



# 20 35

THE REPORT

PLUMMETING SOLAR, WIND,  
AND BATTERY COSTS  
CAN ACCELERATE OUR  
CLEAN ELECTRICITY FUTURE





# CORE PARTNERS

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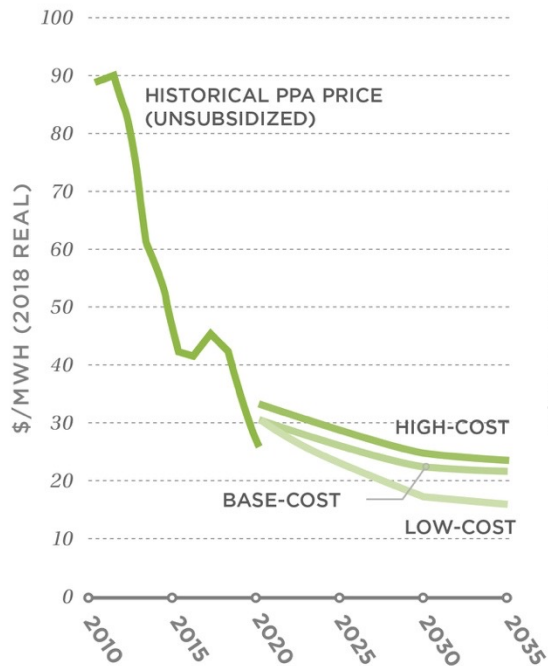
# WHY 90% CLEAN BY 2035?

- The electric sector is a major contributor to greenhouse gas emissions (GHG) –
  - cuts to climate pollution from electric power by 2035 is a critical step needed to cut economy-wide emissions
- Low-cost reductions in GHG emissions must be pursued soon to avoid worst climate change impacts
  - Renewables and storage are now less expensive than fossil power
- This is the first study to show that wind, solar and storage can deliver massive emission reductions w/o increasing consumer costs
- The build out of renewables and storage envisioned is aggressive but feasible
- Economic, health and climate benefits of a 90% clean generation sector are massive and could significantly contribute to COVID-19 economic recovery

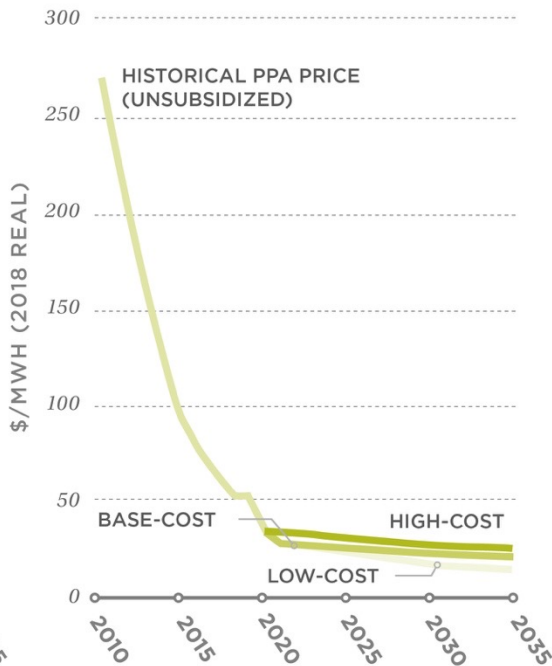


# DRAMATIC COST DECLINES ARRIVED SOONER THAN ANTICIPATED

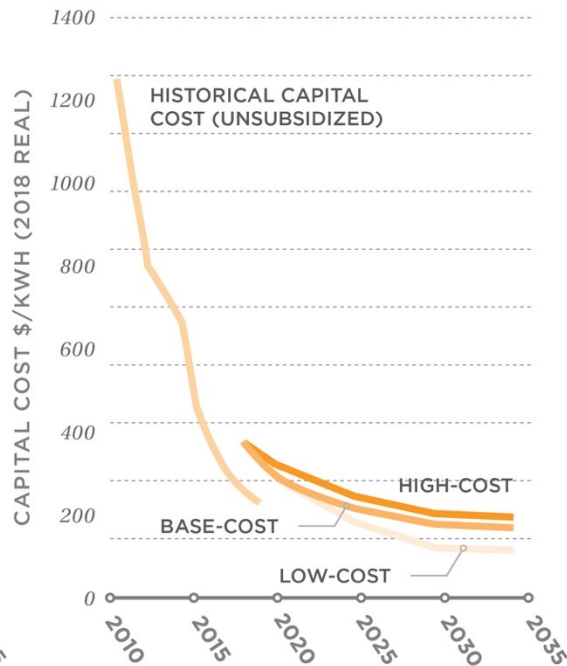
## WIND LCOE



## SOLAR LCOE



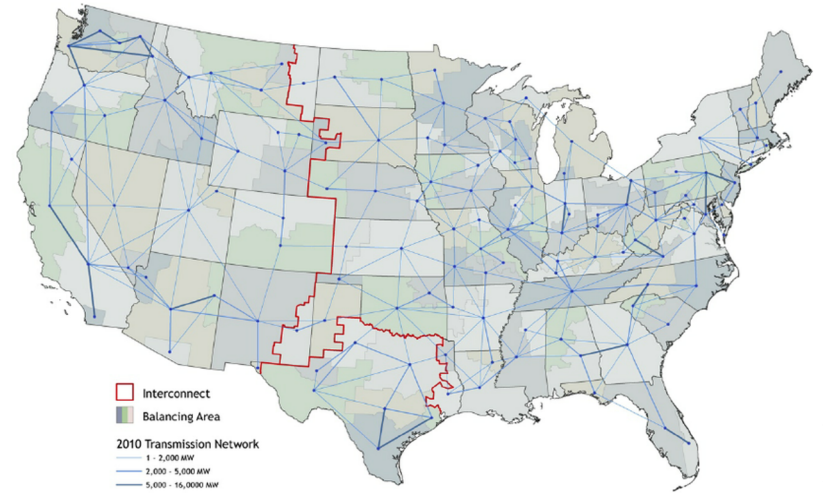
## BATTERY STORAGE CAPITAL COST





# DATA AND METHODS

1. Optimal capacity mix using **ReEDS v2020** (2018-2050)
  - 134 load regions and 356 RE resource regions
  - Simulate several policy scenarios such as RPS / CES mandates, carbon price, electrification etc. and sensitivities on RE cost, gas price, financing cost etc (36 scenarios in total).
2. Hourly dispatch and operations using **PLEXOS** (2035)
  - Translate key ReEDS scenarios to PLEXOS
  - ~22,000 power generating units
  - 7 weather years of hourly RE profiles
  - Utility level hourly load
3. Economic analysis to capture stranded costs



Source – ReEDS Documentation

# ReEDS MODEL MAIN SCENARIOS

## No New Policy

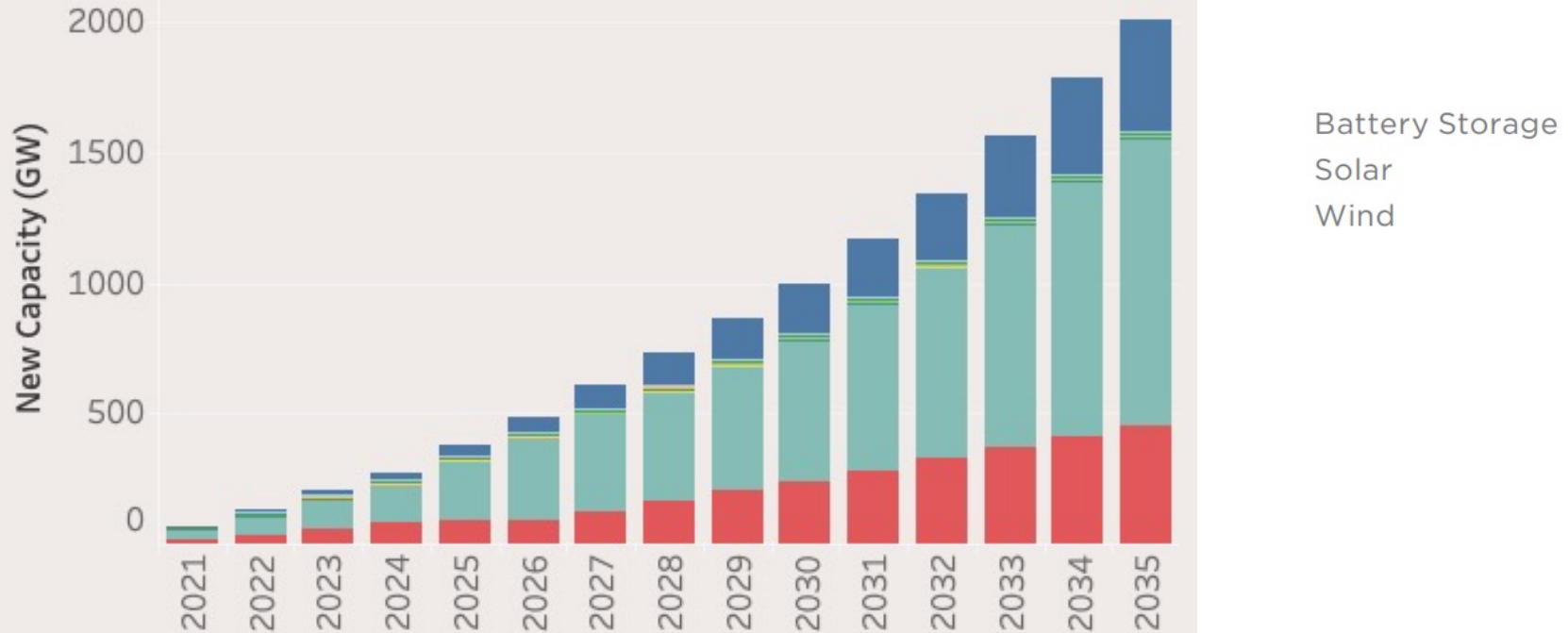
- Policies remain same as in 2019
- Technology Costs: ATB Modified (ATB Low case costs through 2021, then declining at the same rate as the ATB Mid case costs)
- Gas prices: AEO 2020
- Financing Costs: 2.75% real
- No Electrification

## 90% Clean

- National Clean Energy Standard of 90% by 2035, increasing linearly from 40% in 2020 to 90% in 2035
- Technology Costs: ATB Modified (ATB Low case costs through 2021, then declining at the same rate as the ATB Mid case costs)
- Gas prices: AEO 2020
- Financing Costs: 2.75% real
- **Clean includes Hydro and Nuclear**
- Retire all coal capacity gradually by 2035
- No new gas capacity
- Building and Transport Electrification (from NREL Electrification Futures Study)

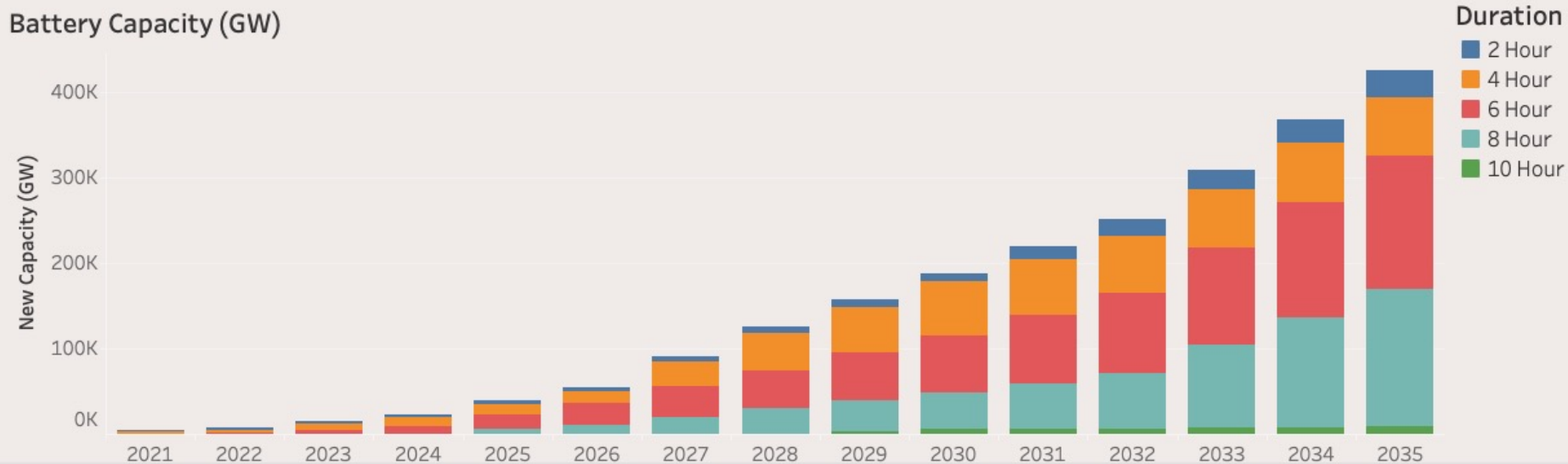
# SCALING UP RENEWABLES CHALLENGING BUT FEASIBLE

## Cumulative New Capacity (GW)



# BATTERY DURATION

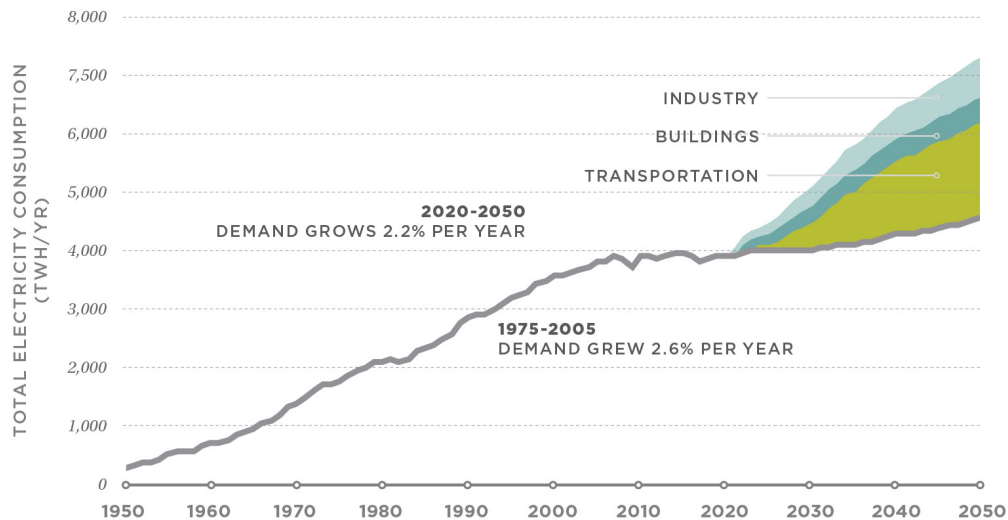
Battery Capacity (GW)



Model deploys 6 hour storage, on average



# GRID IMPACTS MODEST; RAPID INFRASTRUCTURE BUILD-OUT REQUIRED



A 90% clean grid can handle the additional demand due to electrification

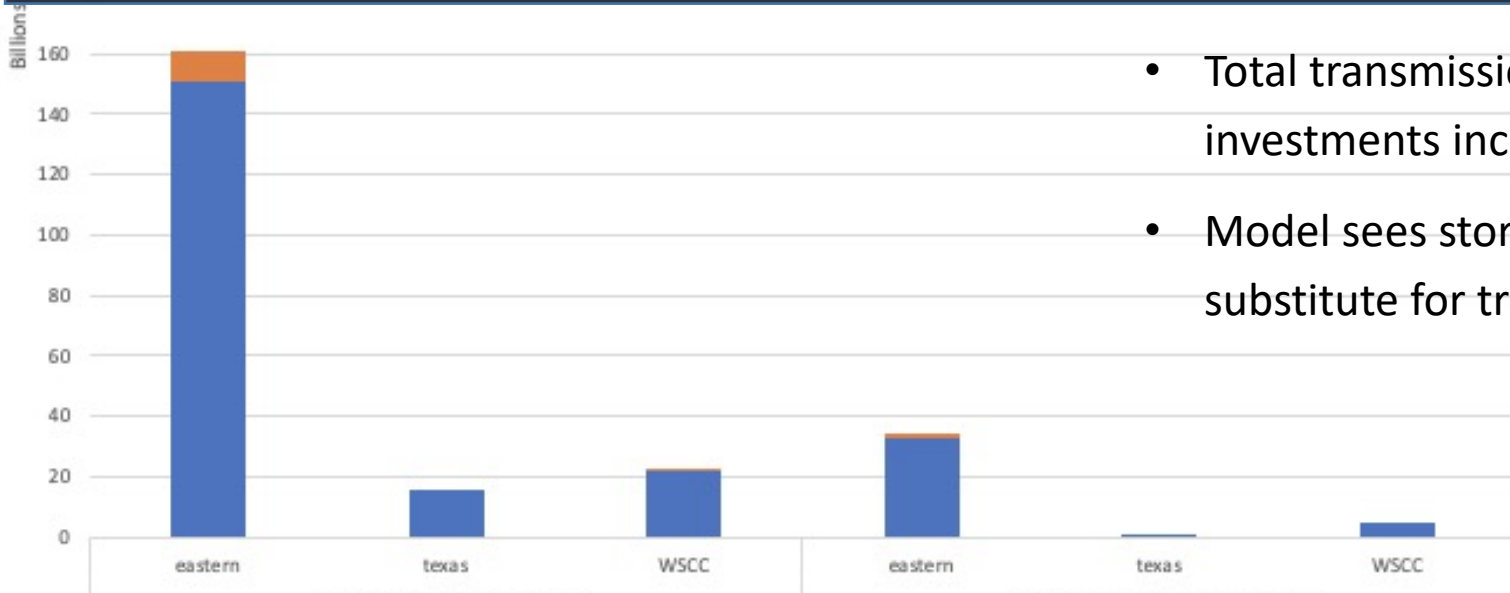
~120GW/yr of wind, solar, & storage capacity additions are needed

Rapid investments in public charging infrastructure are needed (~\$10B/yr), but are modest compared to historical distribution system investments by utilities (~\$30B/yr)

Wholesale electricity costs and distribution costs on a per kWh basis do not increase from today's levels

New public charging plugs: ~300,000/yr  
New highway charging plugs: ~30,000/yr

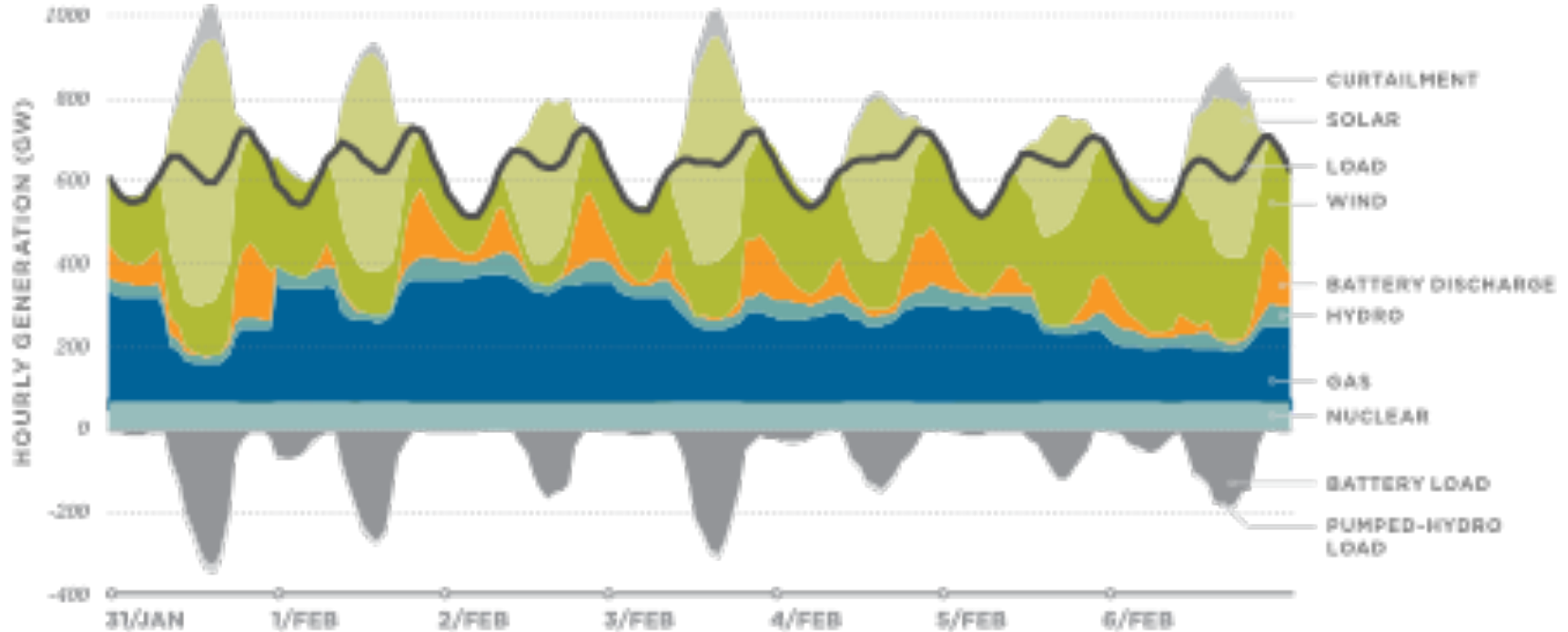
# MOST NEW TRANSMISSION INVESTMENTS ARE SPURLINE



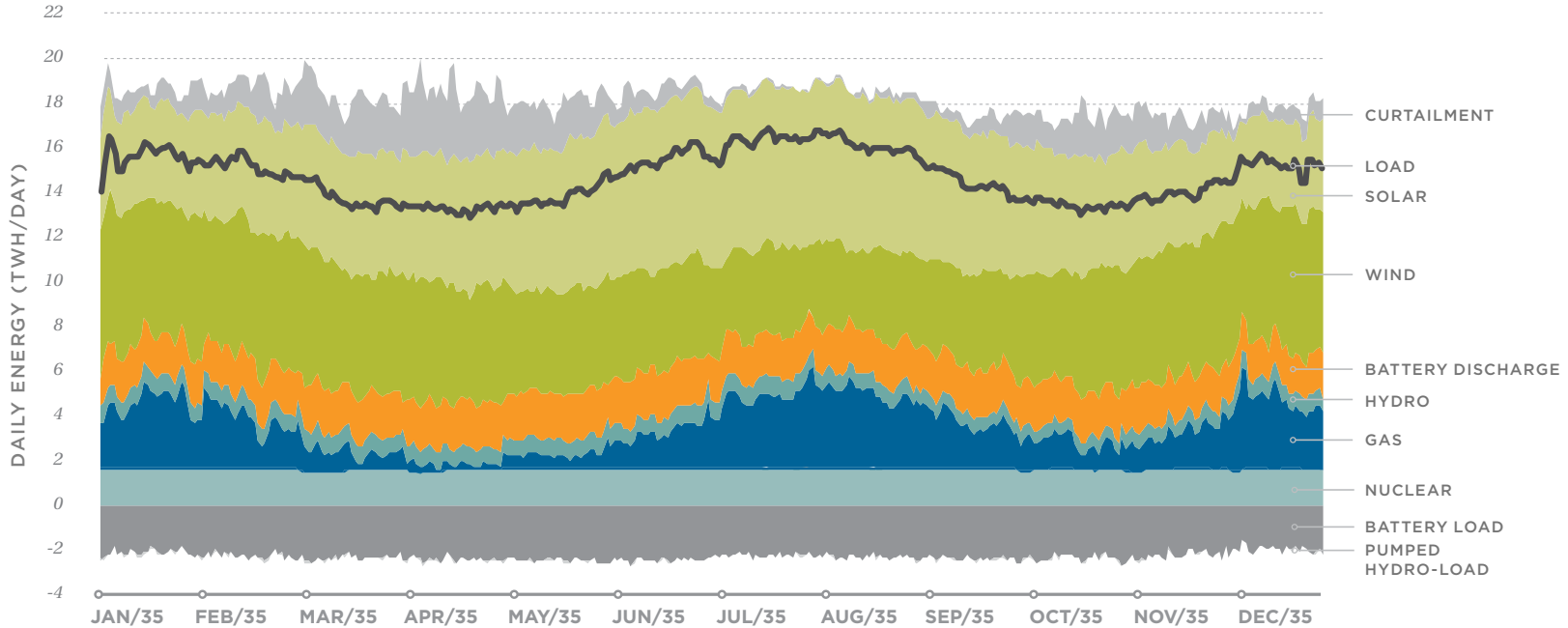
- Total transmission investments increase by >6X.
- Model sees storage as a substitute for transmission

Low-cost RE even in poor resource quality regions along with low-cost storage implies the vast majority of transmission investments are spurline investments as vs bulk transmission system investments.

# HOURLY DISPATCH DURING MAX GAS GENERATION WEEK 2035

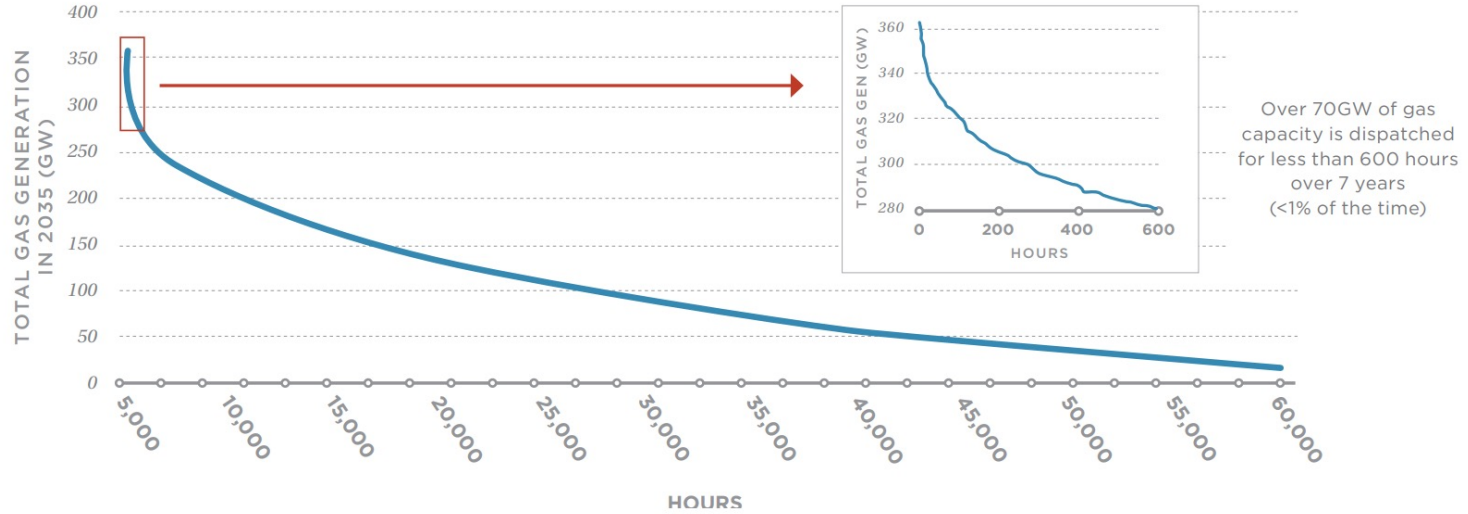


# DAILY US POWER DISPATCH, AVERAGED OVER 7 YEARS



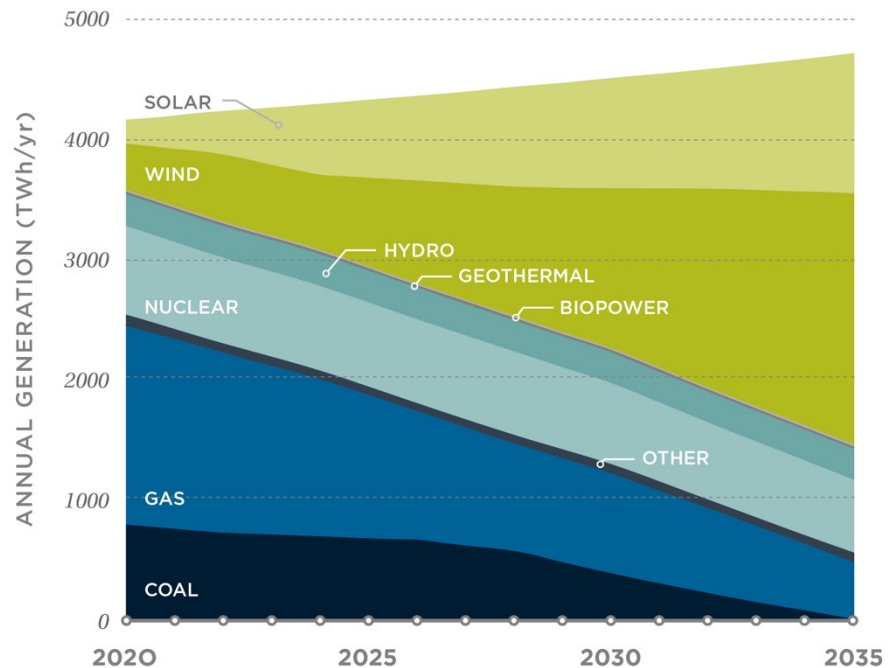


# OVER 70 GW OF GAS IS DISPATCHED FOR <1% OF TIME

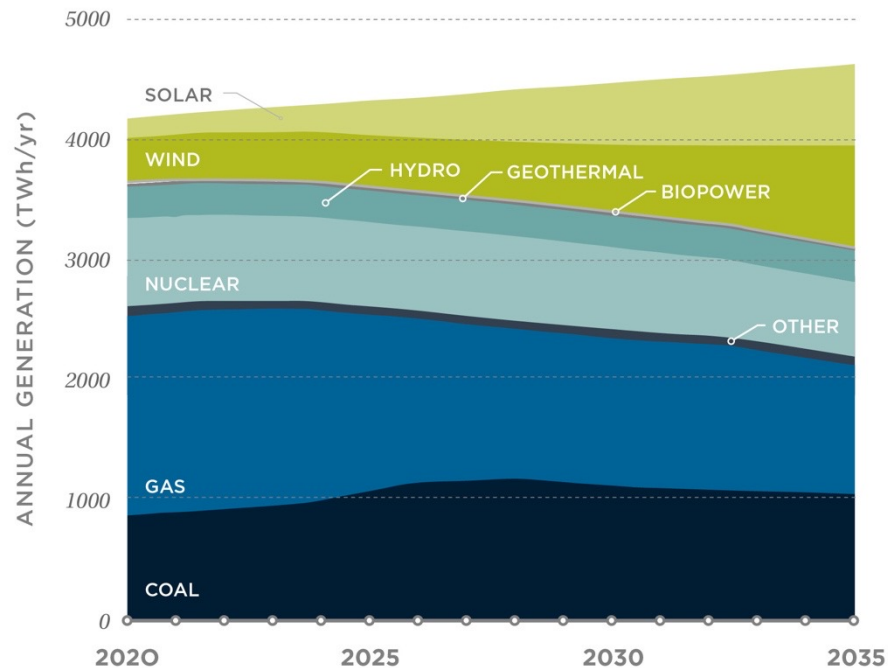


# STRONG POLICIES REQUIRED FOR A 90% CLEAN GRID BY 2035

ANNUAL GENERATION | **90% CLEAN**

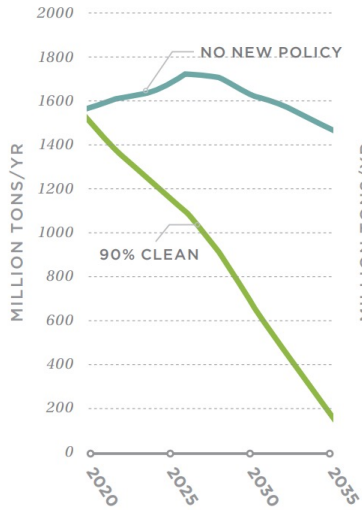


ANNUAL GENERATION | **NO NEW POLICY**

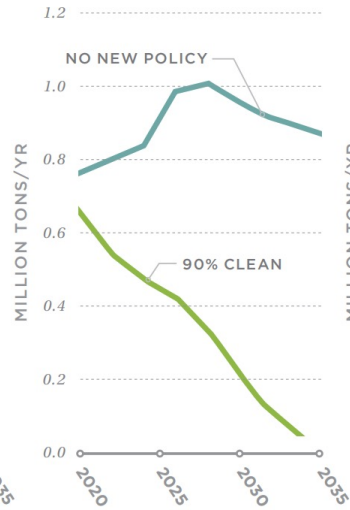


# AVOIDS \$1.2T IN HEALTH AND ENVIRONMENTAL DAMAGES

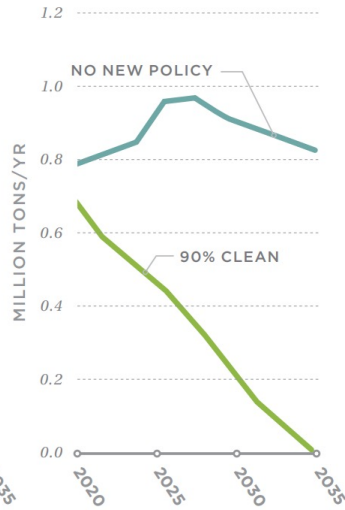
CO<sub>2</sub> EMISSIONS  
(MILLION TONS/YR)



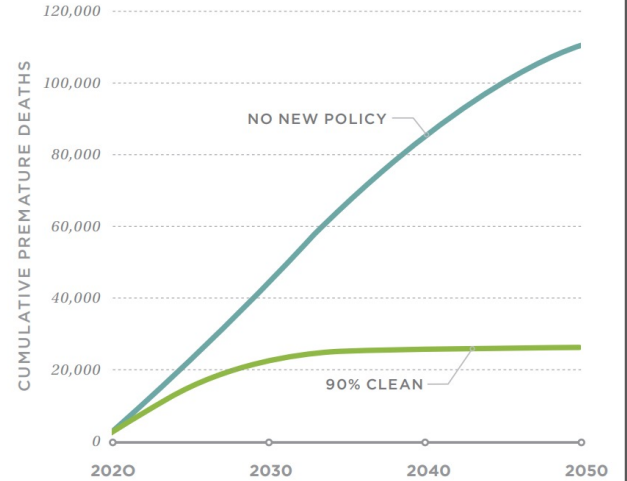
SO<sub>2</sub> EMISSIONS  
(MILLION TONS/YR)



NO<sub>x</sub> EMISSIONS  
(MILLION TONS/YR)



CUMULATIVE PREMATURE DEATHS





20  
35

THE REPORT

QUESTIONS?