REWIRING AMERICA

Pace of Progress Methodology

JUNE 2023 BASELINE REPORT

This methodology is based on modeling done by Evolved Energy Research for Princeton's Net Zero America study, with accelerated electrification targets.

Our pace of progress methodology is as follows:

1. We calculate current appliance proportions: we use EIA's Residential Energy Consumption Survey for space heating, water heating, cooking, and rooftop solar. We use Alternative Fuel Data Center Vehicle Registrations data for current vehicle proportions.

2. We set a stock target: in all cases, we want 100 percent of households to have efficient electric appliances and vehicles by 2050.

3. We set a sales target: we work backwards based on an average equipment lifetime to find the approximate date that sales must be 100 percent electric for stock to be 100 percent electric by 2050 — for example, most space heating machines have a lifetime of about 15 years, so we must reach all-electric sales by 2035 to reach all-electric stock by 2050. We get appliance lifetimes from InterNACHI, vehicle lifetimes from Bureau of Transportation Statistics and FRED, and rooftop solar lifetimes from the Department of Energy.

4. We calculate the sales curve using the equation below.

Let:

- p_t^s denote the proportion of sales of heating type s in year t
- a^s or `current_sales` represent the current proportion of sales of heating type s
- k^s or `sales_target` represent the target proportion of sales of heating type s in the end year
- m or `inflection_point` represent the inflection point of the s curve
- b or `slope` represent the slope of the s curve

$$p_t^s = a^s + \frac{k^s - a^s}{1 + e^{-b(t-m)}}$$

We derive the slope of the S-curve, from Evolved Energy Research/Princeton's Net Zero America study, to be:

$$b = 10/(year_{start} - year_{end})$$

We treat the inflection point of the S-curve as a free parameter, which we vary until the S-curve between 2020 and 2023 roughly matches with the business-as-usual sales trend.

5. We calculate the stock curve from the sales curve and the equipment lifetimes using the equation below.

Let:

- Z_t^s denote the stock of space heating type s in year t, , where $t = 0$ denotes 2020 and Z_0^s is assumed to be from data.
- X_t^s denote the sales of space heating type s in year t, and $X_t^s = \frac{1}{l_s} \times Z_0^s$ for all $t < 0$
- p_t^s denote the proportion of sales of heating type s in year t
- N denote the total number of new space heating units added to the stock each year
- S denote the set of all space heating types

Note that all units are in 1000s

$$X_t^s = p_t^s \left(N + \sum_{s' \in S} X_{t-l_{s'}} \right)$$

$$Z_t^s = Z_0^s + X_t^s - X_{t-l_s}$$

6. We compare the required sales from our pace of progress model to historical growth trends, assuming linear historical growth. We get heat pump historical sales trends from the Air-Conditioning, Heating and Refrigeration Institute (AHRI), heat pump water heater historical sales trends from ENERGY STAR, induction stove historical sales trends from the Association of Home Appliance Manufacturers (AHAM), electric vehicle historical sales trends from the Department of Transportation, and rooftop solar historical sales trends from EIA Renewable Energy Data.