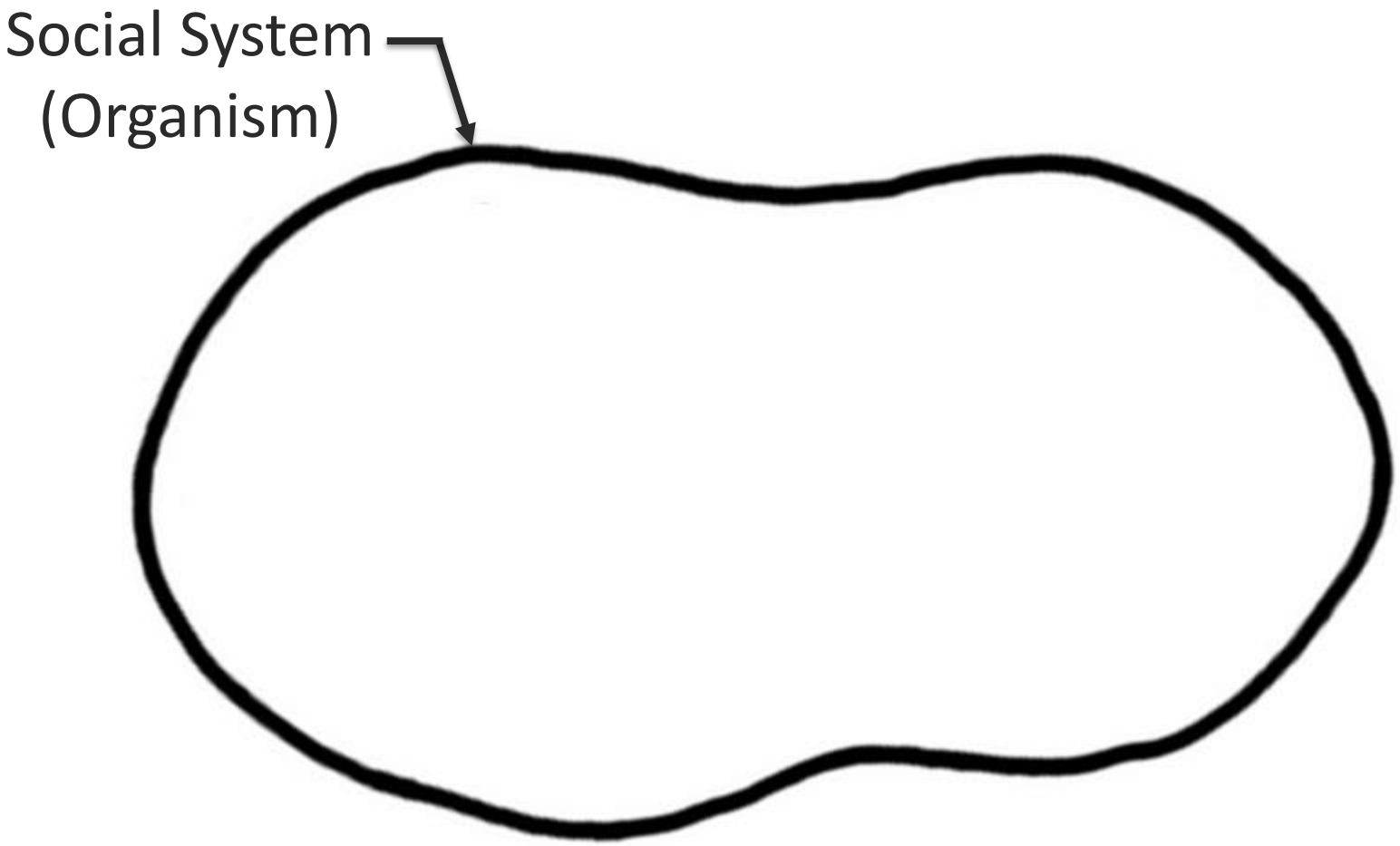
Breakdown

Energy Carriers

- Fats
- Proteins
- Carbohydrates
- Vitamins
- Minerals

Used and produced by organs for…

System Metabolism and Allocations



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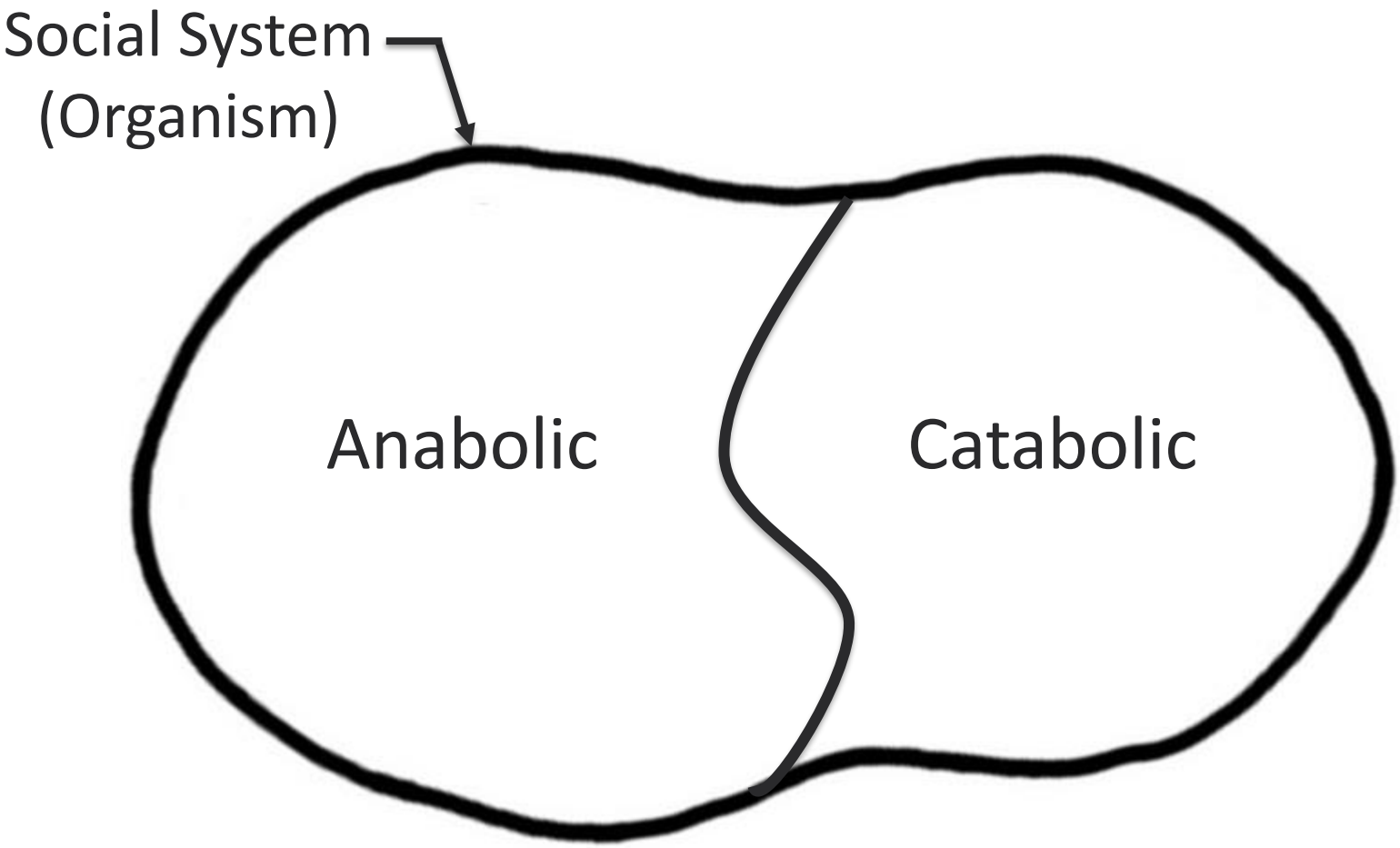

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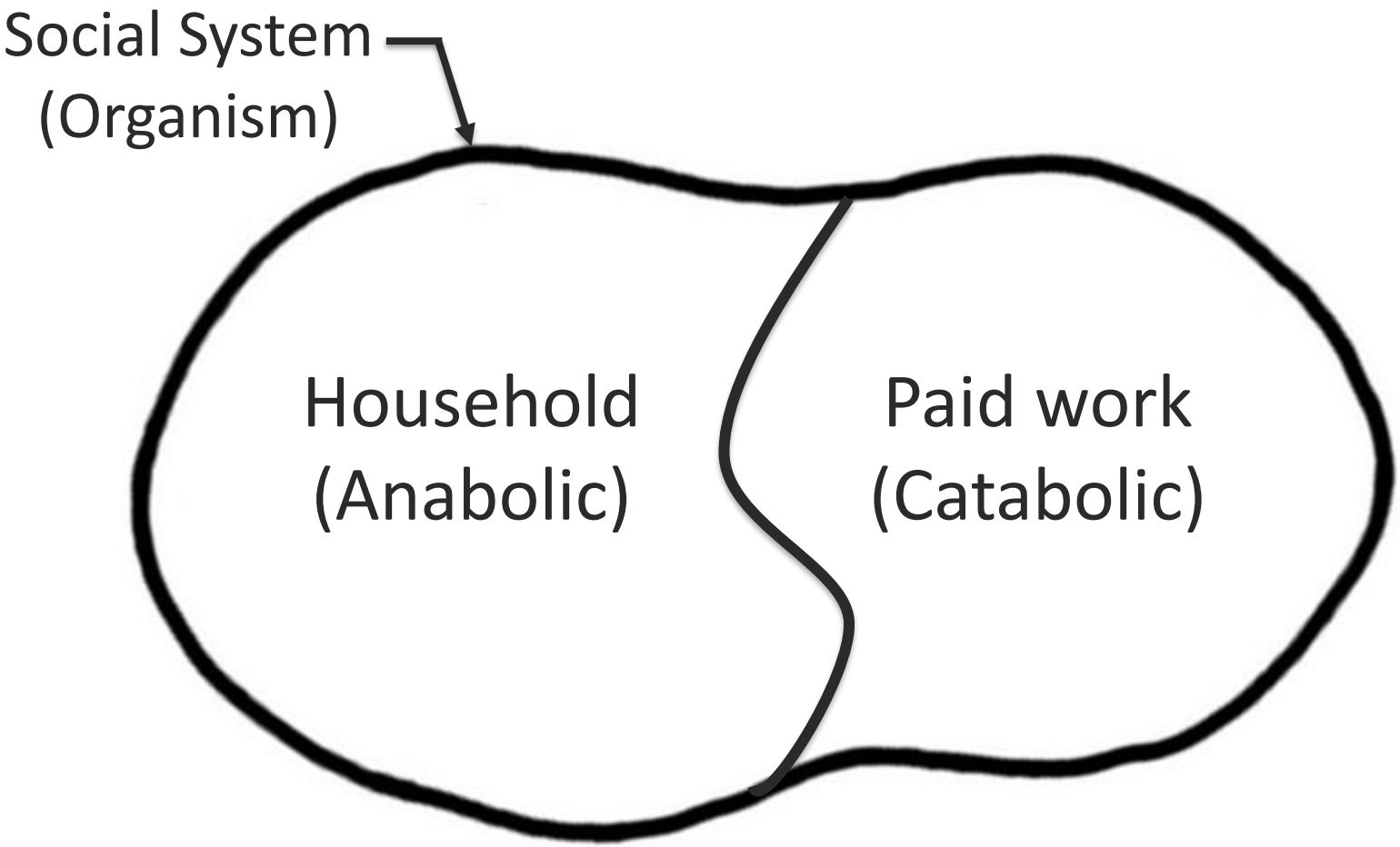

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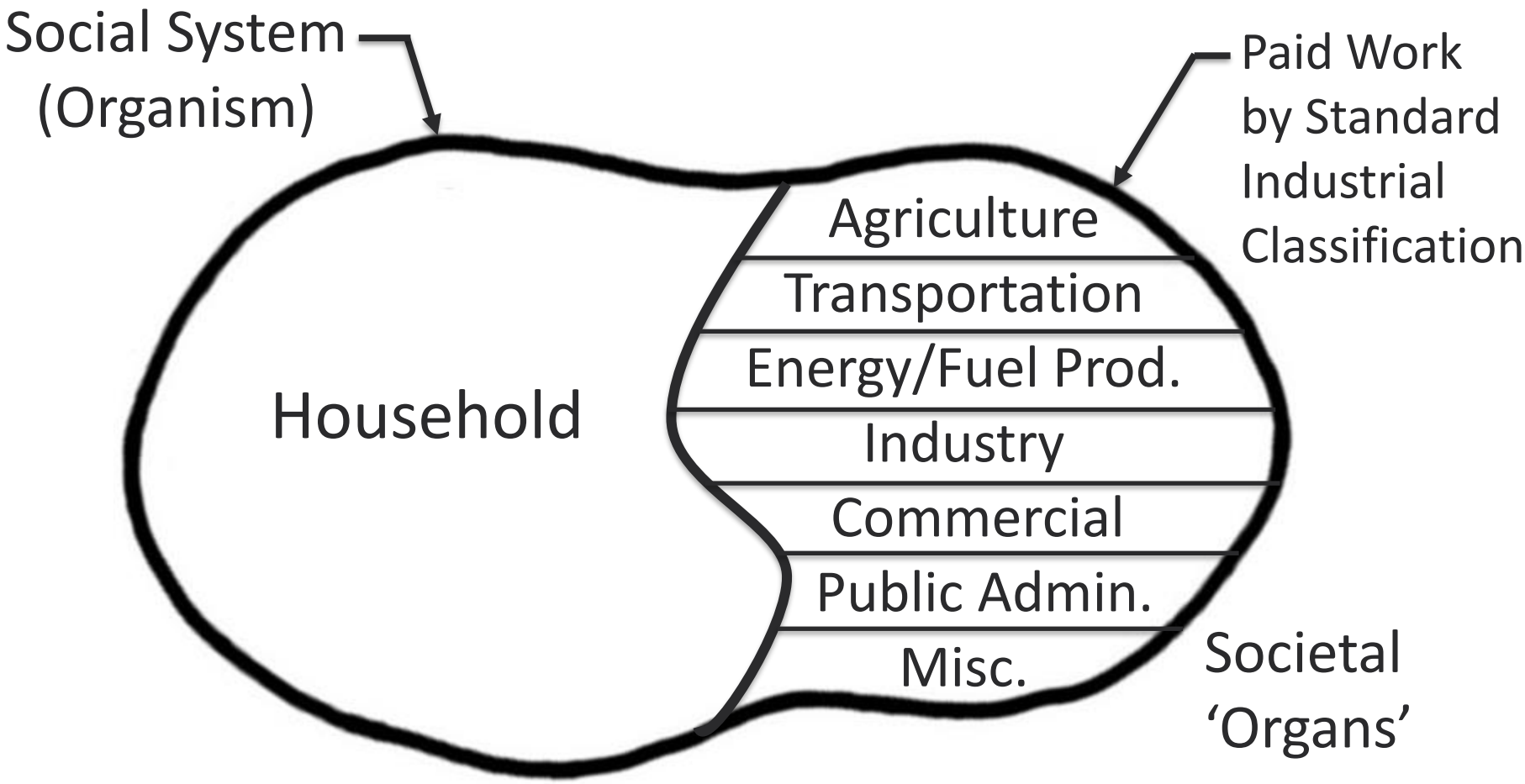
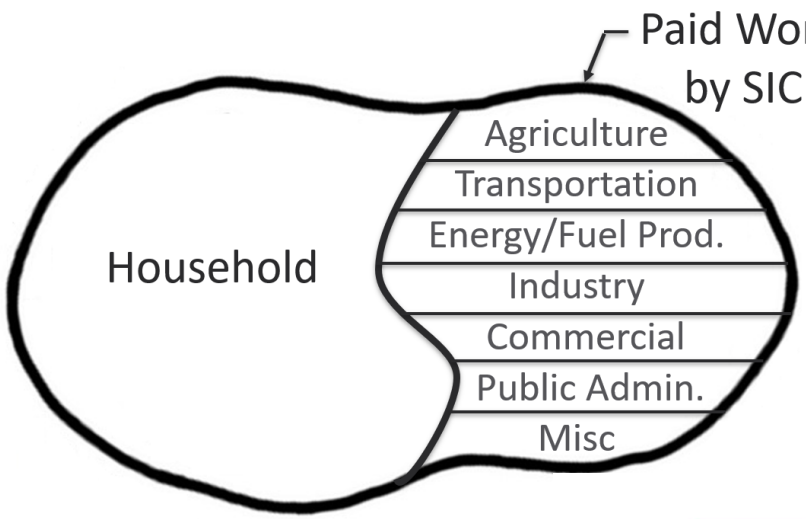
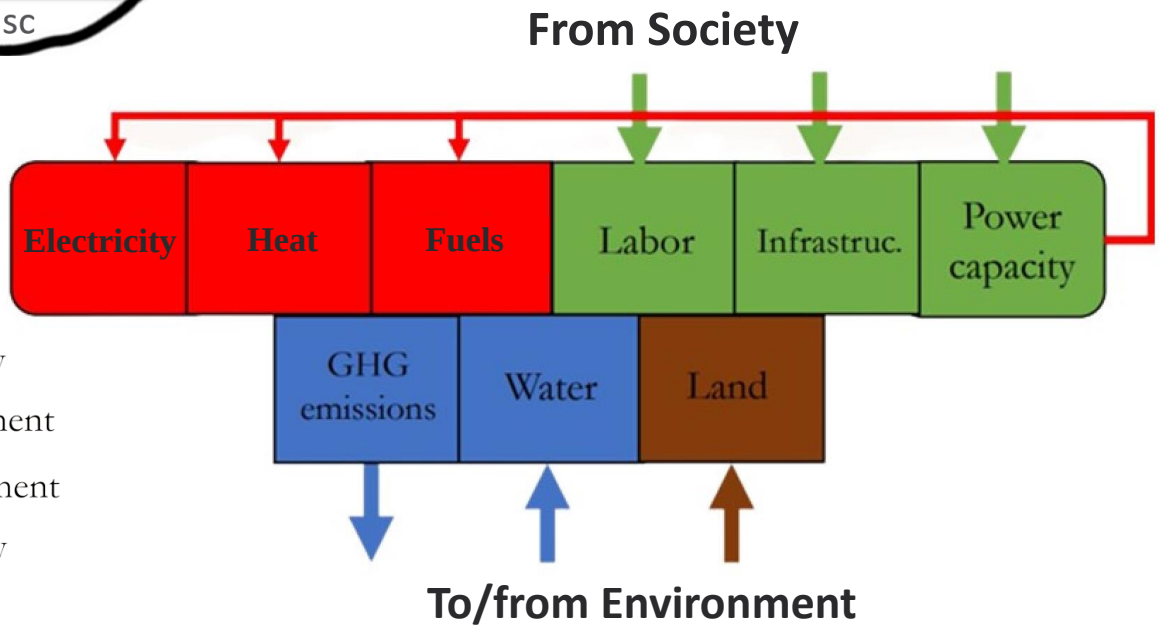


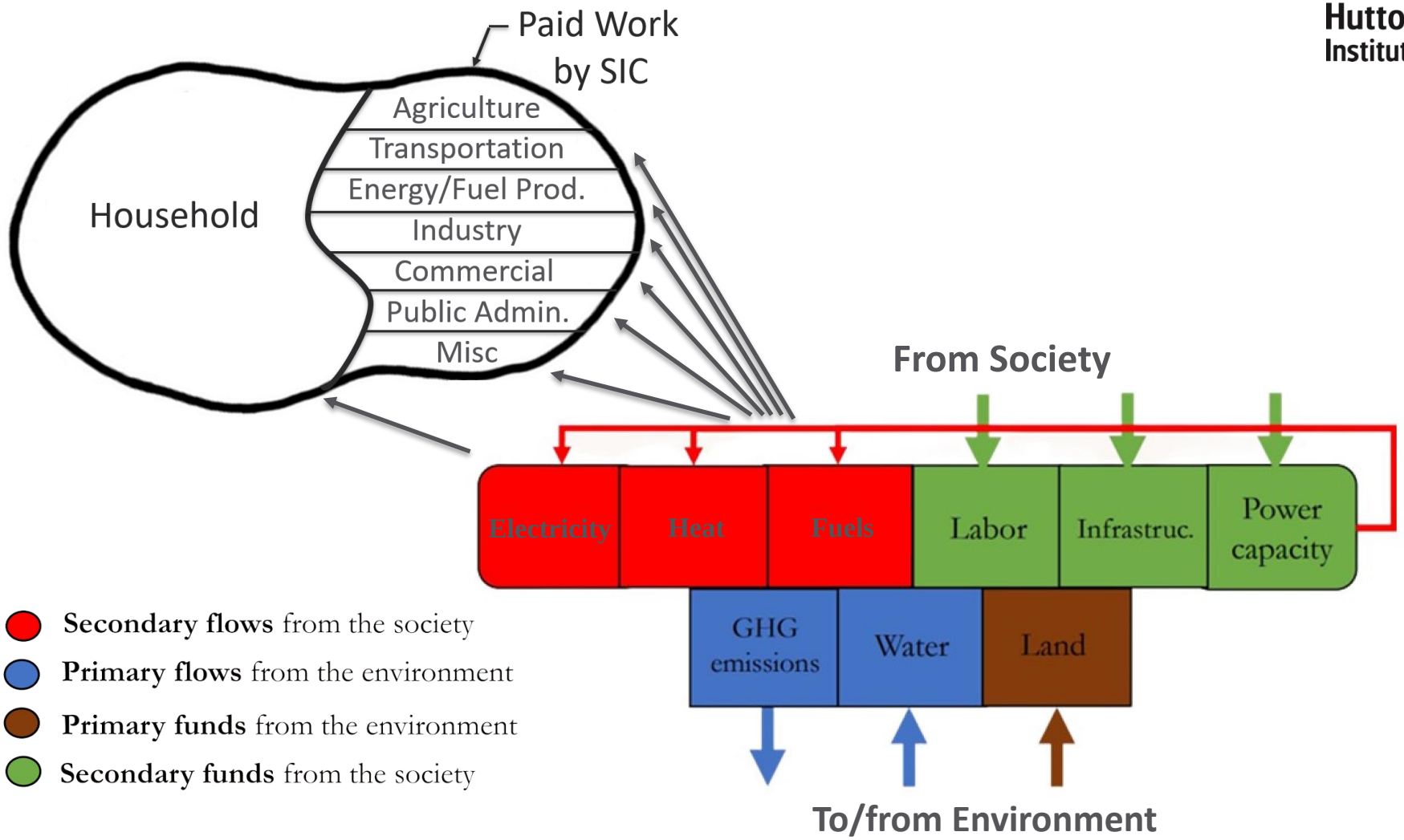
Energy Carriers and Usage





- **Secondary flows** from the society
- **Primary flows** from the environment
- **Primary funds** from the environment
- **Secondary funds** from the society

Energy Carriers and Usage



Energy Carriers and Usage

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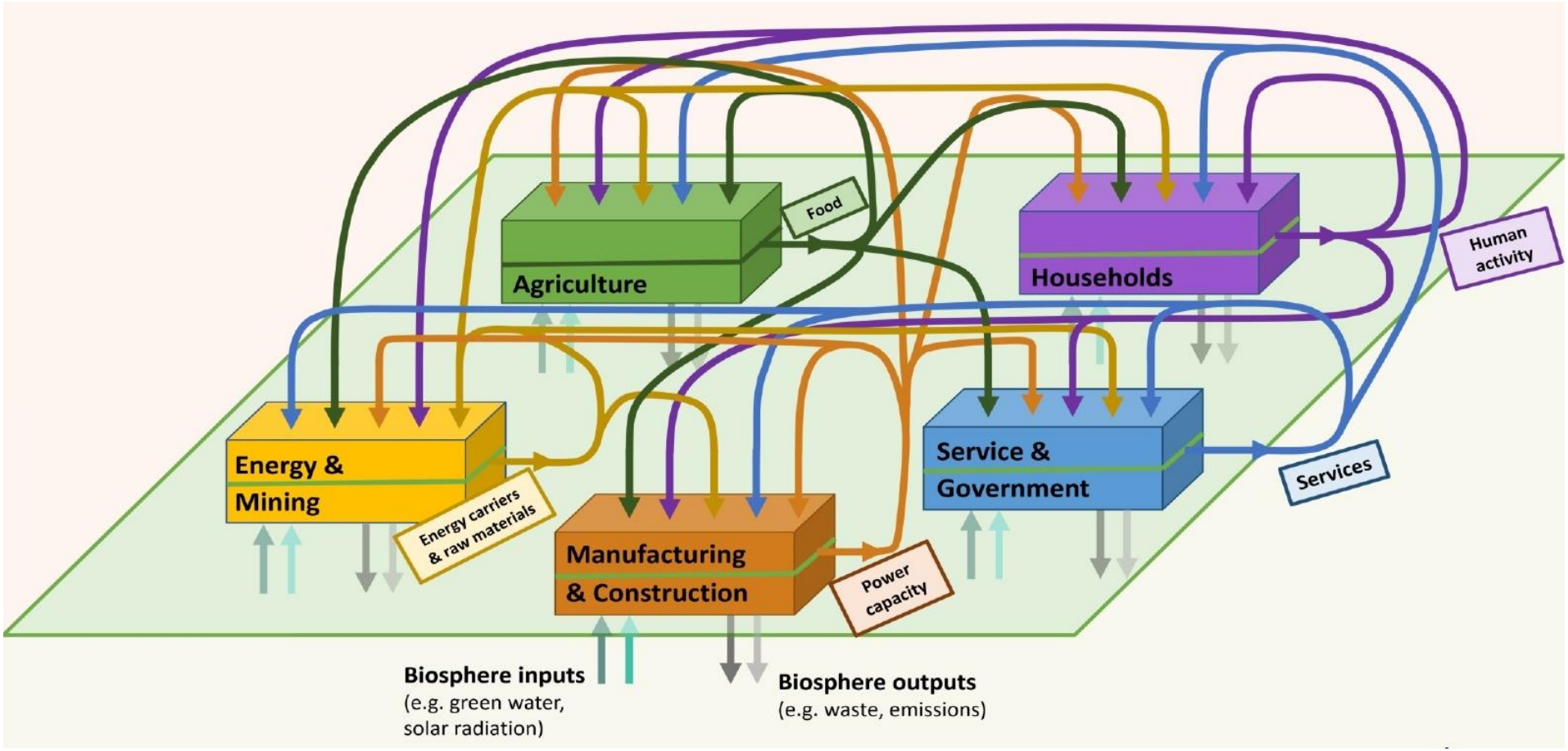

UK 2019 MuSIASEM

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		2019 UK - Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM)																	
		Total Hours of Human Activity	Energy Metabolic Rate				Economic Job Produc-tivity (GVA/Hr)	Energy Flow				Gross Value Added	Energy intensity of £	PW total Income (est)	PW intensity of GVA	GHG	Coupling		
																	GHG Intensity of Hour	GHG Intensity of Energy	GHG Intensity of £
		(Mh)	Total (MJ/h)	Elec (MJ/h)	Heat (MJ/h)	Fuels (MJ/h)	(£/h)	Total (PJ/yr)	Elec (PJ/yr)	Heat (PJ/yr)	Fuels (PJ/yr)	(M£)	(GJ/£)	(M£)	(£/£)	ktCO2e	ktCO2e/ Mh	ktCO2e/ TJ	ktCO2e/ M£
Level 1	**All Society**	585,140	11.1	2.1	4.1	4.8	3.4	6,469	1,238	2,415	2,816	2,017,344	3.2	688,517	0.34	447,877	0.8	69.2	0.22
Level 2 (HH & PW)	**Household Sector**	539,179	3.0	0.7	2.1	0.2	-	1,605	373	1,128	104	-	-	-	-	132,948	0.25	82.8	-
	Paid Work Sector	45,961	105.8	18.8	28.0	59.0	43.9	4,864	865	1,287	2,712	2,017,344	2.4	688,415	0.34	310,909	7	63.9	0.15
	Ratio PW to HH	0.09	35.6	27.2	13.4	306.8	-	3.0	2.3	1.1	26.2	-	-	-	-	2.3	27.4	0.8	-
Level 3 Paid work breakdown	**Agriculture**	271	225.1	56.1	33.6	135.4	50.9	61	15.2	9.1	36.7	13,802	4.4	2,598	0.19	47,352	175	776.3	3.43
	Transportation	1,185	1998.3	16.9	63.2	1918.3	36.8	2,368	20.0	74.9	2272.9	43,618	54.3	16,223	0.37	24,960	21	10.5	0.57
	Energy/Fuel Prod	436	1435.8	397.9	642.1	395.8	119.3	626	173.4	279.8	172.5	51,984	12.0	9,405	0.18	85,619	196	136.8	1.65
	Industry	7,359	132.1	45.1	71.8	15.2	48.0	972	331.9	528.6	111.7	353,544	2.7	114,182	0.32	109,826	15	113.0	0.31
	Commercial	20,449	27.1	12.7	11.0	3.4	54.4	554	260.0	224.8	69.0	1,113,378	0.5	313,739	0.28	28,940	1.4	52.3	0.03
	Public Admin	14,635	15.7	4.4	9.2	2.1	25.3	230	64.3	134.9	30.8	369,748	0.6	211,596	0.57	12,260	0.8	53.3	0.03
	Misc	1,613	33.2	0.0	21.5	11.7	44.2	54	0.0	34.7	18.8	71,270	0.8	20,672	0.29	1,954	1.2	36.5	0.03

- Land, Water, natural capitals, health measures? Net zero? Env. Justice?
- Borders? Input/outputs. Embeddedness/Sudoku

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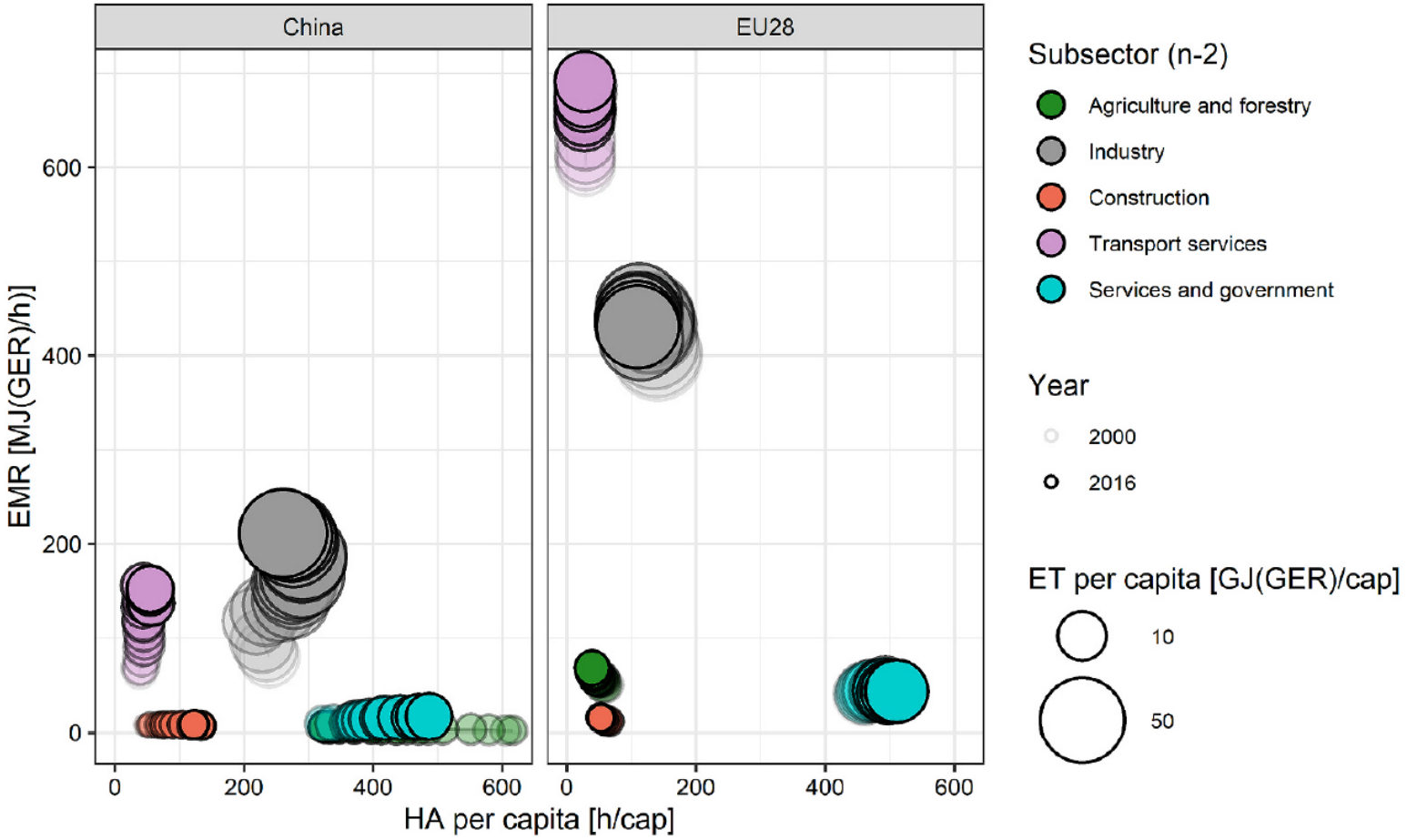
- Absolutes and relative values
- Differential impacts of sectors and qualitatively different from each other

China vs EU – Energy Metabolic Rate vs Human Activity (Velasco-Fernández et al. 2020)



Key Framing Criteria

- Viability
- Feasibility
- Desirability

Discussion

- What about Scotland? The same detail is not available.
- Can glean proportions from UK, but it's different, ie, AG and grazing land are different
- AG – Different sectors, different metabolic character, different policy environment
- Metabolics is esoteric and hard: need hold multiple relations in head at same time. Multi-sector, multi-unit, non-equivalent items, and trade-offs
- Kahneman's Systems 2 thinking – not easy, but more representative of socioecological systems

Discussion

- Systems in government are not set up for metabolic analysis; set up for economic analysis - generally everything reduced to economic units (£, $), this is not working
- This universal currency gives us sloppy grammars
- In the end, we can't externalize - climate change is witness to this.
- Problem shifting (sweep under rug); EU can't feed itself, externalizing emissions, China tends to get blamed
- Metabolic analysis helps track all this… (well, tries!)

Thanks for listening…

- Please comment/critique (and got data?)
- Can we collaborate?
- jean.boucher@hutton.ac.uk
- Or here: