U.S. Energy Horizons to 2050

OnLocation, Inc. Webinar

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[upbeat music]

(00:34)

[Francisco de la Chesnaye]

Good afternoon everyone,

This is Francisco de la Chesnaye, Vice President, Economic Strategy here at OnLocation. We are pleased today to present our U.S. Energy Horizons 2050 report.

(00:50)

But before we get started, a quick disclaimer. This material was produced by OnLocation Incorporated, who provides unbiased predictive energy analysis using quantitative analytical methods and an integrated modeling approach of the US energy system.

(01:06)

All data provided and opinions expressed in this analysis are based on OnLocation's research and experience. The material follows from available public information that we consider current and reliable.

(01:20)

Today, I'm fortunate to be joined by my colleagues, Sharon Showalter, associate director and lead of this report, and Frances Wood, senior director. OnLocation is a KeyLogic company, where KeyLogic is a mid -tier firm, which offers deep domain expertise in the country's most critical undertakings within the energy, federal, civilian, and defense sectors, and covers strategic areas of large-scale data management, emerging technologies, and material and resource analysis, in particular, lifecycle analysis. OnLocation is a specialized firm with decades of experience in developing and applying innovative energy system and economic models to address key energy, climate, and environmental regulations and policies. Our core areas include assessing the role of energy technologies, exploring alternative energy futures, and informing energy and environmental policies. And this year is OnLocation’s 40th, which we're happy to celebrate. As many know, the Energy Information Administration will not be producing its annual energy outlook.

(02:36)

With all the challenges underway and expected to come in the U.S. energy system, including new technologies, policies and regulations, changes in consumer preferences, and of course international interactions, we've decided to put a release of a new energy projection of the US system. Understanding the value of providing a common reference projection for the energy and climate modeling groups and the policy community is important and therefore we put out this analysis this year.

The goals of our Energy Horizons report include the following. Provide updated reference case projections using our version of the National Energy Modeling System, and this is an updated model representation of laws and regulations since EIA's annual energy outlook 2023. We also want to demonstrate new modeling capabilities and enhancements that OnLocation has made using an advanced technology case. These include exploring the role of CO_2 mitigation strategies for the U.S. energy system and can also be used to evaluate the driving forces and challenges to achieve deep decarbonization.

(03:55)

Now the way we produce energy system projection to 2050 is with the application of our national energy modeling system customized based on what we thought was important to develop. The main modules of this model include the energy supply, energy conversion, energy demand, and there's a few other ones that we thought were important to bring in, including other components in an integrated analysis, which include a macroeconomic activity module, the international energy supply and demand, and then a new module that we developed for critical materials used in the energy system.

(04:38)

We develop and apply our version of the NEMS model to analyze energy and climate policy impacts, assess new energy technologies, inform cost -effective approaches and policies to reducing emissions. Some of our customized analysis include the latest Inflation Reduction Act, also Renewables and Electric Vehicle Expansion, a new Hydrogen Economy, as I mentioned before, Critical Materials Analysis, and then the latest innovation that we have started to work on includes modeling the energy demand for artificial intelligence and cryptocurrencies.

(05:20)

To give you some highlights of the Energy Horizons results, I wanted to cover a couple up front. These include clean technologies and enabling policies to reduce carbon dioxide emissions over time in the US energy system. There's also additional research and development that leads to new and lower cost clean technologies which are assumed in the advanced case. All energy sectors we find contribute to reducing emissions,

(05:50)

Particularly in the power sector, this is via increased renewables and CO_2 capture. In transportation, this is with additional sales and increased electric vehicles, but also with biofuels. In industry, there's a continuing trend towards electrification, the use of hydrogen across the sector, and also CO2 capture as well. In buildings, It's the same electrification that we see in industry, and also energy efficiency across the entire system. We also noticed that there is strong decarbonization in the electric grid, which continues to facilitate electrification in the US, and therefore continues to reduce emissions. And one of the last key points is that we see CO2 removal technologies play a key role over the entire system, as I mentioned before, particularly in industry and in power generation. Now, with that, I'm gonna switch over and transfer to my colleague, Sharon Showalter.

(06:56)

[Sharon Showalter]

Thank you, Francisco. Hello, everyone. My name is Sharon Showalter. We will start by comparing the new Energy Horizons reference case with the EIA annual energy outlook 2023 reference case.

While both cases have many underlying assumptions in common, some key differences include the following. We updated policies and regulations that were passed since the AEO 2023 was published in March of last year, including new EPA greenhouse gas standards for both power plants and vehicles, select appliance standards, and state -level policies including zero -emission vehicles and mandates for battery storage and offshore wind.

We implemented a more complete representation of the Inflation Reduction Act, or IRA provisions, including tax credits for clean fuels, hydrogen, and direct air capture, and we implemented additional bipartisan infrastructure law or BIL provisions, including funding for advanced nuclear and CO_2 capture demonstration plants, as well as CO_2 pipeline and storage subsidies. We also assumed lower costs for renewable and carbon capture technologies and four electric vehicles and greater data center electricity demand growth in the commercial sector, along with many other policy and data updates. These modifications lead to greater CO_2 reductions in most energy sectors by 2050 in our new reference case compared to the AEO, especially in the power and transportation sectors as shown in the chart. Next is a look at primary energy consumption between the two reference cases.

(08:47)

A combination of updated policies and regulations and lower technology costs result in a more rapid phase -out of conventional fossil fuels in favor of renewables including solar,

wind, and biofuels and of electric vehicles in the Horizons reference case compared to the AEO. Total primary consumption is higher in the horizon's case, primarily due to higher growth in electricity sales, driven primarily by additional data centers. More detailed information about these fuel shifts will be discussed later in the presentation.

(09:27)

We will now introduce the second OnLocation horizons' scenario and advanced technologies scenario and will compare key results between the reference and advanced scenarios for each energy sector.

The advanced technology scenario is designed to highlight the many model enhancements OnLocation has implemented in the OL NEMS model, most of which enable the model to achieve deeper decarbonization.

These new CO_2 mitigation technologies include the following. Several CO_2 capture options in industry. A representation of hydrogen production and consumption. Direct air capture or DAC technologies that can use either natural gas or grid electricity. Bioenergy with CO_2 capture or BECCS technologies in both power and liquid fuels, and finally, sustainable aviation fuel as a replacement for petroleum-based jet fuel. We introduced an assumed CO_2 price path in this scenario as a way to incentivize deployment of these new technologies, especially direct air capture and clean hydrogen. We assumed that the CO_2 price will drive further technology improvement and changes in consumer behavior.

(10:56)

So, we implemented a transition to advanced technologies with lower costs than the reference case and we enabled greater consumer acceptance of new technologies, of electrification options, and of more energy efficient equipment in the demand sectors. Here we reveal the resulting net CO_2 emissions in the two OnLocation scenarios.

The chart on the left illustrates annual reductions through 2050, and the chart on the right shows which sectors are contributing to the significant CO_2 reduction in each case.

While the reference case CO_2 emissions decline over time, The net emissions in the advanced technology case are significantly lower than the reference case, achieving a reduction of almost 1,400 million metric times by 2050. An important contributor to these reductions is the power sector that achieves net zero CO_2 by 2040 with a combination of newer nobles, battery storage and CO_2 capture, including some bioenergy with carbon capture or BECCS. Some other sectoral emissions are also offset by net negative emissions from both DAC and BECCS in industry, biofuels, and hydrogen production.

Industry and transportation sectors account for most of the remaining emissions in 2050 in both cases.

(12:34)

This slide focuses on all sources of CO_2 captured in our scenarios. Carbon capture and storage adoption is significantly higher in the power sector and in several industrial processes in the advanced technology case compared to the reference case.

In the reference case, CO_2 capture declines by 2040 as the Inflation Reduction Act 45Q sequestration credits end.

In contrast, total CO_2 capture adoption, especially net negative emission technologies such as direct air capture as well as BECCS in industry, hydrogen and biofuels, continues to grow over time in the advanced case supported by the scenario's CO_2 price. This primary energy chart illustrates the growth in renewable energy use caused by shifts from fossil fuels to renewables, especially solar, and by greater electricity consumption driving further increases in renewable adoption over time in both cases.

(13:45)

The advanced case has an even greater increase in renewables compared to the reference case as a result of advanced technology costs and higher fossil fuel costs due to the CO_2 prices.

Biomass consumption also increases in later years due to a combination of greater use of biofuels in transportation and BECCS deployment in industry power and hydrogen production.

As shown here, increasing electrification occurs in all energy sectors in the advanced technology case due to a combination of greater consumer acceptance of electric technologies such as heat pumps in buildings, fuel switching in industry, and new EPA greenhouse gas standards that promote more electric vehicles. In both cases, continued growth of data centers results in higher commercial electricity sales over time.

(14:43)

More information about data center projections will be discussed later in the presentation. By contrast, natural gas consumption illustrated here declines significantly in all sectors due to electrification, energy efficiency, and greater adoption of renewable energy. This reduction is most prominent in the power sector. The remaining natural gas consumed includes CO_2 capture in power and natural gas used for hydrogen production and direct air capture as well as traditional uses in industry and buildings.

(15:20)

Next, we will focus on results from the power sector, which is rapidly shifting to clean sources of electricity in both cases. The electricity generation chart illustrates this shift to clean sources over time.

As shown in a prior slide, the power sector achieves net zero CO_2 emissions by 2040 in the advanced technology case. This is due to an increasing share of generation from renewables, especially solar and wind, and CO_2 capture technologies, both of which displace conventional coal and natural gas generation over time.

Electricity generation is higher in the advanced technology case due to greater electrification in all energy demand sectors as shown in the prior electricity sales slide.

Coal generation without carbon capture is no longer available in later years due to new EPA greenhouse gas standards represented in both cases. The electricity capacity chart also shows this shift to cleaner sources of electricity.

Greater investment in clean technologies, especially solar, wind, and battery storage, and some carbon capture capacity, displaces most conventional fossil capacity by 2050 in both cases.

This additional investment in clean electricity sources is driven by low renewable costs and IRA tax credits in both cases and by greater electricity demand and the assumed CO_2 price in the advanced case.

(17:01)

Fossil with CO_2 capture or CCS includes retrofit coal capacity and both new and retrofit natural gas capacity in the advanced case. CCS is incentivized by a combination of IRA tax credits and the CO_2 price.

As with generation, conventional coal capacity retires by 2040. The remaining natural gas capacity without capture is primarily used to maintain grid reliability. Next, my colleague Frances Wood will present additional scenario results.

(17:30)

[Frances Wood]

Thank you, Sharon. Now, we'll turn to the transportation sector, which has recently become an active focus of efforts to reduce greenhouse gas emissions.

After bouncing back from reduced energy demand in 2020 due to COVID, transportation demand is projected to decline over the long term, primarily due to a shift to electric vehicles and increased fuel economies.

This shift to EVs is being encouraged by a combination of tax policies and mandates, as well as battery cost reductions. As illustrated in the chart, gasoline and diesel consumption are projected to decline while electricity consumption in green increases in both cases.

In the advanced case, the shift to EVs expands in response to CO_2 pricing, along with modest additional cost reductions in electric vehicles. As a result, there are further reductions in liquid fuels offset in part by greater electricity demand. EV sales increase significantly in both scenarios as mandates and standards become more stringent.

(18:41)

The EPA GHG tailpipe standards, which we assume remain in place, phase in through 2032. And the advanced clean trucks rule, adopted by several states, phases in by 2035. Light duty vehicle EV sales reach almost 50 % by 2030 in the reference case. Cost declines in electric vehicles, along with IRA tax credits, support electric light duty vehicles and freight truck sales in this period. In the advanced technology case, CO_2 pricing incentivizes further adoption at EVs, as well as fuel cells in heavy trucks where battery technologies are more difficult to employ.

(19:18)

The gradual replacement of conventional gasoline and diesel vehicles with EVs leads to declining liquid fuel demands in both cases. At the same time, non-petroleum, i.e. biofuels, supplies expand in the advanced tech case stimulated by CO_2 prices. As a result, net exports increase, primarily finished products, and by 2050, the U.S. becomes a net exporter of crude oil in the advanced case. Turning now to the industrial sector, in the advanced technology case, higher rates of electrification lead to lower fossil fuel and higher electricity consumption relative to the reference case, although energy use continues to increase over time. As shown previously, emissions from this fossil usage are mitigated by CCS. The greatest electrification occurs in the bulk chemicals, food, metal durables, and non -manufacturing industries. Carbon capture technologies require higher energy use, but their effect on overall energy consumption is minor.

(20:21)

We project hydrogen production within a new OL -NEMS module that examines the relative cost of production technologies, taking into account relevant tax credits, as well as technological improvements.

The figure shown here focuses on new hydrogen production and does not include current production occurring in ammonia facilities and refineries. In the reference case, new hydrogen demand, primarily from trade trucks, it's met by conventional natural gas steam methane reforming, also known as SMR, which is the most common method used today, as well as some electrolysis while the IRA45V tax credits are available. The higher demand for hydrogen in transportation and industry in the advanced technologies case initially is met mostly by natural gas SMR, but now with CCS, and then met by biomass with carbon capture in later years when the technology becomes available and 45Q credits expire.

(21:23)

The final energy sectors to consider are residential and commercial, combined here as buildings. While building energy consumption rises in the reference case, a combination of electrification, an increased energy efficiency, lowers fossil fuel consumption, and even total energy consumption over time in the advanced technologies case. CO_2 pricing is assumed to focus attention on energy costs and lead consumers to be more receptive to making investments in energy efficiency and electrification when cost effective.

On-site generation, shown in blue, is primarily rooftop PV, and it increases slightly more in the advanced case due to lower technology costs. IRA tax credits stimulate adoption of PV in both cases, although phase out for businesses when IRA emission targets are met in the advanced case. Electricity growth in both cases includes continued expansion of data center demands that has been mentioned previously.

(22:28)

Both cases also include recently enacted appliance standards such as natural gas furnaces and boilers, electric and natural gas water heaters, and refrigerators.

In the reference case, the shares of residential heating technologies are relatively constant, with a modest movement towards more electric heat pumps, which are shown in green. In the advanced technology case, the adoption of electric heat pumps steadily increases over time, replacing fossil fuel consuming equipment, primarily natural gas furnaces and less efficient electric resistance heat to a lesser extent.

(23:03)

Although not shown here, there's also a shift to a higher share of electric heat pump water heaters. Consumers in the advanced case respond to CO_2 pricing that raises the cost of using fossil fuels and are assumed to be more likely to consider switching heating technologies than in the reference case.

There's been a lot of buzz recently about increasing electricity demands of data centers. The first wave of cloud computing and cryptocurrency has been followed by an even larger surge in the use for artificial intelligence or AI applications.

These data centers often have large electric loads and operate 24 /7. Electricity use is not just to power the computers themselves, but also for cooling the machines.

No slowdown of AI applications appears in sight. The pace of continued electricity demand is highly uncertain. In the future, increasing efficiencies of computing and energy may provide an offsetting effect.

(24:03)

Our Energy Horizons Reference Case includes growth of over 600 terawatt hours over the next 30 years, with data centers becoming almost a third of commercial electricity demand by 2050.

We plan to issue a follow -on report focused on data center energy demand this September. And now Francisco will provide a recap of the results.

(24:37)

[Francisco de la Chesnaye]

Thank you, Sharon and Frances, for covering the details. I'm going to just do a quick recap, but I do want to ask everybody who's logged in for this event. Please go ahead and put your questions into the appropriate chat. So, when we get to that section, we can answer as many as we can in the time that we have leftover.

So now I'm just going to go into finishing up the recap and just to remind everybody in the analysis that we've conducted without looking at it out to 2050 with the national energy modeling system that we customized, we do see continuing reduction in CO2 emissions via clean technology deployment and enabling technologies, in the reference case, but of course, particularly in the advanced technology case. Where in that advanced technology case, additional research development into those technologies is a pretty key proponent and factor.

(25:44)

One thing I'm pretty sure everybody noticed is that all of the energy sectors contribute to CO_2 mitigation, both through changes in adoption of technology, but also increased efficiency and staying in line with consumer preferences, particularly power generation, transportation industry, and buildings. One of the other key factors is the decarbonized electric grid continues to facilitate economy-wide emission reductions through electrification.

And then lastly, within the CO_2 removal technologies area, which is relatively a new area, that's another part that we wanted to highlight as well.

Now, we have developed, run, and enhanced this very sophisticated model of the full integrated energy system of the US.

But there's many caveats that are important to keep in mind in this kind of analysis. In terms of the scope of the analysis, we do cover as many of the sectors and subsectors as possible, but it's not fully comprehensive. And particularly, there may be new technologies that we just don't know of, particularly when you're looking at 2050. We do assume different rates of technology development, learning curves, we do this based on the latest available literature in the field, but that's subject to uncertainty and uncertainty is one of those key challenges that we have to deal with and do this kind of modeling.

(27:27)

A couple of things I just want to highlight so we can move on to the questions and answers. Policy assumptions in the framework of analysis, we only model existing policies and measures that are sort of on the books, right? We don't, for the reference case, we don't assume any new policies coming on board or any sunsetting before their legislative intent or regulatory action required.

Last thing I'll just say, particularly for the advanced technology case is that we do assume a CO_2 price to incentivize mitigation technologies to come on.

But I want to make sure that this was done in effort to highlight the model and how those mitigation technologies could come into place.

But it is in no way an endorsement of level of stringency for that kind of a pause. And I think with that, we're gonna just go on to the next, last couple of slides here. You heard from a couple of us here at OnLocation, but this is a full team effort. And here is the whole cast and crew at OnLocation contributed to this report.

(28:46)

And I also want to give a special shout out and thanks to our corporate colleagues and team people for support in the report video and reproduction. Now, one important news to give you all is that after we've completed this reference case and advanced scenario case.

We do have a couple of additional location reports coming up in the next couple of months. As Frances mentioned, we are starting to focus analysis on the critical energy demand for data centers.

This is for artificial intelligence and cryptocurrencies and stay tuned for announcement on the release of that report in September. We're also going to be looking at the employment impacts of the U.S. energy transition, and that's forthcoming in November. And then lastly, an update to work that we completed last fall, and this is the continuing demand for critical materials in the U.S. energy sector. Okay, so with that, we can now get into questions and answers and I'm going to just take a look at what's been coming in.

Let me take just a quick peek at what we've gotten. So, I think the first one I'm going to address is to my colleague Amogh Prabhu.

(30:18)

So Amogh, this is a question about mitigation technologies. The question is which direct air capture technologies are made available and which technologies get built in the modeling framework that we have developed?

(30:35)

[Amogh Prabhu]

Thanks, Paco. Thank you for the question. We have made available three DAC technologies, a natural gas only technology that uses natural gas for fuel and to generate power on site, a natural gas plus grid electricity technology, and an electricity only technology that uses electricity for both heat and power. The model uses an economic choice to determine the location and technology of each DAC site.

We have included the two hubs announced recently by DOE in Texas and Louisiana and have funded two other hubs in the model based on economic choice so that the available ones are used.

We find that outside of the announced DAC hubs that use the B-Termin technology, all the other DAC sites are built using the natural gas only technology. This technology also, by the way, captures the additional emissions due to the combustion of natural gas.

(31:36)

[Francisco de la Chesnaye]

All right, thank you very much Amogh. Okay, let's see other questions are coming in. And remember, everyone who's on just submit the questions and then we'll get them up as soon as we can.

This question, the next one is related to transportation. So, I'll address that to our transportation experts, Samaneh. And the question is as follows, "what policies and regulations were included in the transportation sector analysis, in addition to the ones that are ready, were in the AEO 2023?"

(32:13)

[Samaneh Babaee]

Great, thank you for the question. So basically, we have a few of the main IRA tax credits. So, the first one, we have higher eligibility for 30D than AEO 23, what AEO23 assumes. So basically, 30D is clean vehicle tax credit for light duty vehicles.

We also included 45W, which is a clean commercial vehicle tax credit. And also, it covers the clean buses, school buses. We added also the battery production tax credit, 45x for both live and medium heavy-duty vehicles. In terms of regulations, we added the final EPA GHG rule and as you may know, it requires manufacturers to significantly reduce the average tailpipe emission of different types of vehicles.

(33:16)

The rule will start in 2027 and the requirement will change based on the vehicle size classes. And the last one is advanced clean truck or actual that we included.

So that basically requires a minimum zero emission vehicle sales for different size classes of medium and heavy-duty trucks. For example, the minimum share can go up to 40 % or 75 % by 2035, depending on the size classes.

This rule is from California, but it has been adopted with like 10 other states, and it starts to like around 2025 through 2027, but it goes up to 2035 and beyond. So, these are the main ones that we included in addition to AEO23 policies and regulations.

(34:22)

[Francisco de la Chesnaye]

All right, thank you very much, Samaneh. All right, let's see. You've got a couple of the ones here. Let me address this to Sharon.

This is related more to recent regulatory policy actions. Sharon, the question is, “can you describe which IRA, this is the Inflation Reduction Act, provisions were modeled and which ones were not in the analysis that we've presented?”

(35:06)

[Sharon Showalter]

I’m mute, sorry. Thank you for the question. So many of the IRA or Inflation Reduction Act provisions were implemented in our scenarios. Most of the IRA tax credits are represented directly, including the production tax credits and investment tax credits in the power sector. Also, production credits for clean fuel and hydrogen production, sequestration, 45Q sequestration tax credits, and consumer tax credits for electric vehicles and energy efficient equipment in buildings.

The IRA provisions for loans and grants across the energy sector were generally not represented because we just don't know enough about how those funds will be distributed at this point. Thank you.

(36:02)

[Francisco de la Chesnaye]

Sharon, we've got a bunch of questions coming in, but I'm gonna sort of stay with you for a second. This is because it's still related to the electric power sector. And the question is, “do we have a view into the impact of the tax credits on the expansion of commercial solar power production?”

(36:26)

[Sharon Showalter]

Good question. So just to let you know, the charts that were shown in the discussion on the power sector was focused on central renewable generation. But although we didn't show results, we do get a significant increase in rooftop solar photovoltaic in both commercial and residential sectors.

That increase is due to two different factors. One is the Inflation Reduction Act tax credits in both scenarios. The other is we did reduce the cost for both installation and operations for those technologies and you know the costs in the reference case were a bit lower than what you would have had in the AEO and we reduced that even further in the advanced case. So, the combination of both lower technology costs and the IRA tax credits do have a significant impact in adoption of both commercial and residential solar.

(37:52)

[Francisco de la Chesnaye]

Thank you, Sharon. We're gonna switch to a biofuel-related question that this would go to Frances. So the question is, “can we describe more in terms of what is included in the model with respect to biofuel technology in their application?”

(38:14)

[Frances Wood]

Sure, thank you. So, we've introduced two additional technologies that we feel could be important in decarbonization. One is this sustainable aviation fuel, which is a relatively mature technology, and it comes in in the advanced technologies case, a little bit in the reference case as well. And then there's also biomass-to-liquids with carbon capture and storage.

This technology is less mature, but it comes in the advanced case due to the carbon pricing. It has a great deal of potential in that it becomes a negative emitter. So, under a serious carbon policy case, it becomes quite attractive. Thanks.

(39:01)

[Francisco de la Chesnaye]

All right. Thank you, Frances. All right.

Let's see. Just sort of scrolling through what's coming in. Okay. Here's a good one in terms of a new technology in the area of hydrogen, this is a part of the model that we've been working on for the last couple of years in trying to advance that whole new, what we call the hydrogen economy, both from the production of the consumption.

So, I'm going to address this to our hydrogen expert that would be to Amogh. And effectively, let's see. “Why does hydrogen production from natural gas, SMR, get replaced by, I guess this is bioenergy carbon capture up to 24?”

This is a very detailed question. So, Amogh, can you just describe some of, you know, how we've approached hydrogen production, particularly with SMR?

(40:05)

[Amogh Prabhu]

Yeah, definitely. So, we've seen that natural gas estimate with CCS seems to be the most likely technology to be chosen next decade, given the number of announced projects using this technology. This of course includes other electrolysis technologies that also have been announced due to the 45 eq in the IRA.

What we've assumed is that the BECCS, the bioenergy-based hydrogen production with CCS is only available in later years, primarily after 2040 when IRA section 45B rights expire. And we have a reference for these in the NREL H2A models where most advanced technologies also have a later start date.

We're assuming that this technology is available only later years because the IR&D breakthroughs needed to reduce the cost are only available then. Now, by the way, since bioenergy with CCS is considered a net negative technology, in the presence of an assumed carbon price in the advanced case, it will outcompete most other hydrogen technologies available, and therefore you see that it dominates production once available.

[Francisco de la Chesnaye]

All right, thanks Amogh. Let's see.

I'm gonna this is this is a new one. This is about artificial intelligence. And the question is as follows. Did you assume that artificial intelligence that artificial general intelligence in the advanced technology case were that further accelerating change?

I guess I'll take that as, I mean, we modeled or we started the model, the implication effectively of the energy demand for the data centers that go to AI.

I'm going to go to Frances and just a sec to ask so she can respond a bit more of us to how we model that. So effectively, I'll call it, we model what we would consider the direct implications of increased data centers for artificial intelligence and cryptocurrencies. I think what the question is also trying to get at, I believe, is did we model artificial intelligence helping to advance mitigation technologies and developments in the energy system.

(42:40)

That's no we did not. That's that's a great area of research and you know to expand that. I mean in the model we definitely have advances in energy technologies and climate mitigation technologies via continued adoption, increased efficiency and sort of learning curves, how artificial intelligence may further accelerate those changes. Again, that's a big area of research. We're just starting to think about it, but definitely something we want to tackle. Anyway, Frances, I'll let you answer the more direct question as to how we model this initial step on AI demand.

(43:30)

[Frances Wood]

Sure. And I think you did respond in part to the nature of the question. But to give a little bit more description of how we did the electricity demand part of it. And as Paco said, there's a lot of uncertainty here. So, I should stress that at the very beginning but we've been looking at available information about recent growth in the data centers and electricity demands and anticipated additions in the next several years and then we use sort of a classic S shaped kind of parameter although it's it looks linear sort of in this time frame but to hypothesize a further increase but of course the energy efficiency and other things and even the applications of AR are very uncertain. I mean, looking around at other people's projections as well, I would say we are a little bit on the conservative side, but then some people are projecting the AI demand and data centers could become as electricity man could become as large as total electricity demand today by say 2050.

We think they're probably mitigating factors that may not happen, but we definitely wanted to include some hypothesis about data growth in our reference case, which you see. Thanks.

(44:44)

[Francisco de la Chesnaye]

All right, I'm gonna, Frances, I'm gonna actually stay with you. We got another question, let's see, related to...

Oh, okay, so this is related to, we talked a little bit about electrification. So, could you elaborate a little bit more on what we mean by increased acceptance of electrification energy efficiency in the advanced technologies?

(45:16)

[Frances Wood]

Sure, thanks. So historically, consumers have been relatively slow at adopting new technologies when it's a general regular service, you know, not like a cell phone, but something. So in terms of heating and cooling equipment, people tend to stick with the same technology when it comes to replace their equipment. And this what's reflected in the reference case.

But in the advanced technology case with a carbon price, and with a focus on decarbonization, we think comes with that, we assume that consumers are going to be looking for lower cost alternatives and be more likely to consider looking at other technologies, not just sticking with the one that they have. And so that's on the electrification side. And at the same time, as operating costs become larger for heating in particular and water heating and cooling, actually all the end uses, with energy costs are going to become a larger share of people's income or business costs, in the case of commercial sectors. So again, we're assuming that consumers become more focused on operating costs, not just initial first costs, and are more willing to, again, adopt high efficiency technologies where they're cost effective. And of course, scenario, you know, consumer behaviors are quite unknown, but that's the scenario that we thought might unfold.

(46:42)

[Francisco de la Chesnaye]

All right. Thank you, Frances. Okay. We got a question about energy, primary energy consumption, particularly in comparison between the scenarios, I'm going to address this to our project lead to Sharon.

So, the question is, "why is primary energy consumption higher in the advanced case versus the reference case?" And also in comparison to, I think it's AEO case, I guess this means to the AEO 2023 Scenario.

(47:20)

[Sharon Showalter]

Thank you. The main reason, hold on a second. I just want to get to that slide... So the main reason has to do with the way that we are scoring the primary energy.

So, we're using a fossil fuel equivalent approach for scoring the solar and wind technologies. So in addition to higher electricity sales. It's also sort of an accounting thing. In the advanced case, we get more CO_2 capture that actually raises, that tends to be less efficient than the conventional fossil. So that raises the fossil fuel equivalent that is applied to the renewable technologies there.

So that is the primary reason why primary energy is higher in the advanced case.

(48:15)

[Francisco de la Chesnaye]

Thank you, Sharon.

Okay we're gonna switch from that part of the modeling over to transportation so I'm going to tag Samaneh. And so the question is, it's also sort of a comparison one as well. So how do our electric vehicle projections compare to EPA's analysis for the greenhouse gas rule?

(49:03)

[Samaneh Babaee]

Sure. Yeah, that's a great question. So, comparing with the final EPA GHE rule, the EV sales for the combined cars and bike truck by 2030 is about like 44 percent.

Our projection is 49 percent. So, we are about like 5 percent higher than an EPA projection and the same for 2032. The last year that the EPA that the EV sales is 2032 and the number is about like I think 56 % and our projection is 61 %, so again like 5 % higher. So that's for LVV sign.

(49:55)

[Francisco de la Chesnaye]

Okay thank you very much. Okay I think that gets us pretty much to the end of the questions. Oh, there is okay one more came in. I think this is pretty important. This is going to go back to Sharon for related to power the electric power sector It's related to CO_2 capture.

So the question, Sharon, is "Why does CO_2 capture, in the power decline after 2030 in the advanced case?" Because someone must have taken a screenshot of our slides.

(50:35)

[Sharon Showalter]

Sure, so CO_2 capture and power is a combination of several different technologies, including new and retrofit natural gas with CCS and coal plants with CCS that includes biomass cofiring or BECCS.

So, when the 45Q credits expire, the retrofit natural gas CCS plants are dispatched at a lower, much lower rate due to relatively high heat rates.

That has to do with the fact that it's an older plant, but also when you retrofit the plant with CCS, the plant requires more energy to simply run the capture part of the plant.

So those plants are dispatched at a much lower rate, but the new natural gas combined cycle or with carbon capture and the BECCS plants continue to generate power and capture CO_2 due to support from the scenarios assumed CO_2 price.

(51:54)

[Francisco de la Chesnaye]

Thank you, Sharon. Yeah. Okay, I think we're getting down to the last bit here also just being aware of time. We have a question about industry and electrification.

So I'm going to address this to Amogh Prabhu. Amogh, the question is as follows. “In the modeling, what technologies are made available to incentivize, I guess, advance increased electrification in industry?”

(52:31)

[Amogh Prabhu]

Thank you, Paco. Good question. So, we have used a three-pronged approach here to increase electrification in the industrial demand model.

So, first is we've allowed the carbon price adjusted price, or the carbon adjusted price of fossil fuels to be more transparent to each industry to allow an effect.

We're also allowing an additional shift away from these fuels to electricity, essentially fuel switching based on the level of the carbon price, and we've also allowed increasing the shares of the electric boiler technologies, which is new in AEO23 compared to fossil fuel-based ones, based on a carbon price ratio of existing adjusted prices to the base level price. All three of these approaches lead to the increased electrification by each industrial subsector, as we saw in the webinar.

(53:28)

[Francisco de la Chesnaye]

All right. Thank you, Prabhu. All right. So I think with this, I'm going to go sort of wrap it up. I've got one question which I think will lead us into the close, which is, are we going to make available the slides and the data that goes to the analysis? And so the answer is yes. So shortly after we conclude the webinar, we will be posting the slide deck, the recording, as well as data tables that go to the report.

And then the report itself will be forthcoming. So it's essentially a think about in terms of like an annotated slide deck with the results you see in here, but with additional information related to the analysis. So stay tuned for that. That'll be posted on OnLocation’s website in the next couple of days.

(54:30)

And then I just also want to, I guess, close with reminding everyone that we do have a couple of additional follow-up analyses, the ones I mentioned before, the energy demands for data centers for AI and crypto, September, employment impacts of the U .S. energy transition that will be in November, and then another one around November, December As an update to our critical materials and the energy sector analysis. So with that, I want to thank all of my colleagues here at OnLocation, our corporate colleagues at Team People, and everyone who joined us for the webinar. Thank you very much for joining and stay tuned for more analysis coming out from OnLocation.

(55:17)

Good afternoon, everyone.