Defining energy transitions

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- What is an energy transition?
  - Change in fuel supply?
  - Shift in technologies that exploit fuel, e.g. prime movers end use devices?
  - Switch from an economic or regulatory system (e.g. Cuba)?
  - Time taken for socio-technical diffusion?
  - At what scale?

Table 1
Five definitions of energy transitions.

Definition	Source
A change in fuels (e.g., from wood to coal or coal to oil) and their associated technologies (e.g., from steam engines to internal combustion engines)	Hirsh and Jones [22]
Shifts in the fuel source for energy production and the technologies used to exploit that fuel	Miller et al. [23]
A particularly significant set of changes to the patterns of energy use in a society, potentially affecting resources, carriers, converters, and services	O'Connor [24]
The switch from an economic system dependent on one or a series of energy sources and technologies to another	Fouquet and Pearson [25]
The time that elapses between the introduction of a new primary energy source, or prime mover, and its rise to claiming a substantial share of the overall market	Smil [26]

Source: Sovacool, BK. "How Long Will it Take? Conceptualizing the Temporal Dynamics of Energy Transitions," *Energy Research & Social Science* 13 (March, 2016), pp. 202-215.

Temporality and energy transitions

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- *"Energy transitions have been, and will continue to be, inherently prolonged affairs, particularly so in large nations whose high levels of per capita energy use and whose massive and expensive infrastructures make it impossible to greatly accelerate their progress even if we were to resort to some highly effective interventions …"*

Table 2
The differences in timing and speed of energy transitions in Europe.

Phase-out traditional renewables phase-in coal:		Diffusion midpoint	Diffusion speed
Core	England	1736	160
Rim	Germany	1857	102
	France	1870	107
	Netherlands	1873	105
Periphery	Spain	1919	111
	Sweden	1922	96
	Italy	1919	98
	Portugal	1949	135
Phase-out coal phase-in oil/gas/electricity:			
Core	Portugal	1966	47
	Italy	1960	65
	Sweden	1963	67
Rim	Spain	1975	69
	Netherlands	1962	62
	France	1972	65
Periphery	Germany	1984	50
	England	1979	67

Source: Sovacool, BK. "How Long Will it Take? Conceptualizing the Temporal Dynamics of Energy Transitions," *Energy Research & Social Science* 13 (March, 2016), pp. 202-215.

Temporality and energy transitions

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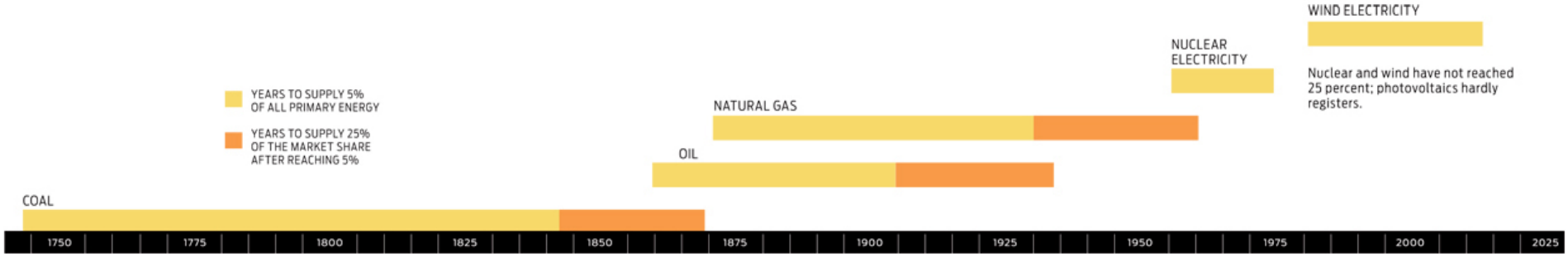

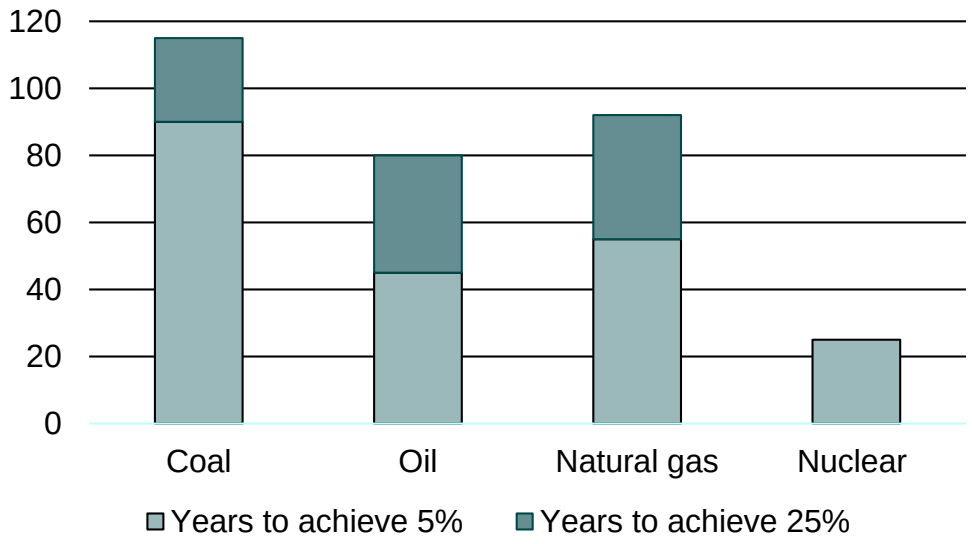

Rethinking transitions: towards acceleration?

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- We have seen at least five fast transitions in terms of energy end-use and prime movers
- Examples of many rapid national-scale transitions in energy supply also populate the historical record

Table 4
Overview of rapid energy transitions.

Country	Technology/fuel	Market or sector	Period of transition	Number of years from 1 to 25% market share	Approximate size (population affected in millions of people)
Sweden	Energy-efficient ballasts	Commercial buildings	1991–2000	7	2.3
China	Improved cookstoves	Rural households	1983–1998	8	592
Indonesia	Liquefied petroleum gas stoves	Urban and rural households	2007–2010	3	216
Brazil	Flex-fuel vehicles	New automobile sales	2004–2009	1	2
United States	Air conditioning	Urban and rural households	1947–1970	16	52.8
Kuwait	Crude oil and electricity	National energy supply	1946–1955	2	0.28
Netherlands	Natural gas	National energy supply	1959–1971	10	11.5
France	Nuclear electricity	Electricity	1974–1982	11	72.8
Denmark	Combined heat and power	Electricity and heating	1976–1981	3	5.1
Canada (Ontario)[a]	Coal	Electricity	2003–2014	11	13

[a] The Ontario case study is the inverse, showing how quickly a province went from 25% coal supply to zero.

Source: Sovacool, BK. "How Long Will it Take? Conceptualizing the Temporal Dynamics of Energy Transitions," *Energy Research & Social Science* 13 (March, 2016), pp. 202-215.

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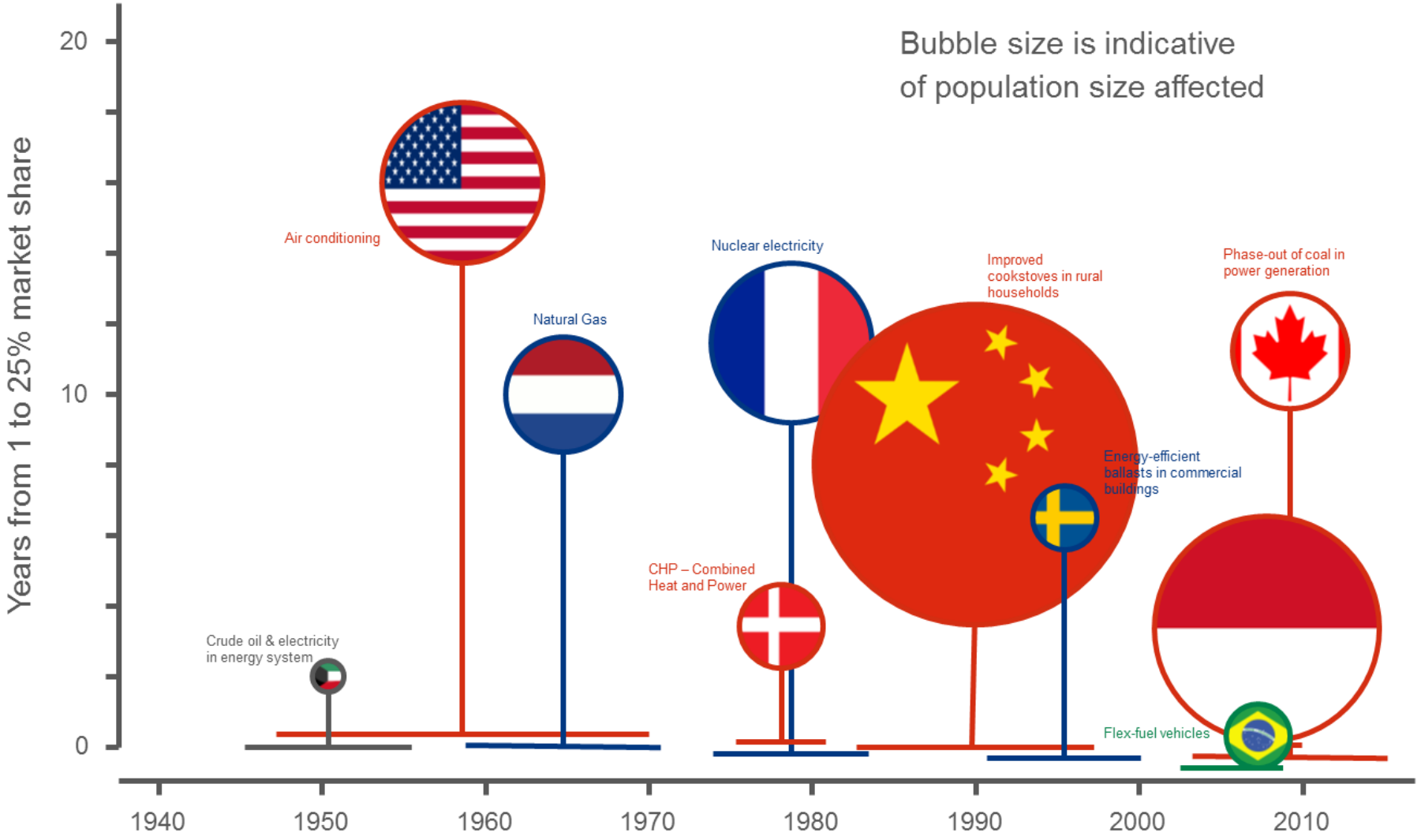

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