

Green transition(s)

UNCTAD Multi-year Expert Meeting on Investment, Innovation and Entrepreneurship for
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Frank Neffke

Science of Cities, Complexity Science Hub Vienna

The green transition is a plural

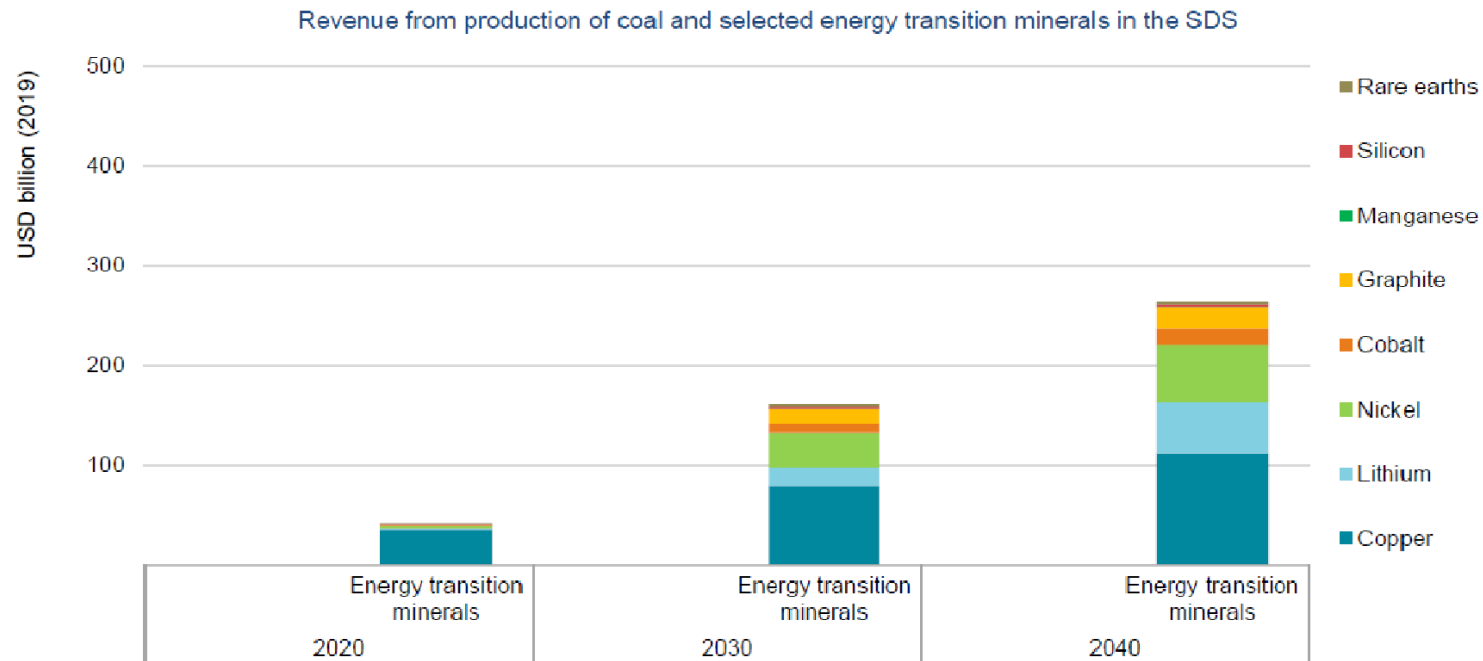
- Multiple transitions:
 - Transition in energy system
 - Transition in minerals supply chains
 - Transition on labor market
 - Transition in global division of labor

Resources

Critical resources

New energy system requires massive amounts of minerals

Changing fortunes: Coal vs energy transition minerals



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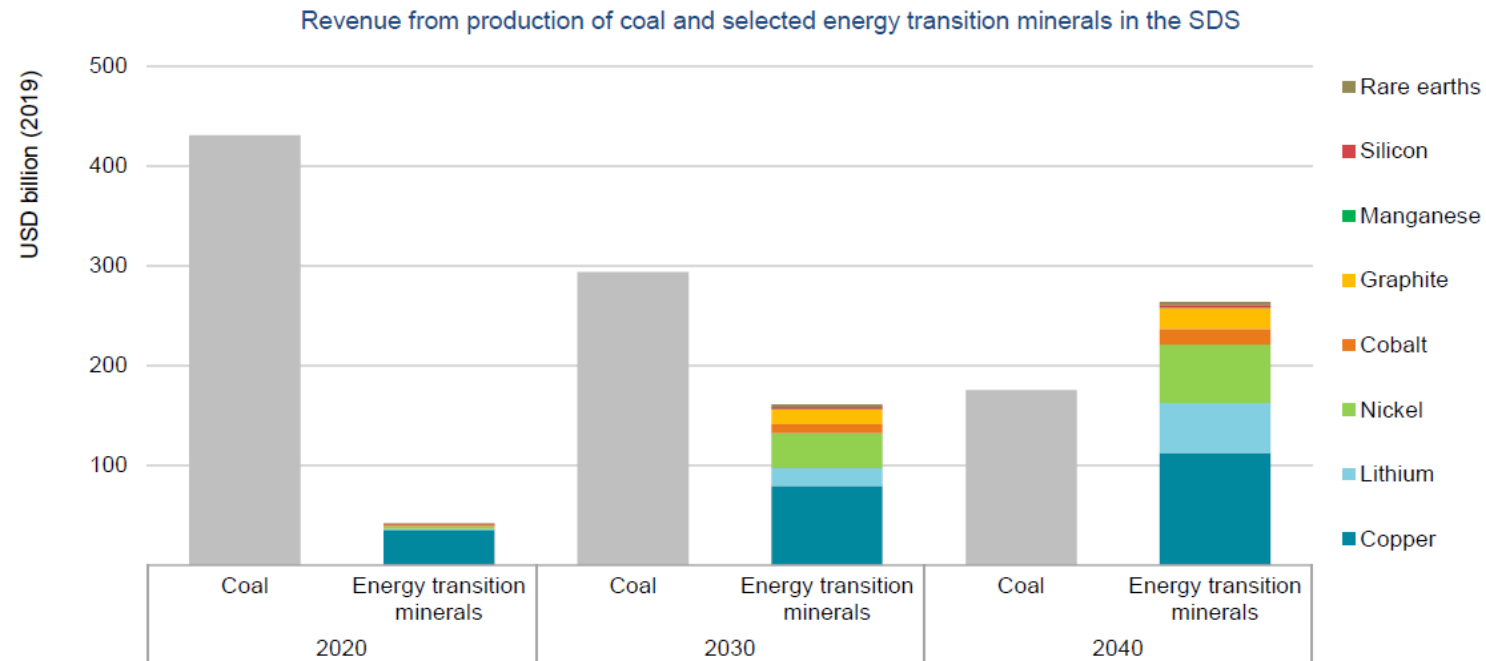
Notes: Revenue for energy transition minerals includes only the volume required in clean energy technologies, not total demand. Future prices for coal are projected equilibrium prices in *WEO 2020 SDS*. Prices for energy transition minerals are based on conservative assumptions about future price trends (moderate growth of around 10-20% from today's levels).

Source: IEA 2022; World Energy Outlook Special Report, The Role of Critical Minerals in Clean Energy Transitions, <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions>, License: CC BY 4.0]

Critical resources

However, so does the old energy system

Changing fortunes: Coal vs energy transition minerals



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Jobs

Reskilling

Example: energy transition

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**Skills Development and
Inclusivity for Clean
Energy Transitions**



- Net zero emissions pathway
 - 15M new jobs in clean energy sector
 - 5M lost jobs in old energy sector
 - Training/reskilling for 30M workers

Source: IEA 2022; Skills Development and Inclusivity for Clean Energy Transitions, <https://www.iea.org/reports/skills-development-and-inclusivity-for-clean-energy-transitions>, License: CC BY 4.0]

Reskilling is not trivial

*Example: From mining to solar panels (O*NET)*

Continuous Mining Machine Operators

47-5041.00

Updated 2022

Operate self-propelled mining machines that rip coal, metal and nonmetal ores, rock, stone, or sand from the mine face and load it onto conveyors, shuttle cars, or trucks in a continuous operation.

Sample of reported job titles: Bore Miner Operator, Continuous Miner, Continuous Miner Operator (CMO), Continuous Mining Machine Operator, Continuous Mining Operator (CMO), Heavy Equipment Operator, Loader Operator, Mine Technician, Mine Utility Operator, Miner Operator

Skills

5 of 12 displayed

- ⊕ **Operation and Control** — Controlling operations of equipment or systems.
- ⊕ **Operations Monitoring** — Watching gauges, dials, or other indicators to make sure a machine is working properly.
- ⊕ **Equipment Maintenance** — Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.
- ⊕ **Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
- ⊕ **Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

Related Occupations

5 of 10 displayed


- 47-5023.00 [Earth Drillers, Except Oil and Gas](#) 🌟 **Bright Outlook**
- 47-5022.00 [Excavating and Loading Machine and Dragline Operators, Surface Mining](#)
- 47-5081.00 [Helpers--Extraction Workers](#) 🌟
- 47-5044.00 [Loading and Moving Machine Operators, Underground Mining](#)
- 47-2073.00 [Operating Engineers and Other Construction Equipment Operators](#)

Reskilling is not trivial

*Example: From mining to solar panels (O*NET)*

Solar Photovoltaic Installers

47-2231.00

 Bright Outlook

 Updated 2023

Assemble, install, or maintain solar photovoltaic (PV) systems on roofs or other structures in compliance with site assessment and schematics. May include measuring, cutting, assembling, and bolting structural framing and solar modules. May perform minor electrical work such as current checks.

Sample of reported job titles: Installer, Photovoltaic Installer (PV Installer), PV Design Technician (Photovoltaic Design Technician), Solar Designer, Solar Installer, Solar Installer Technician, Solar Photovoltaic Installer (Solar PV Installer), Solar Technician



Skills

▼ 5 of 12 displayed

- **Installation** — Installing equipment, machines, wiring, or programs to meet specifications.
- **Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- **Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
- **Monitoring** — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
- **Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

Related Occupations

▼ 5 of 10 displayed

- 49-9099.01 [Geothermal Technicians](#)
- 27-4015.00 [Lighting Technicians](#)  Bright Outlook
- 47-1011.03 [Solar Energy Installation Managers](#)
- 47-2152.04 [Solar Thermal Installers and Technicians](#)
- 49-9081.00 [Wind Turbine Service Technicians](#) 

Source: <https://www.onetonline.org/>

Reskilling

Example: energy transition

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**Skills Development and
Inclusivity for Clean
Energy Transitions**



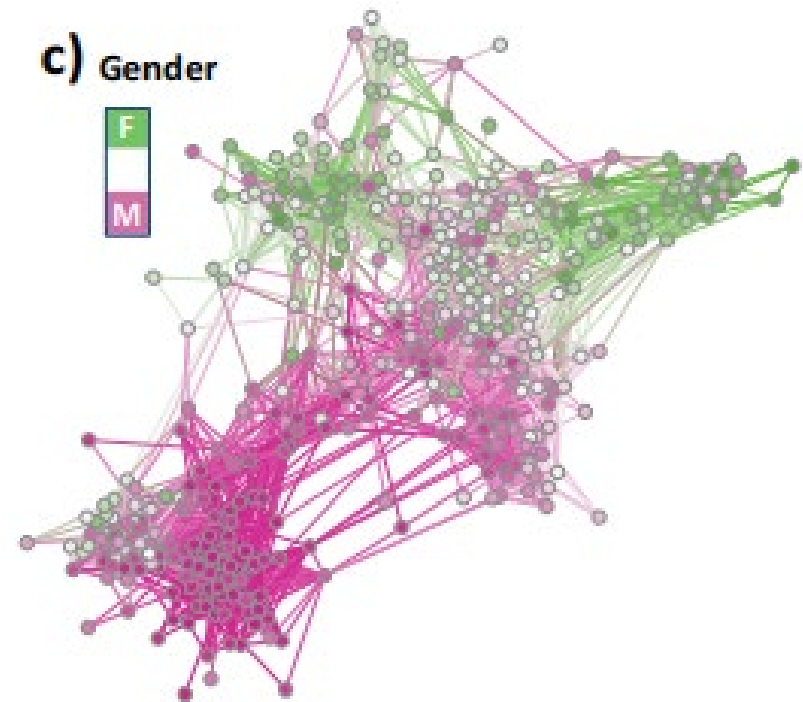
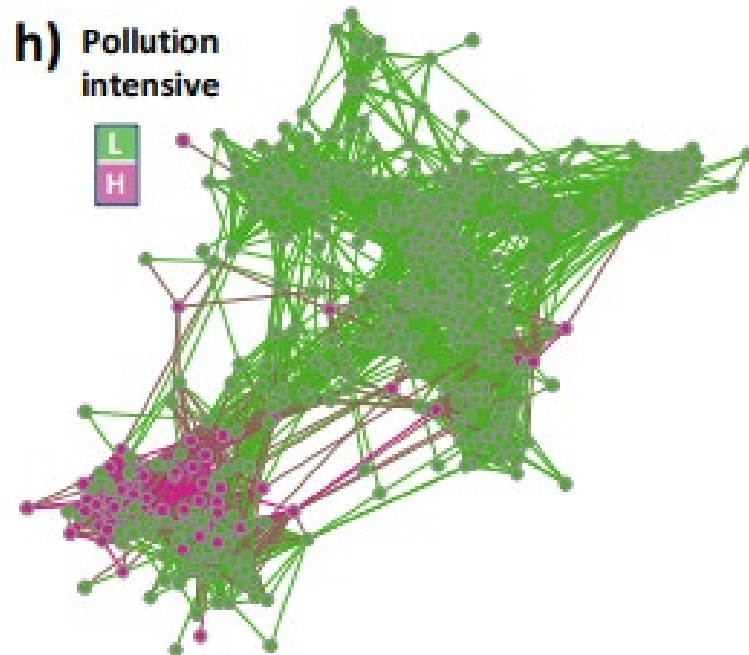
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Source: IEA 2022; Skills Development and Inclusivity for Clean Energy Transitions, <https://www.iea.org/reports/skills-development-and-inclusivity-for-clean-energy-transitions>, License: CC BY 4.0]

Transitioning from brown to green jobs

Skill spaces (Mealy/Del Rio Chanona/Farmer, 2018)



Easiest to transition from brown jobs to other brown jobs

Source: Mealy, P., del Rio-Chanona, R.M. and Farmer, J.D., 2018. What you do at work matters: new lenses on labour. What You Do at Work Matters: New Lenses on Labour (March 18, 2018).

Reskilling

Example: energy transition

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**Skills Development and
Inclusivity for Clean
Energy Transitions**



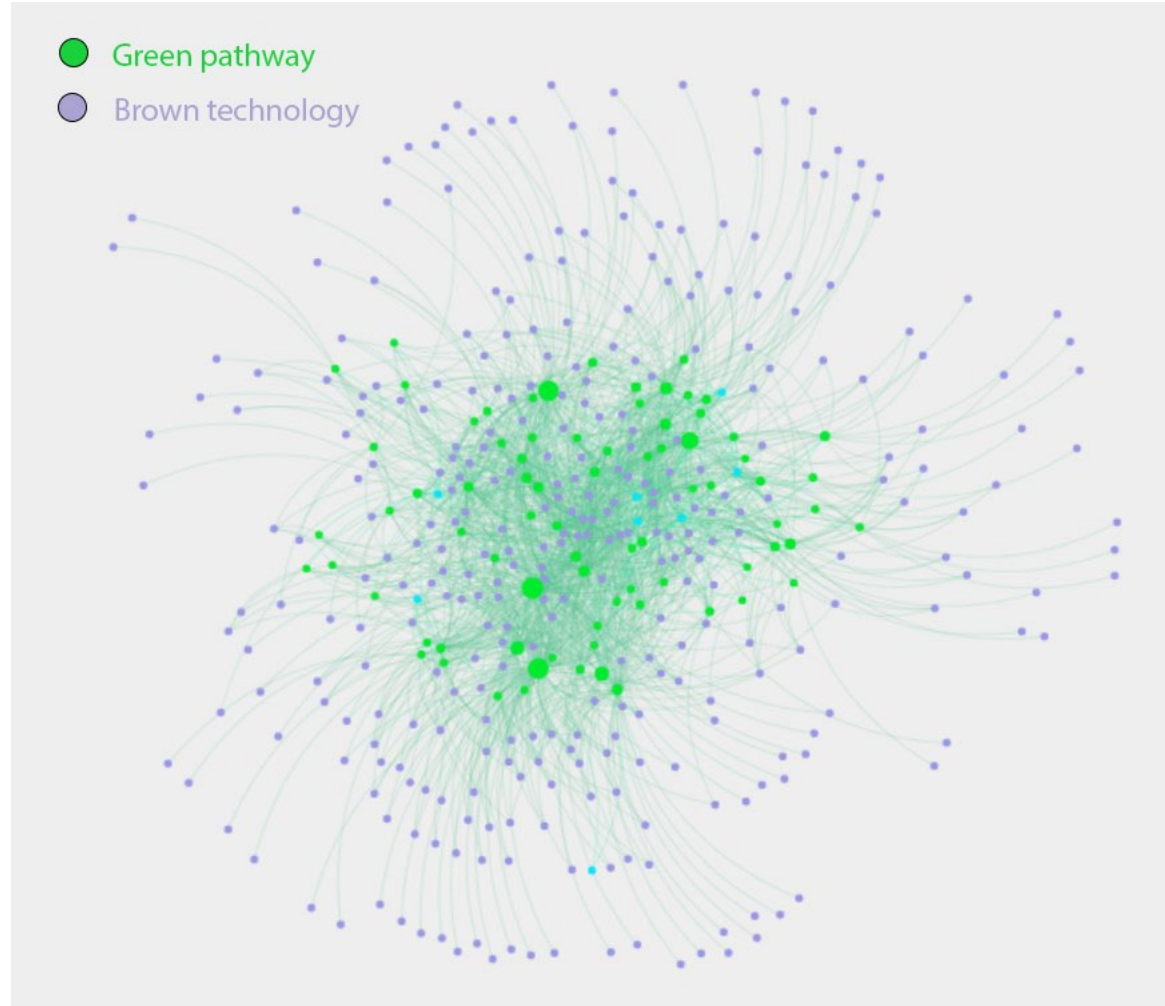
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- Old energy system’s predominantly male workers (~80% vs ~60% in new energy system)

Source: IEA 2022; Skills Development and Inclusivity for Clean Energy Transitions, <https://www.iea.org/reports/skills-development-and-inclusivity-for-clean-energy-transitions>, License: CC BY 4.0]

Opportunities
Space of solutions

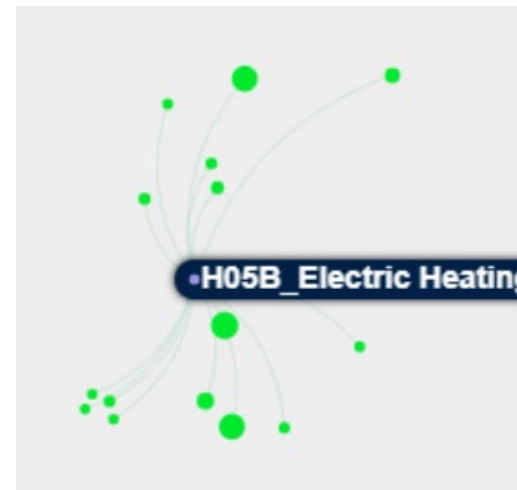
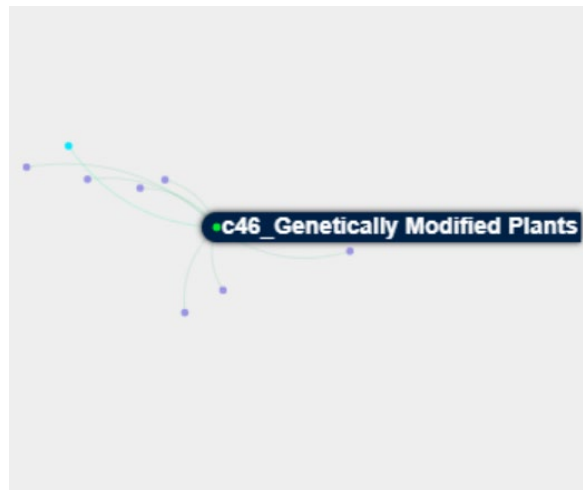
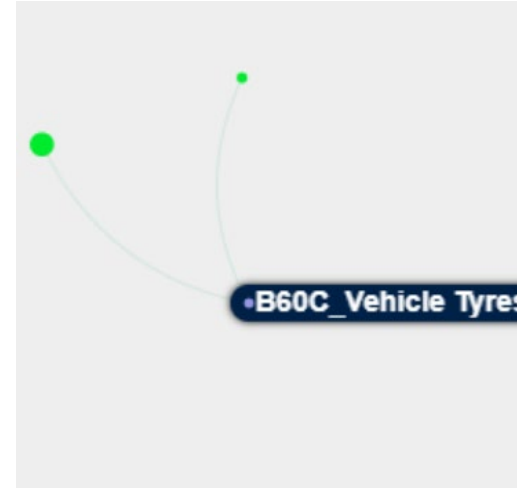
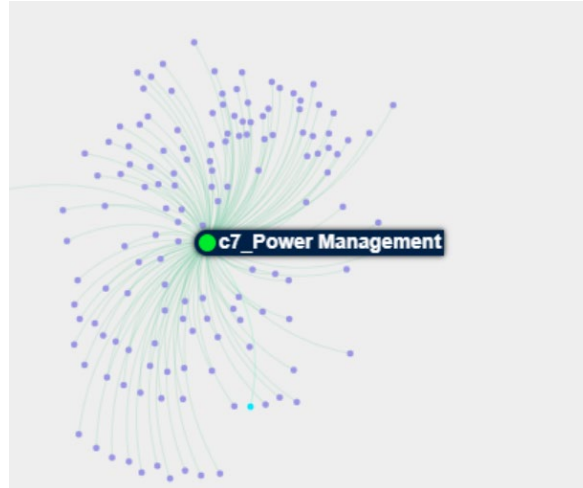
Green pathways

Heterogeneous technology landscape (Li/Neffke, 2023)



Green pathways

Heterogeneous technology landscape (Li/Neffke, 2023)

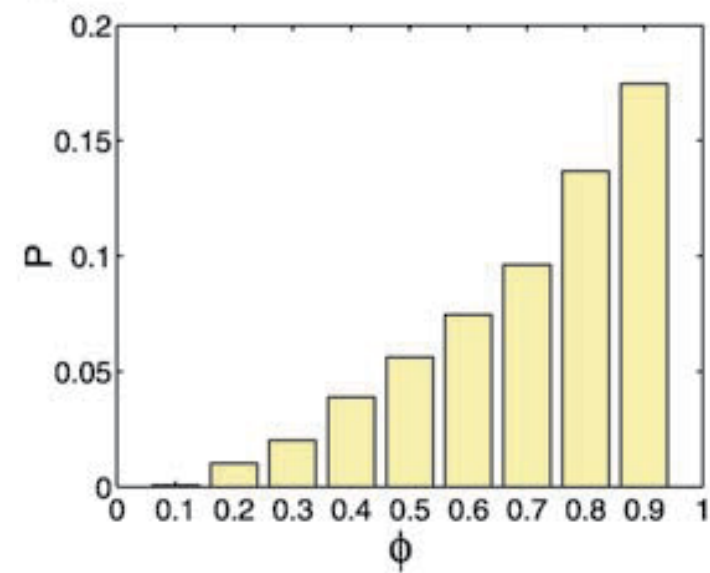
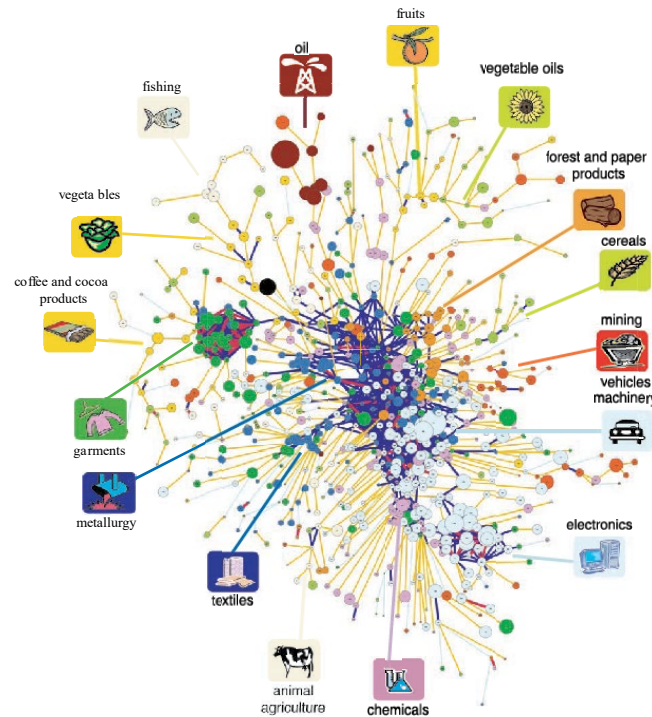


Opportunities:

Complexity & developing the adjacent possible

The Product Space Conditions the Development of Nations

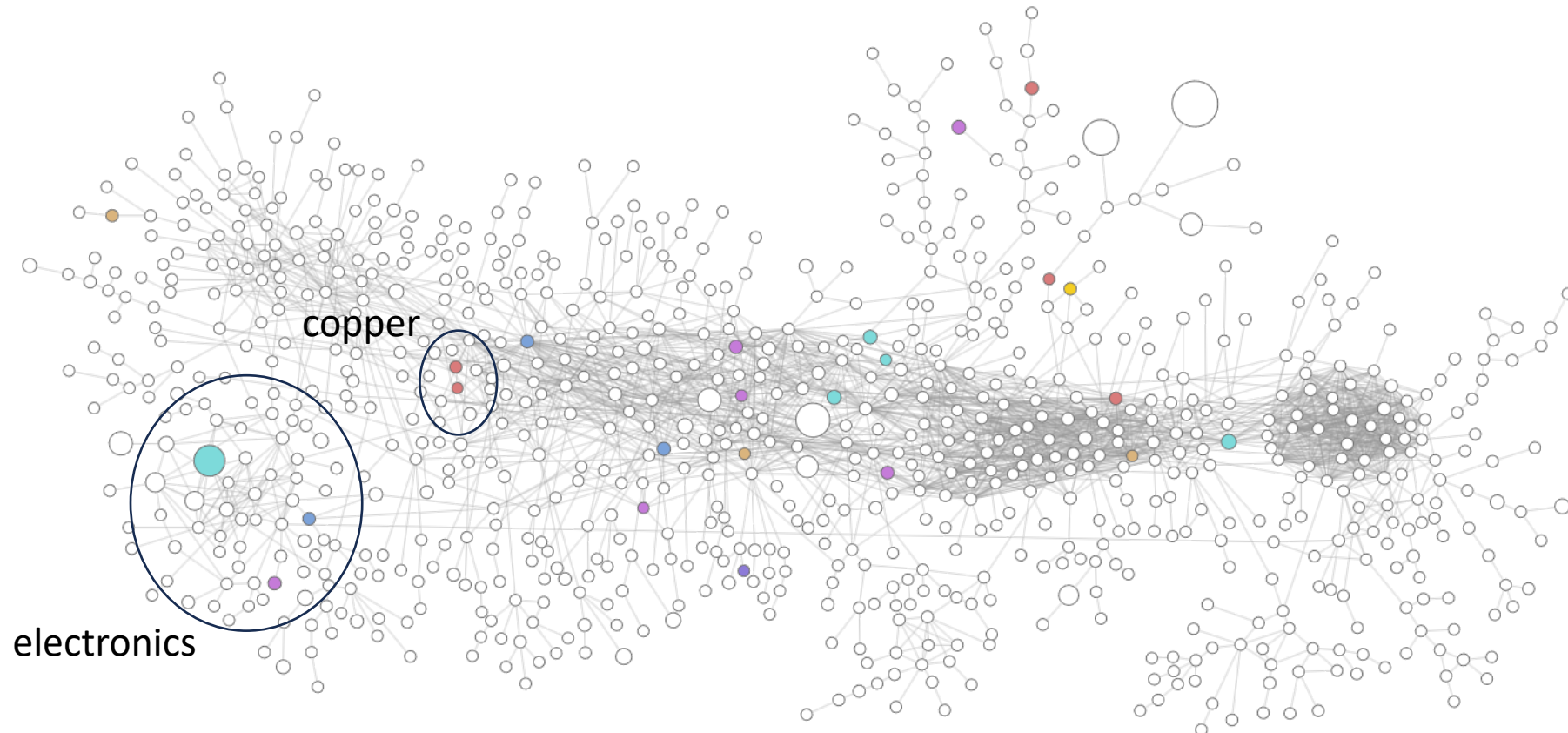
C. A. Hidalgo,^{1*†} B. Klinger,^{2*} A.-L. Barabási,¹ R. Hausmann²



Opportunities in the green transition

Clean tech in the product space

Products related to wind power

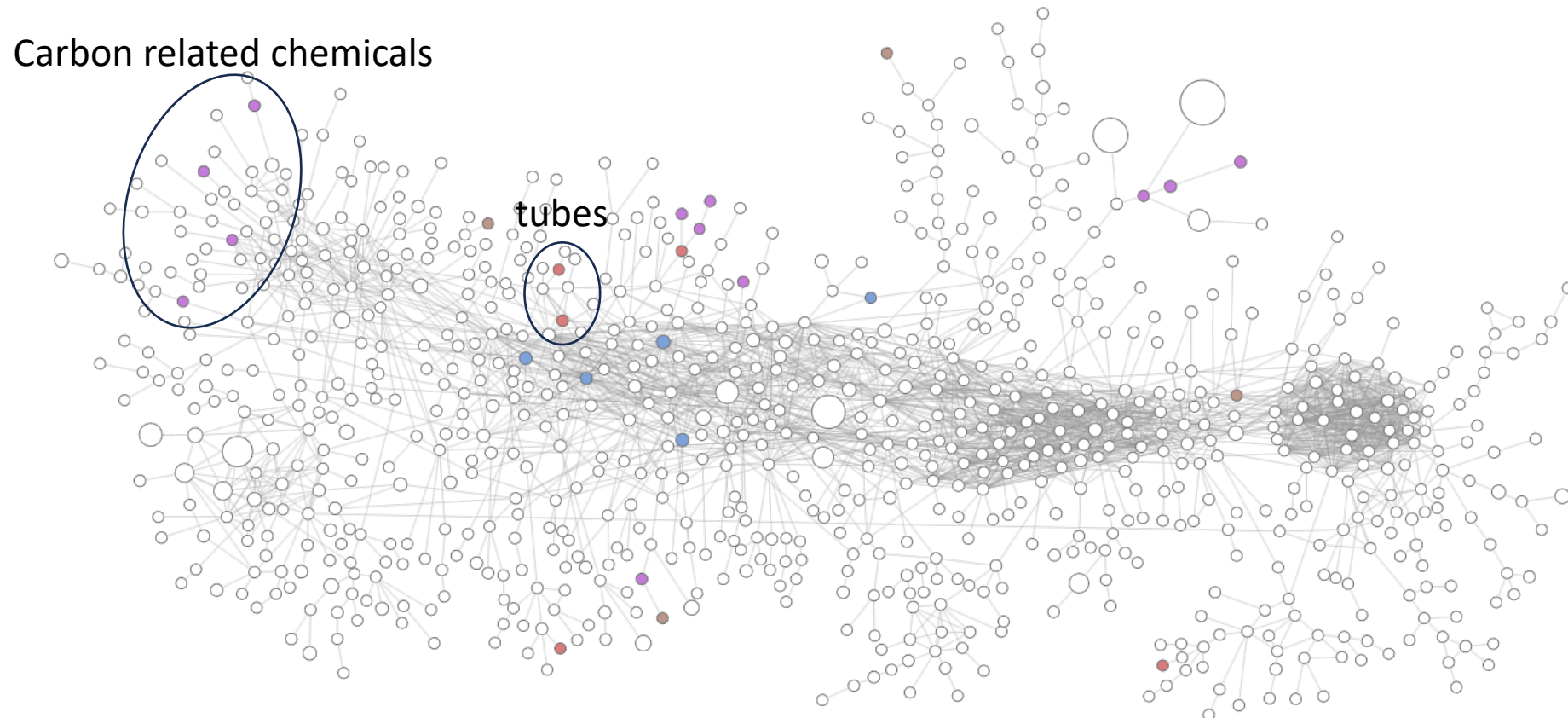


Source: Ongoing work Yang Li @Harvard Growth Lab

Opportunities in the green transition

Clean tech in the product space

Products related to carbon capture



Source: Ongoing work Yang Li @Harvard Growth Lab

Making long jumps

Can resources be leveraged to make long jumps?

- Suppose a country possess rich lithium deposits. Can this kickstart diversification dynamics?
- Moving down the value chain may require new capabilities
- How to acquire these capabilities?
 - Training: expensive & where to get initial experts?
 - Immigration (Moser et al. 2014; Peri et al. 2014; Hornung, 2014, Hausmann and Neffke, 2019,...)
 - FDI (local sourcing conditions)

Uncertainty

Example 1: adoption of electric vehicles

Changes have been taking us by surprise

- Electric vehicles

- ILO 2018 projections market shares of electric vehicles for **2025**:

- Global: 14%
 - Europe: 31%
 - China: 16%
 - US: 5%

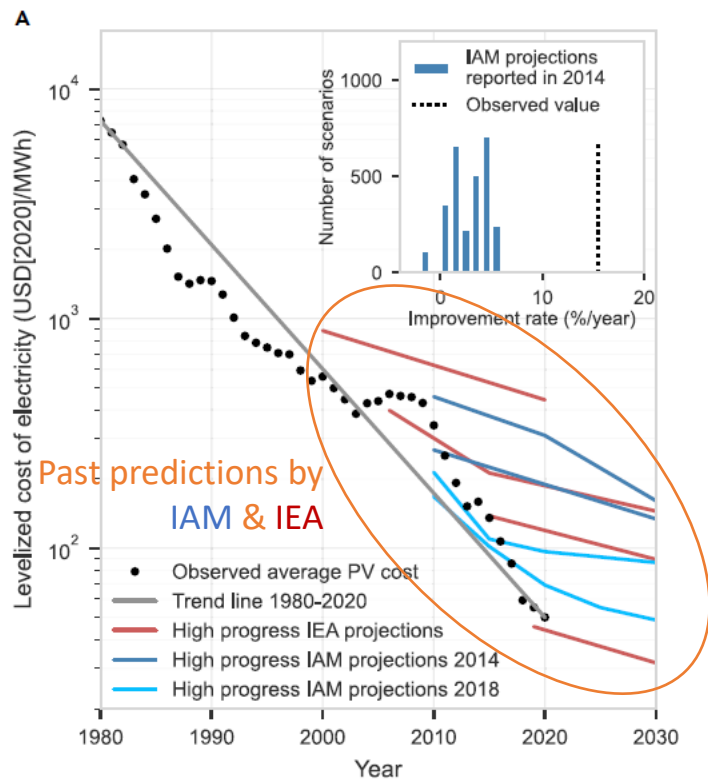
- IEA **2023** projection (based on sales in first quarter sales):

- Global: 18%
 - Europe: 25%
 - China: 35% (government's 2025 goal: 20%)
 - US: 12%

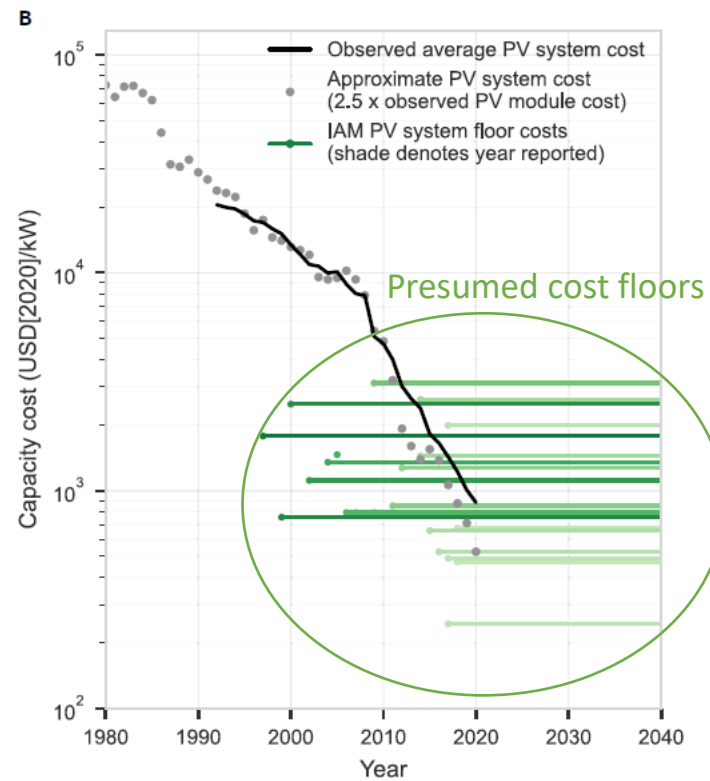
Example 2: Evolution of the cost of electricity

Large historical underestimates (Way/Ives/Mealy/Farmer, 2022)

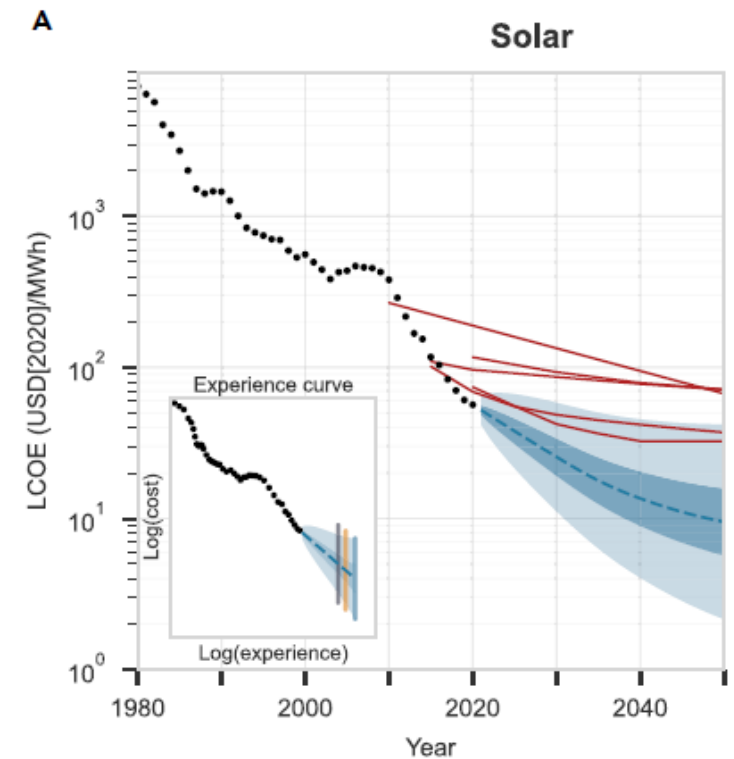
Predicted costs of solar power



Presumed cost floors (IAM)



Projected costs 2040



Projected levelized electricity costs:
 Today: ~100 USD/MWh
 2040: 2-40 USD/MWh

Source: Way, R., Ives, M.C., Mealy, P. and Farmer, J.D., 2022. Empirically grounded technology forecasts and the energy transition. *Joule*, 6(9), pp.2057-2082.

Uncertainty

Green transition: fast moving & constant changes

- Uncertainty in many domains
 - Technological, with spiraling, self-reinforcing dynamics
 - Relative prices
 - Policy
 - Labor markets
- Systemic constraints are not permanent, but have shadow prices
 - Technological and policy constraints have implicit prices
 - As constraints become binding, workarounds increase in value
 - Consequence: innovation to substitute materials, resolve systemic bottlenecks, etc.

In sum

Multiple transitions, challenges and solutions

- Green transition is multifaceted and promises transformation across labor markets, industries, firms and the global division of labor
- Opportunities exist, but with many uncertainties
 - Different industries require different solutions
 - Uncertainty across many domains
 - Systemic shifts due to rising shadow prices of constraints
- Guiding principle: How can the green transition contribute to **sustained** competitive advantages? (Juhász, Lane, Rodrik, 2023).
 - Fit with current capabilities?
 - Local effects (pollution & social consequences)?
 - building up new industries (e.g., local sourcing requirements)? Or reducing costs for other industries? Sovereign wealth funds?