Green transition(s)

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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*

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Critical resources

However, so does the old energy system

Jobs
Reskilling

Example: energy transition

- Net zero emissions pathway
  - 15M new jobs in clean energy sector
  - 5M lost jobs in old energy sector
  - Training/reskilling for 30M workers
Reskilling is not trivial

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

Continuous Mining Machine Operators
47-5041.00

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

- 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

Source: https://www.onetonline.org/
Reskilling is not trivial

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

Solar Photovoltaic Installers
47-2231.00

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

- 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

- 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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- “Green” jobs tend to require higher levels of education (Bowen/Kuralbayeva/Tipoe, 2018) and different skill sets
Transitioning from brown to green jobs

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

Easiest to transition from brown jobs to other brown jobs

Reskilling

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

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*

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
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?