Natural Resources Council of Maine
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Testimony in Opposition to An Act Regarding the Management of the Waste Components of a Solar Energy Development upon Decommissioning

To the Committee on the Environment and Natural Resources
by Jack Shapiro, Climate and Clean Energy Program Director
January 27, 2025

Senator Tepler, Representative Doudera, members of the Environment and Natural Resources Committee, my name is Jack Shapiro, and I am the Climate and Clean Energy Director at the Natural Resources Council of Maine (NRCM). NRCM has been working for more than 60 years to protect, restore, and conserve Maine's environment on behalf of our 30,000 members and supporters. I'm here today to testify in opposition to LD 92, An Act Regarding the Management of the Waste Components of a Solar Energy Development upon Decommissioning.[1]

In addition to our work on climate and clean energy, which supports the development of new sources of Maine-made clean energy like solar, NRCM has a program dedicated to sustainability and reducing waste. The issue that this bill seeks to address is a legitimate disposal issue that is receiving due attention from both the waste and renewable energy sectors, but this bill, which would set an arbitrary 90-day deadline for the recycling or disposal of waste components of a solar project, is not well-thought through, and has several likely unintended consequences.

Policy considerations
From a policy consistency perspective, it is arbitrary to apply this standard solely to solar installations. For example, in the energy sphere, we have no requirement that pipelines, or electricity poles, wires, or transformers be recycled or disposed of within a particular timeframe. More broadly as an example, construction and demolition debris is a significant waste source as well, much of which can be reused or recycled, but is not subject to these same requirements.

Further, this time requirement could actually serve to prevent the recycling or reuse of these panels. As solar energy has grown in the past several decades, the industry has experienced that many panels can still produce significant amounts of energy even after their planned useful lives. Second-hand solar panels producing locally made energy is preferable to either recycling or disposal, and this short and arbitrary timeline could prevent those beneficial reuses from occurring in Maine.

[1] https://www.mainelegislature.org/legis/bills/getPDF.asp?paper=HP0057&item=1&snum=132

The solar recycling industry is expected to grow, because solar panels are made of materials that are either highly recyclable or valuable. Solar recycling is expected to be a $2.7 billion industry worldwide by 2030.[2] However, due to the timing of the significant growth of solar, and the fact that we are still well within the lifetimes of most solar panels installed worldwide, there is currently not enough "supply" to support many large-scale solar recycling facilities. Until the expected growth of solar recycling in the Northeast occurs, this requirement might lead to more solar panels being landfilled rather than recycled when they do reach the end of their lives.

Existing consideration of decommissioning and solar waste
In 2023, this committee unanimously passed LD 466, a "Resolve, to Evaluate Options for the Recycling of Solar Panels and Wind Turbine Blades."[3] The Maine Department of Environmental Protection (DEP) included consideration of solar panels as a candidate for inclusion in their product stewardship report in 2024,[4] and we plan to submit comments on that report by their deadline in February.

Waste context and magnitude
With the above said about this particular bill, there are two additional critical points of context as it relates to waste, energy, and sustainability. The first relates to the magnitude of solar waste as compared to other sources of waste. A 2023 study in the journal *Nature* evaluated the relative scales of several waste streams worldwide.[5] They found that, worldwide, solar waste generated between 2016 and 2050 would result in between 54 and 160 million metric tons of waste. While that is significant, and as stated above, is important to attend to, we should consider it in context of other waste streams, for example:

- Electronic waste: 1,876 million metric tons, <u>11 times greater</u> than solar
- Plastic waste: 12,355 million metric tons, <u>77 times greater</u> than solar
- Coal ash: 45,550 million metric tons, <u>284 times greater</u> than solar
- Municipal waste: 70,350 million metric tons, <u>439 times greater</u> than solar

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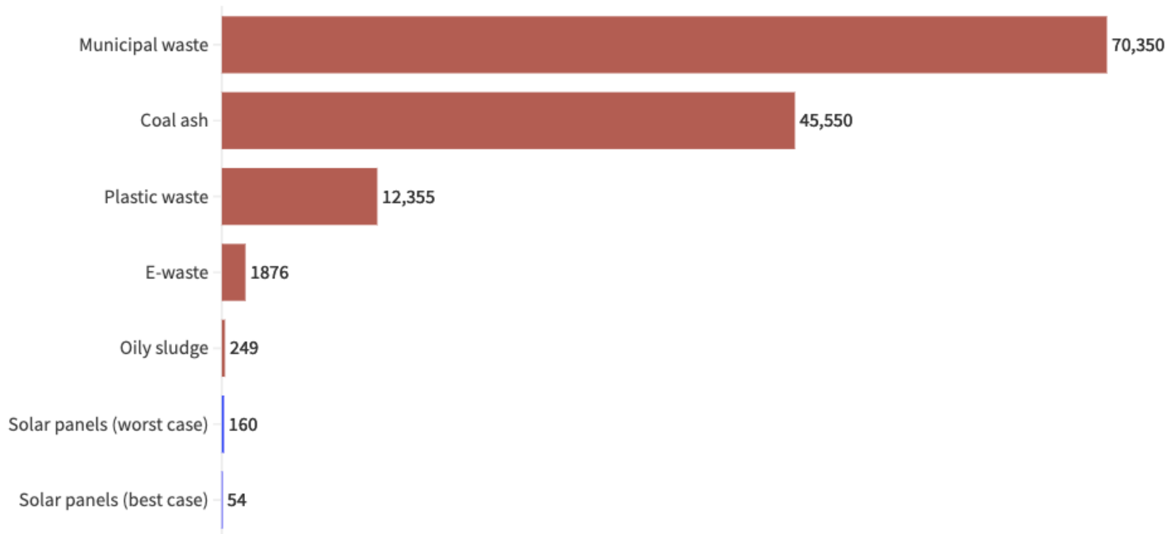
[2] https://www.rystadenergy.com/news/reduce-reuse-solar-pv-recycling-market-to-be-worth-2-7-billion-by-2030
[3] https://legislature.maine.gov/bills/display_ps.asp?snum=131&paper=HP0283PID=1456
[4] https://www.maine.gov/dep/waste/productstewardship/index.html
[5] https://www.nature.com/articles/s41567-023-02230-0

Cumulative waste generated, millions of metric tons



Data Source: Mirletz et al. (2023). Unfounded concerns about photovoltaic module toxicity and waste are slowing decarbonization. Nature Physics.

It is also worth noting that some of these fossil-fuel waste sources are extremely toxic and hazardous. According to the U.S. Environmental Protection Agency, coal ash contains a number of substances harmful to human health, including arsenic, cadmium, and mercury.[6] Fluid waste from hydraulic fracturing or fracking – which is the source of much of the natural gas Maine uses for electricity generation – can be radioactive, and is not currently regulated,[7] leading to dangerous uses, like dust suppression or deicing roads.[8]

Efficiency and electrification

Even more broadly, concerns about waste and environmental impact in the use of energy should point squarely to the rapid adoption of clean energy technologies. The International Energy Agency defines electrification as follows: *"Electrification means replacing technologies or processes that use fossil fuels, like internal combustion engines and gas boilers, with electrically powered equivalents, such as electric vehicles or heat pumps. These replacements are typically more efficient, reducing energy demand, and have a growing impact on emissions as electricity generation is decarbonised."*[9] For example:

- Gas cars are not very efficient, using only about 20% of the energy that is put in for motion. 80% of the energy is wasted, mostly as heat. Electric cars are much more efficient: They use 67% of the energy that comes in, and 22% more is recovered through regenerative braking, which is standard, resulting in roughly 89% efficiency.[10] Further,

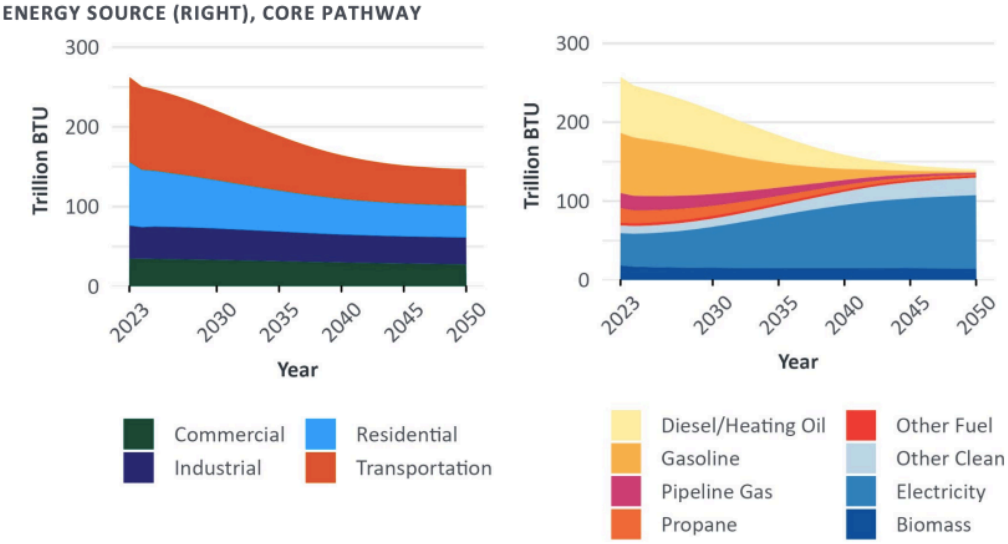
[6] https://www.epa.gov/coalash/coal-ash-basics
[7] https://www.epa.gov/radiation/tenorm-oil-and-gas-production-wastes
[8] https://www.nrdc.org/sites/default/files/fracking-mess-regulation-radioactive-waste-report.pdf
[9] https://www.iea.org/energy-system/electricity/electrification
[10] https://www.sustainabilitybynumbers.com/p/inefficiency-ice

conventional gasoline cars lose 10-20% of their driving range when the temperature drops to 20 degrees, according to the U.S. Department of Energy.[11]

- The maximum efficiency of a modern methane gas furnace or boiler is just above 95%. For an oil boiler, Energy Star-rated boilers are 87% efficient. Heat pumps on the other hand – since they are moving heat energy instead of creating it – can be up to 300-400% efficient at turning energy input into heat. Even in very cold temperatures when the efficiencies of heat pumps drop, they are still 150%-200% efficient, outpacing fossil fuel heating options.
- Burning fuel in an electric power plant to make heat energy, to physically spin a turbine, to then generate electricity is also inefficient compared to generating electricity directly from a solar panel or a wind turbine.

This dynamic is shown in the technical analysis conducted to support the 2025 Maine Energy Plan. The analysis shows overall energy consumption declining, but more of that energy consumption being comprised of more-efficient electrified end-uses:[12]

FIGURE III-1: TOTAL ANNUAL PRIMARY ENERGY CONSUMPTION IN MAINE BY SECTOR (LEFT) AND BY ENERGY SOURCE (RIGHT), CORE PATHWAY



Note: "Other Fuel" includes coal, compressed/ liquefied pipeline gas, jet fuel, kerosene, other petroleum, and residual fuel oil; jet fuel accounts for the bulk of this category. "Other Clean" includes ammonia, liquid hydrogen, on-site hydrogen, and steam. Note that while the demand for diesel, gasoline, pipeline gas, propane, and "Other Fuel" has traditionally been met with fossil fuels, many of these demands are met by carbon-neutral alternatives in the long run. The model determines the most economical way to satisfy these demands, subject to constraints on gross and net greenhouse gas emissions.

Energy flow diagrams from the Lawrence Livermore National Lab also provide an excellent visual of the energy waste inherent in our current system. The light gray "rejected energy" rectangle in the top right represents waste in Maine's energy system.

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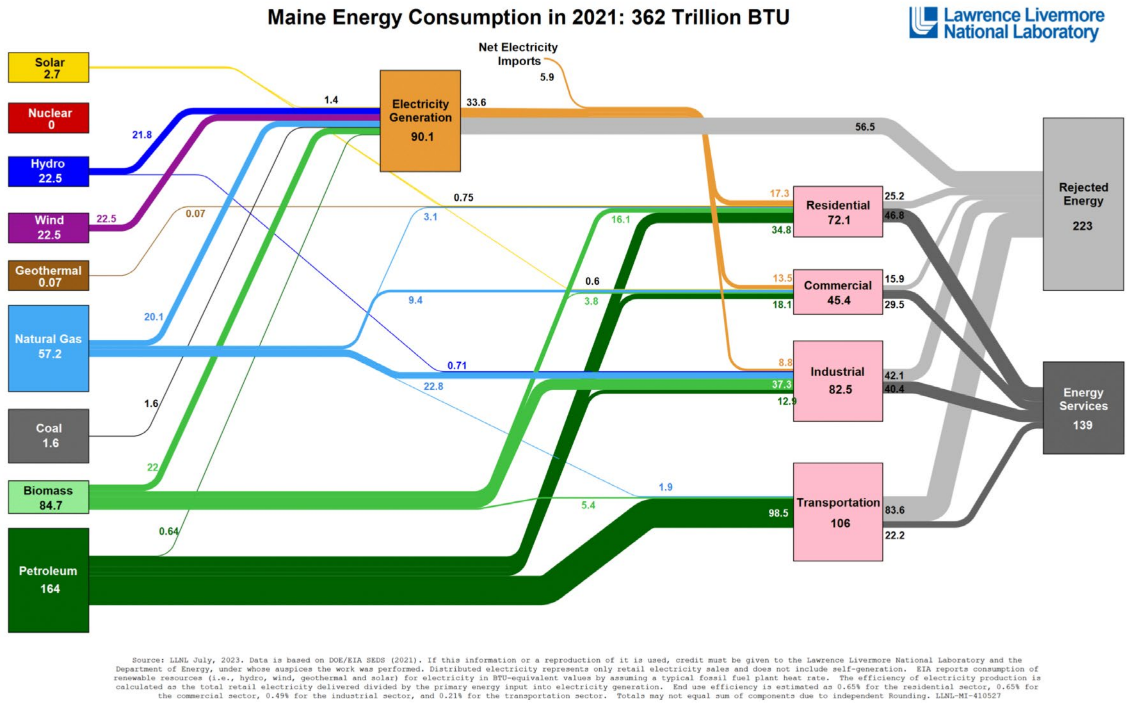
[11] https://www.energy.gov/energysaver/fuel-economy-cold-weather

[12] https://www.maine.gov/energy/sites/maine.gov.energy/files/2025-01/Maine%20Pathways%20to%202040%20Analysis%20and%20Insights.pdf

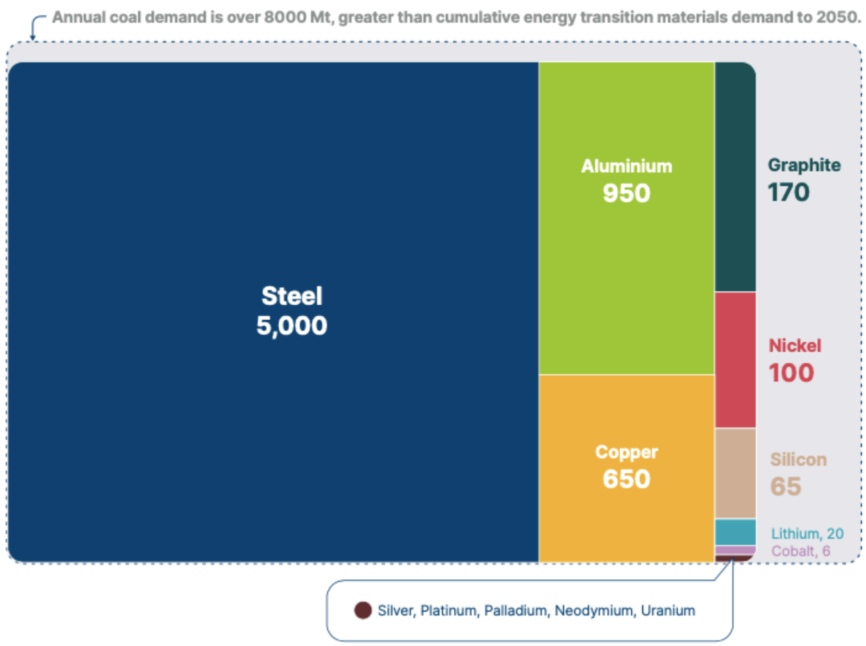


From an overall material demand perspective, clean technologies also out-compete our existing fossil fuel system. A 2023 study evaluated the demand for materials for the entire global energy transition to net-zero carbon emissions by 2050. They found that it would massively reduce mining and other environmental burdens from materials extraction. The upper bound of total material requirements for the energy transition by 2050 would still be less than one year of current coal extraction by mass, with iron ore for steel production accounting for more than 75% of those requirements.[13]

[13] https://www.energy-transitions.org/wp-content/uploads/2023/07/ETC-Material-and-Resource-Requirements_vF.pdf

An upper bound of total material requirements for the energy transition would still be less than one year of coal, by mass; steel accounts for over 75%

Cumulative material requirements for the energy transition,[1] 2022–50
Million metric tonnes



NOTE: [1] Based on the ETC's Baseline Decarbonisation scenario, where an aggressive deployment of clean energy technologies leads to global decarbonisation by mid-century, but materials intensity and recycling trends follow recent patterns. This is for end-use of metals/materials, and quantities refer to amounts of contained material. For example, the values given are for end-use aluminium, not mined bauxite, or for elemental lithium, not lithium carbonate/hydroxide.

SOURCE: Systemiq analysis for the ETC; BP (2022), *Statistical review of world energy*.

Conclusion

In summary, while disposal and recycling of solar panels is an important issue to consider, the specific solution proposed in this legislation does not seem to account for the specific end-of-life considerations for solar panels that would enhance reuse or recycling, or the overall context of energy and waste. We encourage the Committee to vote Ought Not to Pass.

I would be happy to answer any questions.

Thank you.