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Pathways: Managing the complexity and uncertainty of low-carbon transition

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Pathways: Managing the complexity and uncertainty of low-carbon transitions



Outline

- Complexity and uncertainty of low-carbon transitions
- Major contributions to low-carbon pathways (emissions, energy, societal)
- Pathways as sequences of choices and implications



Pathways: An emerging concept for the theory and governance of low-carbon transitions



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ABSTRACT

The concept of “pathways” has increasingly come to frame the challenge of transitioning to low-carbon societies. It also shows promise as a bridging concept, encouraging constructive dialogue among the diverse perspectives and constituencies evoking its use. However, its interpretations and attributes are rarely explicit and have yet to be subject to serious scrutiny. This raises important questions for both theory and governance as the way in which a problem is framed shapes how it is understood and addressed, structuring the possibilities considered and privileging certain responses. Therefore, this study explores the concept of pathways in the context of low-carbon transitions, exposing its conceptions, maturation, and implications. Based on a survey of the relevant climate change mitigation literature, this analysis uncovers three core conceptions of pathways in the context of low-carbon transitions: (1) biophysical, (2) techno-economic, and (3) socio-technical. Constituted by diverse perspectives and approaches, each of these three core conceptions emphasize different yet interconnected dimensions of the decarbonization challenge. This analysis also points to several key attributes and functions of the concept of pathways. Yet, while the concept may possess a variety of features that recommend its use as a critical problem frame for low-carbon transitions, it also raises issues that suggest a need for further reflexivity. If the concept is cast too strongly in terms of individual core conceptions, there may be a tendency to emphasize certain dynamics while paying somewhat less attention to others, inadvertently diminishing the complexity of the decarbonization challenge. Beyond this, there are other facets of the concept that have to date received more limited attention, including the implications of choices at critical junctures and the evolving character of social practices. So, there is room for the concept of pathways to engage more fully with the range of complexities embodied by low-carbon transitions.



Complexity and uncertainty of low-carbon transitions

- How do we get from where we are now to a low-carbon future?

Now:

Carbon-intensive





Complexity and uncertainty of low-carbon transitions

- How do we get from where we are now to a low-carbon future?

Now:

Carbon-intensive



Future:

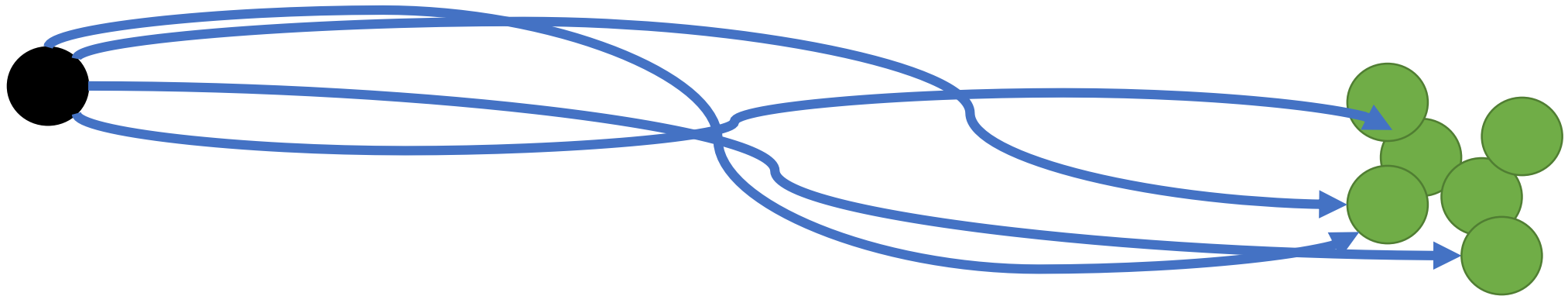
Low-carbon





Complexity and uncertainty of low-carbon transitions

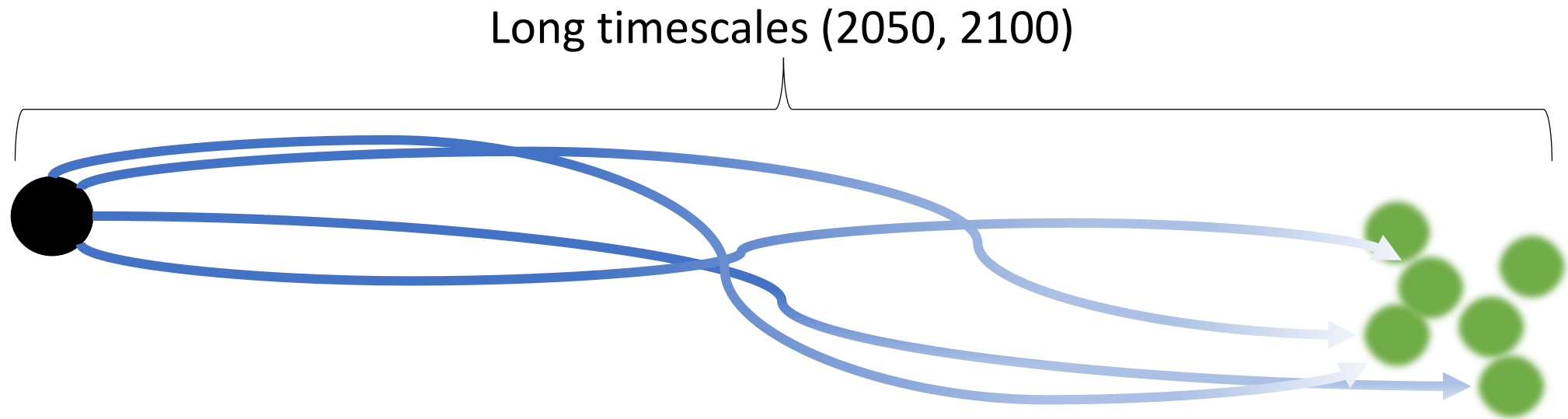
- Which potential pathways do we take to get from where we are now to different possible low-carbon futures?





Complexity and uncertainty of low-carbon transitions

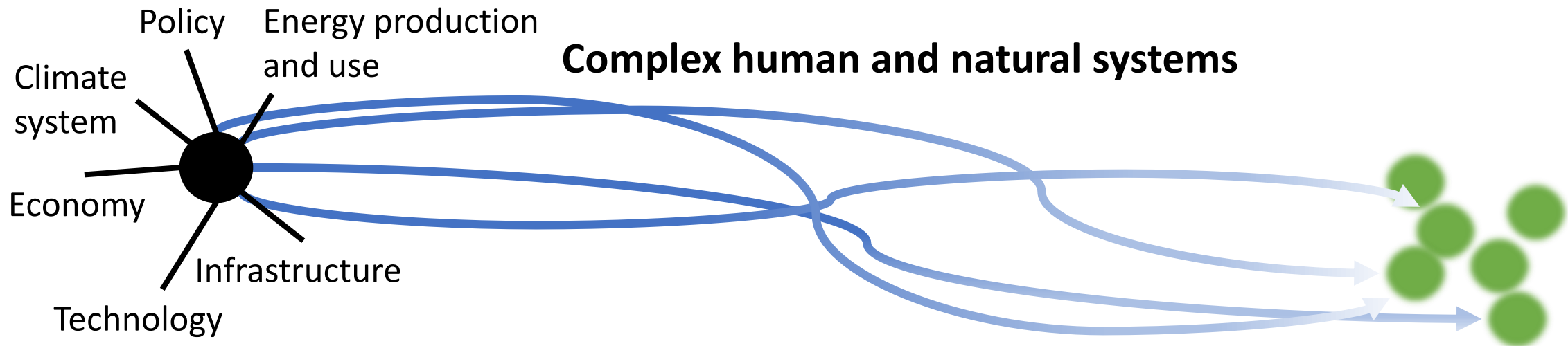
- Which potential pathways do we take to get from where we are now to different possible low-carbon futures in the context of deep complexity and uncertainty?





Complexity and uncertainty of low-carbon transitions

- Which potential pathways do we take to get from where we are now to different possible low-carbon futures in the context of deep complexity and uncertainty?





Complexity and uncertainty of low-carbon transitions: Multiple possibilities (some examples)



**Different possible temperature targets
(with diverging implications)...**



Complexity and uncertainty of low-carbon transitions: Multiple possibilities (some examples)

Nuclear renewal



Coal w/ CCS



Distributed Solar PV



...electricity options...



Complexity and uncertainty of low-carbon transitions: Multiple possibilities (some examples)



Electric mass transit



Self driving EV



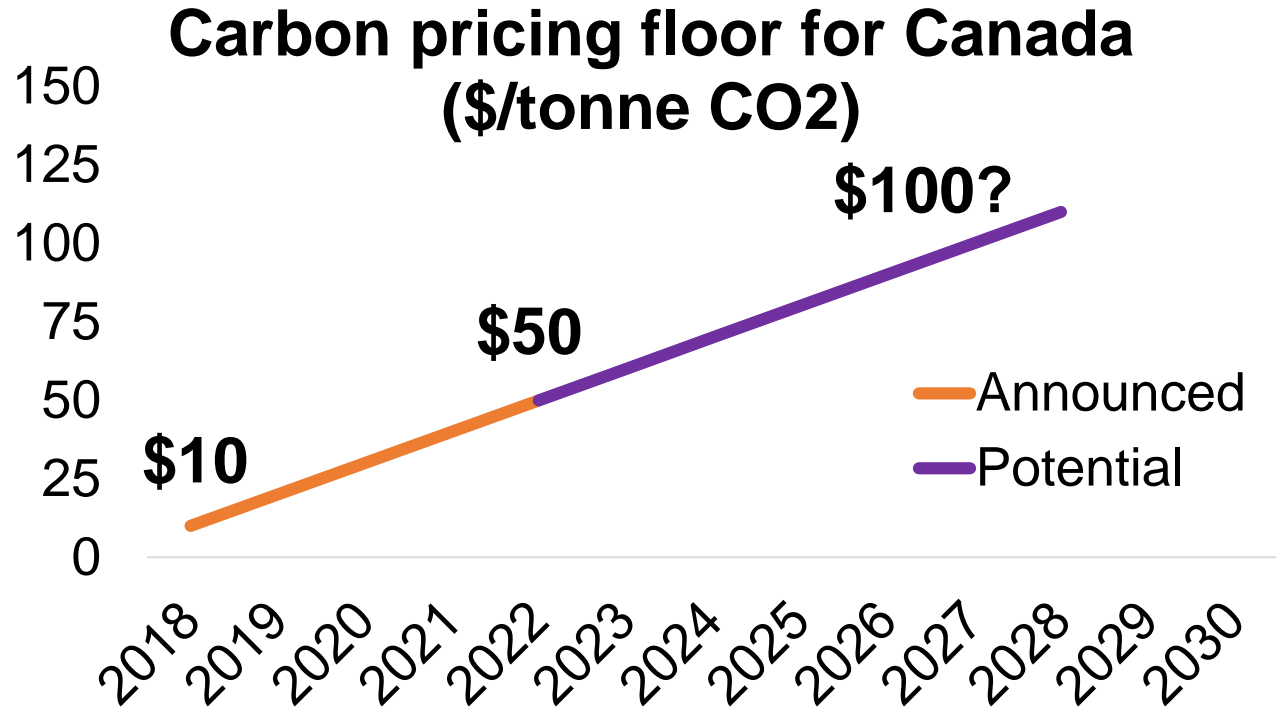
Human powered

...transport modalities...



Complexity and uncertainty of low-carbon transitions: Multiple possibilities (some examples)

Market mechanisms



Regulatory approaches

Coal phase out



...policy frameworks, etc...



Complexity and uncertainty of low-carbon transitions

- In pursuing low-carbon transitions, decision-makers face:
 - Complex and interdependent human and environmental systems
 - Long timescales and uncertain futures
 - Multiple and layered possibilities



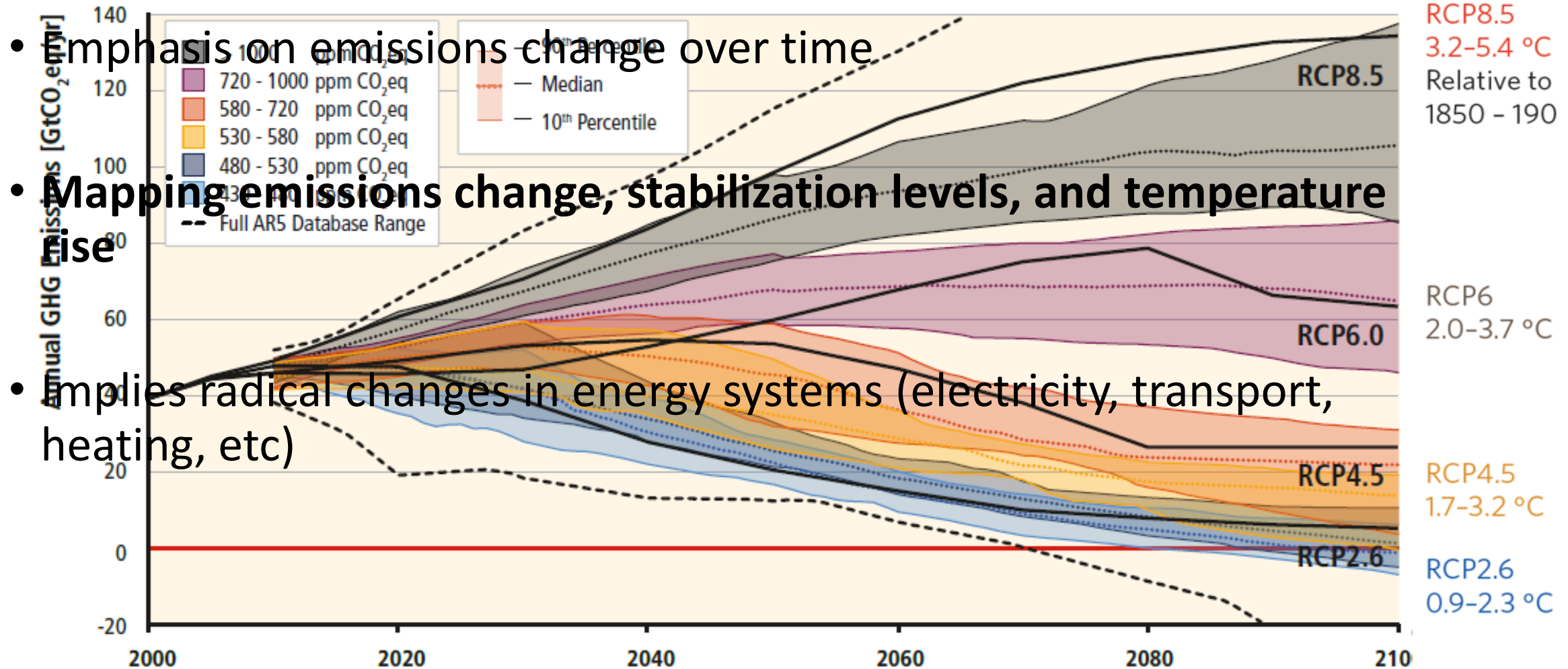
Low-carbon pathways

- **Low-carbon “pathways”** have attracted increasing attention as a way to manage complexity and consider possible courses of action in the face of deep uncertainties
- Three main types: emissions pathways, energy pathways, and societal pathways
- Major contributions: IPCC representative concentration pathways, Deep Decarbonization pathways, IEA energy pathways, socio-technical transition pathways, etc



Low-carbon pathways: Emissions pathways

GHG Emission Pathways 2000-2100: All AR5 Scenarios

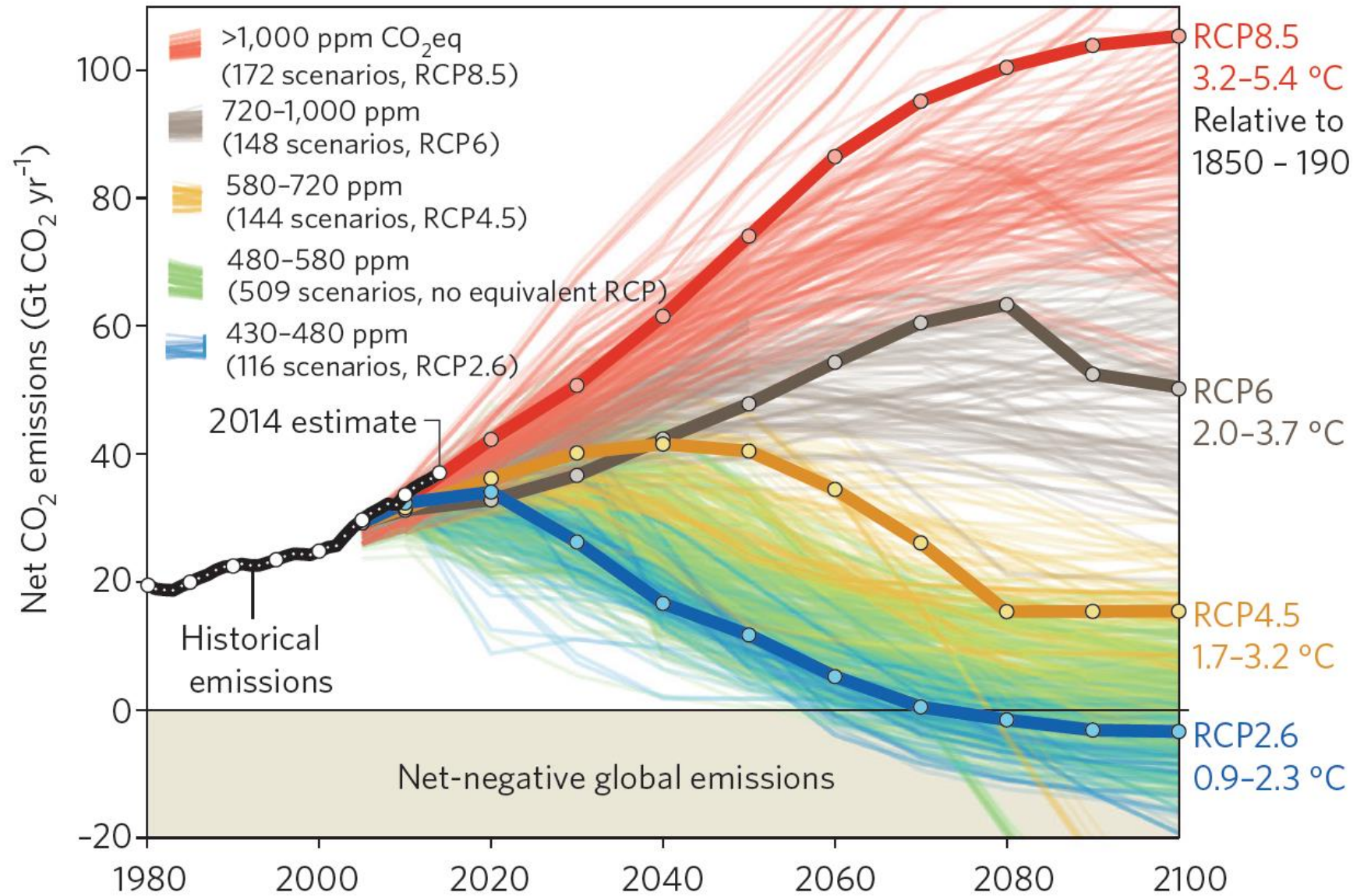


- Emphasis on emissions change over time
- Mapping emissions change, stabilization levels, and temperature rise
- Implies radical changes in energy systems (electricity, transport, heating, etc)



Low-carbon pathways: Emissions pathways

- Primary indicator
- Tracking RCP8.5



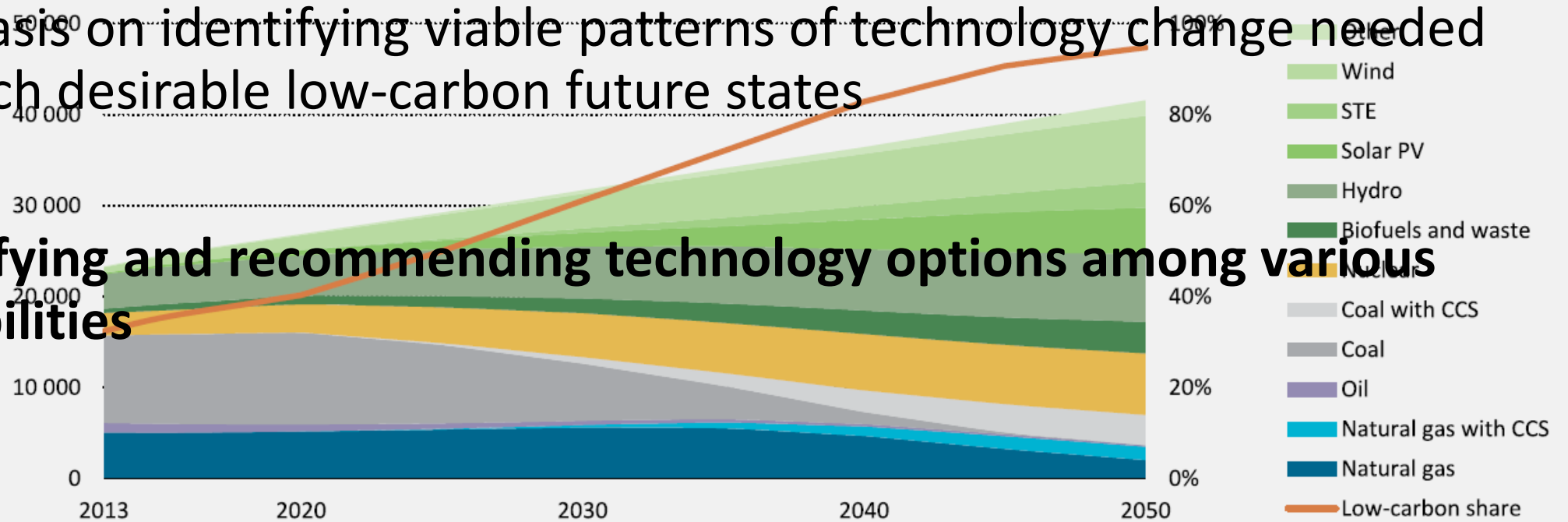
Low-carbon pathways: Energy pathways

Figure 1.7

Global electricity generation mix in the 2DS, 2013-50

- Emphasis on identifying viable patterns of technology change needed to reach desirable low-carbon future states

- Identifying and recommending technology options among various possibilities



Notes: STE = solar thermal electricity. Low-carbon share refers to the combined share of the generation of electricity from renewables, nuclear and CCS.
Source: IEA analysis and IEA (2015f), *World Energy Statistics and Balances*, www.iea.org/statistics.

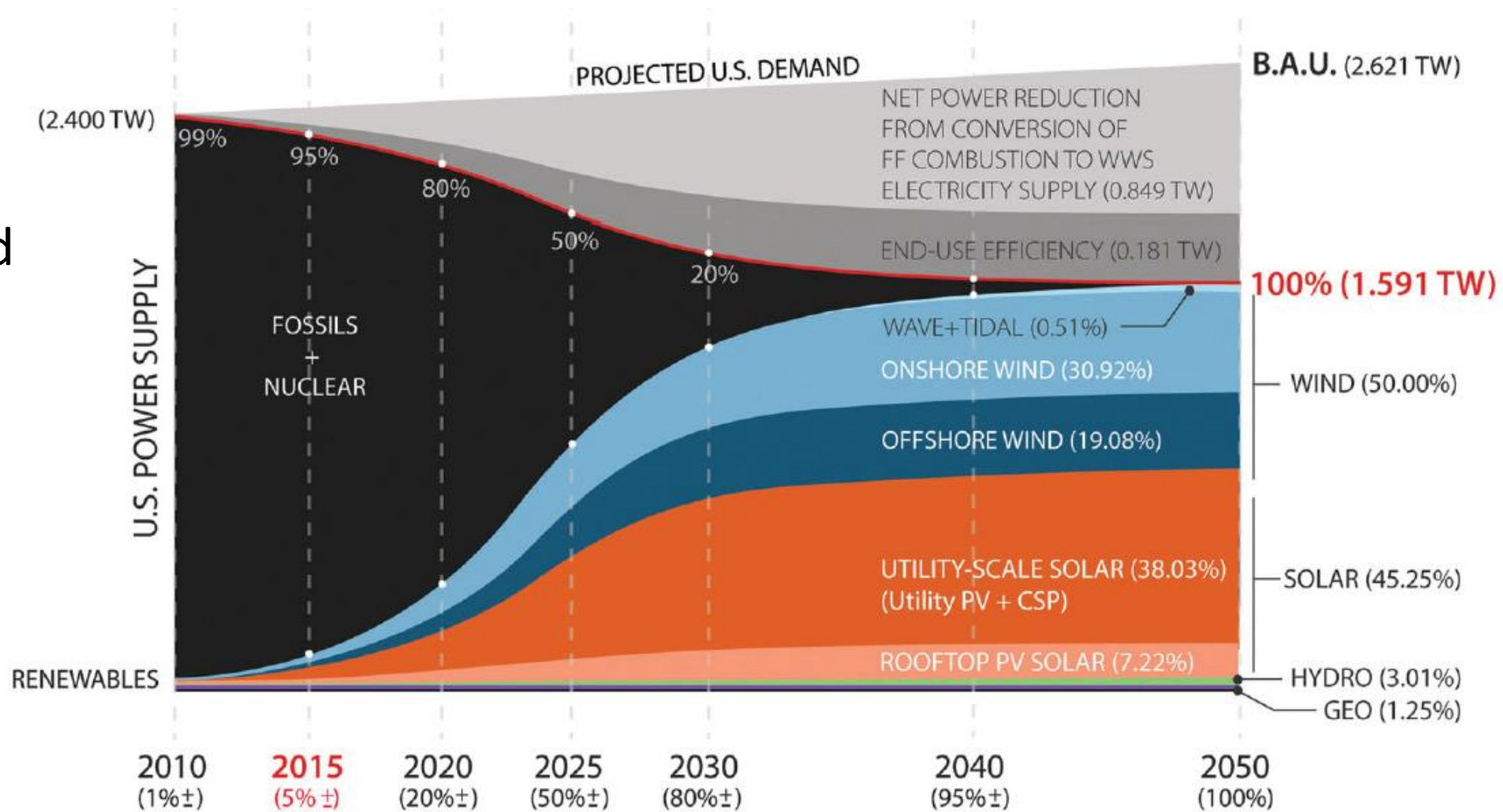
Key point

Today fossil fuels dominate electricity generation with 68% of the generation mix; by 2050 in the 2DS, renewables reach a similar share of 67%.



Low-carbon pathways: Energy pathways

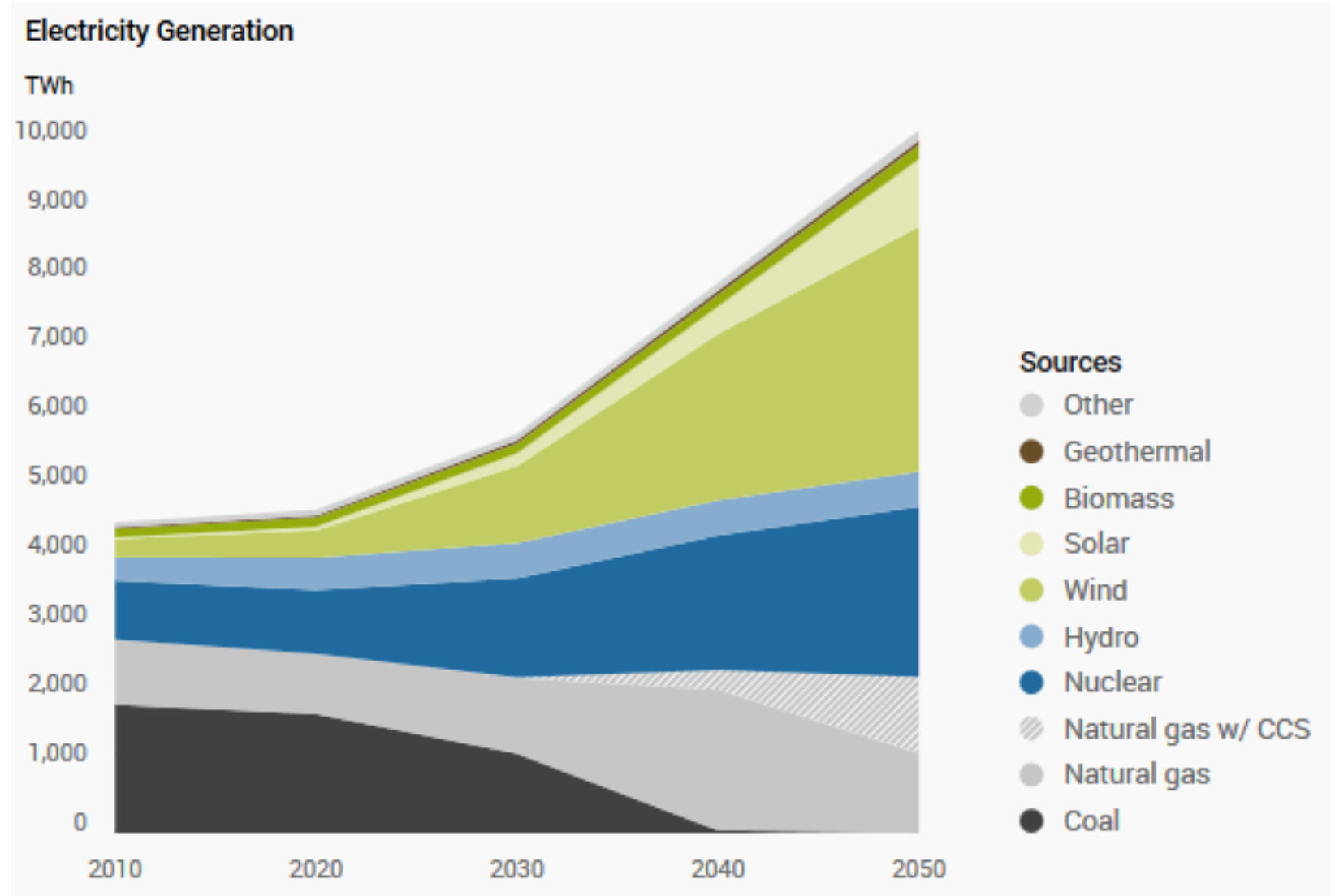
- Possible US electricity pathway based on wind, water, and solar





Low-carbon pathways: Energy pathways

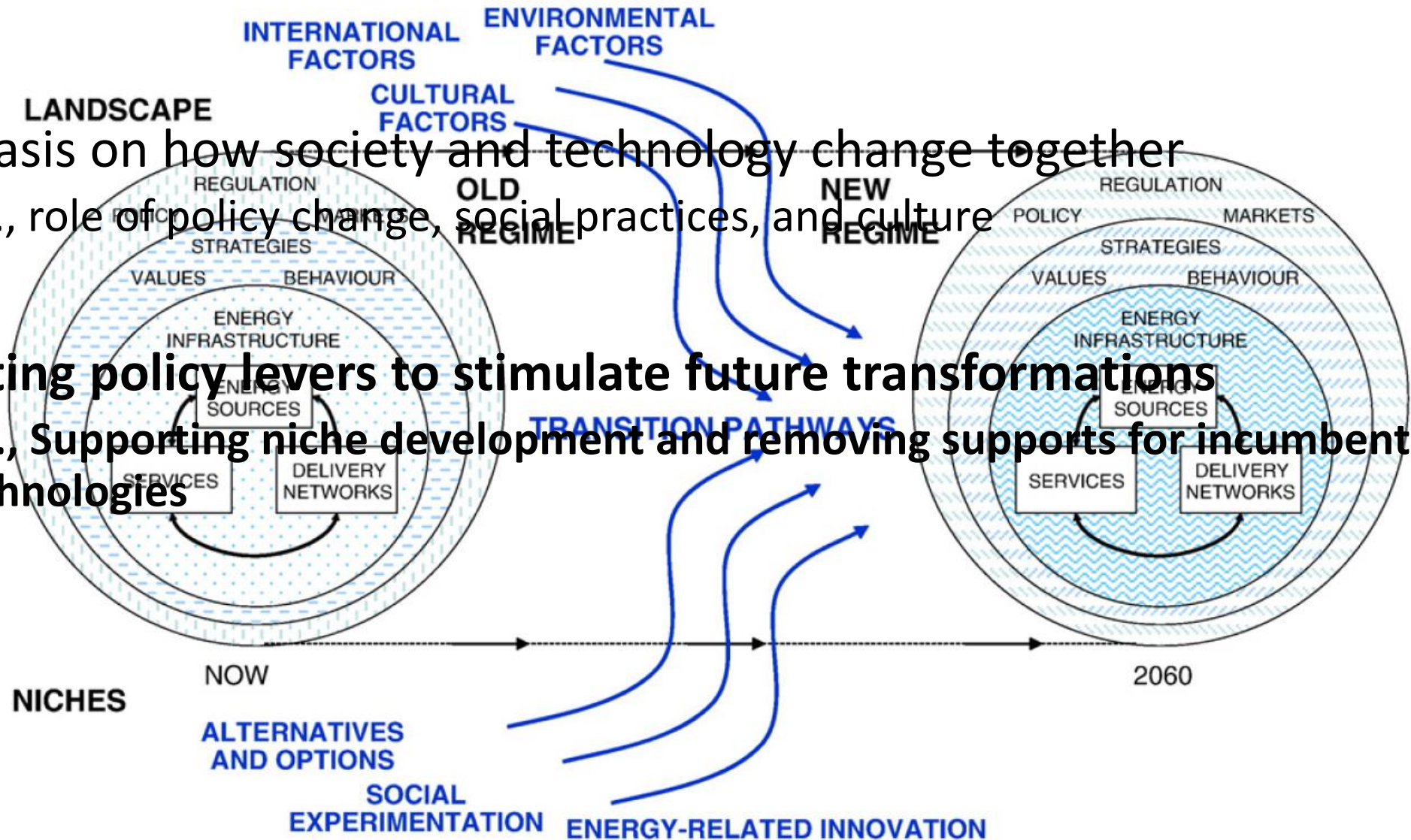
- Possible US electricity pathway based on mixed technological preferences





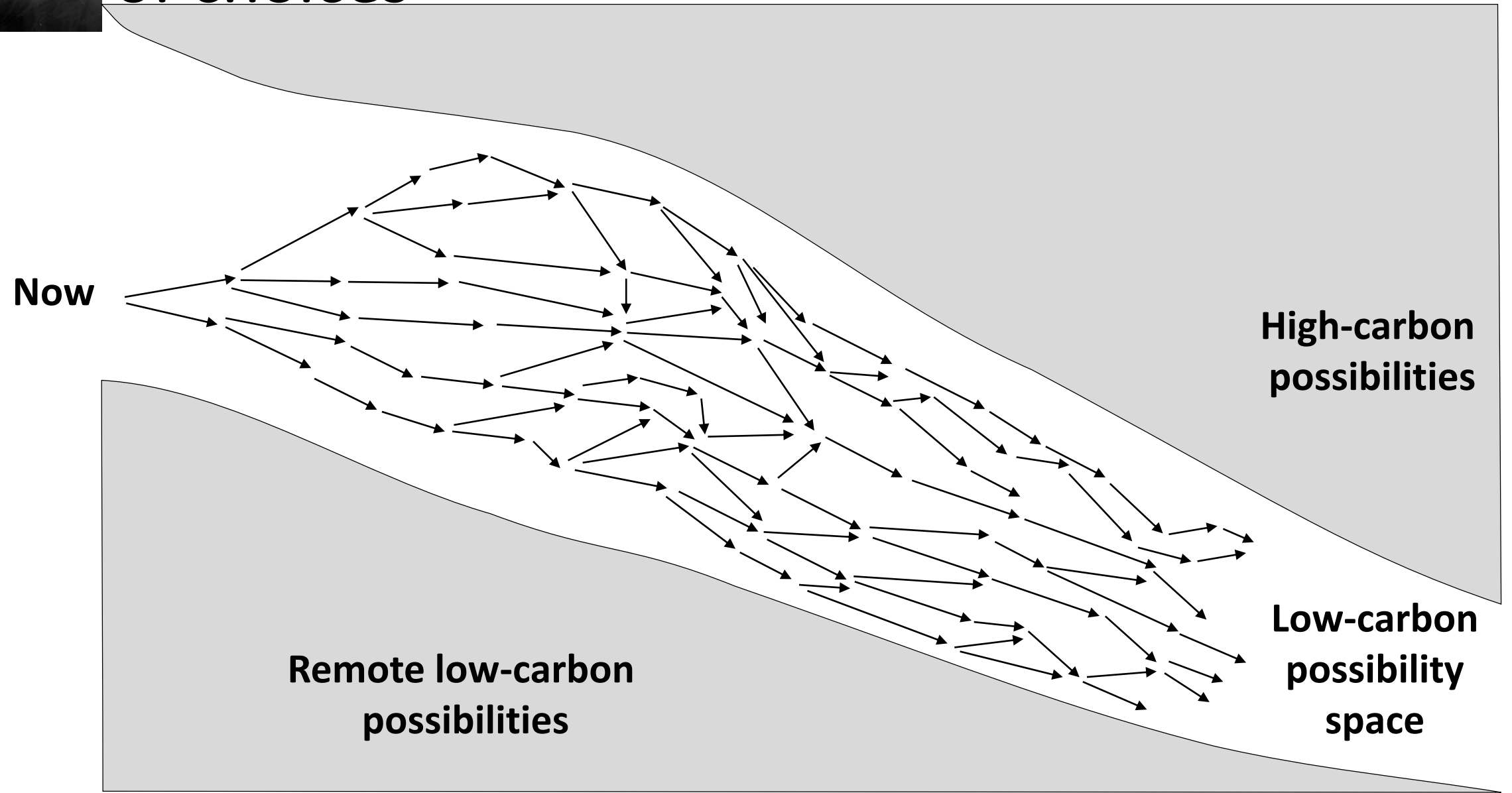
Low-carbon pathways: Societal pathways

- Emphasis on how society and technology change together
 - E.g., role of policy change, social practices, and culture
- Targeting policy levers to stimulate future transformations
 - E.g., Supporting niche development and removing supports for incumbent technologies





Low-carbon pathways are about **sequences of choices**



Now

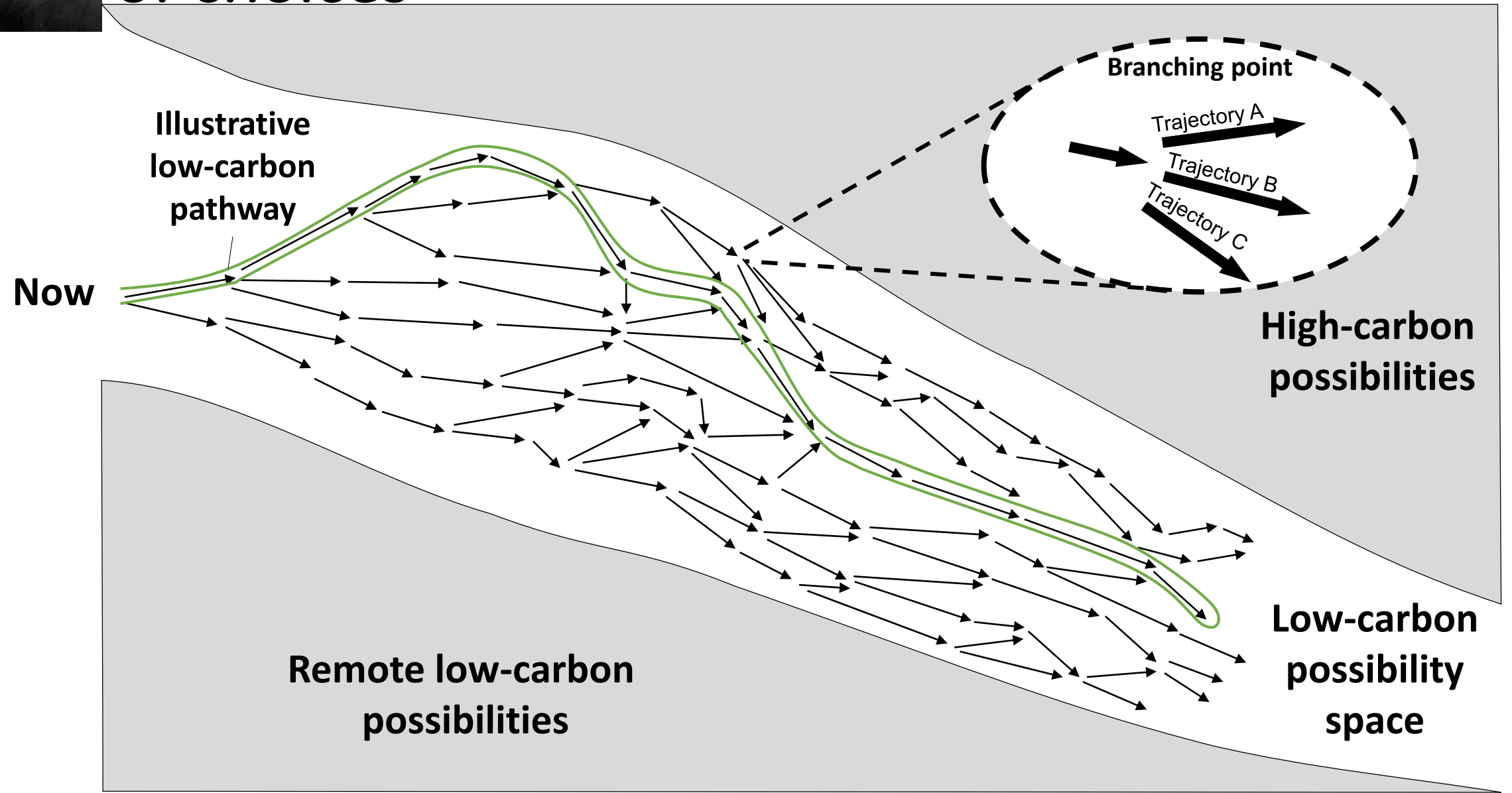
High-carbon possibilities

Remote low-carbon possibilities

Low-carbon possibility space



Low-carbon pathways are about **sequences of choices**





Low-carbon pathways are about choices

Branching point in Ontario's electric power system

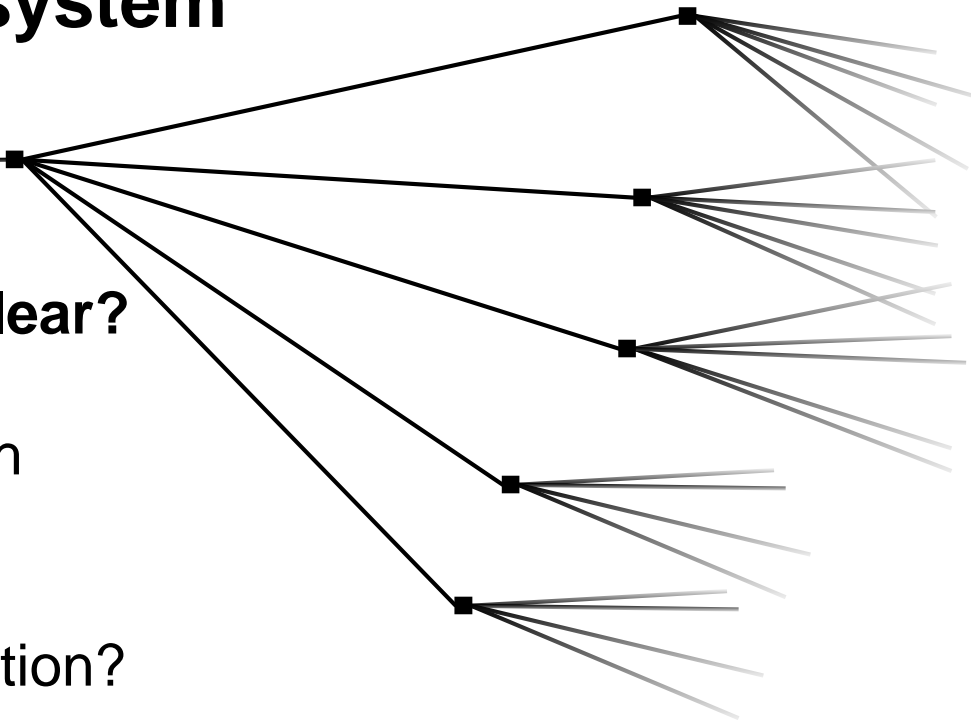
Choices:

-Recommit to nuclear?

-Ramp up trade with
Quebec?

-Promote electrification?

-And many others



Supports
Canada's
nuclear
industry

Reinforces
established
structures

Crowds out other
options (e.g.,
conservation and
efficiency)

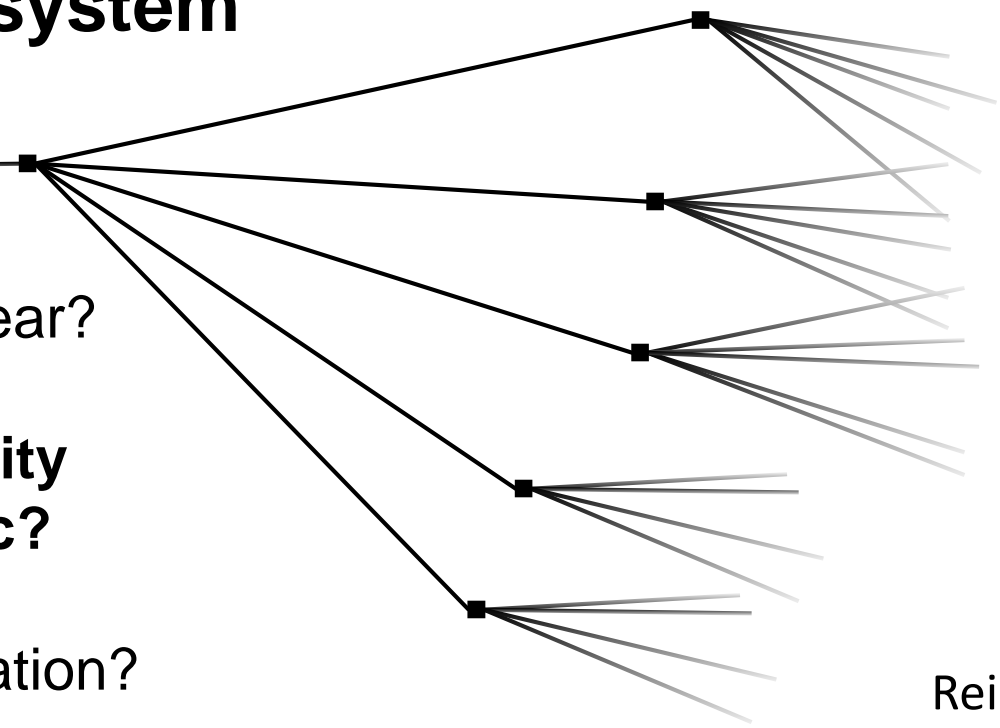


Low-carbon pathways are about choices

Branching point in Ontario's electric power system

Choices:

- Recommit to nuclear?
- Ramp up electricity trade with Quebec?
- Promote electrification?
- And many others



Undermines domestic electricity interests

Expanded role for interconnections and cooperation



Reinforces centralized structure

Navigating public acceptance around new infrastructure



Low-carbon pathways are about choices

Branching point in Ontario's electric power system

Choices:

- Recommit to nuclear?
- Ramp up trade with Quebec?
- Promote electrification?
- And many others

Fundamental
challenge to fossil
fuel interests

Reinforces
personal transport
modality

Supports auto
manufacturers

Could enable
nuclear or new
renewables





Thank you for your attention

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