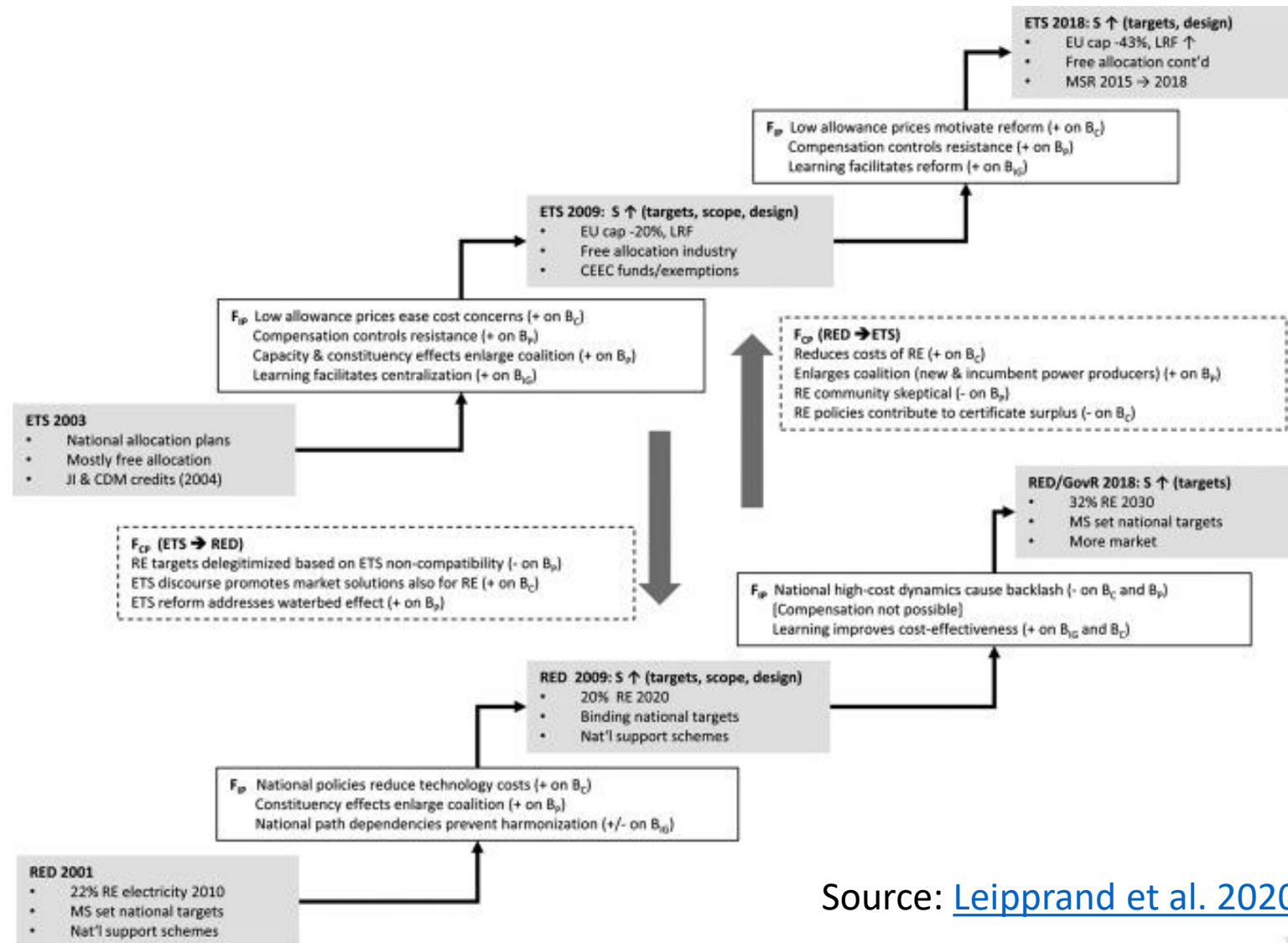


# Renewable energy in the systems perspective

# Case study: Policy sequencing



Source: [Leipprand et al. 2020](#)

- **Synergies?** (positive feedback)
  - RE enables actors to decrease ETS costs
  - Enlarged coalitions (eventually)
- **Conflicts?** (negative feedback)
  - RE increases certificates surplus
  - Both communities initially skeptical

# Systems perspective

*What is a system?*

# Systems perspective

**System components**

**Understanding a system**

**Acting upon a system**

---

Function or purpose

System levers

System levers

---

System boundaries

Unintended consequences

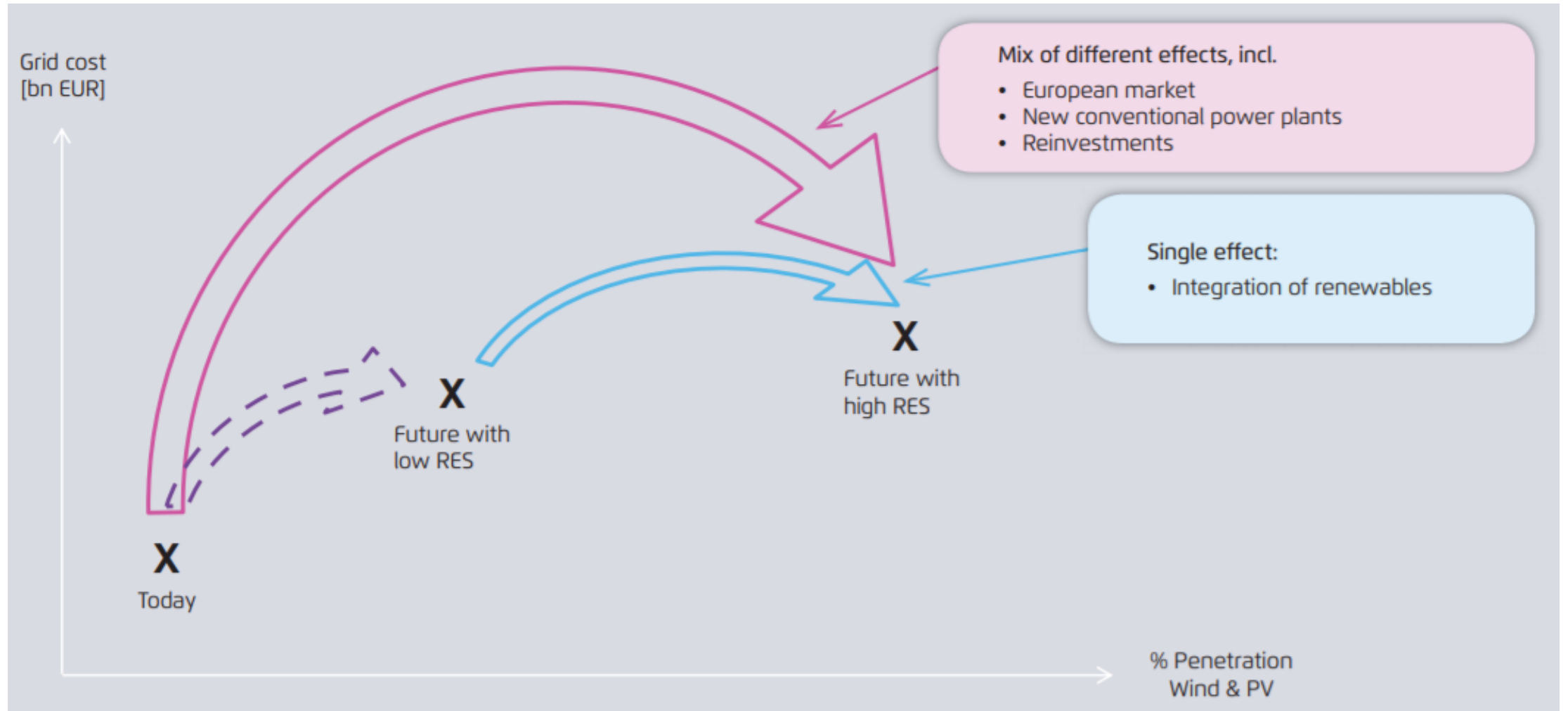
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Parts

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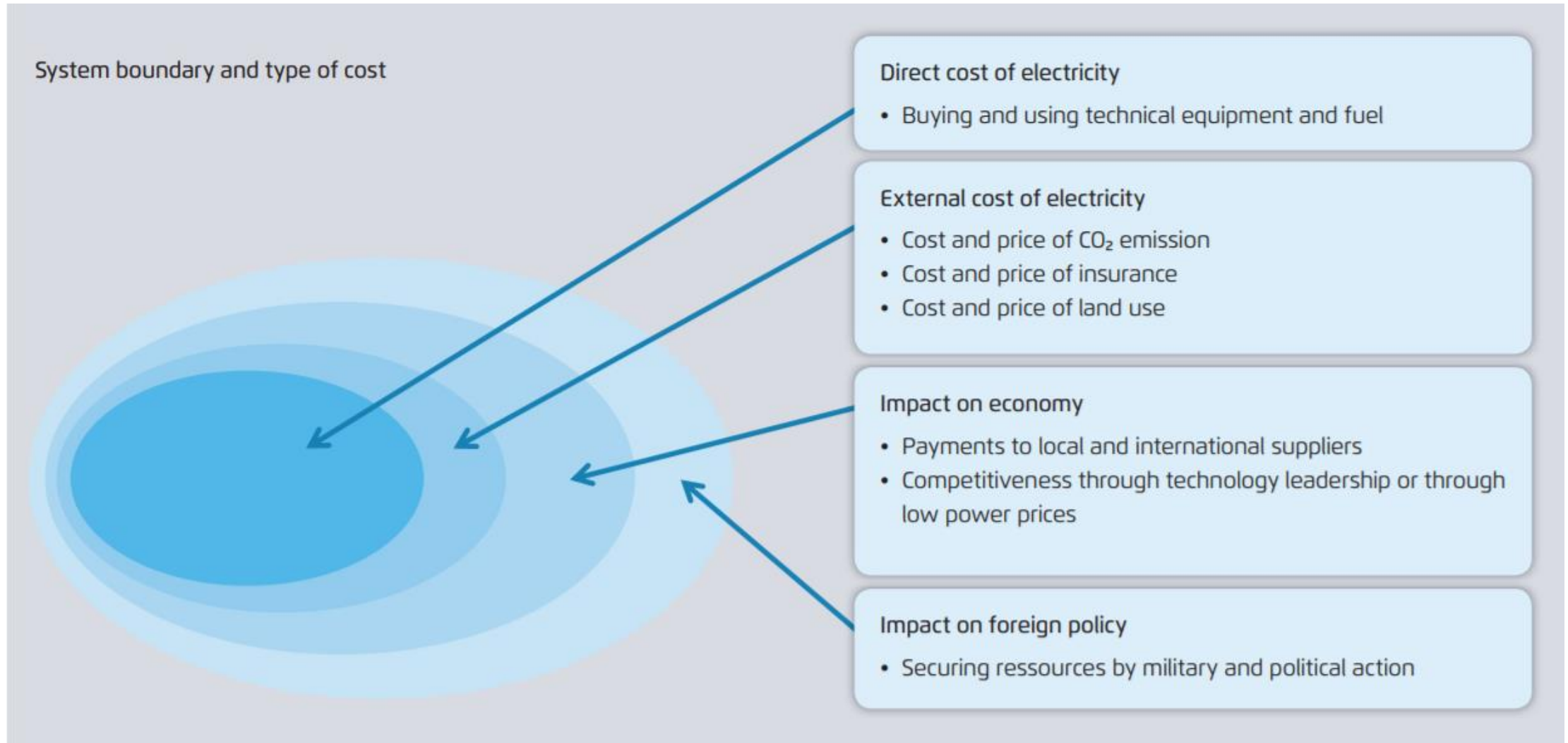
Interactions

# Unintended effects

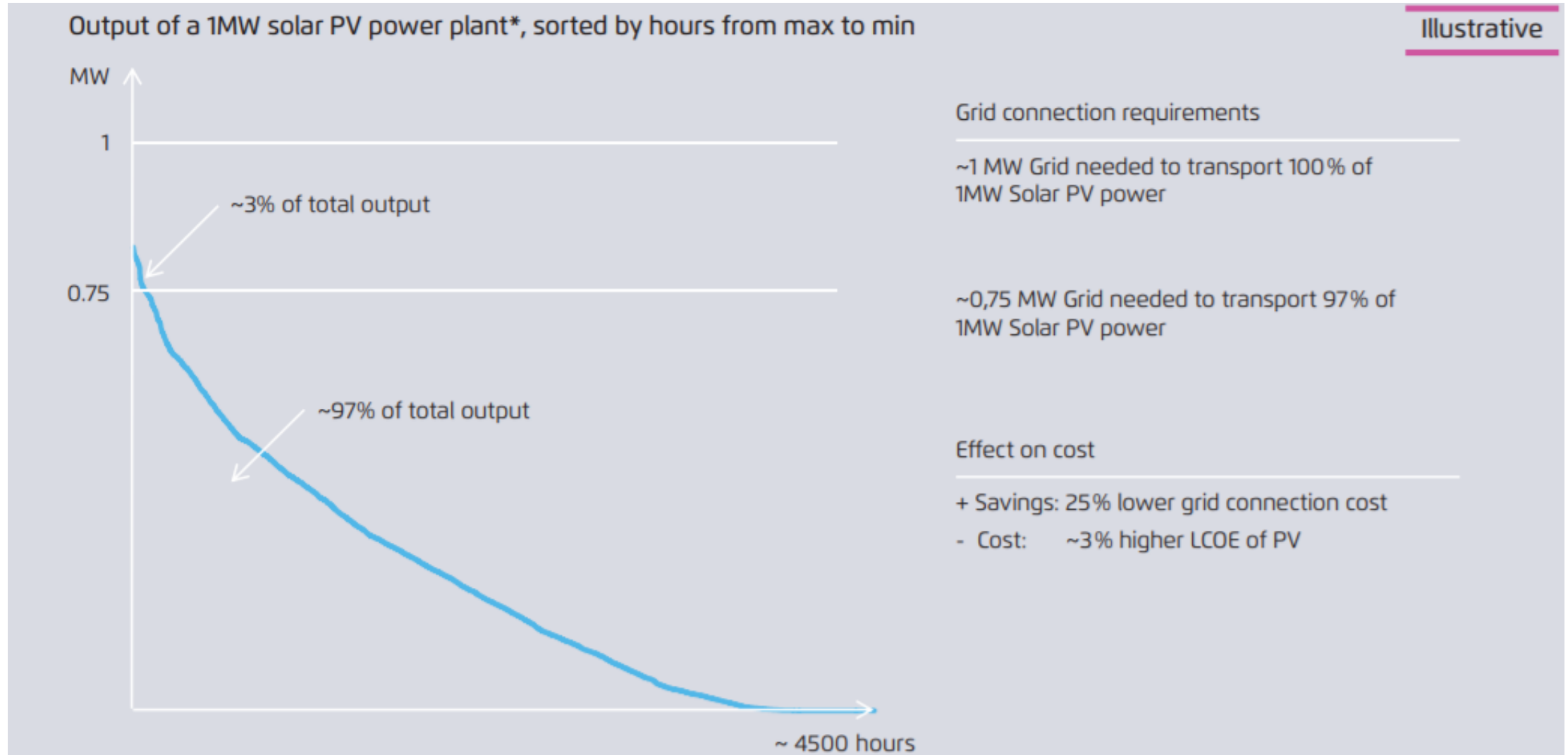


Source: [Agora EW](#)

# Defining system boundaries (costs perspective)

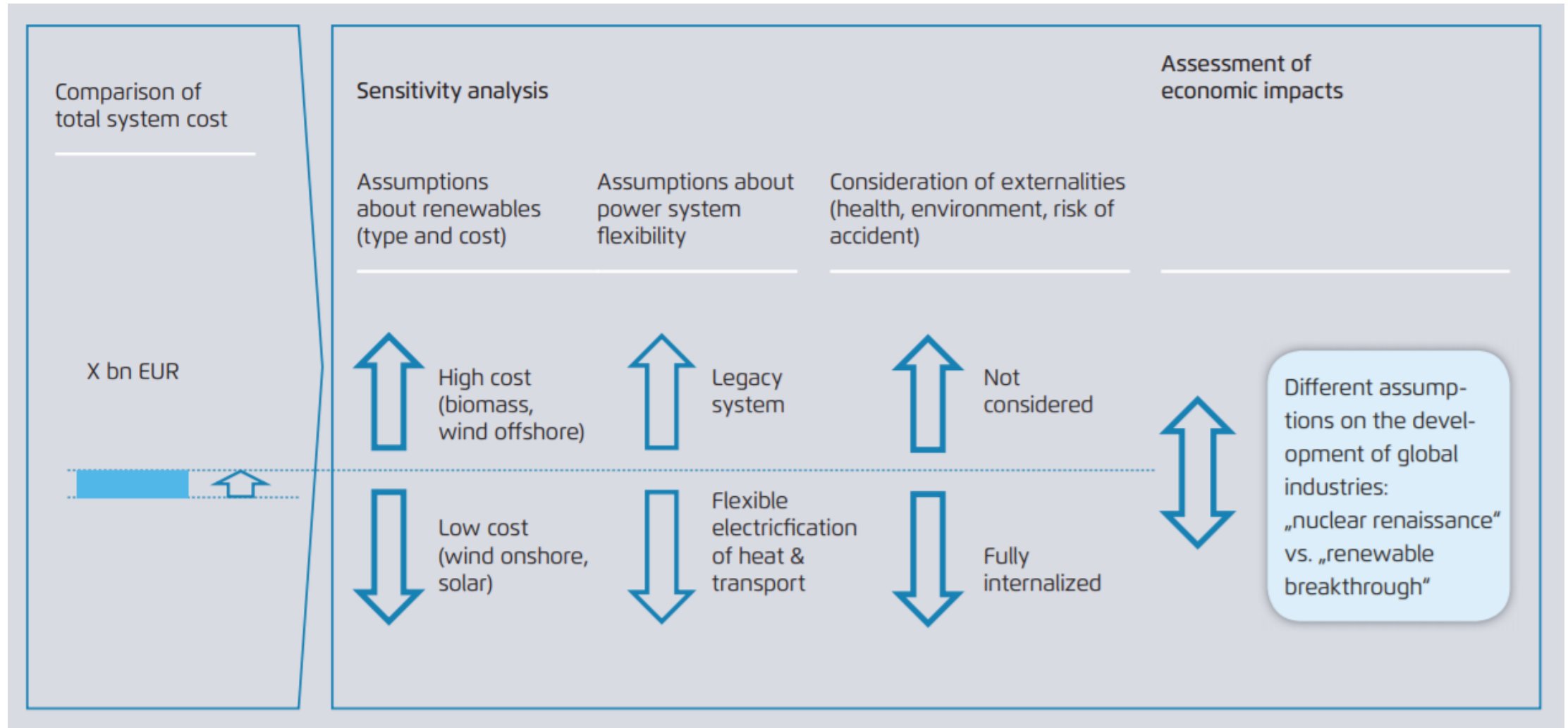


# Defining system boundaries (costs perspective)



Source: [Agora EW](#)

# Defining system boundaries (costs perspective)





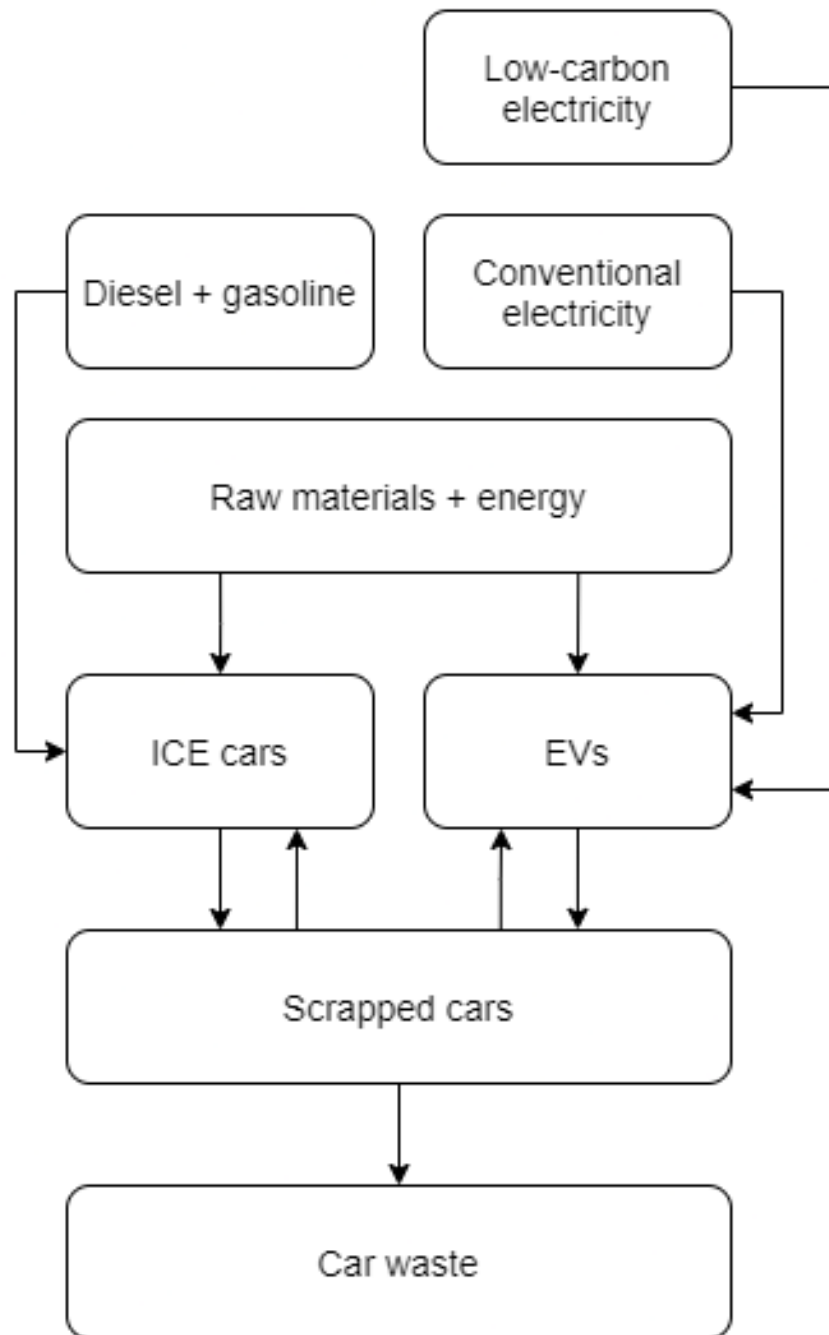
# System levers

= system characteristics

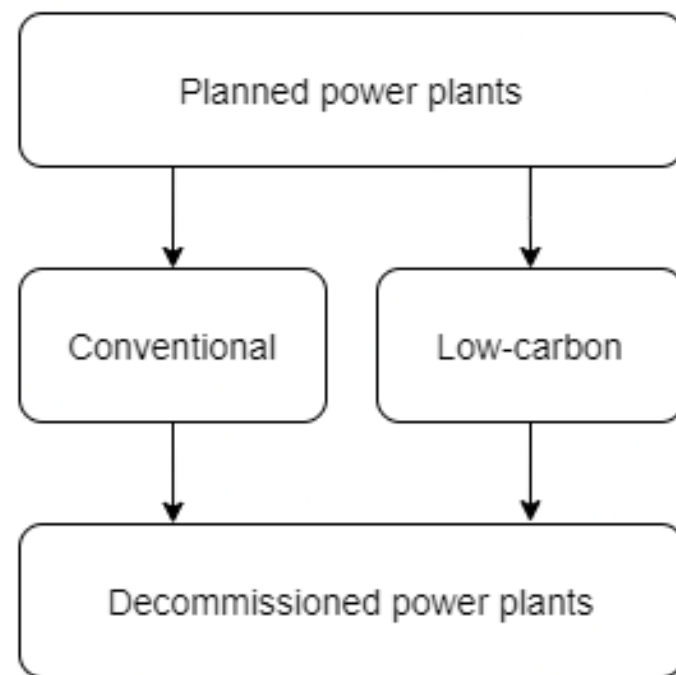
= points of intervention to a system

- Numbers and events
- Stocks and flows
- Feedback loops
- Rules
- Goal(s)
- Mindset

Stocks and flows in individual car transport

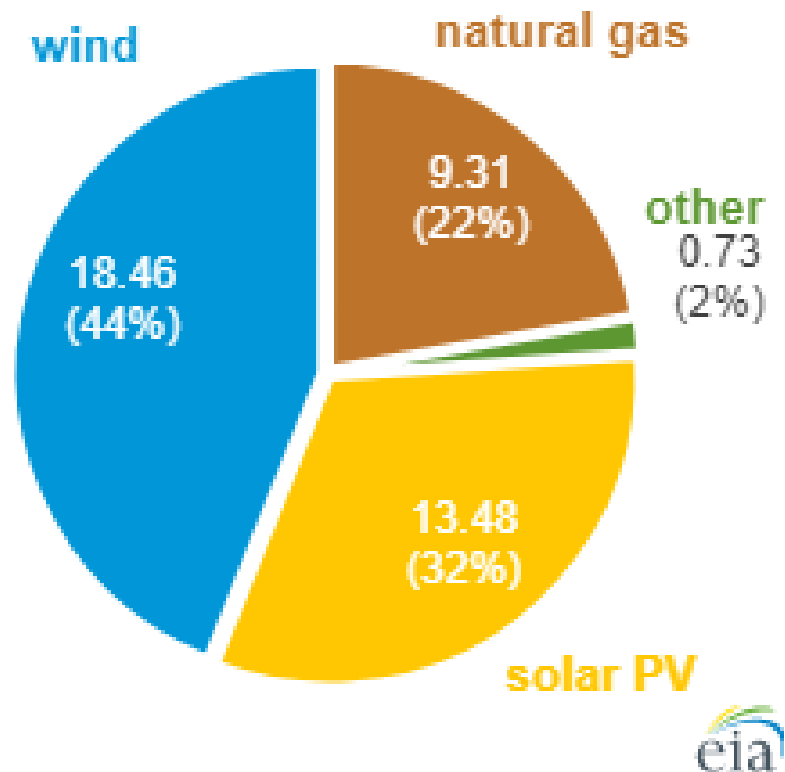


Stocks and flows in the power plant population

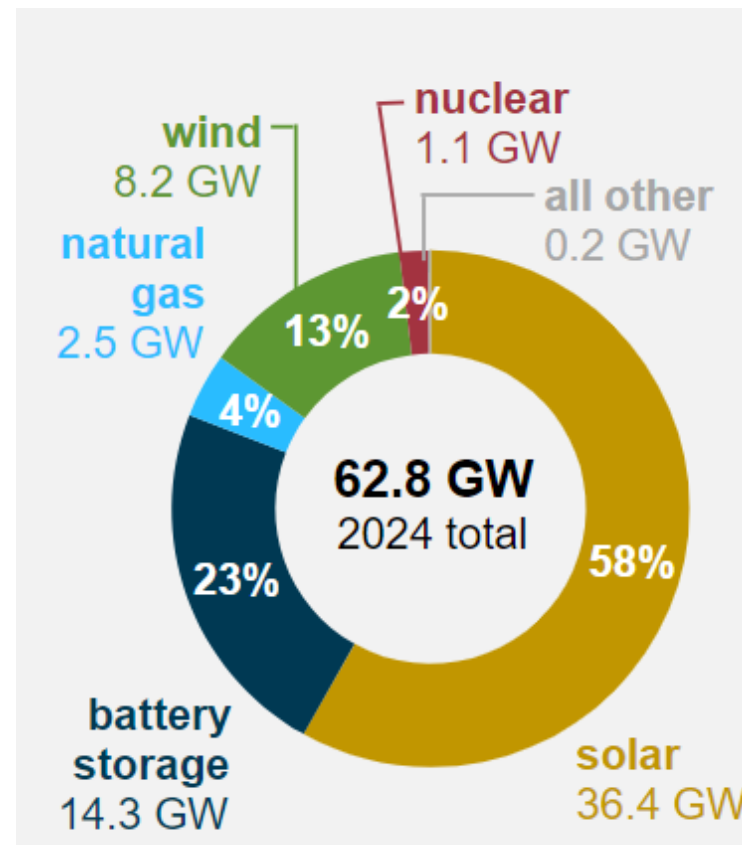


# Stocks and flows, delays

## New capacity (USA, GW, 2020)



## New capacity (USA, GW, 2024)



# Feedback loops

Reinforcing (positive)

$A \Rightarrow A \ggg B \Rightarrow B \ggg A \Rightarrow A \ggg B \Rightarrow B$

Balancing (negative)

$A \Rightarrow A \ggg B \Rightarrow B \ggg A \Rightarrow A \ggg B \Rightarrow B$

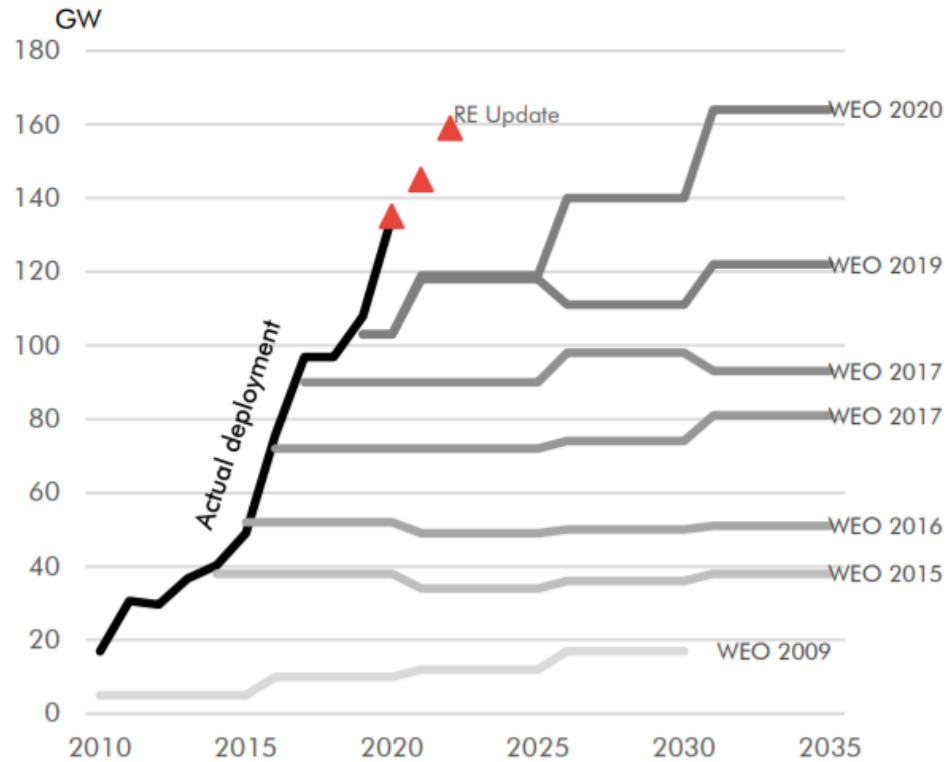
# Feedback loops

*What are the feedback loops associated with renewable energy deployment?*

*Which are positive and which negative?*

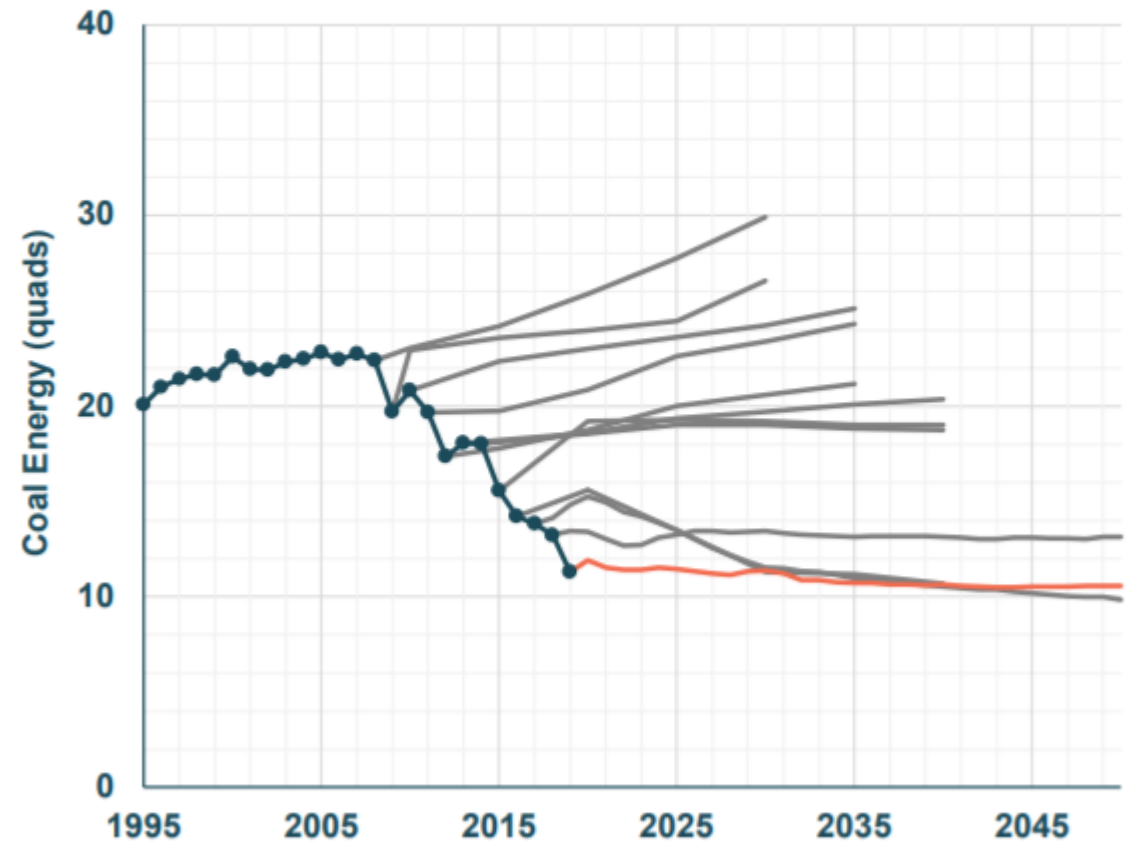
# Where next? The transition feedback loops

## 3.1 IEA FORECASTS OF SOLAR DEPLOYMENT



Source: Carbon Brief; Notes: projections represent the IEA's Stated Policies Scenarios (STEPS) taken from the World Energy Outlook (WEO); RE Update from the IEA's Renewable Energy Market Update<sup>30</sup>

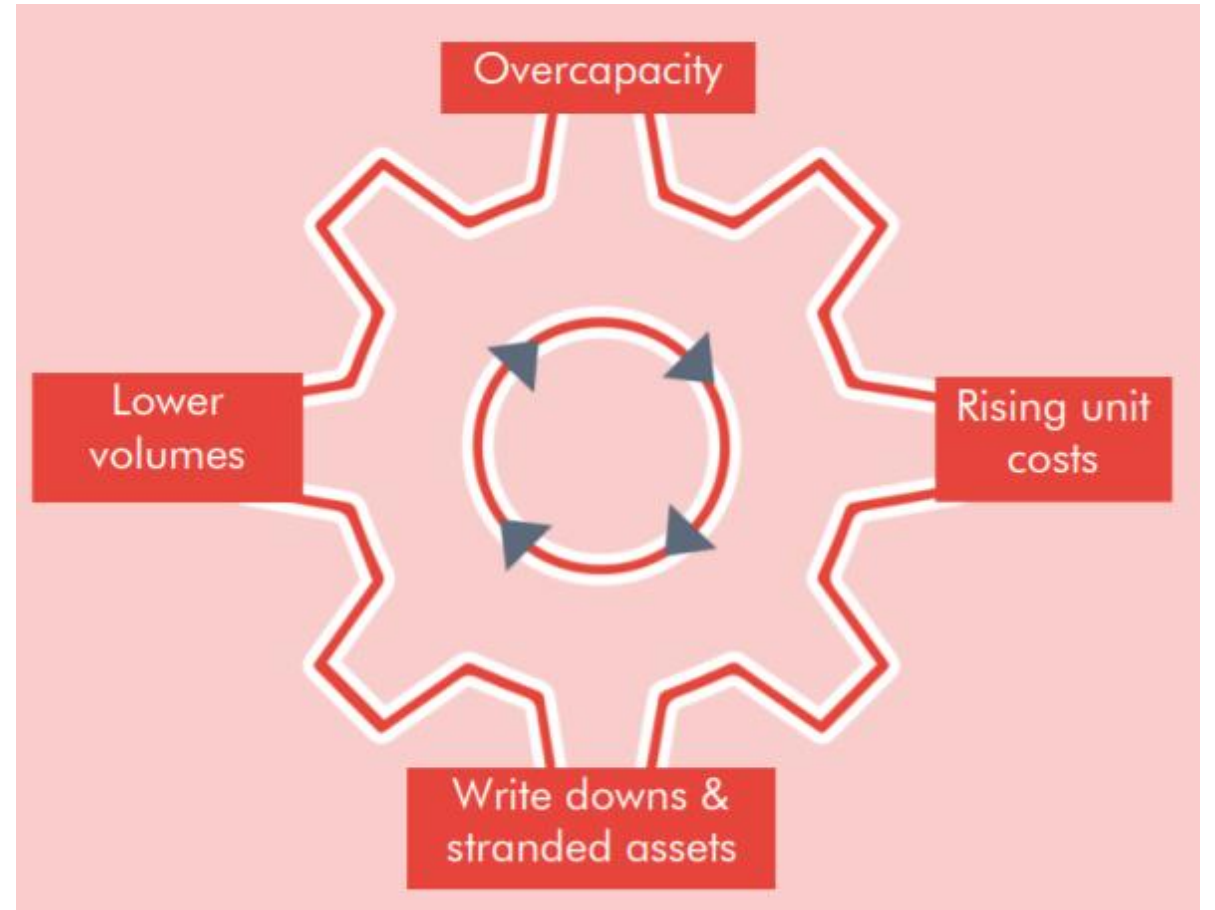
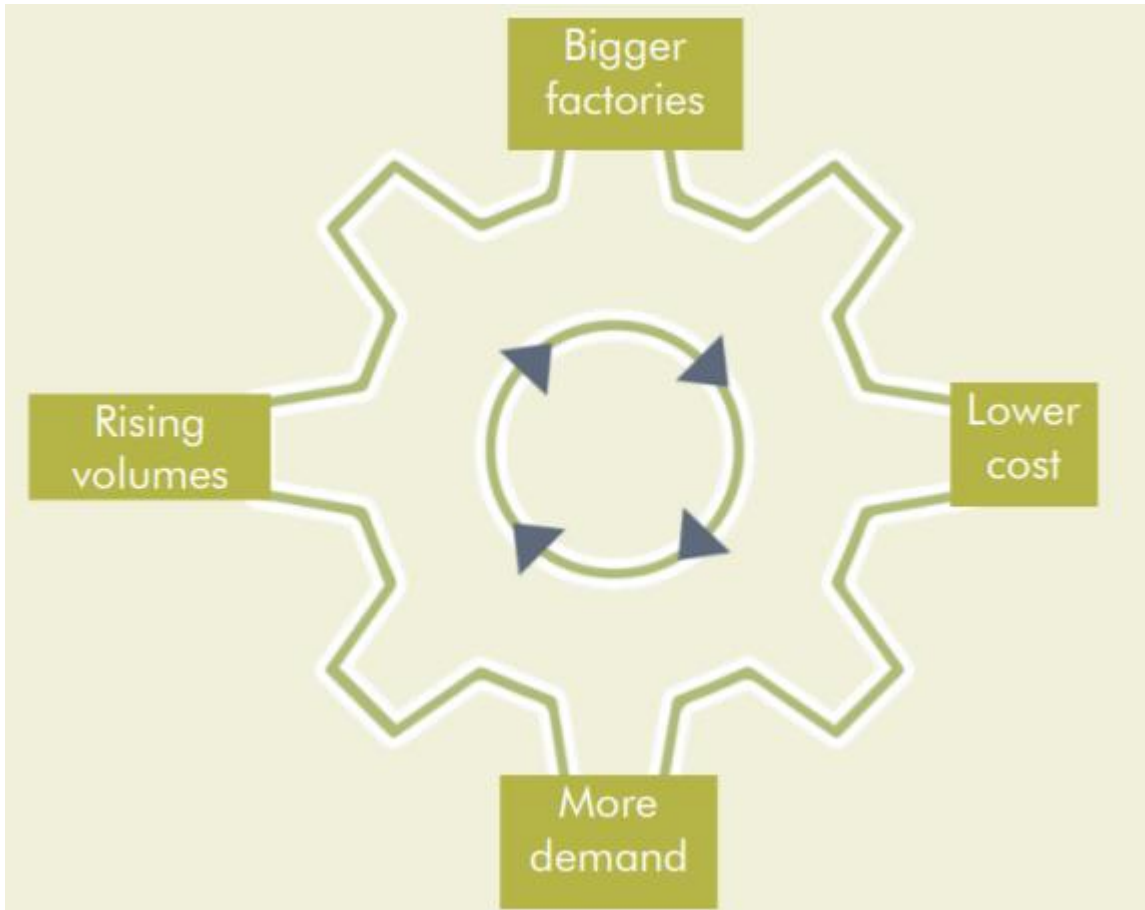
Figure 6. Disruption of Coal Power in the United States



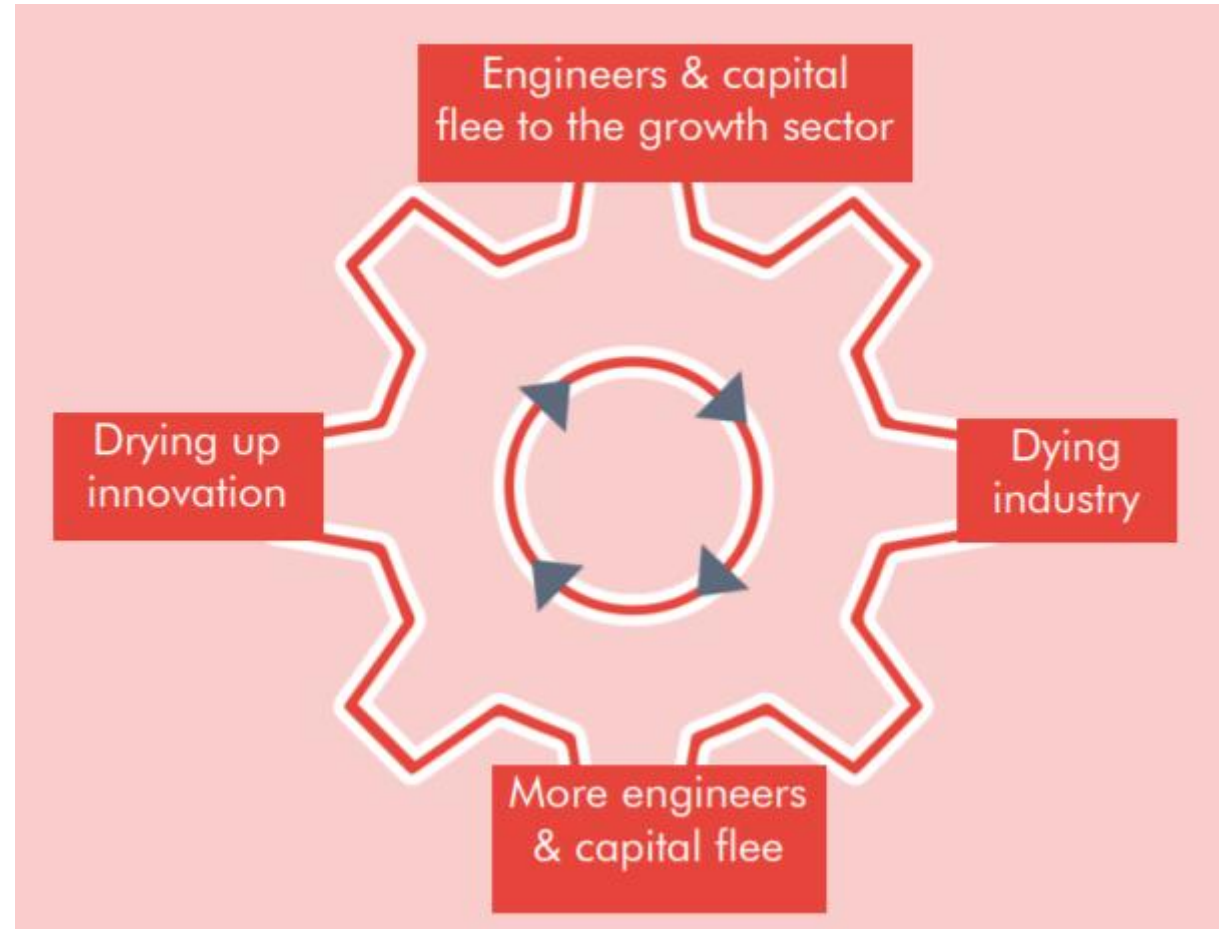
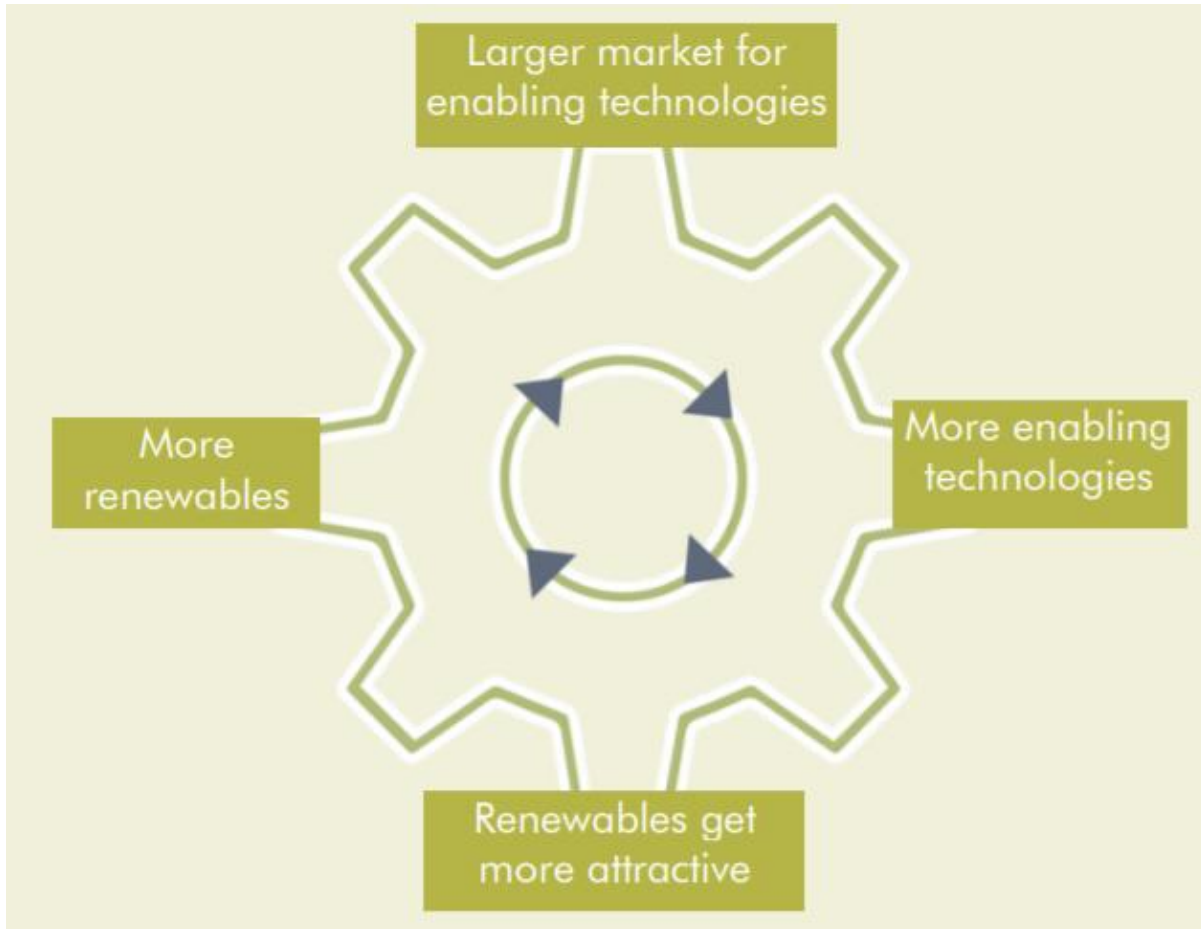
Source: US EIA Annual Energy Outlook series, 1995-2020.<sup>14</sup>

Sources: [Carbon Brief](#), [RethinkX](#)

# The volume-cost loop



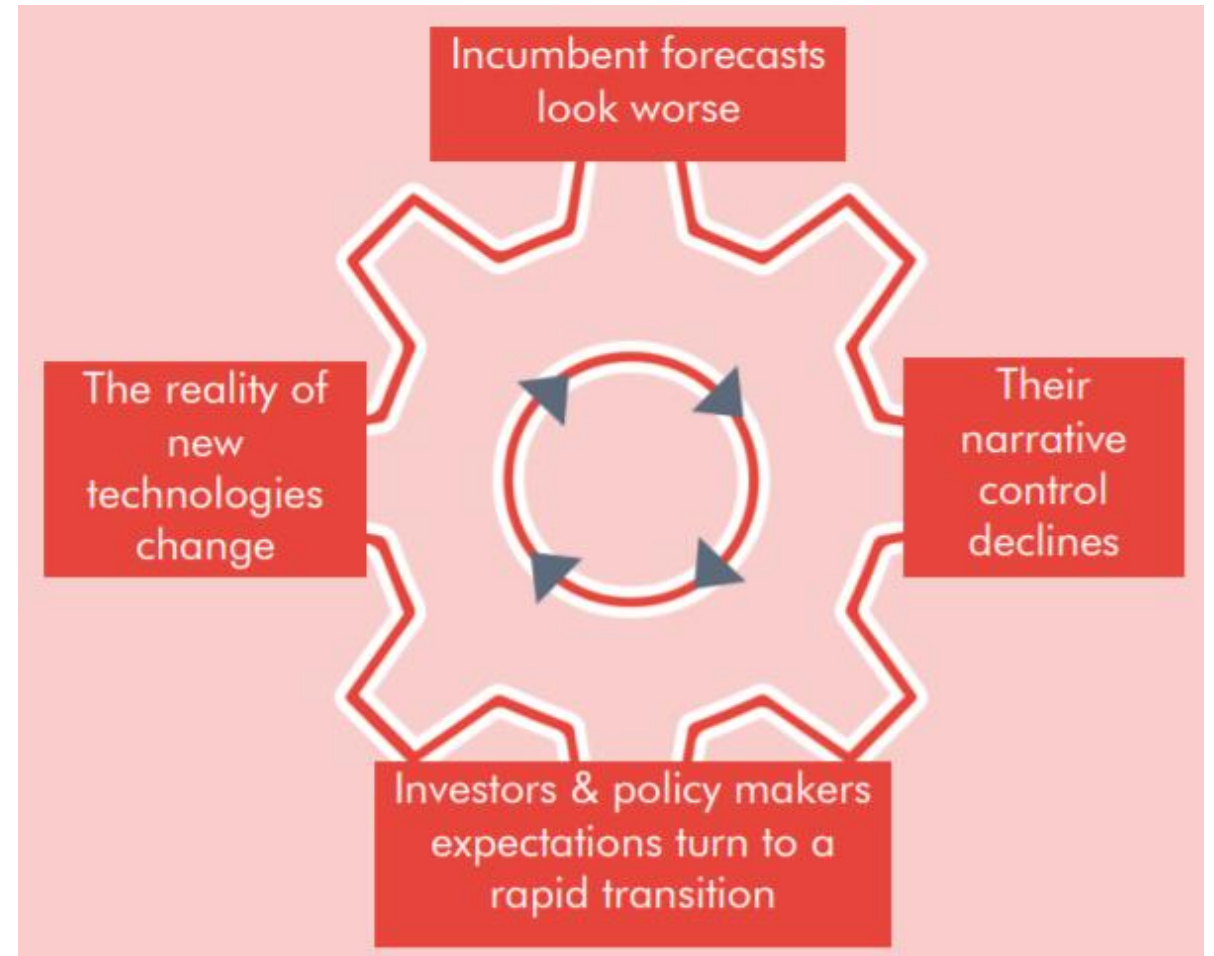
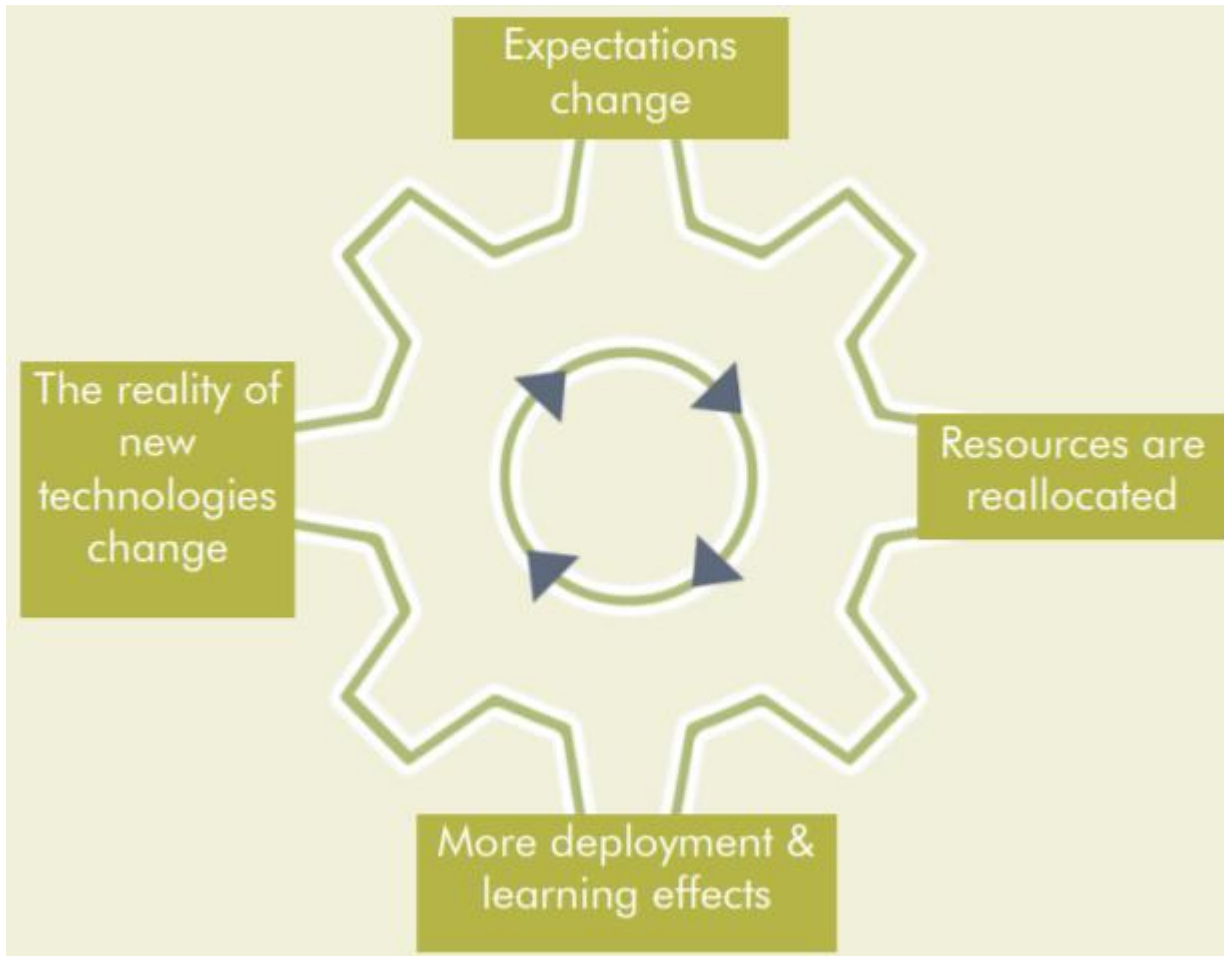
# The technology loop



Source: [Carbon Brief](#)

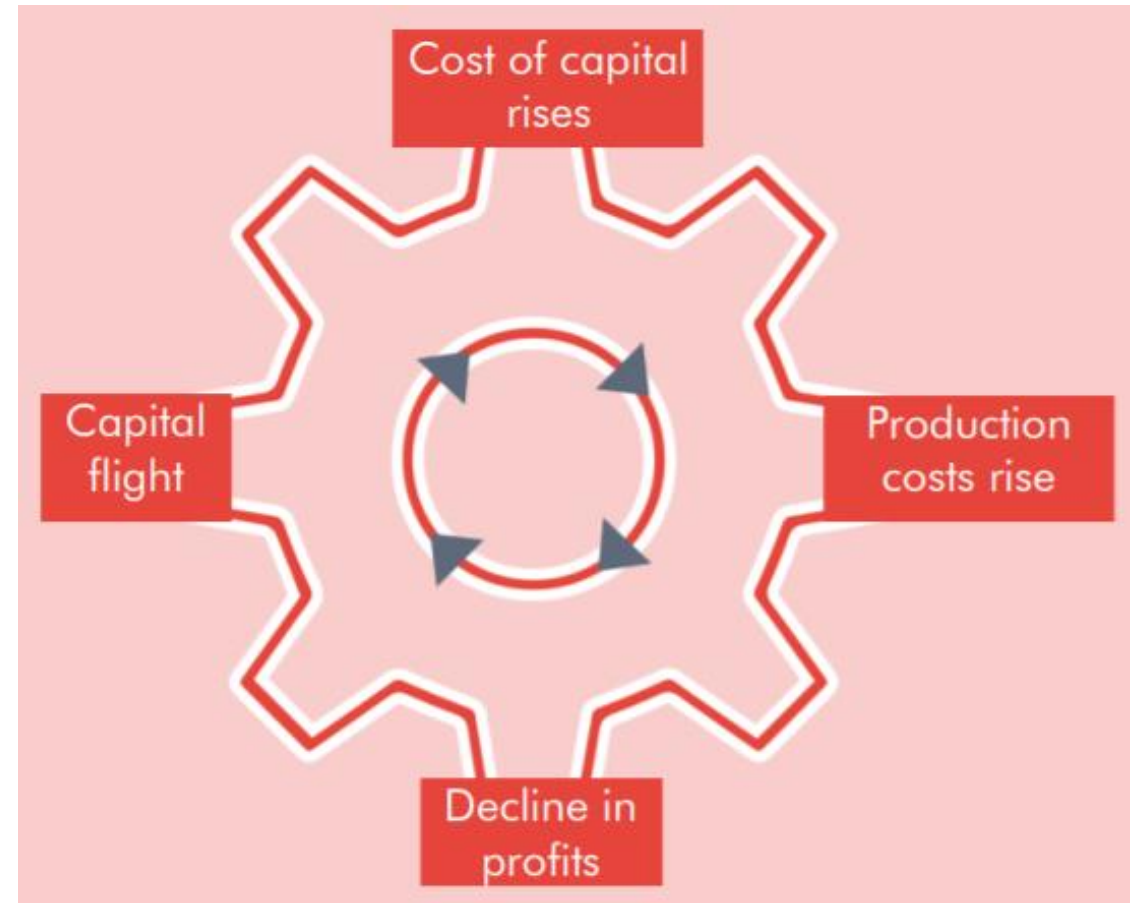
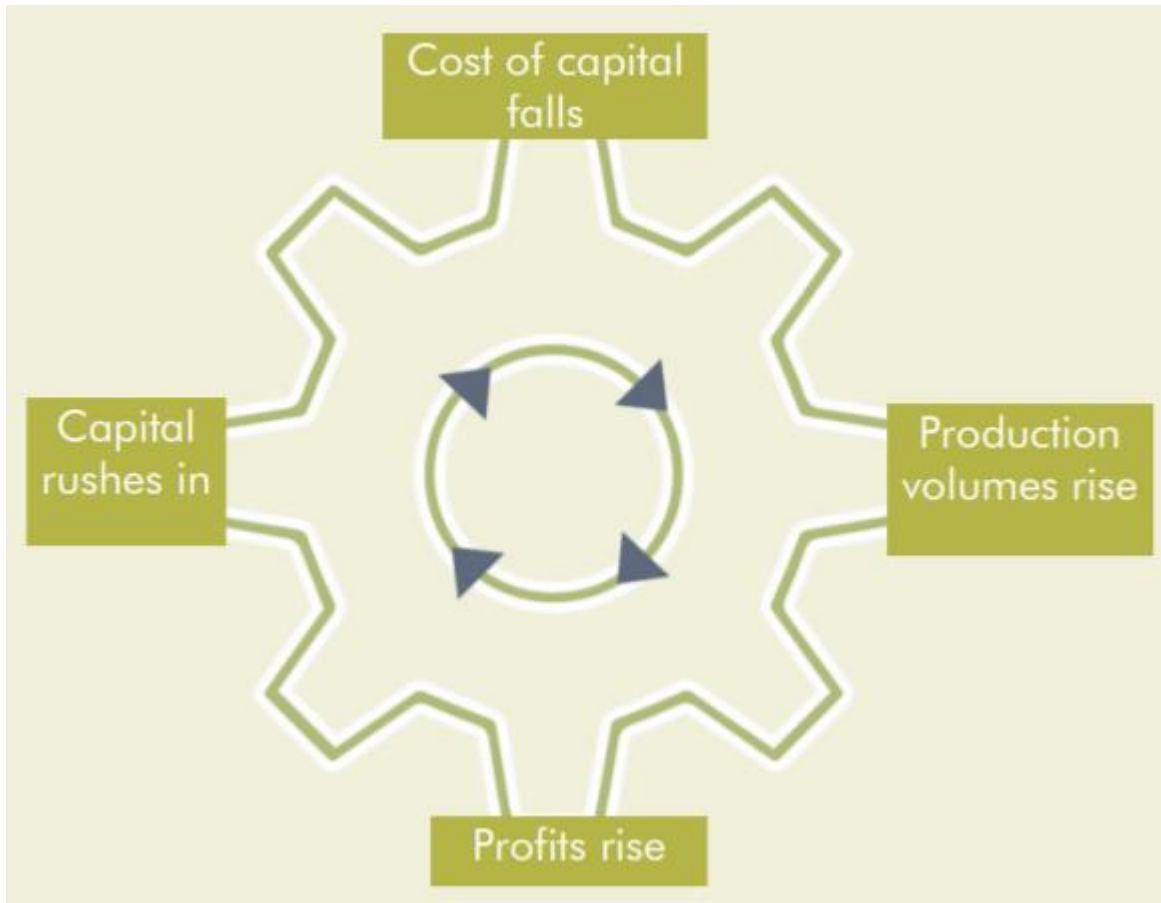


# The expectations loop

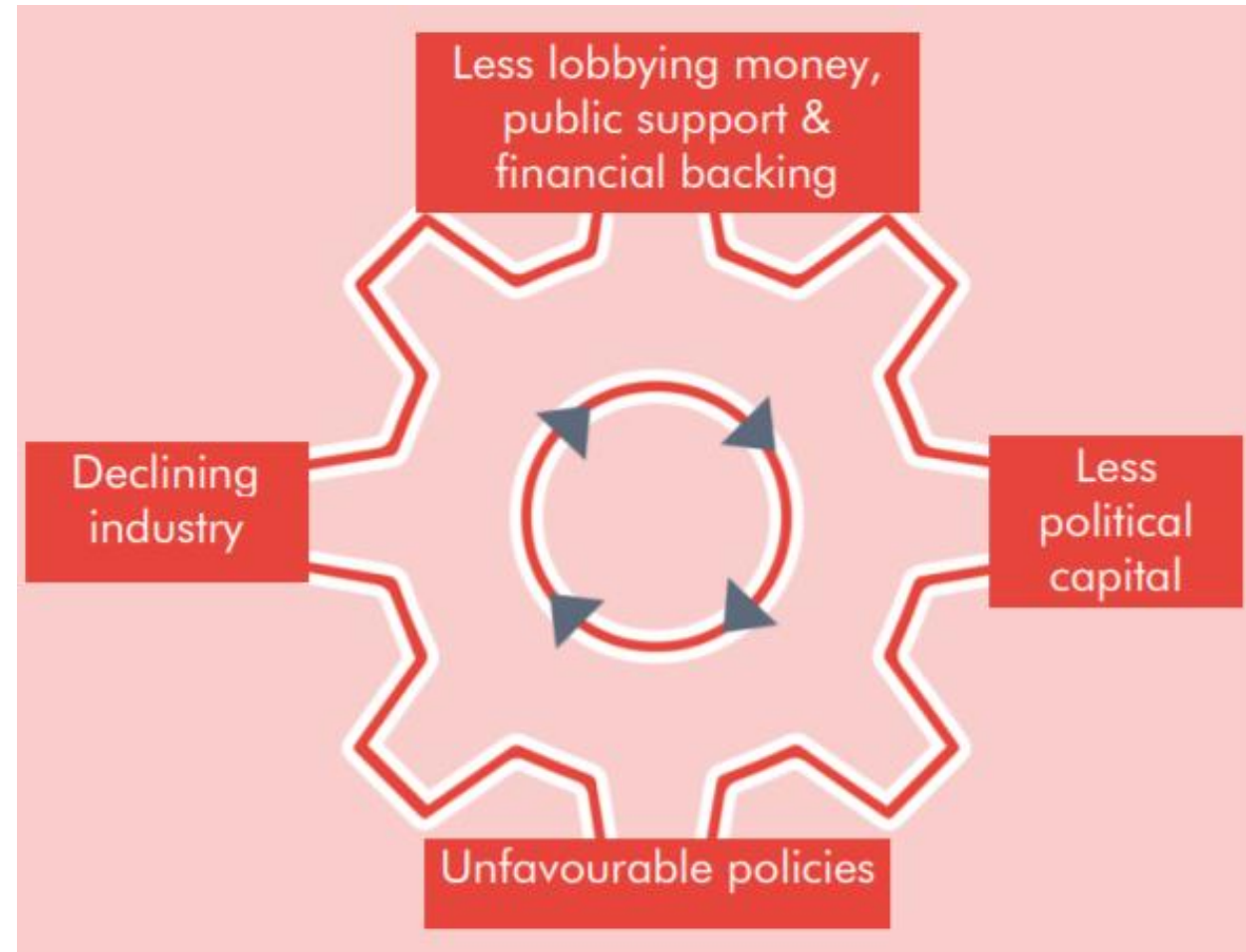
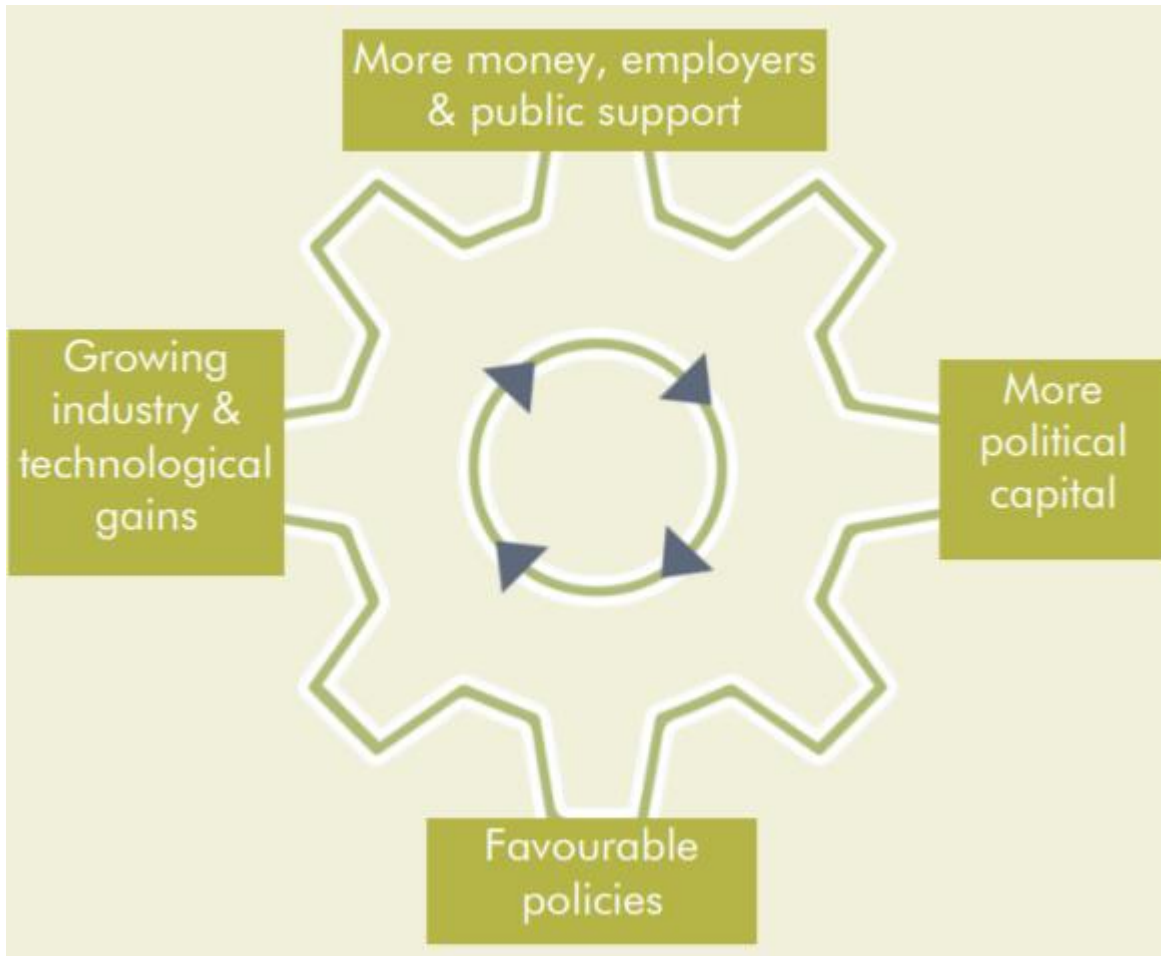


Source: [Carbon Brief](#)

# The finance loop



# The politics loop



Source: [Carbon Brief](#)

# Rules

*Which rules govern our energy system?*

# Goals

*Which goals does the design of our energy system pursue?*

# Mindset

*„The shared idea in the minds of society, the great big unstated assumptions — unstated because unnecessary to state; everyone already knows them — constitute that society’s paradigm, or deepest set of beliefs about how the world works“*

[D. Meadows: Leverage Points: Places to Intervene in a System](#)

# System levers = system characteristics

- Numbers and events
- Stocks and flows
- Feedback loops
- Rules
- Goal(s)
- Mindset

