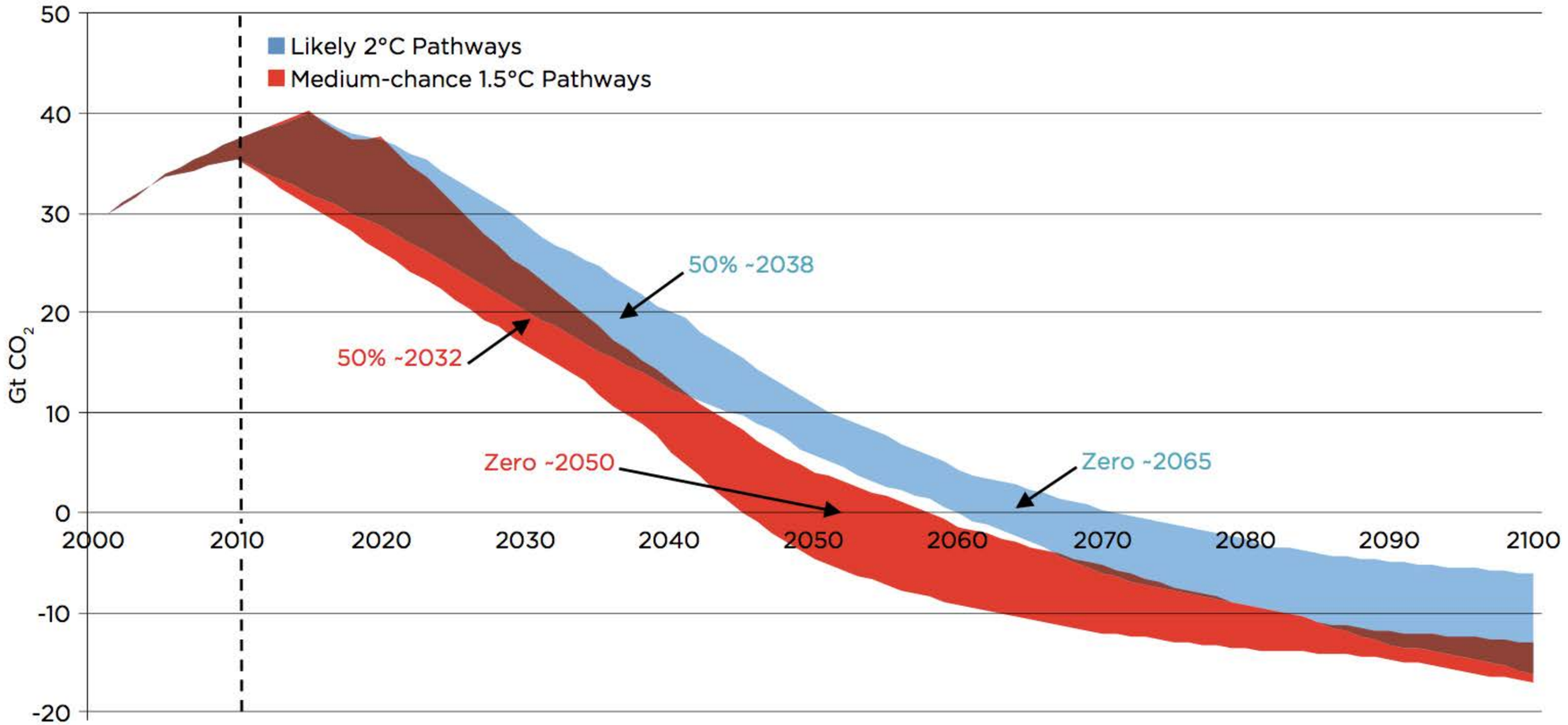
Electrify everything!

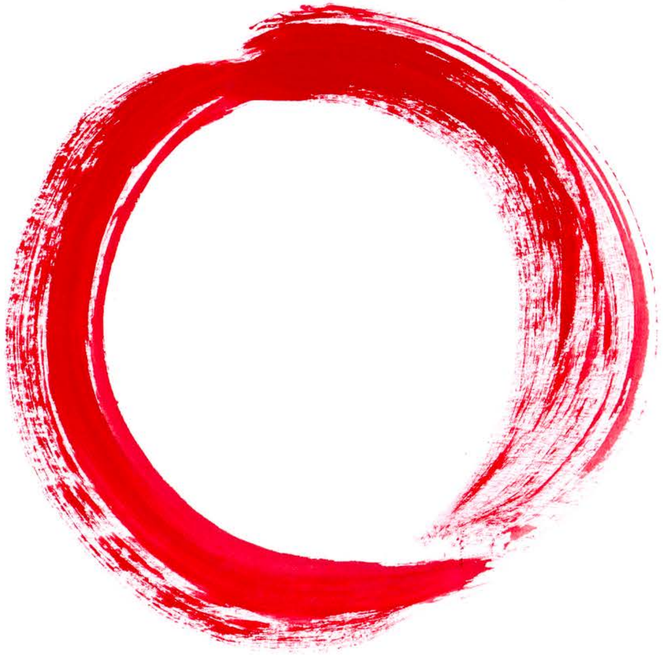
David Roberts, vox.com

Climate change requires 100% decarbonization by midcentury

Figure 1: Range of Global Emissions Pathways in Scenarios Consistent with Likely Chance of 2°C or Medium Chance of 1.5°C[18]



Sources: Joeri Rogelj et al



Zero-carbon electricity is within reach.

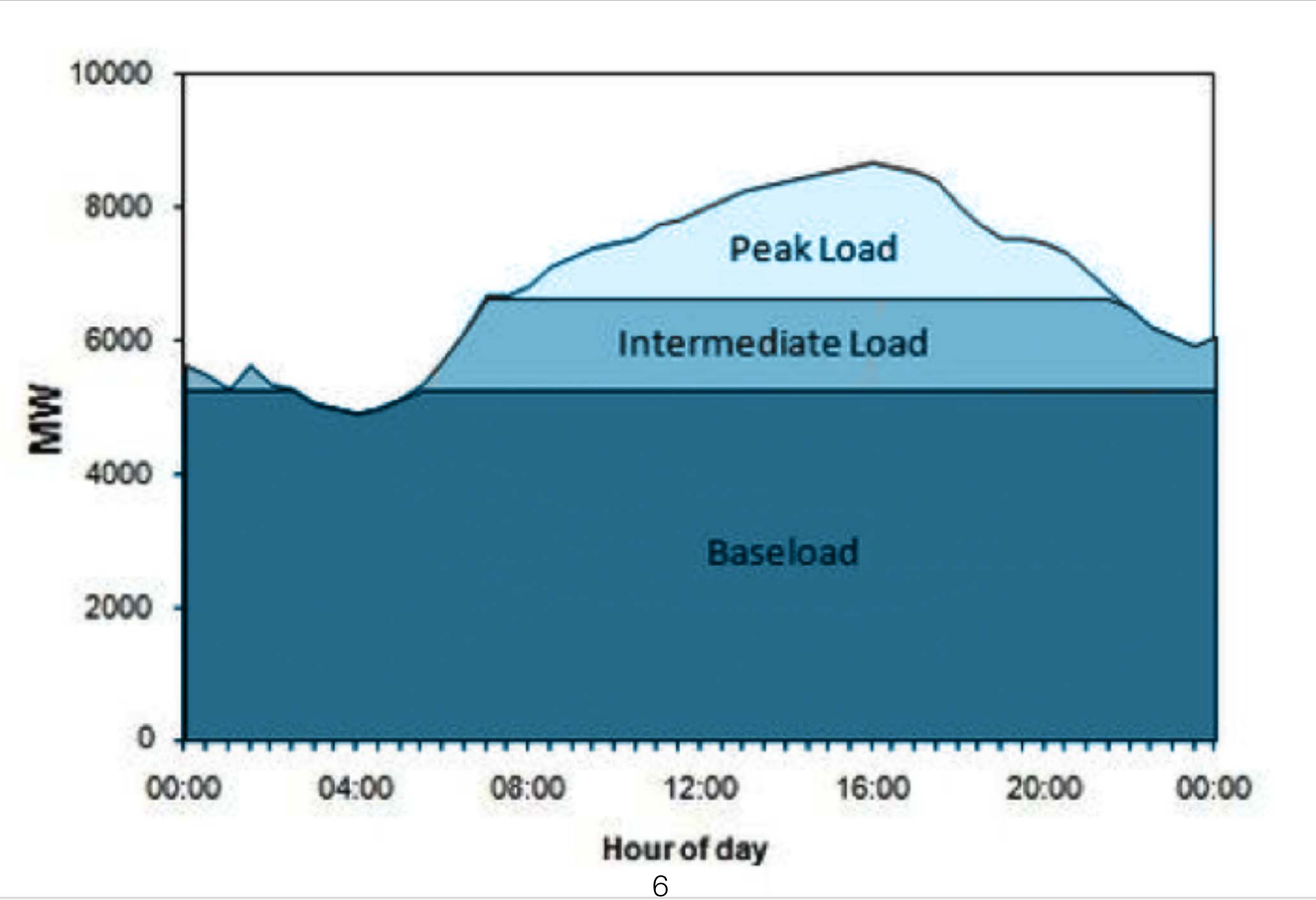
Zero-carbon fossil/biofuels are not.

Thus: **electrify everything!**

1. Green the grid
2. Get everything on the grid

Two kinds of problems:
1. Balancing the grid
2. Electrification policy/politics

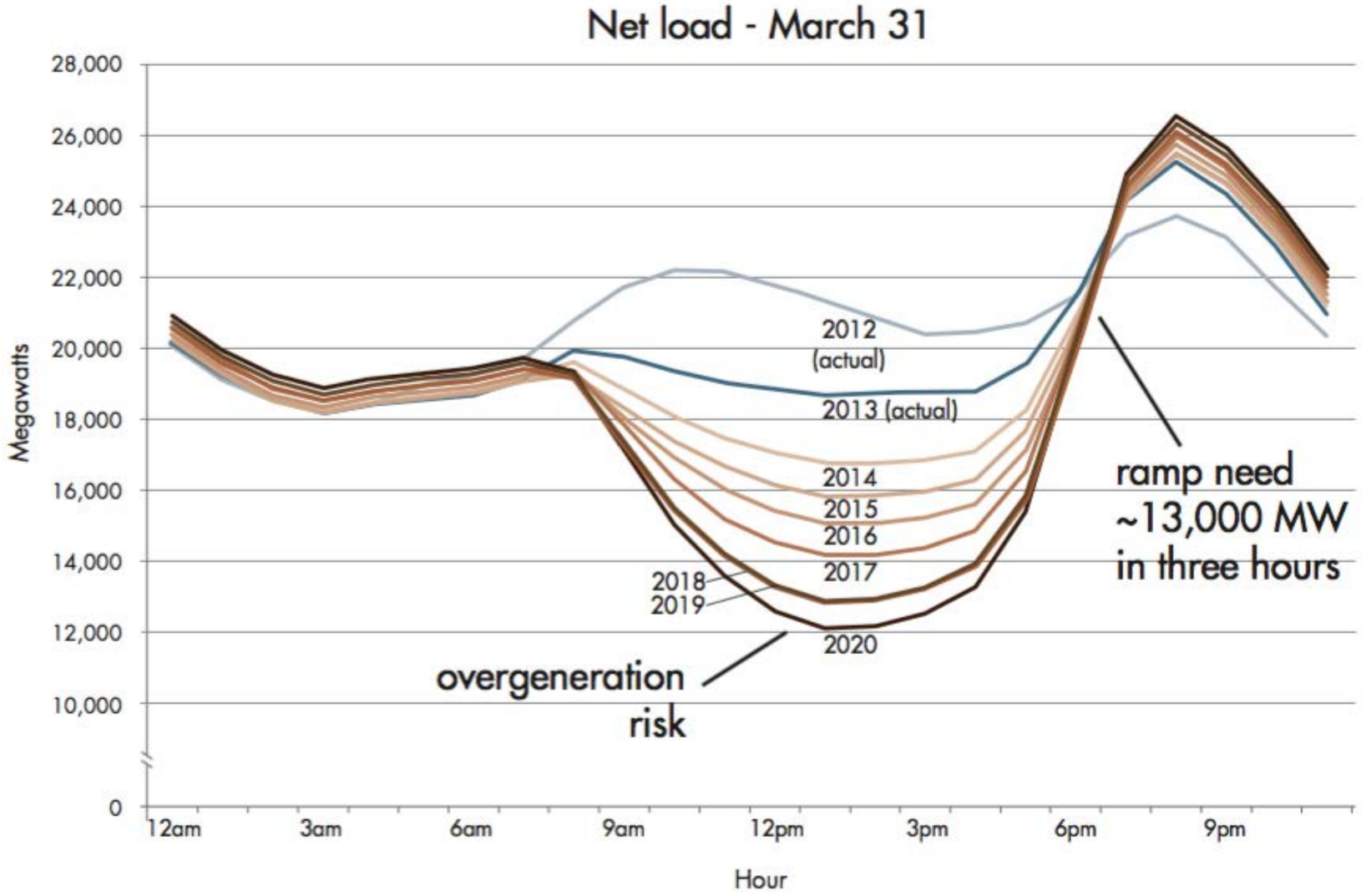
Old model: supply is dispatchable and load (demand) is inflexible



New model: supply is more variable and load is more flexible

The dreaded duck curve

Figure 2: The duck curve shows steep ramping needs and overgeneration risk



Electrifying everything means finding ways to balance short- and long-term variations in wind & solar

Right now, most of that balancing is being done with natural gas.
Awkward.

Grid flexibility solutions:

1. **shut down baseload plants** (a political, not technical, challenge)

Grid flexibility solutions:

1. shut down baseload plants
2. **build transmission lines** (another political, not technical, challenge)

Grid flexibility solutions:

1. shut down baseload plants
2. build transmission lines
3. **storage and other DERs**: batteries, solar panels, fuel cells, electric vehicles, and microgrids, oh my!

Grid flexibility solutions:

1. shut down baseload plants
2. build transmission lines
3. storage and other DERs
4. **demand-side magic**: shift loads, find new sources of demand, coordinate EV fleets

Grid flexibility solutions:

1. shut down baseload plants
2. build transmission lines
3. storage and other DERs
4. demand-side magic
5. **improve grid architecture**: more smart meters & smart inverters, more sensors and AI, more microgrids

Grid flexibility solutions:

1. shut down baseload plants
2. build transmission lines
3. storage and other DERs
4. shift demand
5. improve grid architecture
6. **better energy markets**: value grid services properly, open electricity services up to market competition

Grid flexibility solutions:

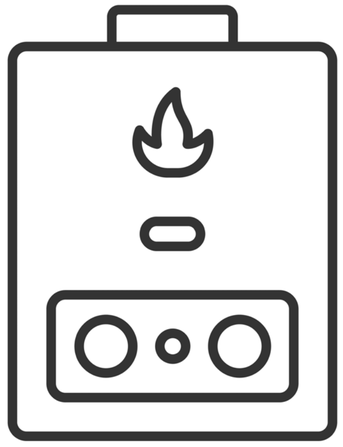
1. shut down baseload plants
2. build transmission lines
3. storage and other DERs
4. shift demand
5. improve grid architecture
6. better energy markets
7. **etc.**

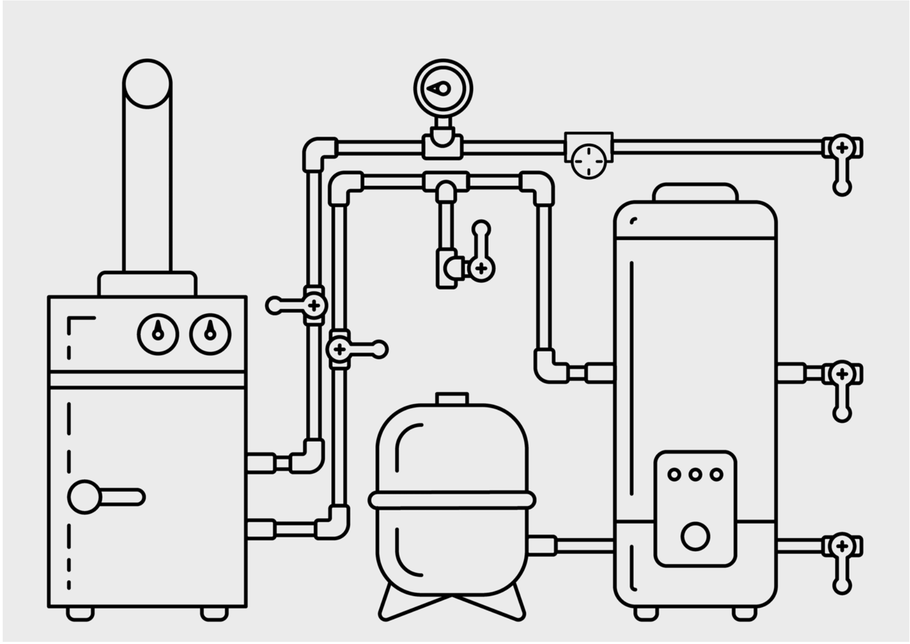
Electrification challenges:

1. Transportation

Electrification challenges:

2. Heating & cooling





Electrification challenges:

3. Industry

Thanks!

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