U.S. Energy Outlook Research August 2021

- U.S. Energy Administration Annual Energy Outlook 2021
 - Highlights
 - Demand Projections
 - Effect of Natural Gas Availability on assumptions
- University of Texas at Austin Study on Electric Vehicle Effects on the Grid
- Electrical Generation Challenges in the News
- Grid North Partners: 2050 Transmission Report Summary
- Charging Infrastructure Challenges
- Global Development of Coal Burning Power Plants

Annual Energy Outlook Highlights - 2021

- A return to 2019 levels of U.S. energy consumption will take years; energyrelated carbon dioxide emissions fall further before leveling off or rising.
- Renewable energy incentives and falling technology costs support robust competition with natural gas as coal and nuclear power decrease in the electricity mix.
- Continuing record-high domestic energy production supports natural gas exports but does not necessarily mean growth in the U.S. trade balance in petroleum products.

AE02021 examines a range of conditions from 2020 to 2050

Assumptions

- Current laws and regulations as of September 2020 remain unchanged
- Current views on economic and demographic trends, and technology improvements
- Compound annual growth rate for real U.S. gross domestic product (GDP) is 2.1% (Reference case)
 High Economic Growth case (2.6%) and Low Economic Growth case (1.6%)
- The Brent crude oil price by 2050 is \$95 per barrel (b) in constant 2020 dollars (Reference case)
 - High Oil Price case (\$173/b) and Low Oil Price case (\$48/b)
- Oil and natural gas supply cases
 - High: more accessible resources and lower extraction technology costs than the Reference case
 - Low: fewer accessible resources and higher extraction technology costs than the Reference case
- Renewables cost cases
 - High: no cost reductions in renewable technologies
 - Low: renewables achieve 40% lower overnight capital costs by 2050 compared to Reference case

AE02021 does not specifically examine impact of electric vehicles (EV's)...

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The pace of recovery for gross domestic product (GDP) and energy consumption remains highly uncertain

U.S. gross domestic product assumptions AEO2021 economic growth cases

trillion 2012 dollars



U.S. delivered energy across end-use sectors AEO2021 economic growth cases quadrillion British thermal units

Source: Annual Energy Outlook 2021 (eia.gov)

2050

2050

Industrial and electric power drive most of the increases in U.S. energy consumption in the Reference case

U.S. energy consumption by sector AEO2021 Reference case

quadrillion British thermal units

2020 45 45 projections history 40 electric power 40 35 35 30 30 industrial 25 25 transportation 20 20 15 15 10 10 residential 5 5 commercial 0 0 1990 2000 2010 2020 2030 2040 2050

U.S. energy consumption by fuel AEO2021 Reference case

quadrillion British thermal units



Source: Annual Energy Outlook 2021 (eia.gov)

The majority of petroleum consumption growth occurs in industrial sector use of liquefied petroleum gas



Source: Annual Energy Outlook 2021 (eia.gov)

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Electricity demand grows modestly throughout the projection period

U.S. electricity use growth rate, three-year rolling average AEO2021 economic growth cases

percentage growth



U.S. electricity use by end-use sector AEO2021 Reference case



Note: Onsite generation is electricity produced onsite for own use.

AE02021 forecasts **2X** increases in demand across residential & Industrial to 2050

Source: Annual Energy Outlook 2021 (eia.gov)

Electricity generating capacity increases 52% to 84% across AEO cases; additions come mostly from solar, wind, and natural gas

Cumulative electricity generating capacity additions and retirements (2021–2050) AEO2021 selected cases

gigawatts



Source: Annual Energy Outlook 2021 (eia.gov)

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Electricity generation increases by a third; natural gas prices influence competition with renewables

U.S. electricity generation, AEO2021 oil and gas supply cases



AE02021 <u>clearly shows</u> generation dependency on oil and gas supply!

Source: Annual Energy Outlook 2021 (eia.gov)

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Power Generation Challenges in the News...

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Electric Cars Will Challenge State Power Grids

PROJECTS

TOPICS

STATELINE ARTICLE January 9, 2020 By: Alex Brown Topics: Energy and Environment & Economy Read time: 7 min

The average electric vehicle requires 30 kilowatt-hours to travel 100 miles — the same amount of electricity an average American home uses each day to run appliances, computers, lights and heating and air conditioning.

FEATURES

ABOUT

GET INVOLVED

A U.S. Department of Energy study found that increased electrification across all sectors of the economy could boost national consumption by as much as 38% by 2050, in large part because of electric vehicles. The environmental benefit of electric cars depends on the electricity being generated by renewables.

> So far, states predict they will be able to sufficiently boost power production. But whether electric vehicles will become an asset or a liability to the grid largely depends on when drivers charge their cars.

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SEARCH

University of Texas at Austin study:

THE CONVERSATION

Academic rigor, journalistic flair

All told, American drivers log about <u>3 trillion miles</u> per year, consuming more than 170 billion gallons of gasoline and diesel in the process. Converting all those road miles to electricity would place new demands on the nation's system for producing and delivering electricity.

If the US relies completely on Electric Vehicles, the projected growth in electricity demand can be seen below:

for EV recharging...





Source: Article

The risk of timing the recharging of EV's at non-ideal times of day:











The capacity of the grid is exceeded significantly. This will impact reliability.

Source: Article

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Electrical Generation Challenges in the News...

REUTERS World Business Markets Breakingviews COMMODITIES MARCH 5, 2021 / 7:07 AM / UPDATED 5 MONTHS AGO 20 EV rollout will require huge investments in strained U.S. power grids 1,5 By Nichola Groom, Tina Bellon 9 MIN READ f 9 (Reuters) - During several days of brutal cold in Texas, the city of Austin saw its 1,0 (Reuters) - During several days of brutal cold in Texas, the city of Austin saw its 5 That problem will be magnified next year, when officials plan to start purchasing 5 electric-powered vehicles exclusively. 5

Estimated U.S. capacity if 66% of all cars are EVs by 2050

Gigawatt electric capacity needs to double to power 186 million light-duty EVs in 2050



"Reliability keeps you awake," California Energy Commission member Siva Gunda said in an interview.

Rolling blackouts during a California heat wave last year prompted the state to direct its utilities to procure emergency generating capacity for this summer and to reform its planning for reserve power.

Estimated U.S. generation requirements – Electric Vehicle Effect

Estimated U.S. capacity if 66% of all cars are EVs by 2050

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Grid North Partners: 2050 Transmission Report Who We Are

CapX2020 is one of the largest transmission-development initiatives in the nation. Our duty is to reliably and affordably serve consumer's current and future power supply needs and growth. Our goal is to enable regional energy policies and provide safe, reliable, and affordable energy in the evolving electric industry.

The ten CapX2020 utilities include cooperatives, municipals, and investor-owned utilities providing reliable transmission service to nearly 5.5 million electric customers, consumers, and members ("consumers") for decades. Collectively, we operate over 42,000 miles of transmission lines in our combined service territories and are national leaders in planning, building, and maintaining a reliable transmission system capable of using the most cost-effective resources available. The CapX2020 utilities include:

- Central Municipal Power Agency/Services
- Dairyland Power Cooperative
- Great River Energy
- Minnesota Power
- Missouri River Energy Services

- Otter Tail Power Company
- Rochester Public Utilities
- Southern Minnesota Municipal Power Agency
- WPPI Energy
- Xcel Energy

Source: Article

Grid North Partners: 2050 Transmission Report

Dispatchable Resources

Generation resources that may be called upon with short notice to meet immediate customer needs. Utility operators depend on these resources' ability to ramp up or ramp down their energy output as needed by the system. Dispatchable resources include resources such as coal, natural gas, hydro-electric, and nuclear facilities. Future dispatchable resources may include various new technologies.

Non-dispatchable Resources

Intermittently operating resources whose output cannot generally be controlled when operating. In particular this refers to wind and solar facilities without energy storage. Due to its variability, real-time operators cannot depend on the desired amount of energy at a specific time.

Grid North Partners: 2050 Transmission Report Finding #1

Dispatchable resources support the electric grid in ways that non-dispatchable resources presently cannot. They provide physical attributes that help maintain a stable and reliable grid. As dispatchable resources are retired, it will be essential that new and existing generation and transmission technologies are deployed with the ability to provide grid support in the appropriate locations to ensure reliability is maintained.

Finding #2

Reliably meeting real-time operational demands will become more challenging than they have been in the past as dispatchable resources are retired and their corresponding ancillary services are lost.

Grid North Partners: 2050 Transmission Report

Finding #3

To maintain reliability of the system as we integrate more non-dispatchable resources and retire dispatchable resources, more transmission system infrastructure will be needed in the upper Midwest.

Finding #4

Non-dispatchable resources alone will be incapable of meeting all consumer energy requirements at all times. Dispatchable resources and/or energy storage with capacity for multi-day support will be needed.

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Charging Infrastructure Challenges

Expanded charging infrastructure is needed for EVs to make long-distance trips that require multiple stops for charging. A recent study by the International Council on Clean Transportation <u>indicated</u> that 10,000 more charging stations will be required to support EVs traveling on inter-city corridors by 2025, based on trends of increasing EV ownership.

For drivers who live in apartments, parking garages are rarely equipped with charging infrastructure, and installing such infrastructure may be cost prohibitive for building managers.

There are important cost differences between charger types. According to a <u>study</u> by the Rocky Mountain Institute, costs for a level two charger's components range from \$2,500 to \$7,210 and from \$20,000 to \$35,800 for a DC fast charger.

A recent study by the International Council on Clean Transportation <u>indicated</u> that 10,000 more charging stations will be required to support EVs traveling on inter-city corridors by 2025, based on trends of increasing EV ownership. When it comes to longer trips, EV owners can experience "range anxiety," the fear that the car will run out of power before reaching a suitable charging station.



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Global Investment in Coal: China

Despite Pledges to Cut Emissions, China Goes on a Coal Spree

China is building large numbers of coal-fired power plants to drive its postpandemic economy. The government has promised a CO2 emissions peak by 2030, but the new coal binge jeopardizes both China's decarbonization plans and global efforts to tackle climate change.

BY MICHAEL STANDAERT · MARCH 24, 2021

China is proposing to build plants Which would generate 5X the gigawatts Of the <u>rest</u> of the world

247 gigawatts

of coal power in planning or development A total of 247 gigawatts of coal power is now in planning or development, nearly six times Germany's entire coal-fired capacity. China has also proposed additional new coal plants that, if built, would generate 73.5 gigawatts of power, more than five times the 13.9 gigawatts proposed in the rest of the world combined. Last year, Chinese provinces granted construction approval to 47 gigawatts of coal power projects, more than three times the capacity permitted in 2019.