MEERTALK

MINERAL SUPPLY CHALLENGES TO PHASE OUT FOSSIL FUELS

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SUMMARY

Since conventional oil supply peaked in 2005, we have witnessed a remarkable period of volatility in the price of base and rare minerals. Dr. Michaux conducted an assessment of the extra capacity required of alternative energy electrical powers to completely replace fossil fuels. He found that current plans are unrealistic, and the task of shifting from an economy run on fossil fuels to one completely run on critical minerals is much larger than our current paradigm allows for. While in no way second guessing the necessity of the energy transition, he demonstrates that the total metal required to produce one generation of EV's batteries, wind turbines and solar panels, using only 4 weeks of energy storage buffer for wind and solar, which is an incredibly conservative estimation, exceeds current global metal production by two orders of magnitude. It also exceeds current reported global reserves by approximately a factor of 5. You can't recycle what you haven't already built, so this will prove a particularly relevant question over the course of the next 30 years.

Dr. Michaux draws our attention to the relatively poor "Energy Return on Energy Invested" of renewables. He highlights that solar PV requires extremely high temperatures to be manufactured, and that these temperatures can only be achieved with coking fuel, as of now. To replace that primary energy source with biofuels would be possible, but would entail a massive increase in environmental pollution. Strikingly, he questions whether an industrial economy of the sort we are accustomed to today could be powered entirely by renewables and have enough excess energy to reproduce itself for successive generations.

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SUMMARY CONTD

Dr. Michaux views solar, wind and other renewable technologies as a stepping stone, but to where is still an open question; if we don't find an alternative, however, we could be stepping into a very low energy future indeed. As the excess energy of our industrial economy decreases due to a fundamental shift away from fossil fuels, the challenge of extracting additional minerals will only prove more difficult as the ore quality deteriorates and costs to extraction rise.

Dr. Michaux emphasized the sheer quantity of energy that is wasted and encourages a more intentional assessment of our relationship with energy, assessing who really needs what energy services and for what purpose rather than attempting to recreate our current energy system, albeit with new fuels.

MEER COMMUNITY QUESTIONS

- ·What is the optimal mix of clean energy sources from the perspective of efficient mineral and metal use?
  - A: Hydropower is the best performer by far, but is constrained by the availability of good resource locations. Wind power may be the runner up, as it doesn't face the same challenge with needing cooking fuel that silicon wafers for PV panels do. The most important tasks are to reengineer our technologies to accommodate a rougher power grid, look at what we are using power for, analyze this in a systematic way, and make rational decisions.
- How will the future system (governance and all) function?
  - A: We need to change our relationship with energy, possibly with each other, and also with minerals. If we are moving into a world where there isn't enough to go around, we will need to cooperate to some degree or else risk negative outcomes. He envisions a combination of bottom up (free market) and top down (collectivist) forces to divvy up and distribute resources.
- What are the groups of society you have described?
  - A: Dr. Michaux has described four groups:
    - *cornucopians* – claim there is no problem and thus can't be reasoned with
    - *vikings* – will attempt to steal other people's resources, at least in the short term when that will still be at least a partially viable strategy
    - *realists* – people who work on the practical challenge of how people can continue to live well and society won't tear itself apart
    - *arcadians* – those who are interested in making a genuinely stable society that maintains a level of technology and knowledge that we have now, alongside important achievements like human rights.
  - Realists and arcadians are joined at the hip. The highest maintenance group is actually the cornucopians, claiming everything is fine.

LIVE AUDIENCE QUESTIONS

- What is the potential of seafloor mining?
  - A: He wouldn't suggest this route because it is expensive, extremely challenging, and, to deliver the quantities of metals needed, it would kill off whatever life in the ocean there still is.
- Will concentrated PV or thermal PV be more scalable than regular PV?
  - A: He hasn't done an analysis on this, but thinks that in concept, it is a great idea. Instead of scaling that up, however, what about scaling down our needs to match what we have?
- Are the forecasts theoretical or physically possible?
  - A: Forecasts relied upon by policymakers are theoretical, but in his analysis not feasible (which has been the purpose of his work).
- Does ammonia have potential as an energy carrier?
  - A: There are many great ideas but the key is to ask what resources are required to make it viable and then scale it up for a task across the planet. The next work needs to be done on solving that problem.
- Do nonconventional batteries still have materials constraints?
  - A: Possibly not, but that wouldn't have an impact in the short term. While we wait for amazing technological breakthroughs, it may be best to scale back our expectations of performance and complexity.
- How do you expect future mineral and ore extraction rates will be affected by both declining ore quality and rising costs to extract them?
  - A: Badly. If we are going to need more resources, we are going to need more energy to pull them. If we are in an entirely non fossil fuel powered world, the technology that we have at the moment is not particularly good.
- Are algae plumes a viable energy resource?
  - A: Somewhat surprisingly, the energy required to produce a portion of fuel of algae was 10 times more than what came out of the algae. Lots of breakthroughs will be needed to make that viable.
- What amount of finite water will be needed to mine?
  - A: This is a real problem, and increasingly so. While it wasn't a focus of his current research, he has done other writing on it.
- How soon does the system need to be changed?
  - A: We should have started 20 years ago. A better question is when we will get our first serious shock. Once we understand all of the moving parts of the system (including biodiversity loss), then we can make a credible plan.