

# Methods for Assessing the Raw Material Requirements in Energy System Analyses

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**IEK-3: Institute of Techno-economic Systems Analysis**

# Interest in the Energy-Material-Nexus Has Increased Over the Last Decade

DOI: 10.1016/j.energy.2019.05.156

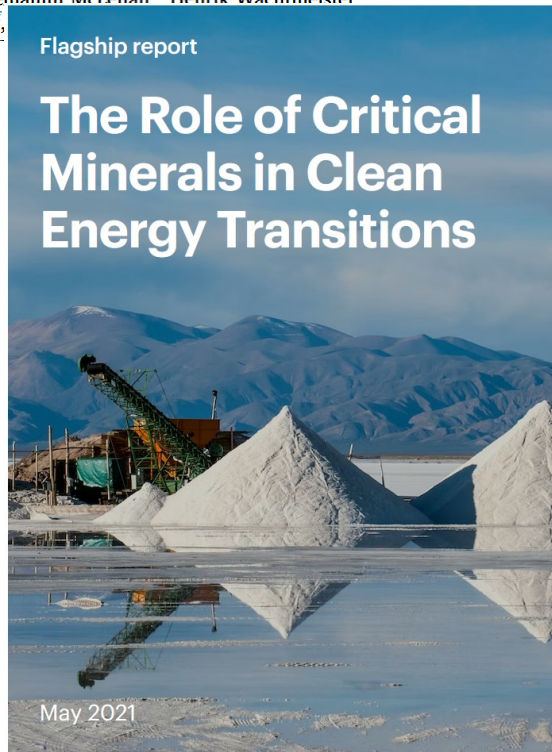
**Energy-material nexus:** The impacts of national and international energy scenarios on critical metals use in China up to 2050 and their global implications

Ayman Elshkaki <sup>a,\*</sup>,

Energy modeling approach to the global **energy-mineral nexus**: Exploring metal requirements and the well-below 2 °C target with 100 percent renewable energy

Koji Tokimatsu <sup>a,b,\*</sup>, Mikael Höök <sup>c</sup>, Benjamin McLellan <sup>d</sup>, Henrik Wachtmeister <sup>c</sup>, Shinsuke Murakami <sup>e</sup>, Rieko Yasuoka <sup>f</sup>,

DOI: 10.1016/j.egypro.2017.12.167



Energy modeling approach to the global **energy-mineral nexus**: of fuel cell vehicle

DOI: 10.1016/j.apenergy.2018.05.047

McLellan <sup>c</sup>, Mikael Höök <sup>d</sup>, Shinsuke Murakami <sup>e</sup>, Rieko

Yasuoka <sup>f</sup> and Masahiro Niishiro <sup>g</sup>  
Incorporating mineral cycles into **metal-energy nexus** of China's

Chen <sup>h</sup>, Jian-Ping Ge <sup>c</sup>, Wenjia Cai <sup>d</sup>, Wei-Qiang Chen <sup>a,f,g,\*</sup>

DOI: 10.1016/j.apenergy.2019.113612

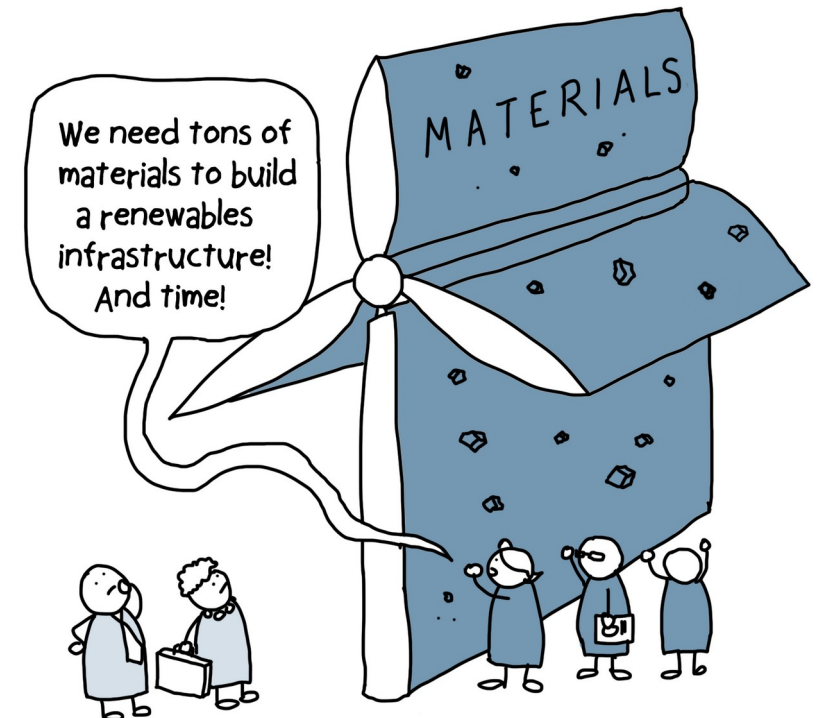
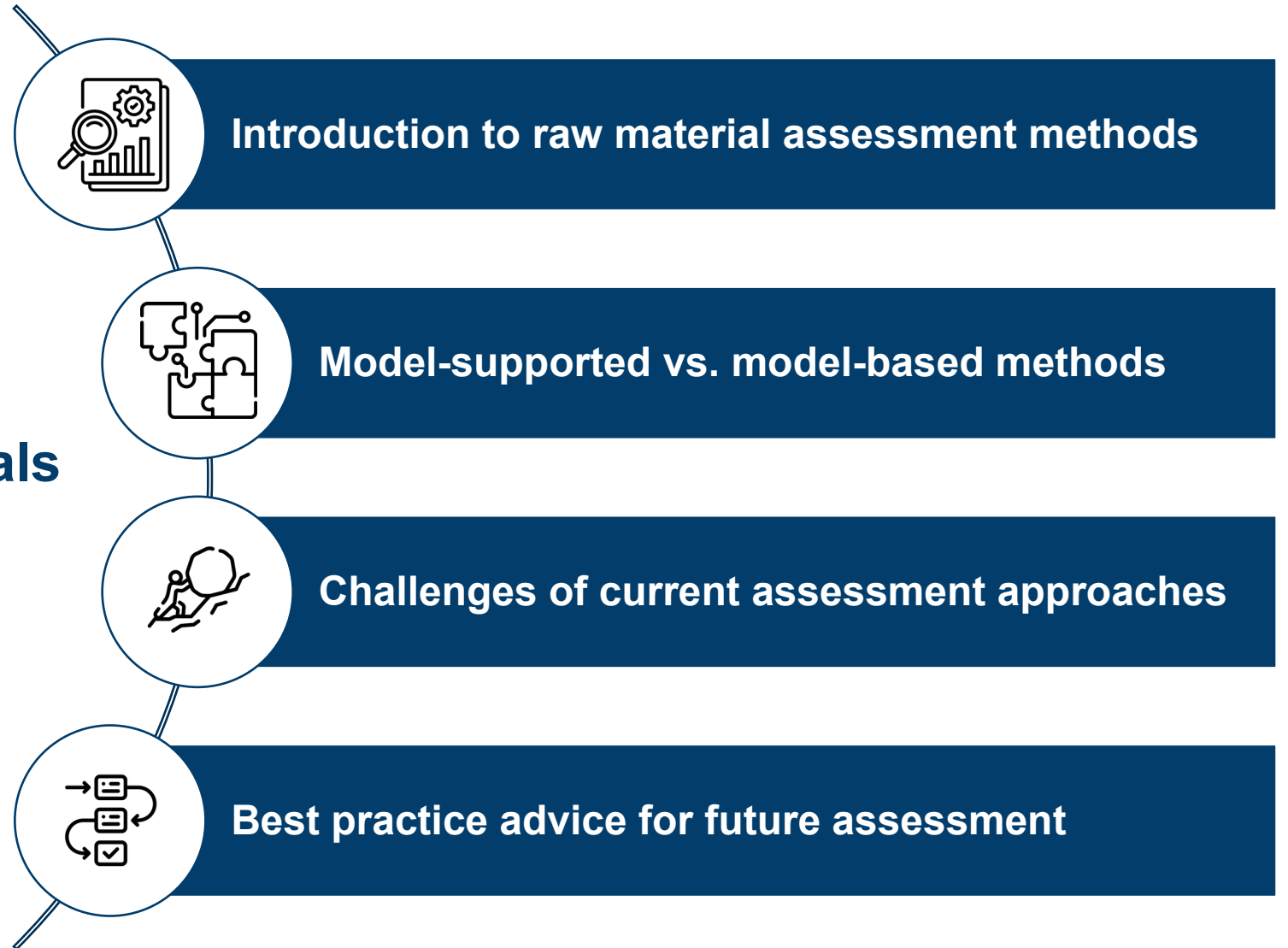


Image from <https://www.businessillustrator.com/> and International Energy Agency

# Improve the Modelling and Assessment of Raw Materials in Energy System Models



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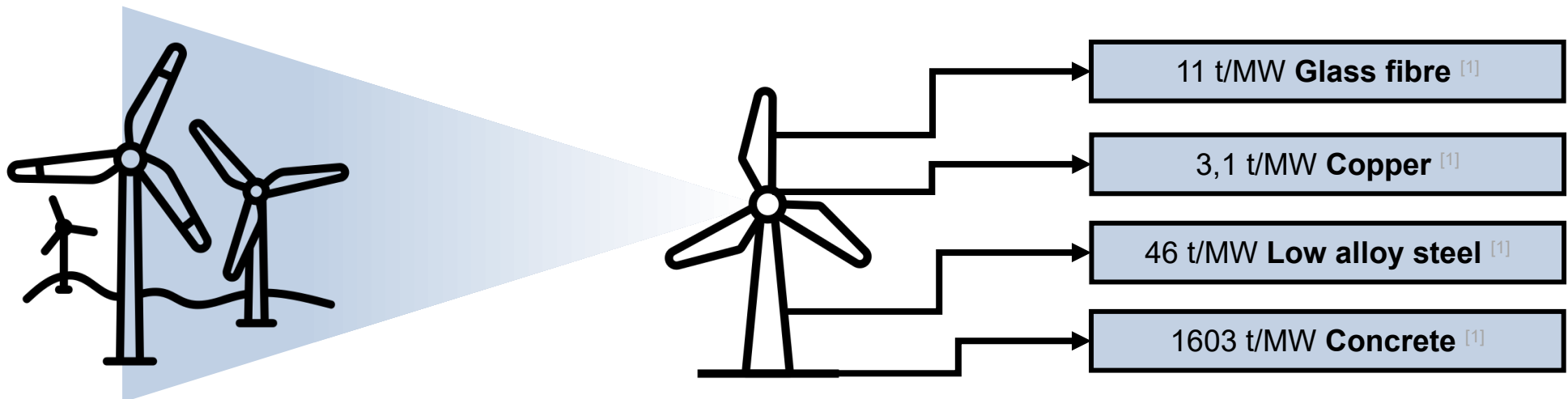
# Assessing the Raw Material Demand of Energy Systems Starts at the Technology Level

## Material demand assessment

Installed capacity of  
*technology X*



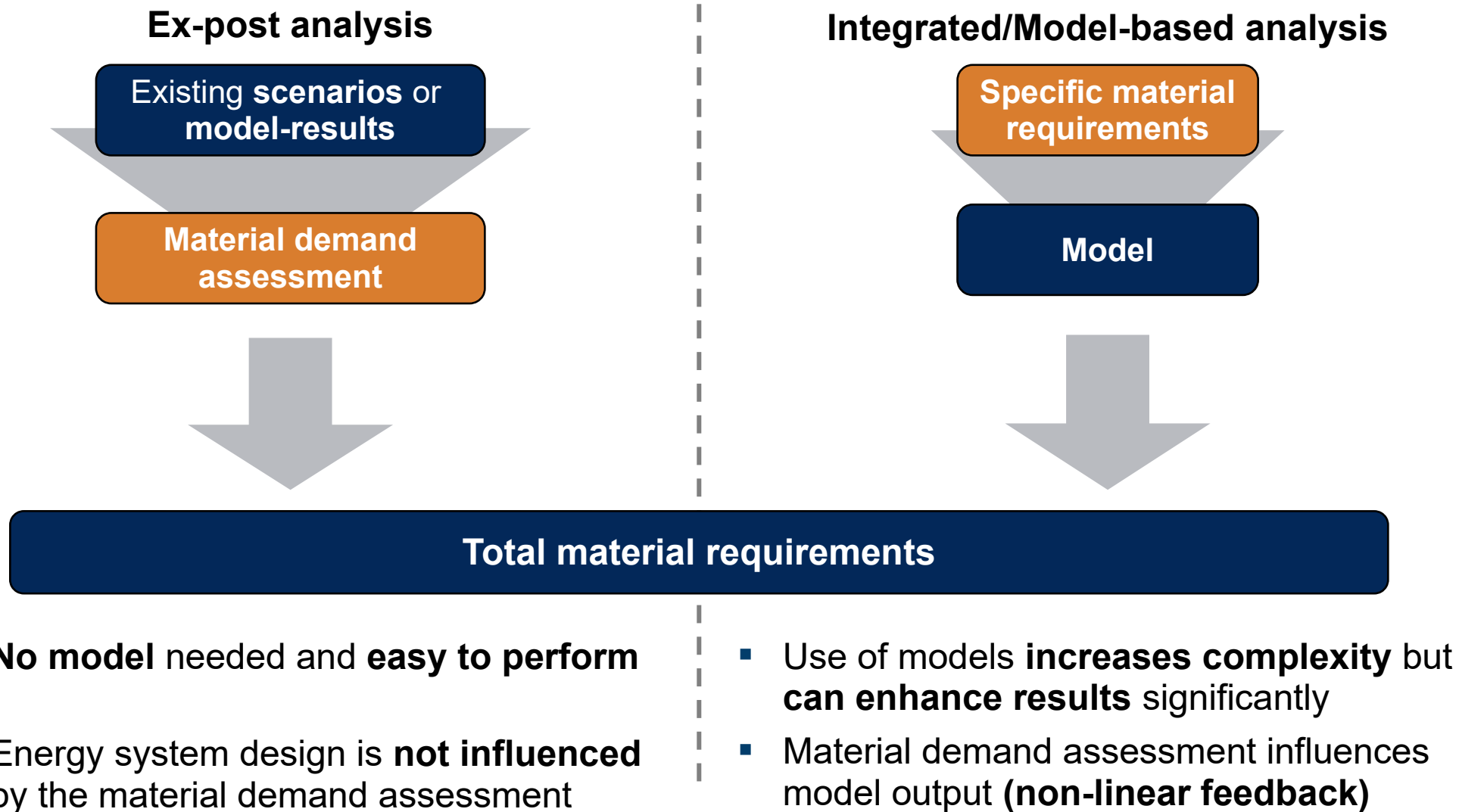
material requirements of  
*technology X* per unit of  
installed capacity



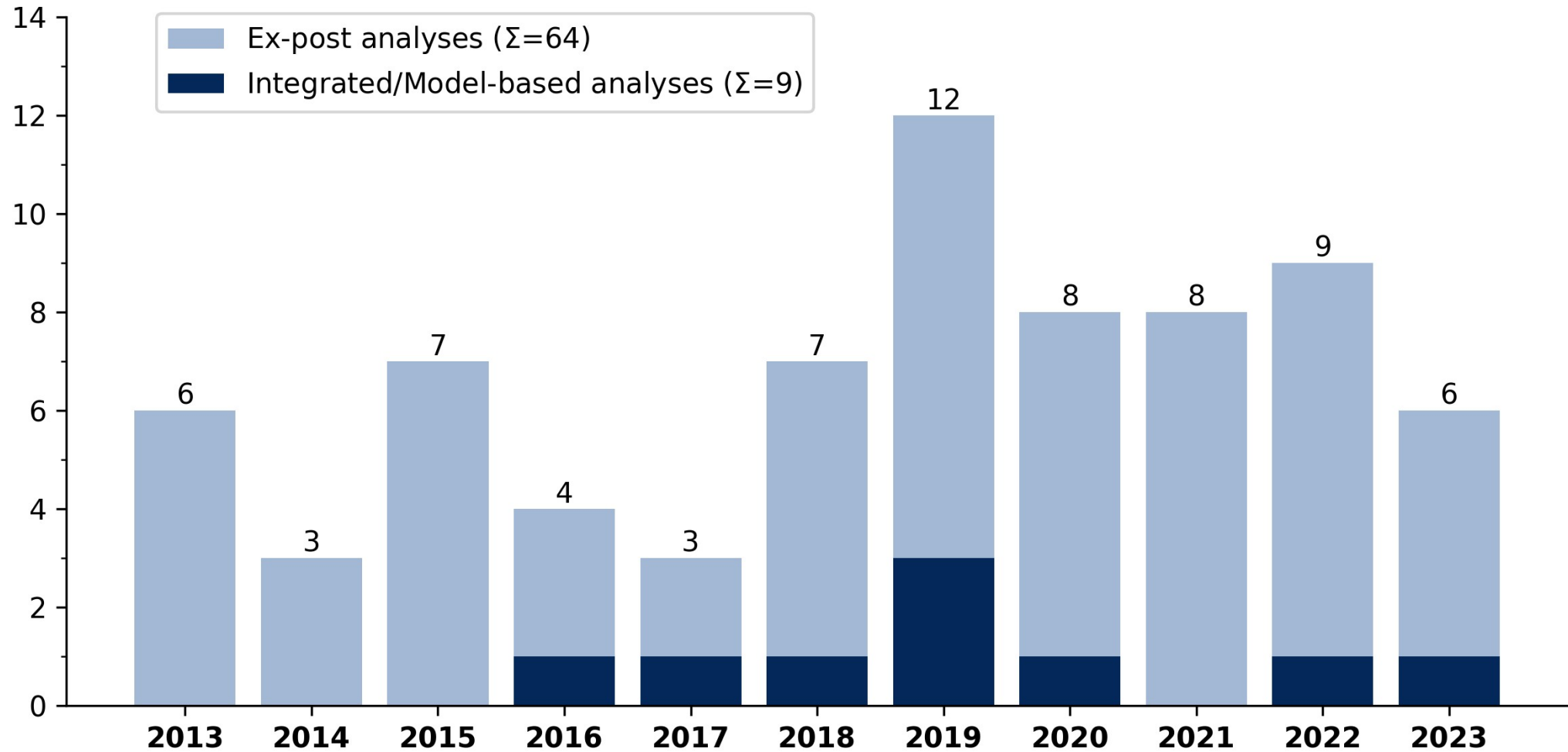
[1] Values for 2020 based on Gervais et al. (2022) – DOI: 10.24406/PUBLICA-427

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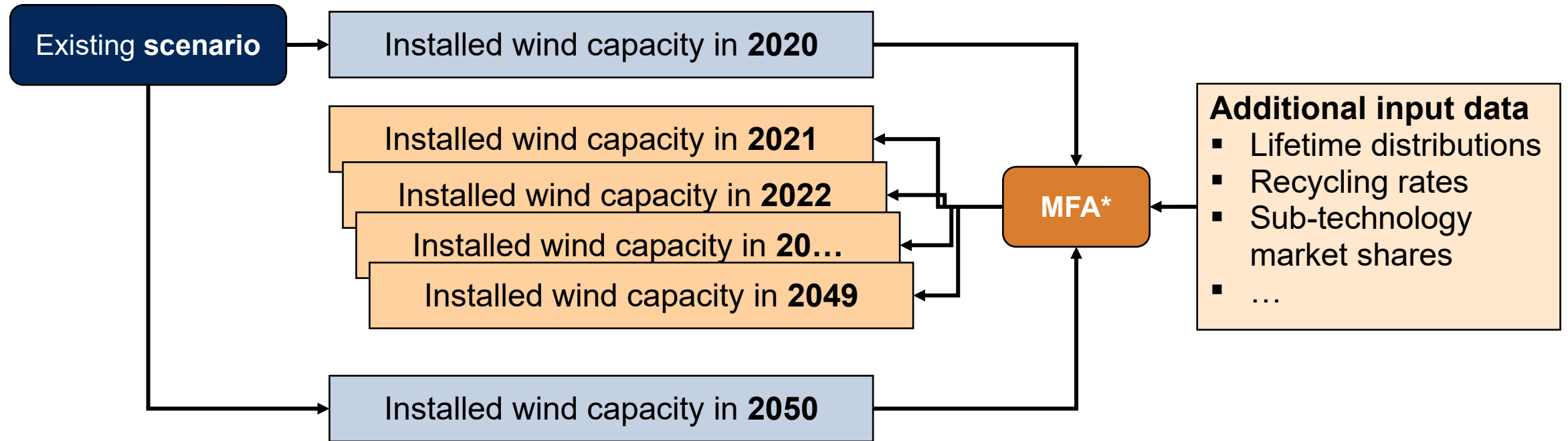
# Two Main Methodologies for Assessing Raw Materials in Energy Systems Exist



## Ex-post Analyses Dominate the Research Field



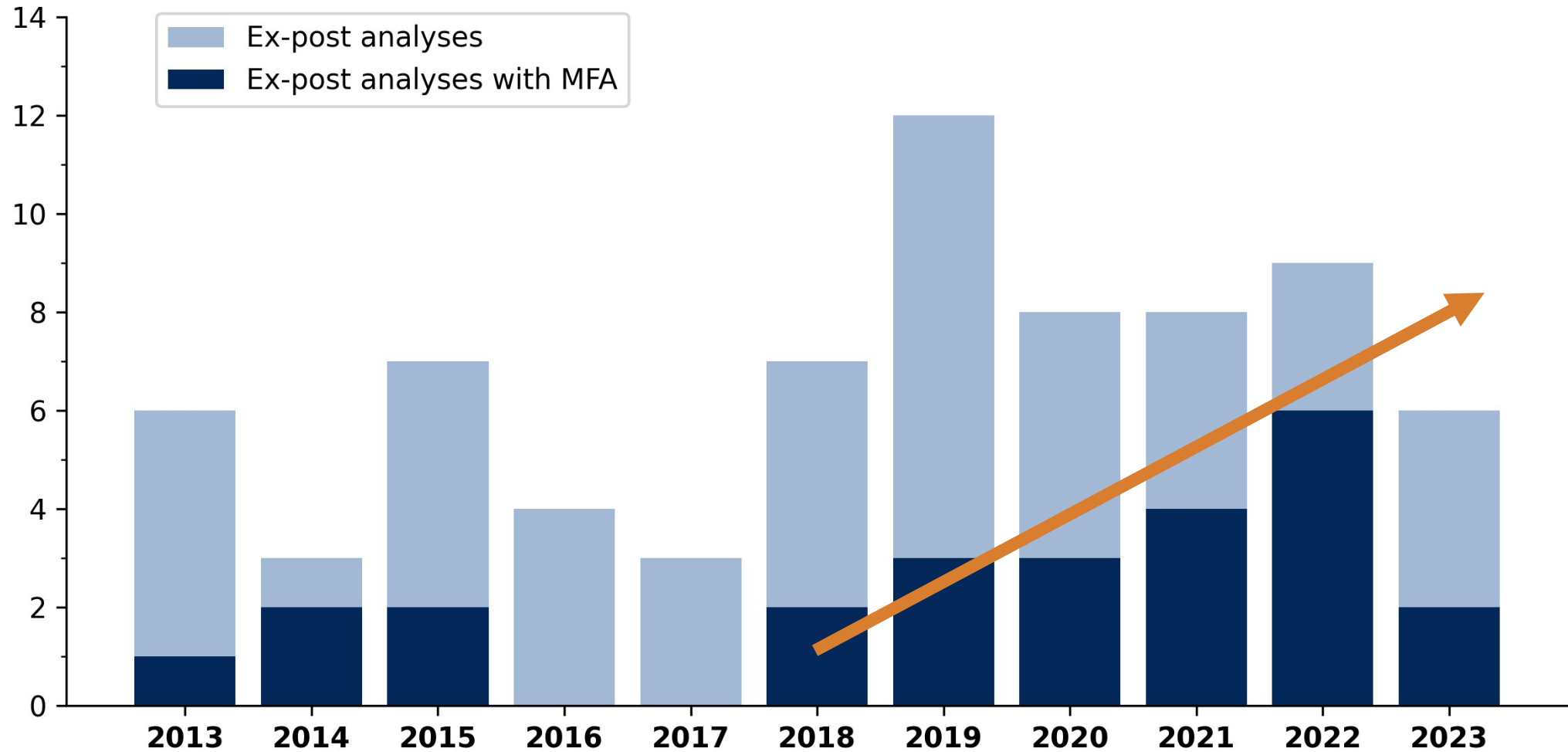
# Material Flow Analysis Can Enhance the Quality of Ex-post Analysis



1. MFA can be used to **fill in data gaps**
2. MFA can **increase the informative value** of ex-post analyses

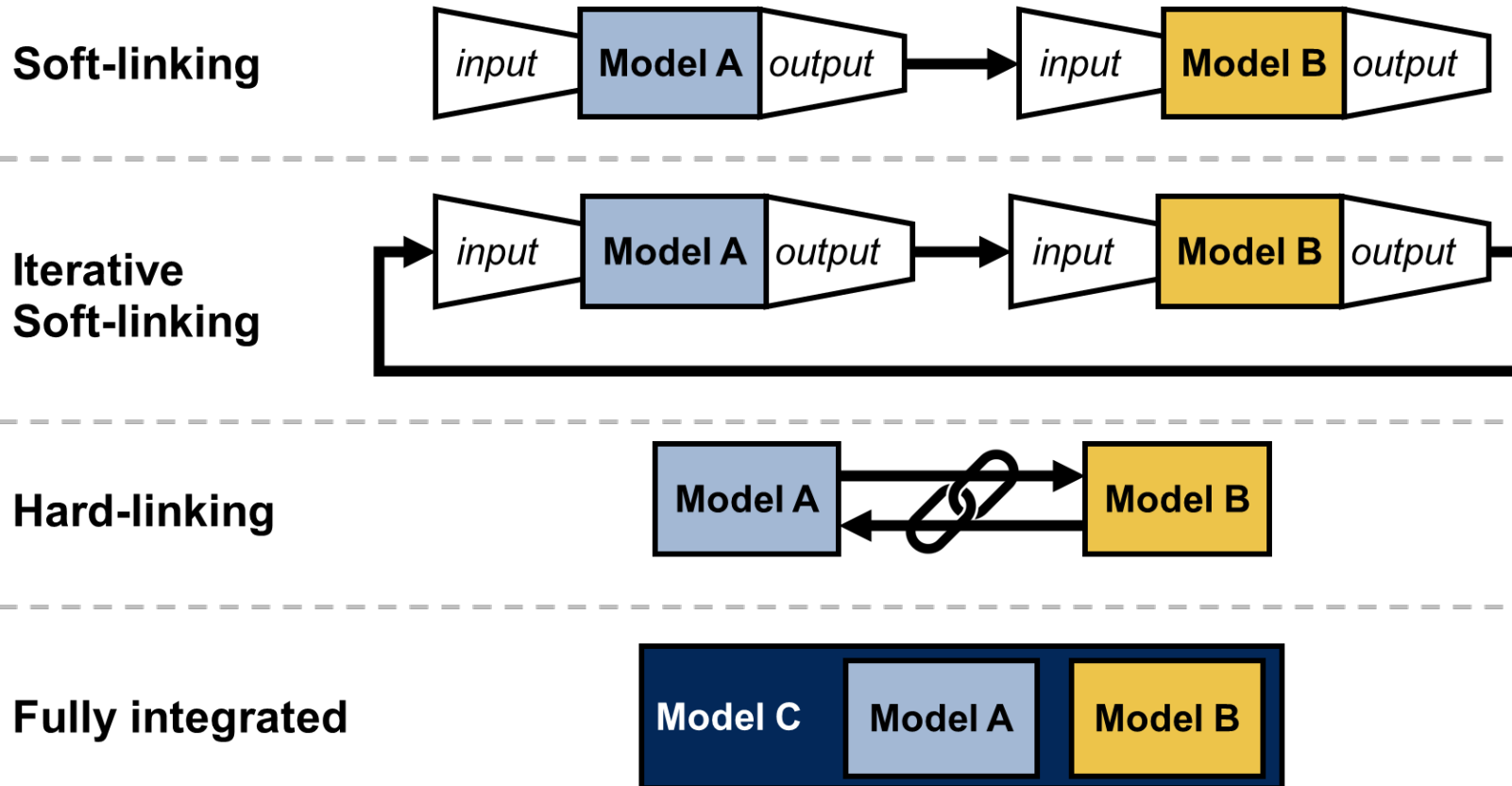
\*Material Flow Analysis

## Share of Model-supported Ex-post Analyses is Slowly Increasing



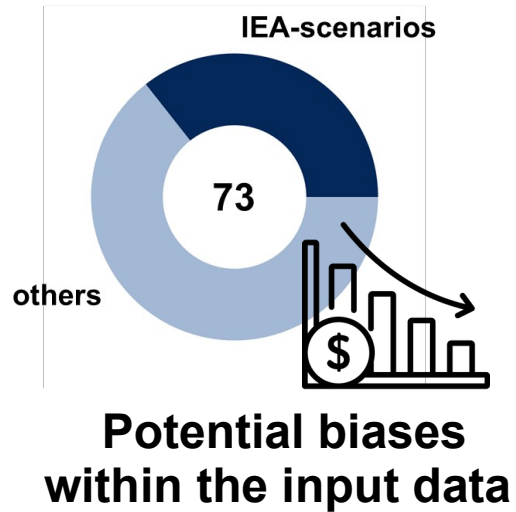


# Integrating Material Assessment into Energy System Models Requires “Coupling-Methods”

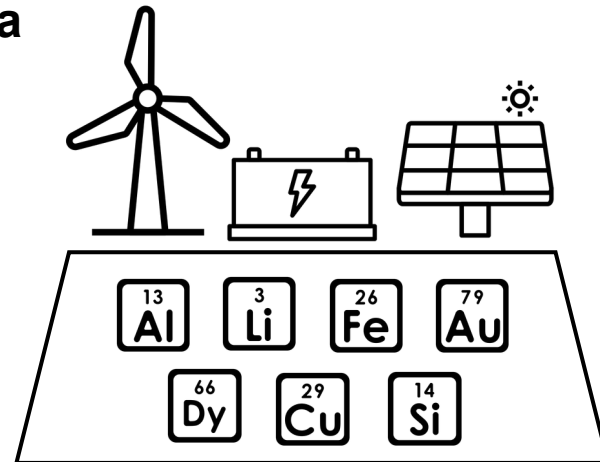


Due to their high complexity, “Linking”-approaches are still rarely used

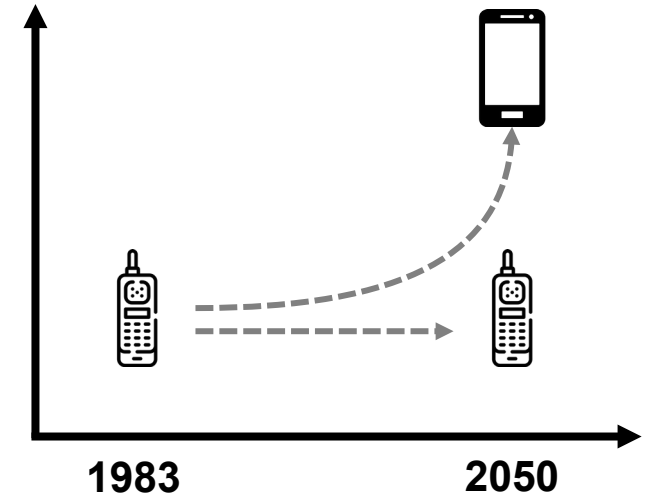
# Current Assessment Approaches Face Multiple Challenges



Unrealistic Lifetimes



Insufficient scope



No technology development over time

Broken wind turbine image by Chris Landsberger (The Oklahoman)  
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# Best-Practice Advice for the Raw Material Assessment of Energy Systems

1. Aim for a **model-supported** or **model-based** analysis approach
2. Be as **detailed as possible** while **maintaining a systemic viewpoint**
  - Place national analyses into an **international context**
  - **Couple models** of different sectoral-scopes and levels of details
  - Account for **material demands of remaining sectors** – especially for bottleneck analyses
3. Avoid static input data, instead **use time-dependent input data or learning curves**
4. **Extend the time-horizon** of your analysis beyond the average 40 years
5. Always **account for uncertainty** within your input data
6. Aim for **interdisciplinary approaches**
7. Comply with the **FAIR\*** principles



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**THANK  
YOU!**



\*<https://www.go-fair.org/fair-principles/>

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