John Mulrow

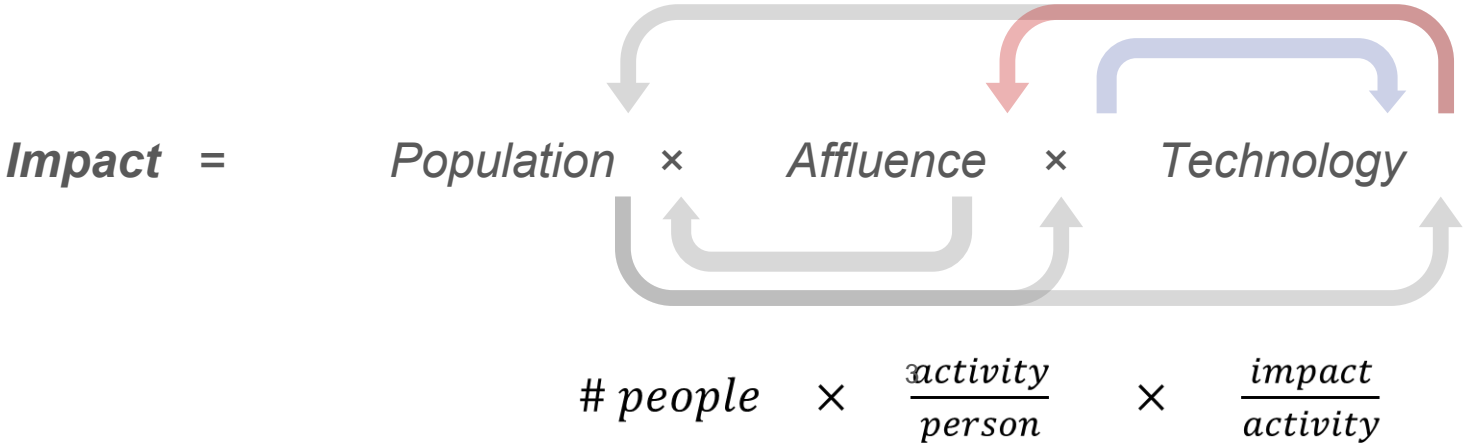
The ecological-economic possibilities of a **non-rapid energy transition**

Kendrick Hardaway, Thomas Maani, Miriam Stevens, John Mulrow*
Environmental & Ecological Engineering / Degrowth Coffee Hour
Purdue University (Indiana, USA)

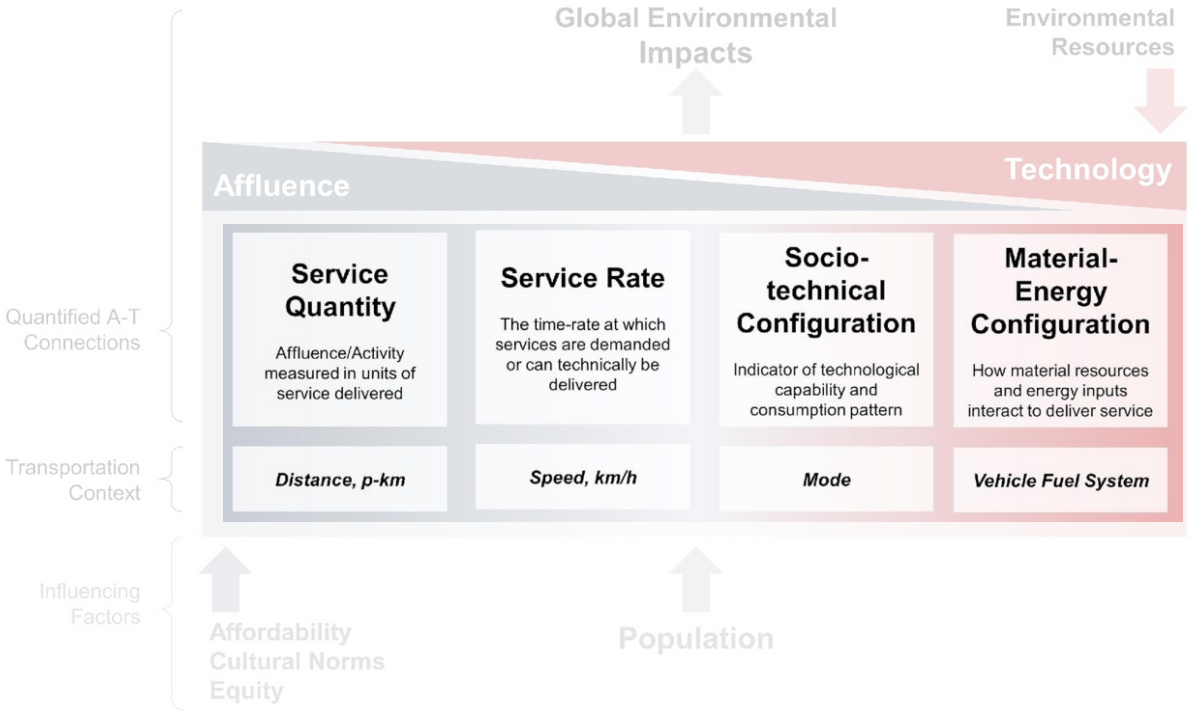
CANSEE 2023 – Toronto, ON

*Presented by John Mulrow, Visiting Assistant Professor, EEE: jmulrow@purdue.edu

Affluence-technology interactions



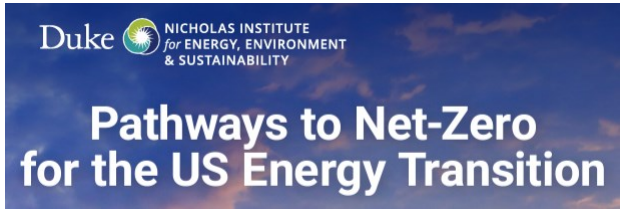
A-T research scope



How does this apply to the suite of technologies comprising the "energy transition"?

Especially given the focus on rapidity.

What is a rapid transition?



"the US must **rapidly scale clean electricity** production while concurrently electrifying high energy–use sectors and developing new technologies for emission sources that are difficult to electrify.

→ **Zero-carbon infrastructure *buildout***

"requires accelerating **the shift** to non-emitting sources of energy, such as wind and solar"

→ ***Swap* fossil fuels for zero-carbon**

"We need to mobilise a rapid rollout of renewable energy…to **cut world emissions in half within a decade**."

→ ***Reduce emissions***

"1.5°C compatible pathway requires a **wholescale transformation** of the way societies consume and produce energy."

→ **All the things**

Transition strategy risks

Zero-carbon infrastructure *buildout*

→ "past energy "transitions" could be more accurately described as energy *additions*" (York & Bell, 2019)

***Swap* fossil fuels for zero-carbon**

→ "The impacts within communities, similarly, will be rapid, and will fall disproportionately on more vulnerable socio-economic groups, including those within fossil fuel communities" (Raimi et al. 2022)

Reduce emissions

→ "Future research must shift from the prevailing and parochial view on carbon ('carbon myopia') towards more harmonized and globally reconciled environmental, economic and social assessments." (Harrison et al. 2021)

Simple energy transition model

US Primary Energy Production, 2023
115 Quadrillion BTU
(33,000 TWh)
FF: 100 BTU
ZC: 15 BTU

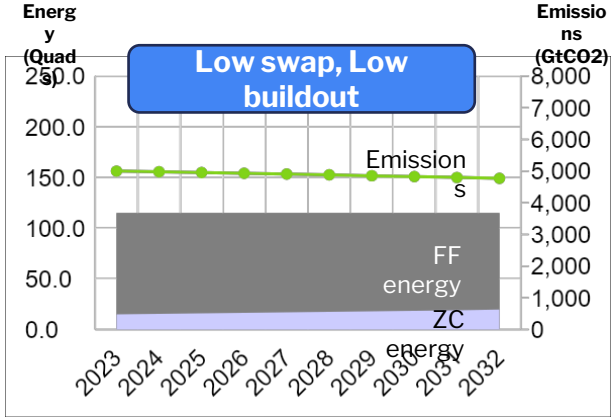
$$\boldsymbol{\beta = ZC\ buildout\ (\%\ growth)}$$

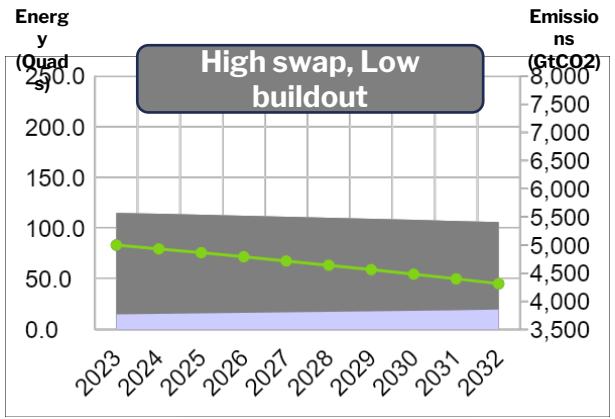
$$\boldsymbol{\sigma = \frac{FF}{ZC}\ swap\ ratio}$$

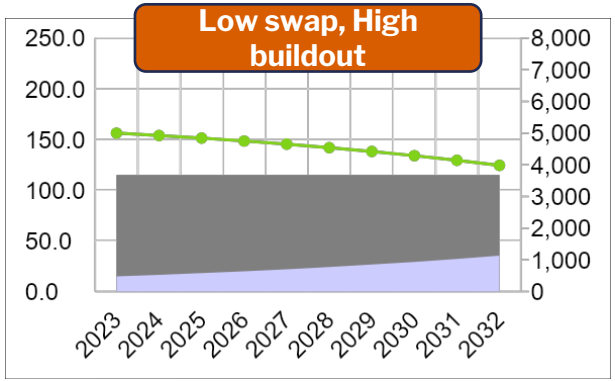
$$ZC_y = ZC_0(1+\beta)^y$$

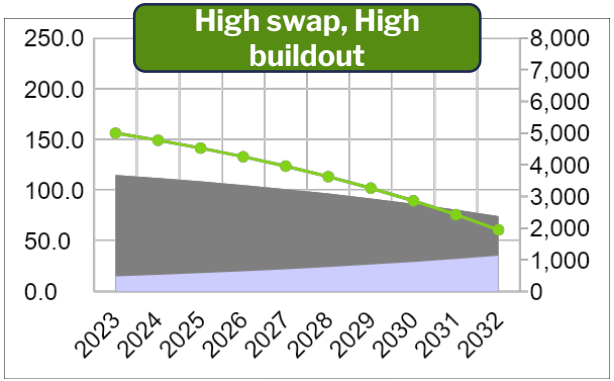
$$FF_y = FF_0 - \sigma(\Delta ZC)$$

$$PE_y(ZC_0, FF_0, \beta, \sigma)$$

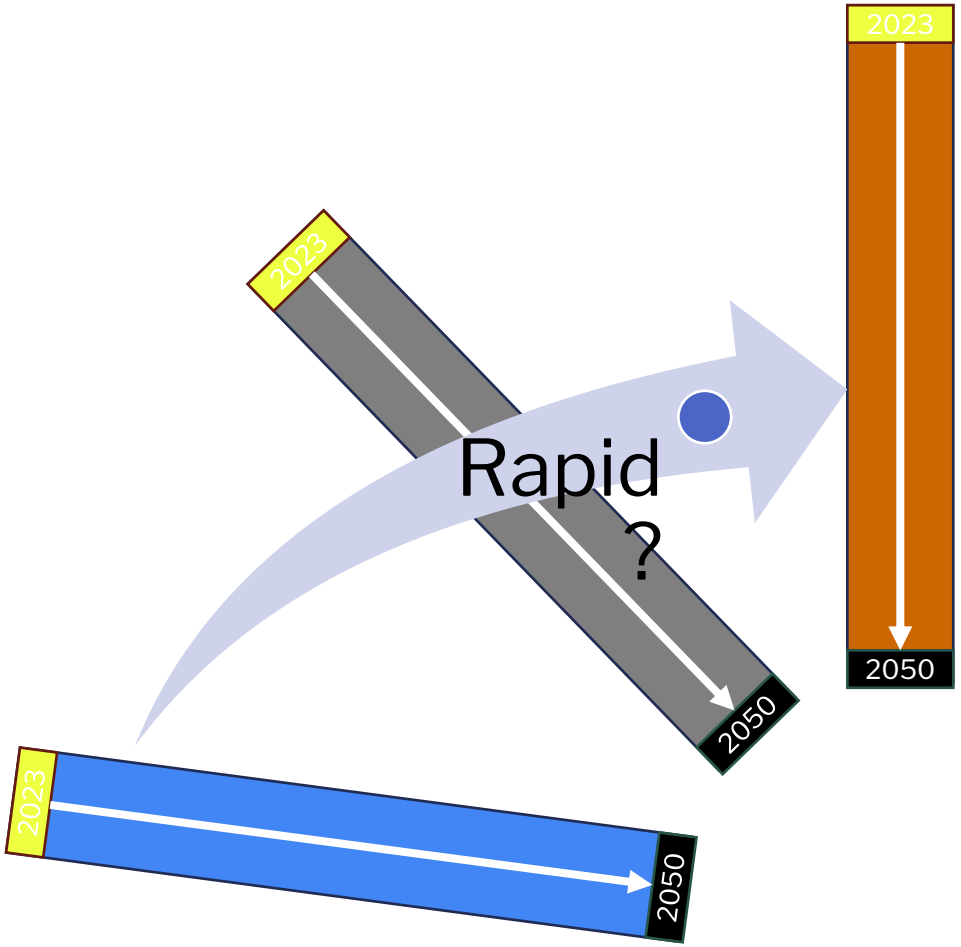








3. METHODS



Transition strategy risks

Zero-carbon infrastructure *buildout*

→ "past energy "transitions" could be more accurately described as energy *additions*" (York & Bell, 2019)

***Swap* fossil fuels for zero-carbon**

→ "The impacts within communities, similarly, will be rapid, and will fall disproportionately on more vulnerable socio-economic groups, including those within fossil fuel communities" (Raimi et al. 2022)

Reduce emissions

→ "Future research must shift from the prevailing and parochial view on carbon ('carbon myopia') towards more harmonized and globally reconciled environmental, economic and social assessments." (Harrison et al. 2021)

All the things

→ Factors combine to create turbulent feedbacks that diminish social and ecological outcomes.

Potential feedback mechanisms

Zero-carbon infrastructure *buildout*	• Cost response from FF industries • Carbon-intensive material extraction and processing requirements • Conflict over control of material extraction sites
***Swap* fossil fuels for zero-carbon**	• Political pressure to keep FF communities whole • Resilience, reliability, and response to disaster • General resistance to lower energy demand / economic activity
Reduce emissions	• Conflict over control of material extraction sites • Cleanup, management, and security of new, more diverse energy extraction infrastructure
All the things	Society is not accustomed to rapid transition + there is always some more *urgent* matter at hand!

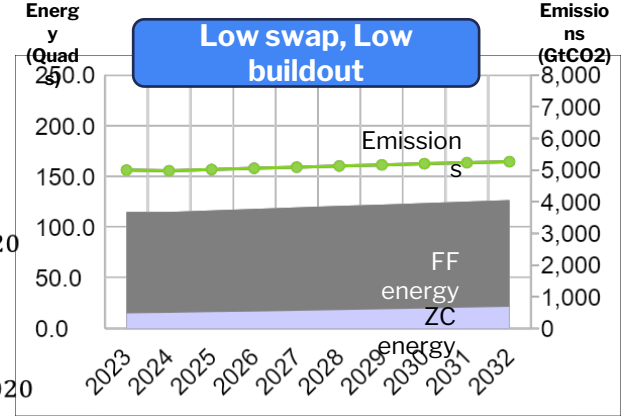
Positive feedback ∝ Weighted distance from commonplace change

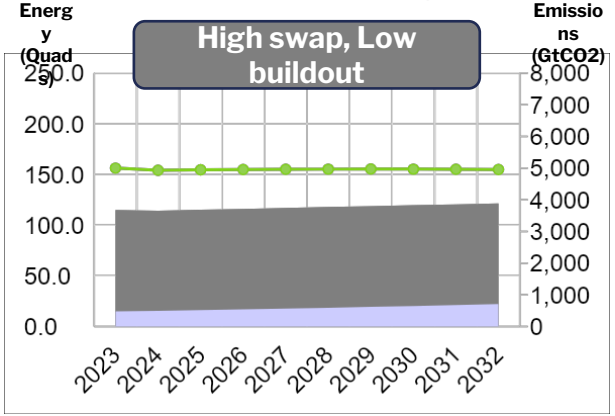
$$\Delta PE = \Delta PE_0 + \epsilon(d_{ff} + d_{zc})$$

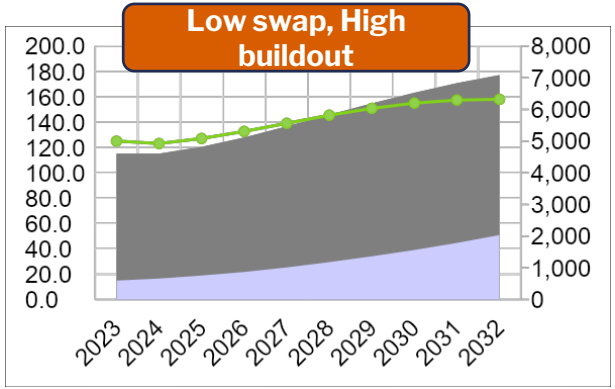
$$d_f = \frac{FF_y - FF_{y-1}}{FF_y} - CAGR_{FF,1990-2020}$$

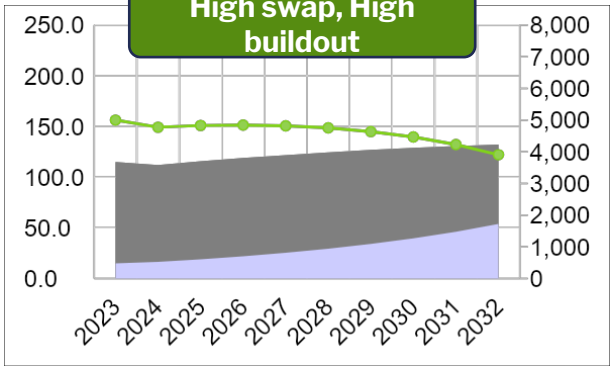
$$d_z = \frac{ZC_y - ZC_{y-1}}{ZC_y} - CAGR_{ZC,1990-2020}$$

ϵ: *feedback coefficient*



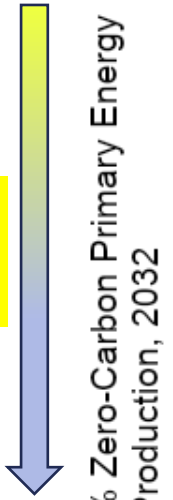


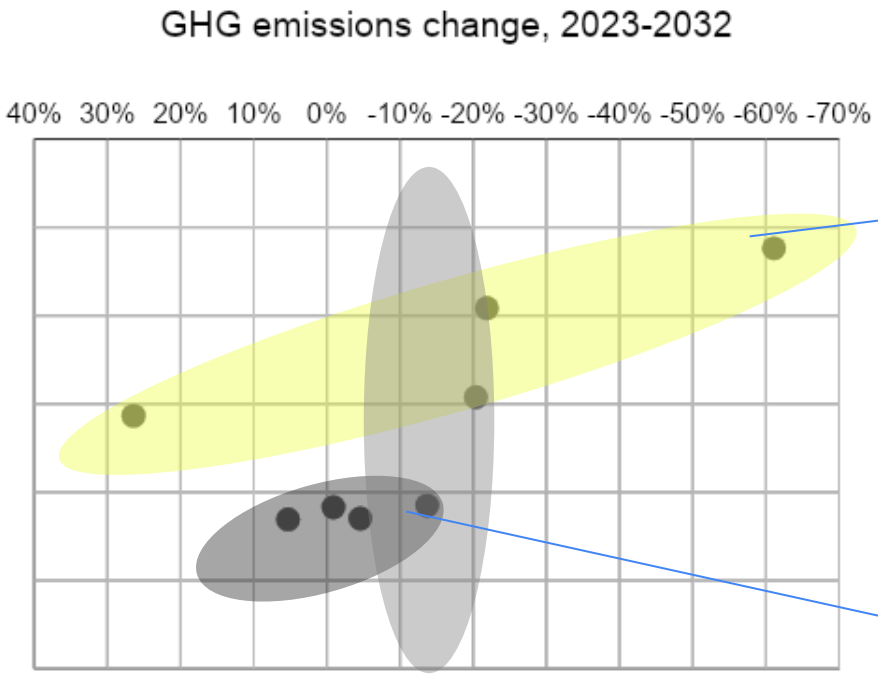




Initial observations

Slower Buildout
=
Lower risk





HHL
High swap
High buildout
Low feedback

Is this even possible?

HLL
High swap
Low buildout
Low feedback

Countervailing negative feedbacks from:
- Slowing down a factor, - Aiming for lower total PE demand

Outcome matrix

		Feedback coefficient	
		High	Low
Transition speed (convention)	High swap High buildout	Lowest emissions, but risks Low swap scenario	Not feasible
	Low swap High buildout	Emissions increase!	Low emissions
	High swap Low buildout	No change, but could lower feedback going forward?	Low emissions

Rapid

Non-rapid

Calibrating physical and social feedbacks

Zero-carbon infrastructure *buildout*

- Cost response from FF industries
- Carbon-intensive material extraction and processing requirements
- Conflict over control of material extraction sites

***Swap* fossil fuels for zero-carbon**

- Political pressure to keep FF communities whole
- Resilience, reliability, and response to disaster
- General resistance to lower energy demand / economic activity

Reduce emissions

- Conflict over control of material extraction sites
- Cleanup, management, and security of new, more diverse energy extraction infrastructure

Inertia of production rate capacity additions

- mine financing/capacity data
- construction equipment financing data

Resistance/delays to alternative energy projects

- energy mix changes vs. lawsuits
- plans/projections vs. reality

Thank you

www.jmulrow.org/degrowth-coffee-hour