

NOVEMBER 2021

Mass Beneficial Electrification



AGENDA

This talk explores aspects of a national mass electrification project, including the required timeline, scale and technology - and discusses related policy changes and financial mechanisms.

The Bay Area is home to several ground-breaking initiatives in this arena. What are they, and how can your individual actions contribute to solving the climate crisis?

Good news!

**Political will is the only obstacle to solving
climate change.**

No technological breakthroughs are needed!

Bad news!

**Political will is the only obstacle to solving
climate change.**

What is the goal:

**Stabilizing the climate at an
acceptable level!**



What *is* an acceptable level?

- Paris Climate Accords aim to substantially reduce global greenhouse gas emissions in an effort to limit the global temperature increase in this century to 2 degrees Celsius above preindustrial levels, while pursuing means to limit the increase to 1.5 degrees.
- Intergovernmental Panel on Climate Change (IPCC): “Limiting global warming to 1.5°C would require rapid, far-reaching and unprecedented changes in all aspects of society”

Where are we now?

- Currently around 1.2°C above preindustrial levels
- September 2020 was hottest month ever globally
- 2020 was the second hottest year ever, just behind 2016
- Continue to add committed emissions
i.e. coal & NG plants, FF vehicles, etc. ☀

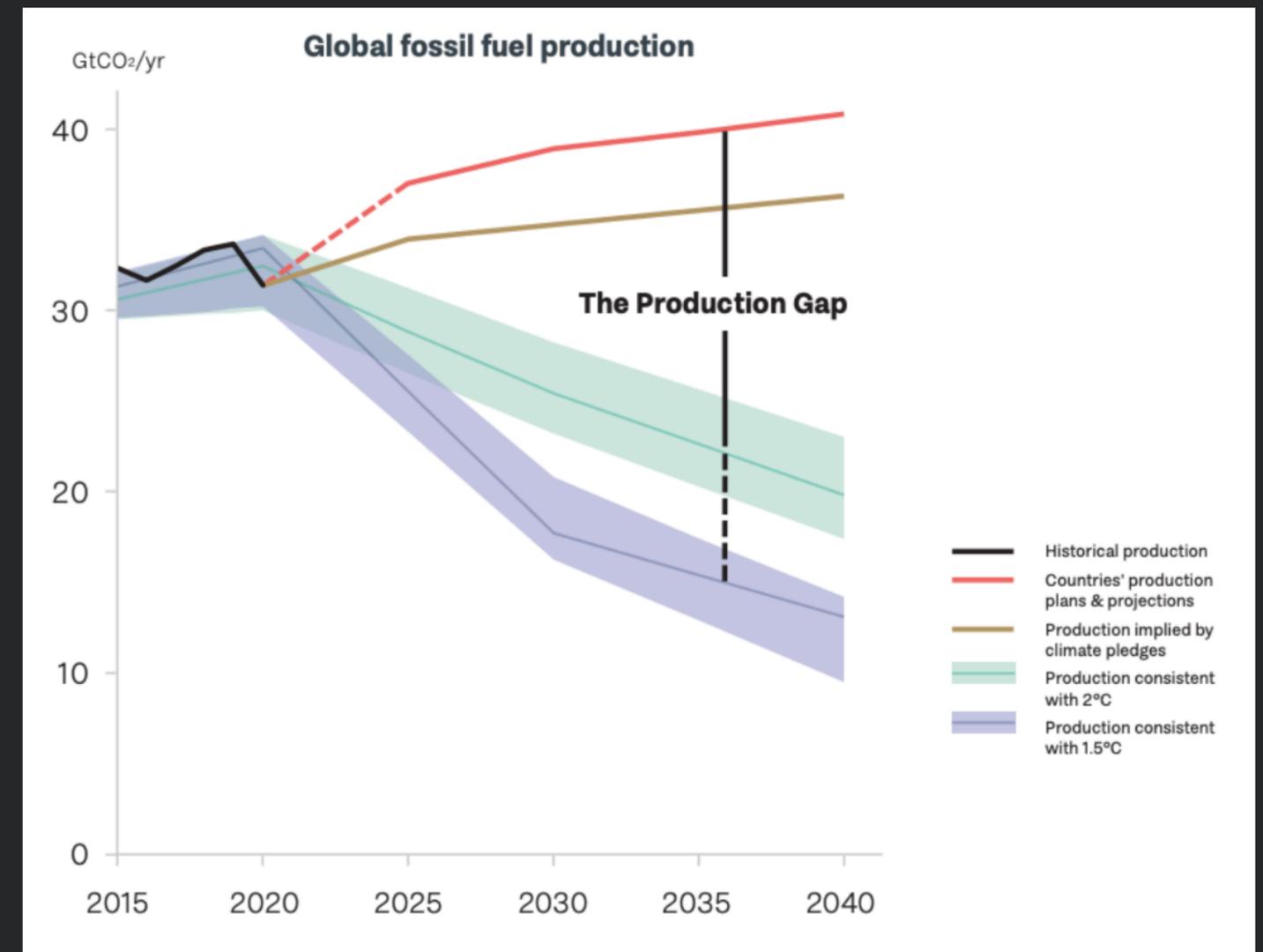
THE GOAL

UN report: Top fossil fuel producing countries aren't setting the right goal

Fossil Fuels

UN Report: Despite Falling Energy Demand, Governments Set on Increasing Fossil Fuel Production

Top countries are projected to produce twice the limit on oil, gas and coal required to meet Paris climate agreement goals.



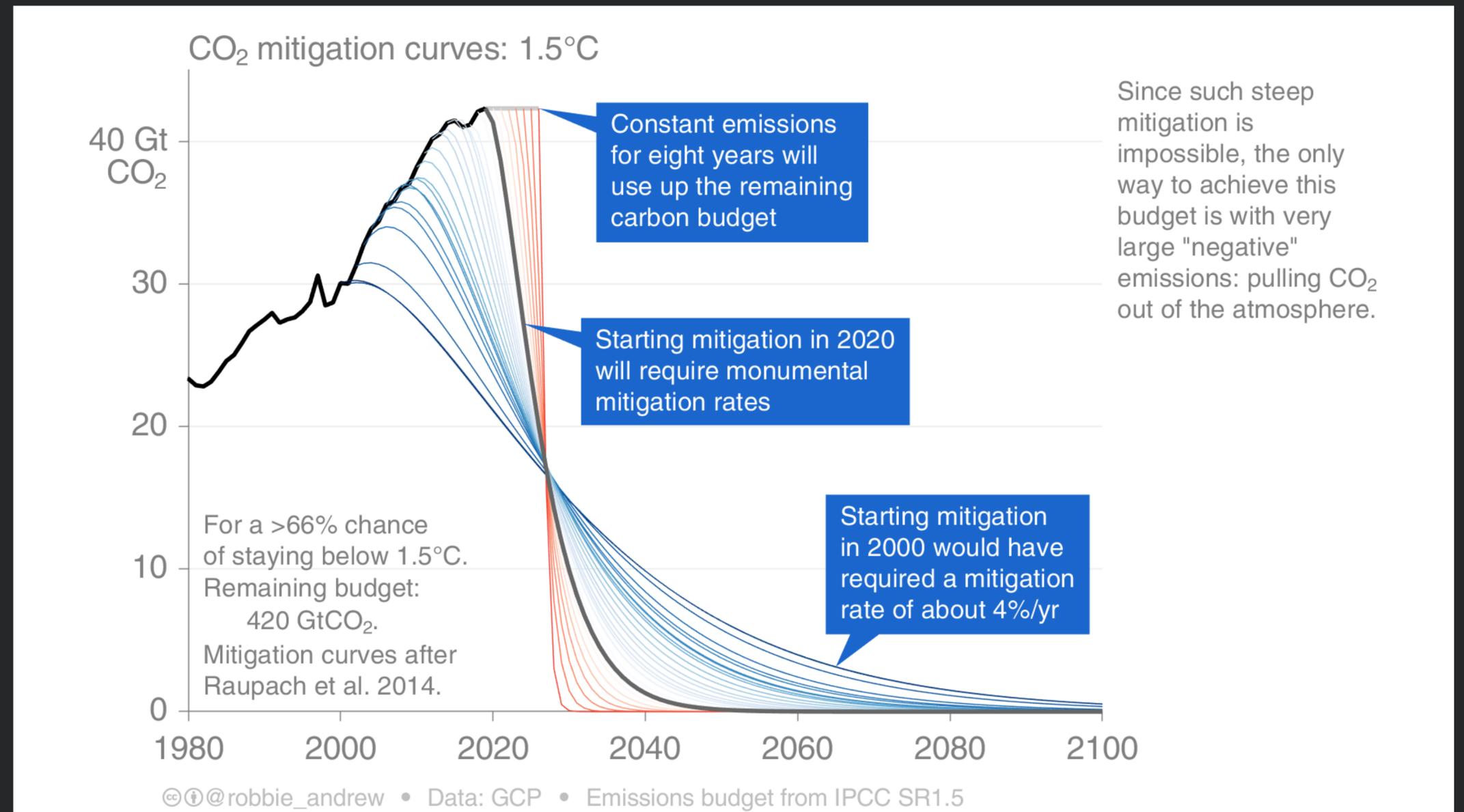
THE GOAL

And...



THE GOAL

A 1.5°C future?

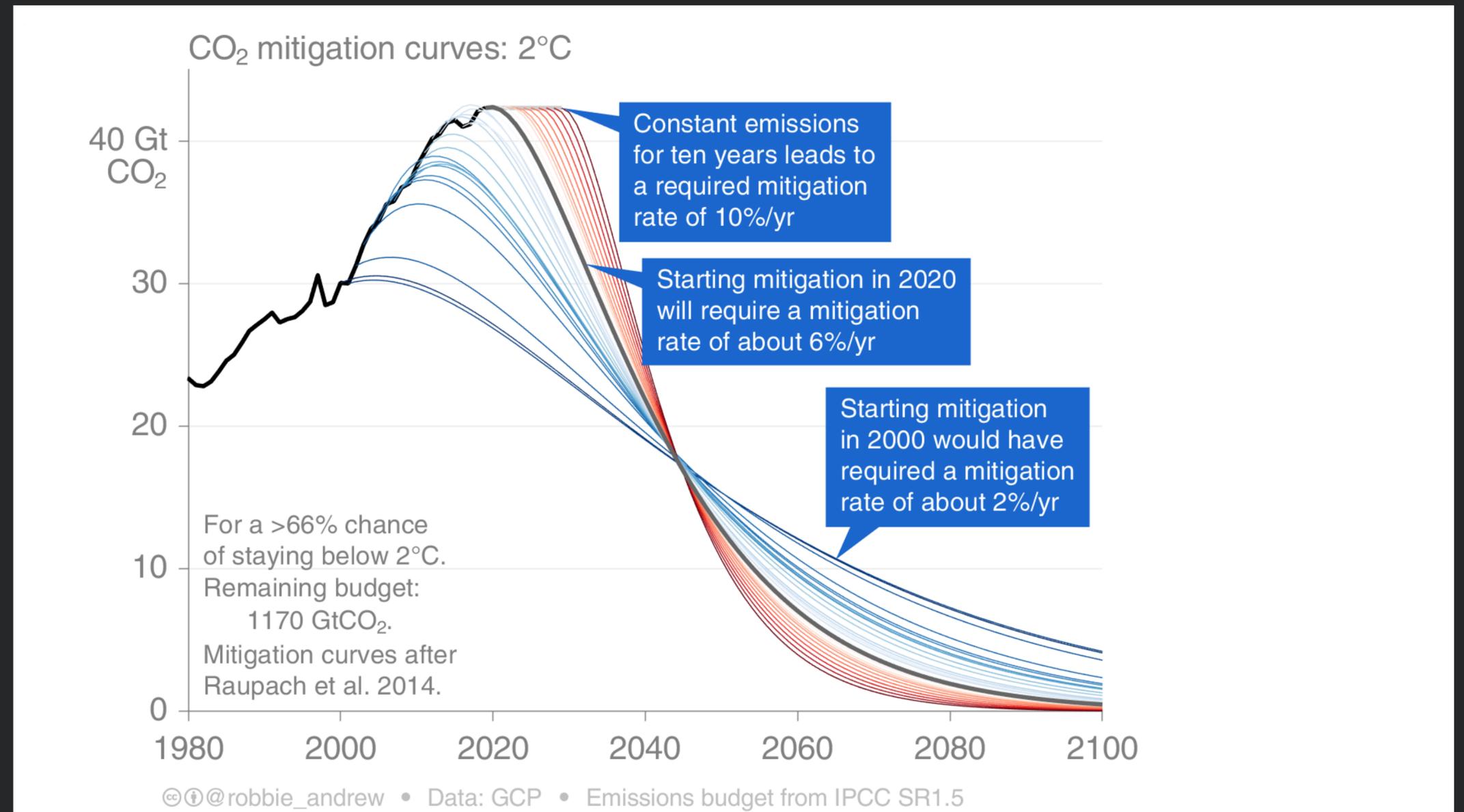


https://folk.universitetetioslo.no/roberan/t/global_mitigation_curves.shtml

- Currently > 40Gt / year emissions
- graph budget: 420 Gt current budget: 235 Gt*
* <https://constrain-eu.org/wp-content/uploads/2020/02/CONSTRAIN-Zero-In-On-The-Remaining-Carbon-Budget-Decadal-Warming-Rates.pdf>
- assuming no use of negative emissions technologies (NET)
- extremely unlikely that 1.5°C is attainable in the near future ☀

THE GOAL

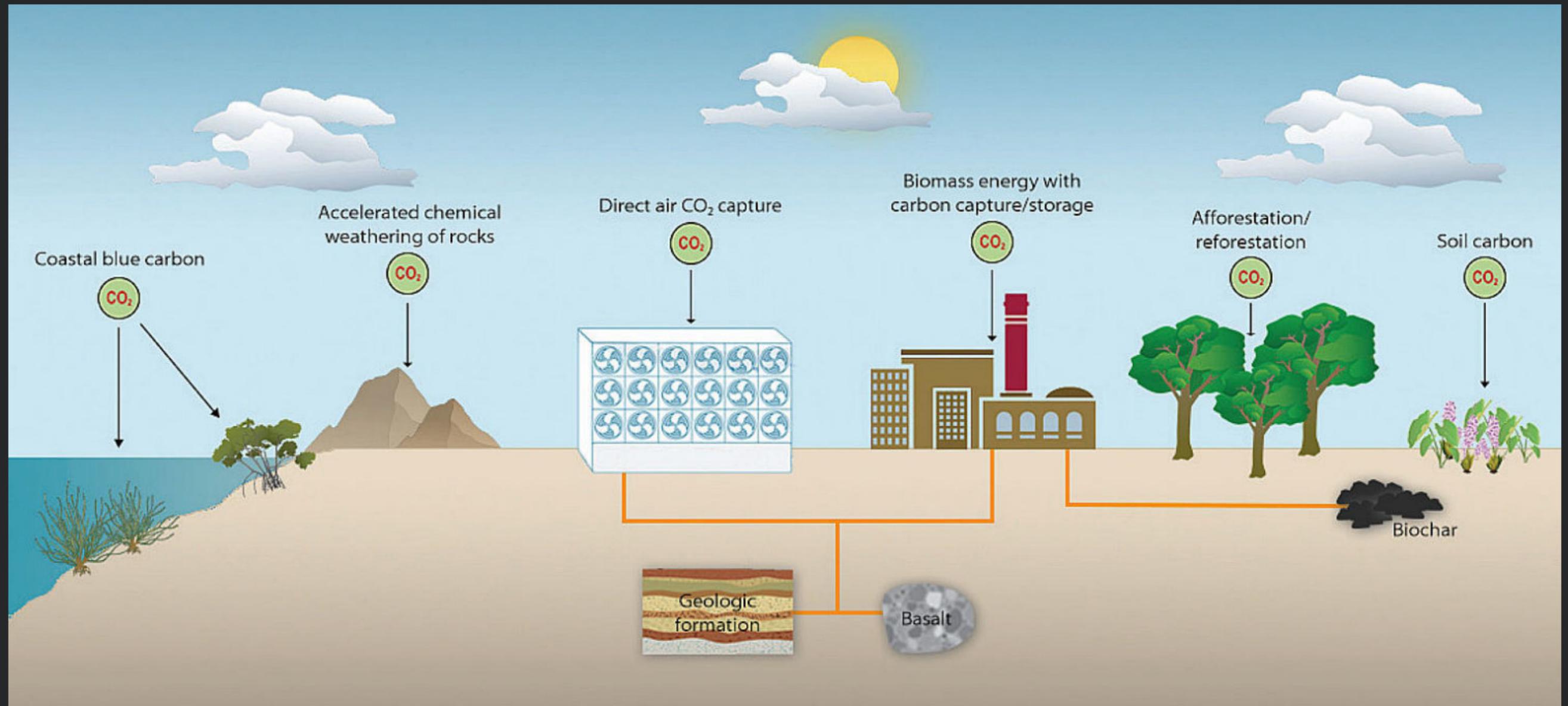
A 2.0°C future?



- Currently > 40Gt / year emissions
- graph budget: 1170 Gt current budget: 985 Gt
- assuming no use of negative emissions technologies (NET)
- we should shoot for an outcome closer to 1.5° ☀

THE GOAL

NETs

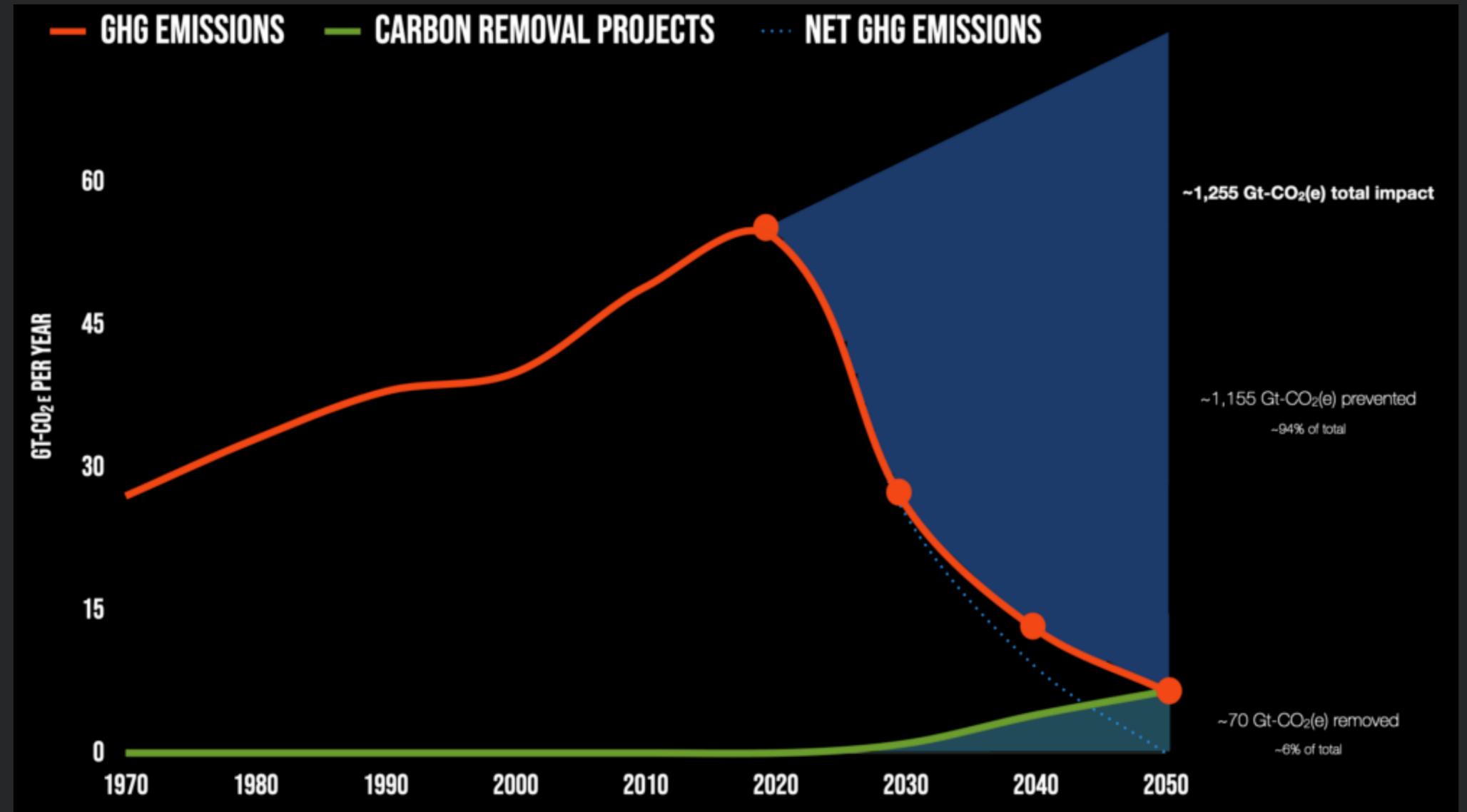


NATIONAL ACADEMY OF SCIENCES, 2018

- Negative Emissions Technologies (NETs) range from low-tech, such as planting more trees, to more high-tech options, such as developing machines to scrub CO₂ from the air.
- “Negative emission technologies may have a useful role to play but, on the basis of current information, not at the levels required to compensate for inadequate mitigation measures.” - European Academies Science Advisory Council

THE GOAL

NETs are a side show at best

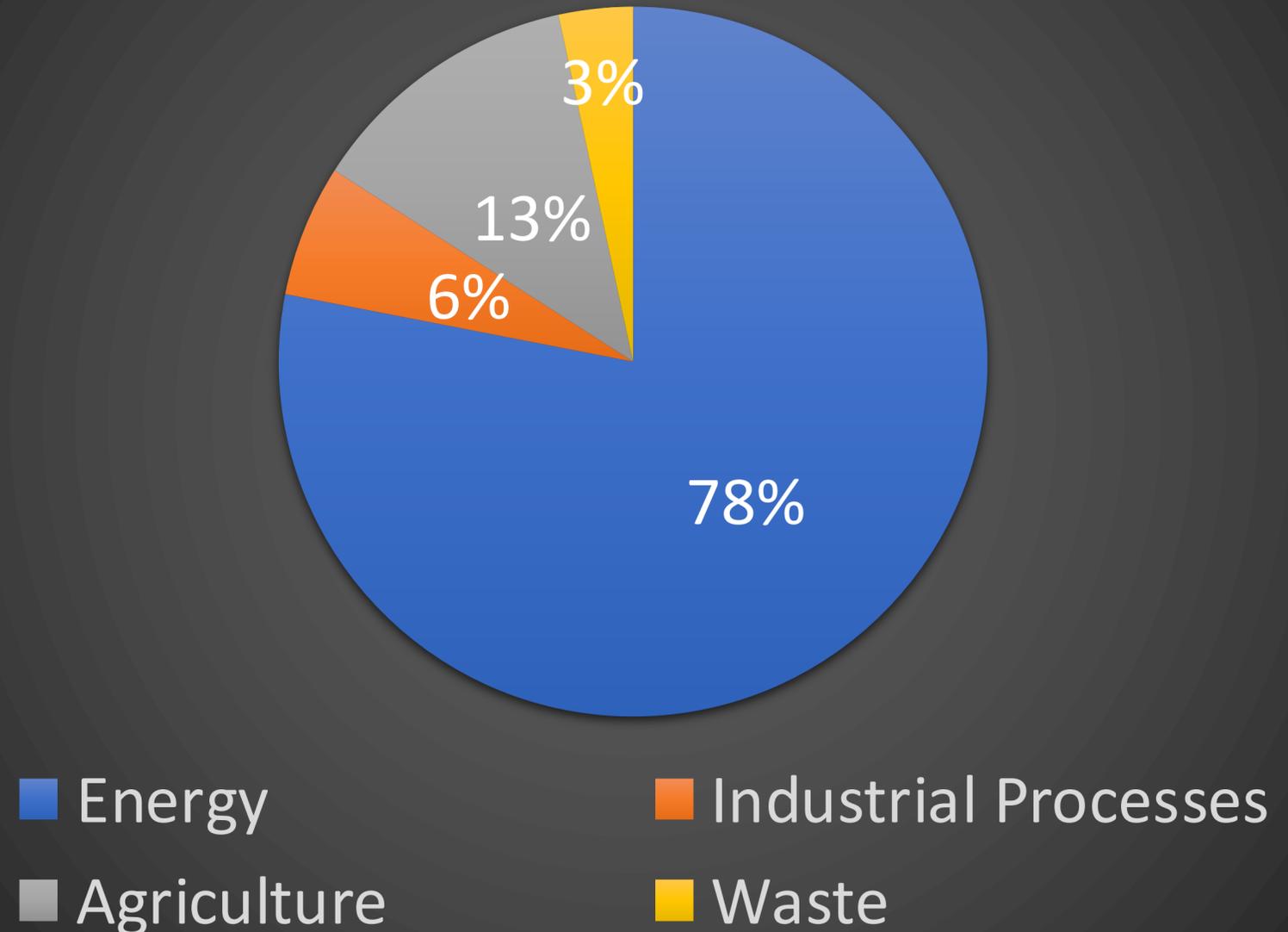


7 Reasons Why Artificial Carbon Removal is Overhyped
Dr. Jonathan Foley, Executive Director of Project Drawdown

THE GOAL

78% of global emissions are related to energy

2016 Global Emissions by Sector



data from <http://climatewatchdata.org>

Humanity produces more CO₂ than it does all other materials combined!

A new energy infrastructure



Mass beneficial electrification

- Decarbonize electricity supply
- Electrifying (almost) everything
- Replace our FF infrastructure with modern, clean electricity-based one ☀️

Beneficial electrification

Beneficial Electrification includes the application of electricity to end-uses where doing so satisfies at least one of the following conditions, without adversely affecting the others:

- Saves consumers money over time
- Benefits the environment and reduces greenhouse gas emissions
- Improves product quality or consumer quality of life
- Fosters a more robust and resilient grid

<https://be-league.com/>

A NEW ENERGY INFRASTRUCTURE

Big Picture

- Requires a massive, transformational approach -
i.e. industrial mobilization
- This transformation will save money in the end -
not a cost
- Need a production ramp akin to WWII ramp
- Generates jobs in every zip code (renewables generate
a lot more jobs than the FF industry)
- Warm homes, hot water, cool cars, clean air, clean
water



By J. Howard Miller - U.S. National Archives

Zero Carbon Energy



Transition to zero carbon electricity



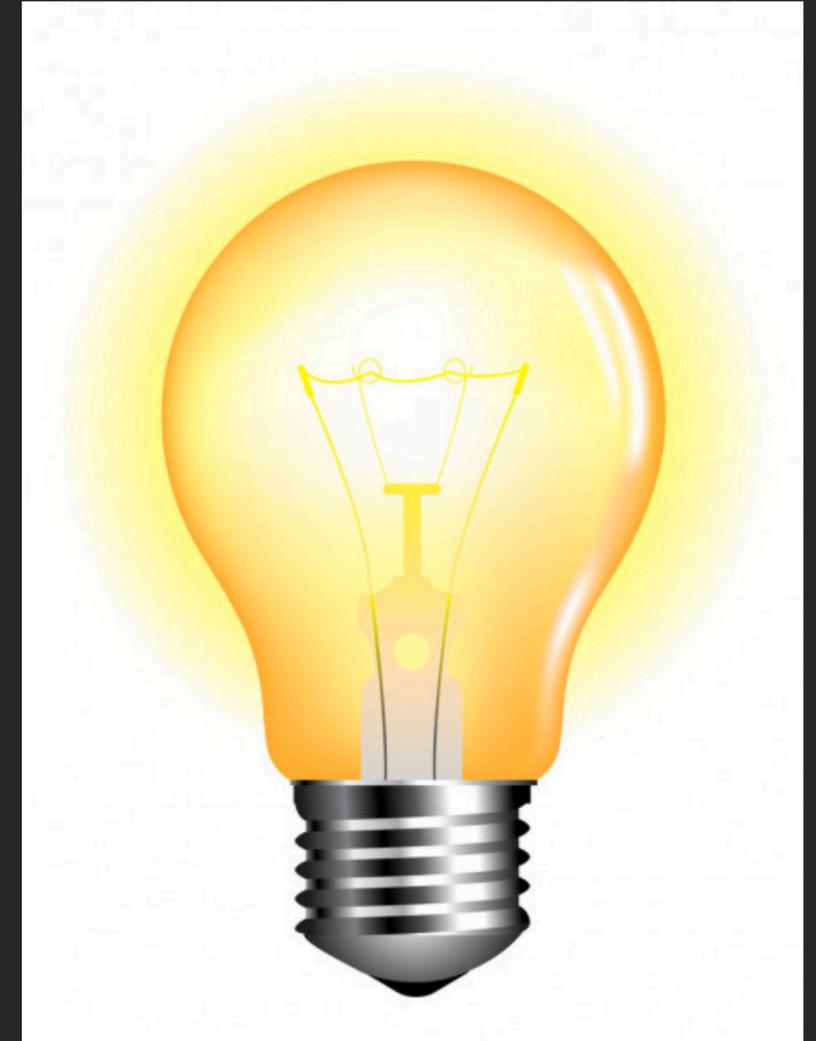
- Solar / Wind / Hydro / Geothermal / Nuclear
- Storage will play an extremely important role (likely dominated by batteries)
- Need to upgrade our electric grid to Grid 2.0
- Requires 3-4X our current electricity supply
- New devices are ultra-efficient
- Renewable energy is a technology - costs will decline over time ☀️

Positive global trends for decarbonized electricity



- International Energy Agency (IEA): The world's best solar power schemes now offer the "cheapest...electricity in history" with the technology cheaper than coal and gas in most major countries.
- Solar electricity is some 20-50% cheaper today than the IEA had estimated in last year's outlook, with the range depending on the region.
- There are similarly large reductions in the estimated costs of onshore and offshore wind.

Electrify everything!



ELECTRIFY EVERYTHING!

Transition FF devices to ultra-efficient electric devices



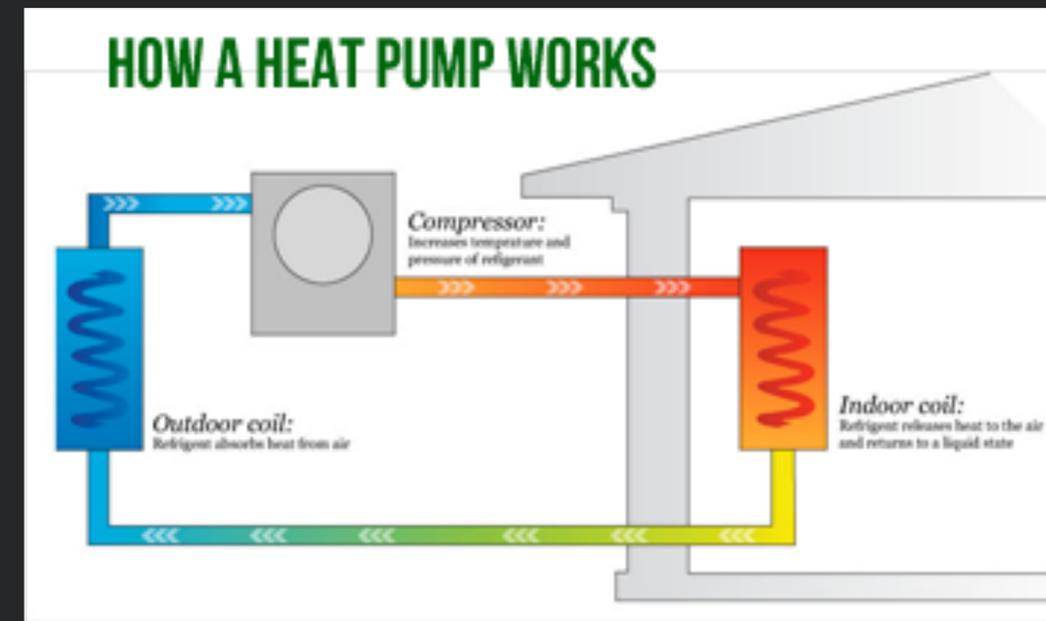
- Rapidly move to no new FF devices (water heaters, HVAC, vehicles)
- Replace existing devices at end of life (but with near 100% replacement rates)
- Requires new performance-based standards which phase out FFs
- Requires large scale financing at zero or nominal interest rates (think FHA -> Federal Climate Authority)
- Fossil fuels are cheap now and expensive later, renewables are expensive now and cheap later

Beneficial electrification (BE) technologies



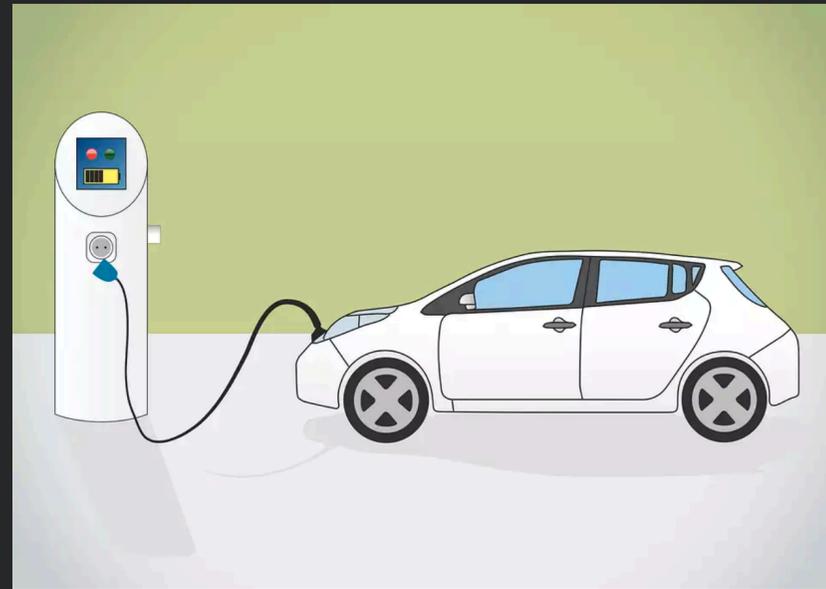
Heat pumps

- Refrigerators use heat pumps - a proven technology.
- Heat pumps move heat from one place to another
- They can achieve spectacular efficiencies:
400% efficiency for WHs
400-500% efficient for HVAC



- That's compared to efficiencies of existing devices that typically range from 60-98% efficient
- No, that not a typo and it doesn't violate any laws of thermodynamics!
- These efficiencies slash the operational cost of electric devices by 4-5x and make them competitive or even cheaper to operate than FF devices

Batteries / EVs



- EVs largely exist because of advances in battery technology
- 50 KWH batteries give 200+ miles of range
- Automotive industry is finally putting increasing emphasis on EVs
- Total cost of ownership of EVs is < gassers
- EVs have extremely low maintenance and awesome performance
- A ton of battery R&D is going on. Expect further advances.

- “To replace our 250 million personal gasoline-powered vehicles with EVs in the next 20 years, we will need over a trillion batteries, or around 60 billion 18650(*) batteries every year. That is similar to the 90 billion bullets manufactured by the world today. We need lots of batteries, but it is possible. We need batteries, not bullets.” - Saul Griffith

* (a battery w/ 18mm diameter x 65 mm long)

Grid 2.0



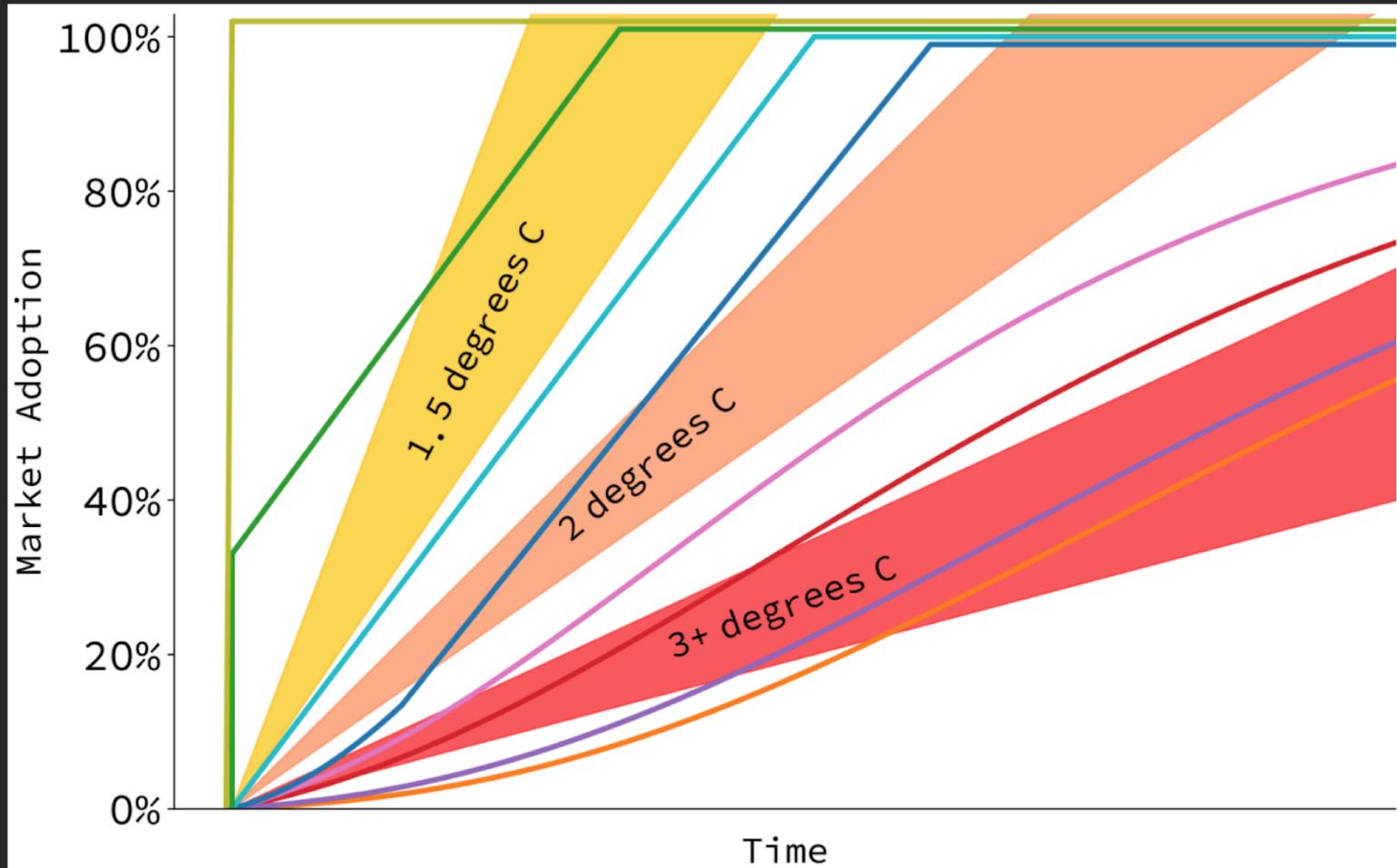
- Our power grid needs some updating. The basic design is over a 100 years old. We need a smart grid.
- The power grid should excel in sharing power across regions, so that each region doesn't have to be 100% self-sufficient, although distributed generation and local storage are important.
- Grid interactive devices can be used to supply power to the grid or to delay the consumption of power. WHs can be grid interactive.
- Vehicle to home/building - V2H/V2B. Enables EVs to power homes and buildings - good for power outages.
- Vehicle to grid - V2G. Enables EVs to contribute power to the grid or be charged at times that are best for the current load on the grid.

Pace of electrification



PACE OF ELECTRIFICATION

Electrify more rapidly!

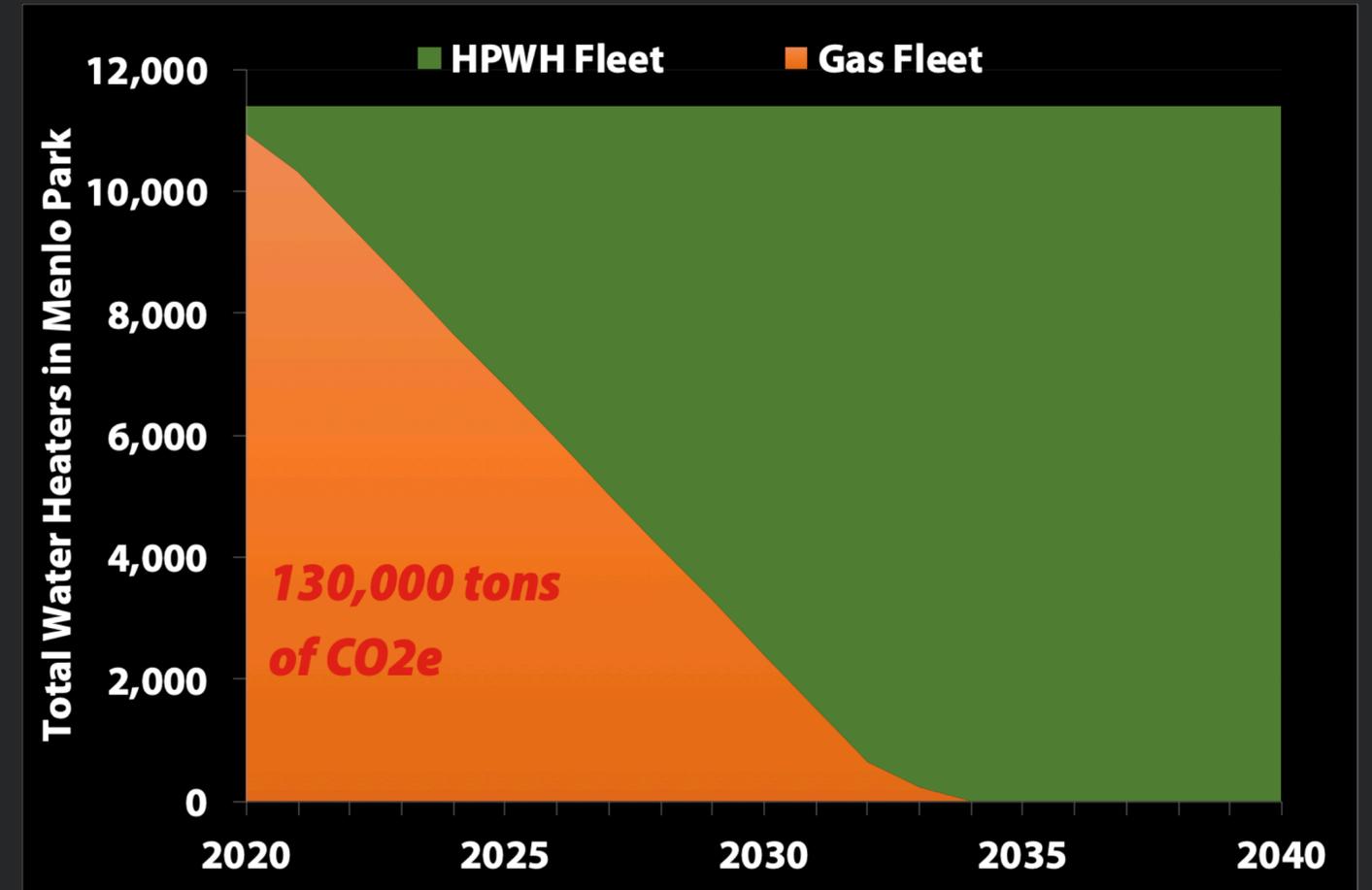
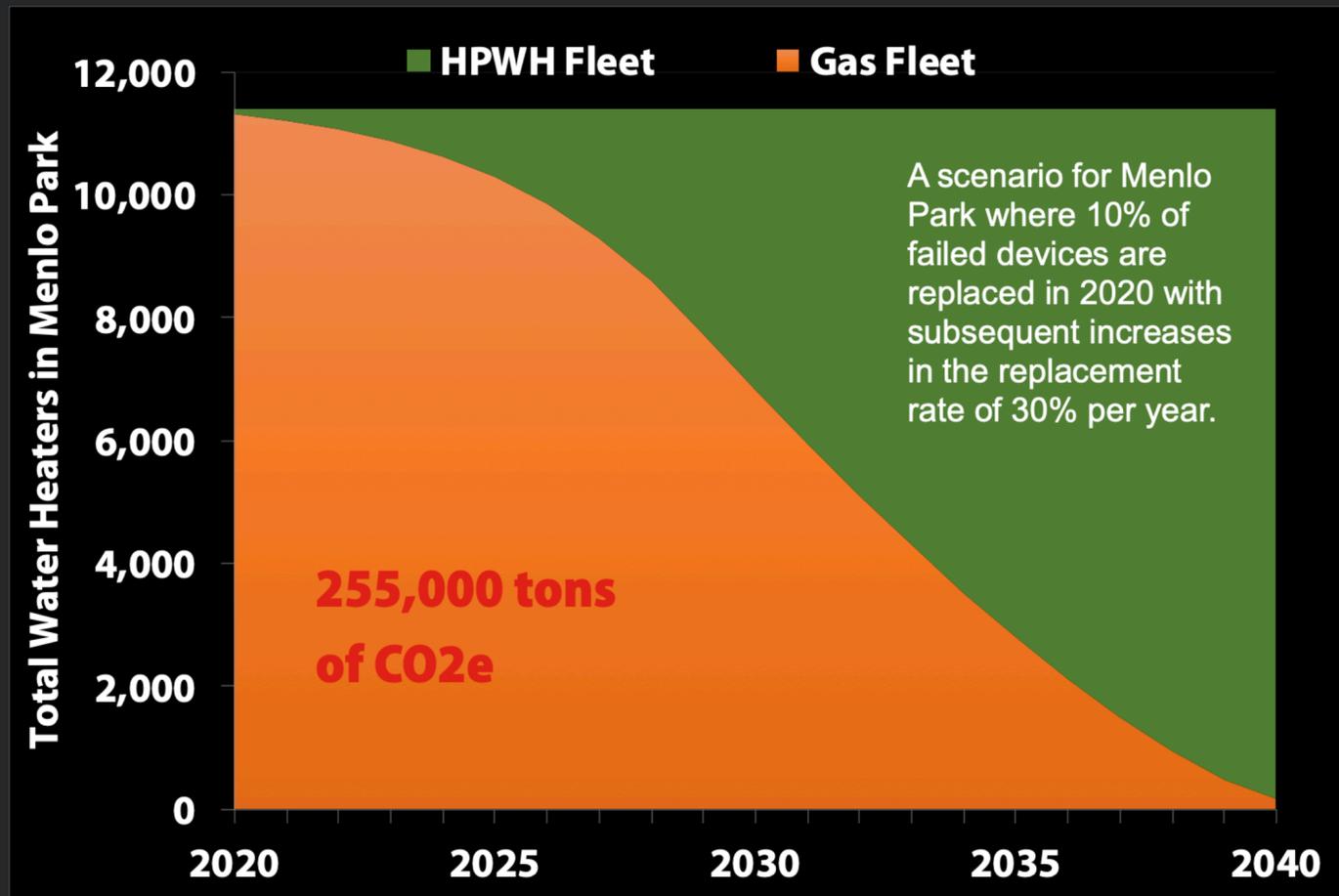


PACE OF ELECTRIFICATION

Menlo Park: Business-as-usual replacement rates are inadequate

Even aggressive rebates are not generating the replacement rates that are needed to electrify the majority of the water heater fleet in the next 10 years.

Replacing essentially all FF devices reaching their EOL with BE devices achieves the goal.



PACE OF ELECTRIFICATION

Palo Alto's 80/30 goal

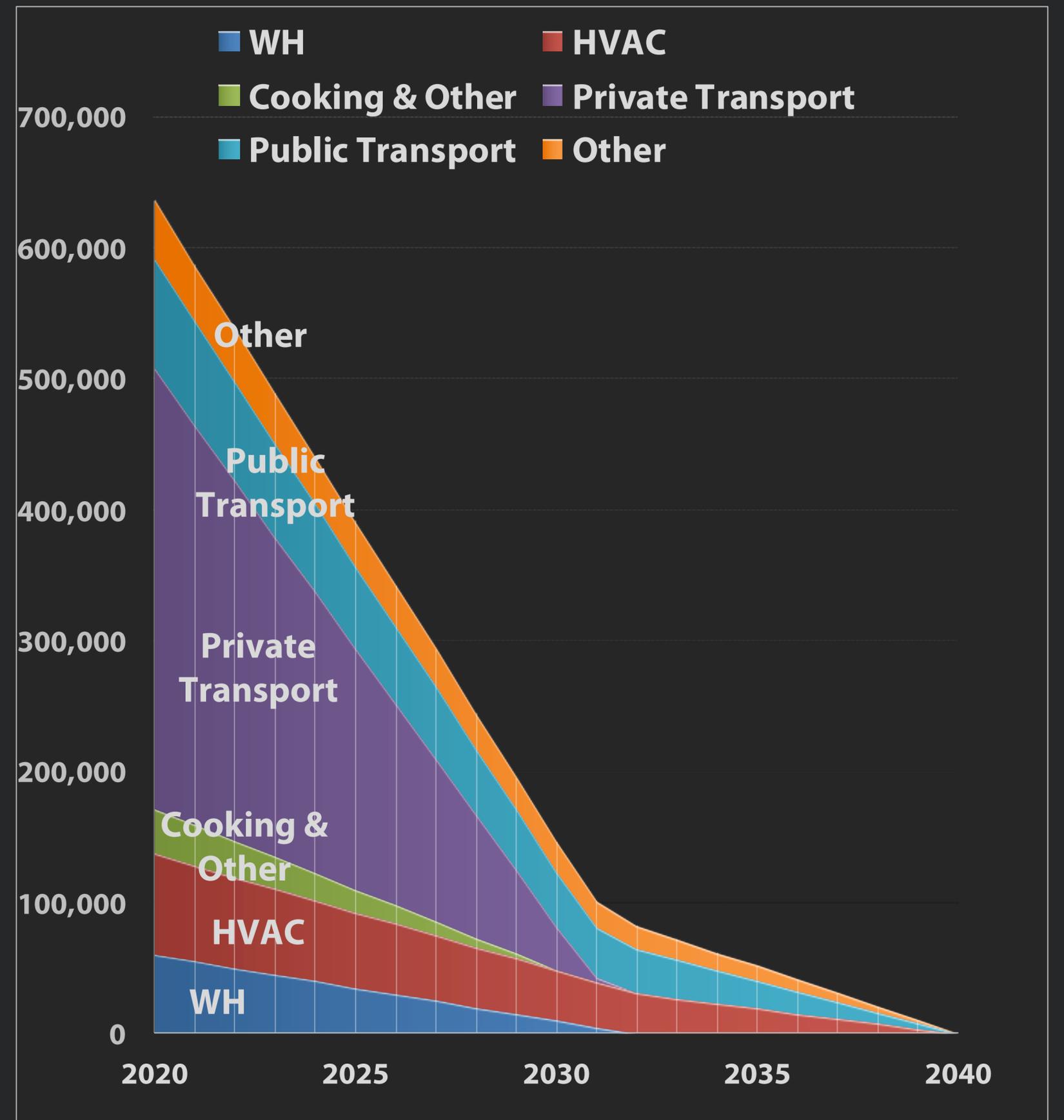
Modeling shows that Palo Alto can only meet its 80/30 goal by a 100% replacement rate of all devices (including vehicles) at or near their end-of-life.

=> replace **2,333** WHs / yr

=> replace **1,400** HVACs / yr

=> thousands cars / yr

Recent paper by Dan Kammen, Leah Stokes, Tom Steyer, et. al. says that state needs this goal as well (80/30)



PACE OF ELECTRIFICATION

Production ramp up



We need significant time to ramp up production capacities of new devices:

4X - EVs

16X - batteries

12X - wind turbines

10X - solar modules

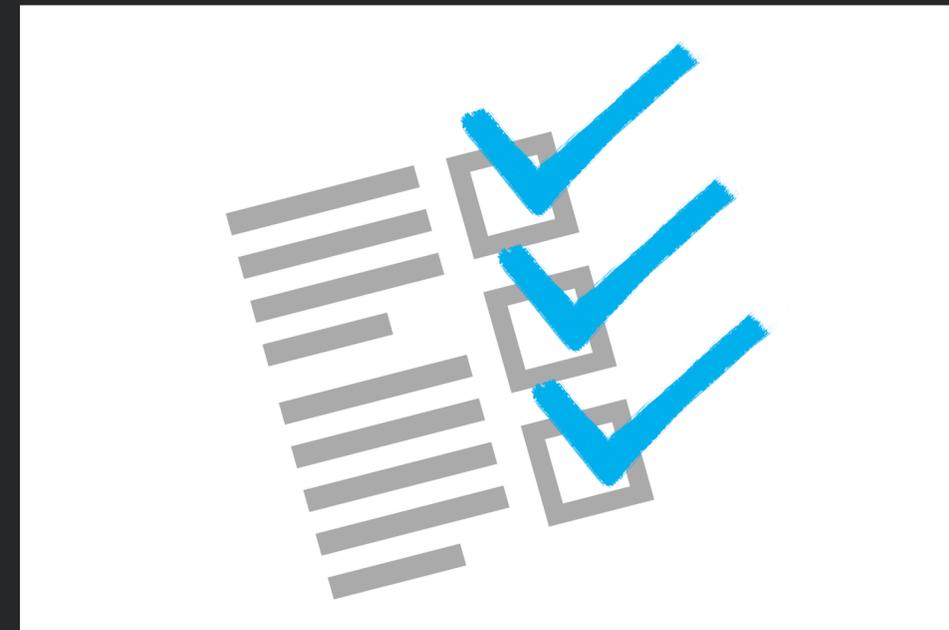
?X - heat pump water heaters

?X - heat pump HVAC ☀

Rebates and incentives alone won't enable mass electrification

- Rebates are financed by utility rate payers and do not scale beyond early adopters.
- Even large rebates don't help low and moderate-income residents without the additional capital needed to participate.
- Rebates alone don't reduce the complexities of electrifying for building owners.
- Rebates are an absolute cost with no recovery, and is difficult if not impossible to apply to all customers across 10-20 years
- For the Bay Area: \$400M per year in rebates for water heaters alone (assuming a \$2000 rebate/WH)

Effective policy approaches



- Need to quickly move to mandates or performance standards that effectively prohibit new FF devices
- 100% replacement at EOL is a logical extension of energy reach codes and is a common-sense approach
- Should focus on market transformation to upgrade our energy infrastructure
- Should encourage zero interest financing of FF devices
- Should also address racial and economic injustice issues
- Should encourage proactive replacement of FF devices in buildings by utilities
- Should encourage working from home and a commensurate reduction in commuter traffic
- Should phase out FF vehicles (but how?)

One approach to mass electrification - BE Smart

- Utilities proactively orchestrate the replacement of soon-to-fail FF devices with BE devices.
- The replacement process is designed to be quick and easy for the customer.
- Customers pay an initial outlay equal to the normal business-as-usual (BAU) cost of replacing the device with another FF device (BAU outlay).
- The difference between the device installation cost and the BAU outlay is financed at low interest rates ($\leq 2\%$) for all customers, with no credit checks.



National policy



President Biden has pursued climate policy changes aggressively:

- Reentered the Paris Climate Accords
- Cancelled the Keystone XL pipeline
- Objectives include:
 - Center the Climate Crisis in U.S. Foreign Policy and National Security Considerations
 - Take a Whole-of-Government Approach to the Climate Crisis
- \$1T infrastructure plan (\$174B EVs, \$100B electric grid)
- \$1.9T Build it Back Better plan
- Set a goal of a 50% reduction in GHGs by 2030 (2005 baseline)
- Reinstated Obama-era regulation of methane emissions (86x CO₂)

Action in the Bay Area



Bay Area leading the charge

- 2010-present : Rise of CCAs providing low carbon electricity
- 2010 : Marin Clean Energy
- 2015 : Sonoma Clean Power
- 2016 : Palo Alto becomes one of the first carbon neutral electric utilities
- 2016 : CleanPowerSF
Silicon Valley Clean Energy
Peninsula Clean Energy
- 2018 : East Bay Community Energy
- 2019 : San Jose Clean Energy
- 2019 : Berkeley gas ban - using municipal police powers
- 2019-present : Municipal energy reach codes adopted from San Francisco to San Jose. Diane Bailey of Menlo Spark organizes Fossil Free Buildings Campaign Silicon Valley to provide crucial momentum. Acterra joins effort.
- 2021 : Performance standards and mandates

What can you do?

- Take personal responsibility!
- Focus on your big, long-lasting purchases - develop a plan to ditch FF
- Replace your NGWH at end-of-life (EOL) (or sooner!) with a HPWH
- Replace your NG HVAC at EOL with a HP-HVAC
- Replace your FF vehicle at EOL with an EV
- Reduce your consumption (buy/drive/fly less)
- Plug into the political process - demand local action



Acronym soup

FF - fossil fuel

NG - natural gas

WH - water heater

HVAC - heating,
ventilation,
and air
conditioning

HP - heat pump

EOL - end-of-life

EV - electric
vehicle

A call to action



A CALL TO ACTION

“We now face a climate emergency as challenging as all of our other 20th century emergencies combined. It requires mobilization with extraordinary speed and resources. Without doubt you are worried, scared, or worse. That’s reasonable, but we can’t do nothing, and as we’ll find out, this is also a vast opportunity to improve our world.”

- Saul Griffith

Let’s roll!

- Bruce Hodge

CONCLUSION

Thank you!

Bruce Hodge

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Deep Dive:
Rewiring America Field Manual
by Saul Griffith, et. al.