MEMORANDUM

TO Chair Cathy Macdonald and Members, Oregon Global Warming Commission

FROM Angus Duncan

SUBJECT TIGHGER Packages

DATE January 23, 2022

I am pleased to endorse and support the work of the Commission and the Oregon Department of Energy in undertaking the TIGHGER "McKinsey analysis" project. This is an effort that I sought support for during my terms as Commission Chair, but due to funding limitations was only able to conduct a limited and not very useful such analysis that is now a decade out of date.

The most damaging omission from that earlier (2012) project was its isolating on individual measures. Due to the funding limitations, we were unable to look at synergies among different actions that could result in an emissions outcome greater than a simple summing of individual outcomes. In some cases an action by itself had little greenhouse gas (GHG) impact but it enabled other measures to amp up in effectiveness.

I strongly urge the Commission, given this second bite of the apple, to remedy that core omission and direct its modeling contractor to evaluate at least the most critical of these packages. I am drafting this memo, at the suggestion of Deputy ODOE Director Zelenka, to help identify which packages of measures have, when pursued collectively, the greatest potential for a combined impact on Oregon's GHG emissions reduction outcomes.

Below I identify five opportunities to package measures into internally-reinforcing strategies. They should be modeled, if possible, to test the hypotheses that they will produce more emissions reductions together than if pursued in isolation; and to test if packages of measures may boost the rankings of certain Medium and Low ranked actions.

One note on emphasis: the Statewide Transportation (GHG emissions reduction) Strategy (STS) developed by ODOT and stakeholders in 2013 identifies three overall packages of measures as key to arresting the growth of transportation emissions. These are: Transit,

Electric Vehicles and Urban Design. I have tried to elaborate on these themes in describing the strategic linkages below.

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1. **<u>Urban land use and transportation package</u>**: This is probably the most important package to structure and test. I note that the spreadsheet includes "#65. Implement . . . compact mixed-use development" (LOW) and "#80. Fund urban public transportation [and, "#79: bike/ped projects"]*as described in ODOT" Climate Action Plan" (MEDIUM).*

   First note: ODOT's Climate Action Plan is itself seriously deficient in setting goals, ways and means, and accountability for outcomes with respect to transit/bike/ped among other of its ambitions (see my comments to OTC of August 10, 2021, attached).

   Second note: Any number of urban studies have found that when higher housing and commercial densities, together with services and recreation, are located along transit corridors, both transit and urban livability realize magnified benefits. Transit service levels and connections across the urban area are enabled to increase to serve the additional customers whose homes and businesses abut the corridor, while the transit service levels will encourage still greater adjacent densities. The densities also support more commercial, medical, cultural and recreational facilities; and the compact development enables greater reliance on bicycles and walking. The GHG efficiency effects are further magnified when the increased densities are housed in medium to larger scale apartment structures, where common-wall construction and central HVAC systems (or #47: district systems serving multiple buildings) are thereby enabled as well.

   Planning for and developing these transit-served, densely-occupied neighborhoods requires coordination of multiple tools, including: zoning; roadway design (including for separated transitways); public investment in transit infrastructure, vehicles and operating support; public and private real estate investment; and neighborhood support for community facilities. That seems a tall order, but a short drive out the N Williams and Vancouver one-way-pair demonstrates the vigorous private sector interest in developing such corridors when the public sector demonstrates support, even without the added push of purposeful GHG outcomes.

2. **<u>Electric Vehicles and Supporting Infrastructure package</u>**: Most (but not all) of the elements of this strategy are captured in the TIGHGER spreadsheet (rev 4). The full suite of actions, however, should be assembled and modeled as a single package that includes: #64|Clean Car Standards (HIGH); #77|Include charging stations in building codes (MED); #85/86|Clean Vehicle & Charge Ahead rebates (MED/LOW); #124| Increase Public Charging Stations.

   To these can be added: a) require conduit/prewiring for EV's in *all new and existing garages* with a capacity <u>≥</u> 6 spaces; b) require a minimum percentage of public charging

facilities to be Level Two and DC Fast Charge; c) require a minimum percentage of public charging to be sited at community centers of activity in low-income neighborhoods; d) direct public electric utility planning to demonstrate its preferred pathway to vehicle-to-grid (V2G) interconnection capability.

3. **GHG Efficiencies in Buildings**: Generally, encouraging denser, net-zero, vertical apartment housing and local commercial services, of the sort to be found already in the Williams/Vancouver corridor, South Waterfront, the Pearl and Slabtown areas of Portland, will result in lower emissions per square foot, support transit/bike/ped access, and enable low/zero emissions district HVAC (#47 – MED). Add # 7&8, installing electric heat pumps in lieu of separate gas furnaces and electric chiller systems, for greater HVAC efficiency and to eliminate GHG emissions from natural gas combustion. Distributed electricity generation (e.g., #19/building integrated solar; #20/(distributed) energy storage; #23/smart grids/microgrids) can reduce emissions and increase resiliency.

   This housing/commercial development strategy will also reduce pressure on urban growth boundaries in urban areas, contributing another driver to more transportation-efficient compact development.

   Energy-related building codes should be designed, and regularly updated, to maximize energy and GHG efficiencies, for ***both new and existing buildings***. A fundamental of building GHG efficiency is that 80% of the structures we will be using in 2050 are already in place today. Oregon cannot reach its goals without requiring all cost-effective (construed to include a Social Cost of Carbon) efficiencies being retrofit into existing structures. The Commission should recommend that a retrofit evaluation be required at least every ten years, or at any point of sale or major remodel.

   [Other building/energy measures are of more dubious value, including: #24/biomass district energy; #37/residential hydrogen fuel cells]

4. **GHG Efficiencies in Electric Utility Central Station Generation/Transmission**: The spreadsheet generally covers this ground piecemeal. A packaged recommendation should encompass termination of fossil-fueled generation, the development of geographically- and meteorologically-dispersed wind and solar, integration of these resources into a re-conceived transmission grid that optimizes for wind/solar resource diversity and access to short/mid/long duration electric energy storage facilities (including both generation-based storage and customer-located storage, including electric-to-thermal energy storage and V2G Electric Vehicle networks).

   Electric utility grids are already reorganizing themselves into larger, interconnected balancing areas and dispatch institutions (e.g., California Independent System Operator, or CAISO). Oregon regulators should encourage this ongoing integration, and the State should support national efforts to increasingly interconnect separate grids into more

efficient larger operational networks, markets and dispatch protocols (while taking care to compartmentalize individual utility systems for security and reliability).

Transmission system design will be critical to development of off-shore wind off the Pacific Coastal states. Transmission that interconnects north (OR/WA/BC) and south (CA) utility service territories and balancing areas will add to system efficiency, stability, power quality and reliability.

5. **Forest Management Practices / Natural and Working Lands**: While there are multiple actions that can be integrated to optimize carbon capture and retention in this sector, the single most important element will be to extend forest harvest rotation intervals on private forestlands. Today these are often in the 35 year to 45 year cycles, whereas the greatest carbon capture gains generally take place in growth years 20 to 90. To maximize carbon capture and retention in privately-owned forests, harvest and carbon gain cycles need to better align (that is, extend to Years 80 -90). Accomplishing this will likely require a combined incentive + regulatory strategy that addresses operations cost, cash flow management, community economics and hazard and regulatory risk among other factors.

   Such actions on Oregon's private forestlands need to be integrated with federal forest management, segregating and conserving as much old growth ($\geq$ 90 years) as possible irrespective of ownership, and seeking through federal intervention to shape similar practices in Pacific Coastal rainforests from California through the Pacific Northwest and British Columbia to Alaska.

   The actions also need to be integrated into forest health and wildfire management strategies which will often result in a near-term strategic *reduction* in forest carbon as thinning and prescribed fire reduce forest carbon content. Treatments must be designed only for their forest health and fire management outcomes, and not to generate Forest Service and private revenues through harvest of the larger stems that hold the greatest both market value and carbon sequestration value.

August 10, 2021

Memorandum

For	Bob Van Brocklin, Chair OTC Kris Strickler, Director ODOT Travis Brouwer, Deputy Director ODOT Amanda Pietz, Director Policy, Data and Analysis Kristen Sheeran, Climate and Energy Advisory to Governor Brown
From	Angus Duncan
Subject	ODOT Climate Action Plan 2021-2026

In July of this year the ODOT Climate Office issued a Climate Action Plan (the Plan, or CAP) that promised "substantial and swift action to reduce carbon . . .." It referenced the Governor's Executive Order 20-04 which directed agencies including ODOT to "take immediate actions to address climate change" and "to add a GHG reduction lens to project investment decisions" in ODOT's STIP process. ODOT, in response, promised to include emissions reductions and climate change adaptation in the upcoming Oregon Transportation Plan (OTP) update. While the CAP references 2013 Statewide Transportation Strategy (STS) early in the document, it fails to deliver either the essential elements of the STS or its projected and intended outcomes.

I begin these comments with the STS reference because it contains many of the elements of a transportation climate strategy that this Climate Action Plan does not. While the STS was not without its flaws, it (a) began with transportation GHG reduction goals, (b) evaluated different sector actions for achieving them, (c) identified priority near-term and long-term measures that would most effectively reduce emissions at least cost, (d) linked actions together into mutually reinforcing strategies (e.g., transit and urban density), (e) identified the primary mover if it was not ODOT, and (f) developed metrics to track and evaluate effectiveness. The notable flaw in the STS was the absence of an accountability process that would enable strategy adjustments over time. For that, the stakeholder/staff Policy Committee was relying on the Transportation Commission to adopt the Strategy and require reporting and recommended modifications. But the Commission, under new leadership in 2013, effectively dismissed the entire report, findings and recommendations, ensuring little climate action from ODOT for the ensuing half decade or more (until OTC adoption of the STS in 2018). Coincidentally, transportation GHG's began climbing again that year, and have increased or gone sideways ever since (see timeline, attached below).

This July 2021 Climate Action Plan, while a step forward for ODOT, is less a strategy than a laundry list of largely ongoing initiatives, often admirable in themselves, that intersect and mutually reinforce in ways that are unclear at best, and random at worst. They are largely absent even proxy goals, let alone specific GHG reduction goals. There is no prioritization by contribution to emissions reductions. There is "monitoring and data" cited at the end but these metrics are mostly broad data

sweeps that do not measure effectiveness of individual programs or programs grouped into strategies (as the STS was structured).

And ODOT excuses itself upfront[1] from including in its strategies links to the efforts of local governments, businesses and private citizens, although any successful GHG reduction strategy must include the actual sources generating the emissions (and several CAP actions reflect this reality). This is especially true for the three priority areas identified by the STS: electric vehicles, transit and urban design. In each of these areas ODOT should be setting state intermediate/proxy targets that translate to emissions reductions and link to local jurisdiction actions, measuring results and analyzing failures to achieve the targets (or successes!).

- Vehicle Electrification: The CAP references ODOT's TEINA study, prompted by the Governor's EO, as its trigger for initiating a "Statewide ZEV Charging Infrastructure Deployment Strategy." This is a worthy initiative (if coming ten years after the STS made the case for it) and will help guide use of likely new federal charging infrastructure funding. It leaves unanswered (so far) several critical EV questions:
    - will funding be available to write down costs of Level 2 home and business charging, including convenient access to charging for those without driveways and garages (e.g., apartment residents)?
    - will home charging funding be structured to enable low-income households to switch to EV's?
    - will the state offer incentives to local governments that require full or substantial charging capability in new commercial and business garages, along with retrofit requirements for existing garages?
    - will the state strategy prioritize "fast DC" charging for public chargers spaced along federal and state highways (with a ± 30 minute recharge capability) to enable distance driving (not just commuting and errand driving)?
    - Will the state develop a funding strategy to enable low-income households – especially those without convenient access to transit for commuting – to trade out ICE for electric vehicles?
    - Are there other incentives – access to HOV lanes; free or discounted parking; etc. – to encourage movement to EV's?

  It is late in the game for Oregon to be addressing these issues, a tardiness that in part explains why the state missed its lowball 2020 target of 50,000 EV's on the road (the count on April 30, 2021, was 36,608 EV's out of 23.2 million passenger vehicles). Proper accountability would be analyzing why and proposing corrective actions. Instead, ODOT's only 2021 EV legislative initiative appears to have been a proposed measure that would have imposed a higher fee – in effect a penalty – for higher fuel efficiency vehicles, with the highest special fee reserved for EV's (happily, it failed to advance).

[1] "The CAP is unique to ODOT's work, and only contains actions under the agency's authority and the partnerships the agency is engaged in." CAP page 5

- Transit: The CAP has two modest urban transit support efforts, both targeted to "small to medium transit agencies." It has larger efforts underway for intercity rail and transit (again, with no goals cited). But there's nothing apparent that supports either service levels or electrification initiatives at the largest transit agencies in the state, TriMet and Lane Transit. If emissions reduction were a priority, ODOT would be zeroed in on where transit could deliver the greatest returns (which would also prioritize equitable service to the largest number of low-income households in densities that support effective transit service). It would particularly be looking at strategies and tools to support transit through the pandemic drop in ridership, and to rebuild ridership post-pandemic. And it would be supporting transit electrification as diesel buses reach the end of their useful life, or earlier as costing tools (such as the Social Cost of Carbon) allow acceleration of this transition (the CAP includes a "Transit Vehicle Lifecycle Cost Analysis Tool" for transit agencies but no explicit support beyond this technical tool).

- Urban Design: The success of transit and "active transportation" (walking/biking) are both closely linked with good urban design. At the legislature's direction, ODOT is undertaking a Transit and Housing" Study to inform local governments and transit providers. But a great deal is already available in urban research and analysis (including at agencies like Metro) to support specific urban design choices. A state emissions strategy would be developing incentives and conditions (like priority access to STIP funding) that would accelerate desired changes in urban form such as walkable/bikeable neighborhoods, walking access to services (shopping; health care), recreation (parks) and transit. Again, these are actions that were recommended in the STS in 2013.

There are several other options for emissions reduction that were identified in the STS or the EO but are missing or attenuated in the CAP. Among them:

- Apply an emissions reduction lens to STIP funding criteria: This obvious action was recommended also by members of ODOT's STIP stakeholder advisory committee a decade ago with mixed success. That is, we were able to get GHG emissions included as a criterion without getting it any priority and without removing any other criterion. As a result, my review (transmitted to ODOT) of the ODOT 2021-24 STIP identified, out of 197 projects "three that were primarily bike-oriented; also one "bus/transit" and four "pedestrian" projects.[2]" Since STIP dollars are ODOT's most flexible source of funding, they are the easiest to use in demonstrating a shift in priorities. To its credit, ODOT is proposing a greater allocation to emissions-related projects in the 2024-27 STIP package; that is, by ODOT's calculation, a shift from 6% of the STIP funding to 12%. The $255 MM over three years can be compared to an overall ODOT biennial 2021-23 budget of $5.1 billion, or the half billion dollars scheduled for a single project (Rose Quarter I-5 Improvement Project). Hard to see the "emissions reduction lens" or the

[2] ODOT STIP Projects – Public Comment from Angus Duncan submitted to ODOT April 2, 2020

Governor's EO directive to "Prioritize actions that reduce GHG emissions in a cost-effective manner" in either the STIP or overall ODOT budget.

- Costing: The STS included in some detail how the full range of infrastructure, operations and social costs should be incorporated into an ODOT cost analysis of emissions reductions. For example, on page 50 it addresses "Infrastructure" and "Implementation" costs, and how they could be expected to proceed for an STS Vision case and a base case. STS analysis suggested that if there were a doubling or tripling of transit service, with accompanying costs, road expansion (and costs) could be defeased resulting in lower overall infrastructure (and implementation/operating) costs. The Global Warming Commission in 2020[3] further recommended that "all state agencies (should) use the Social Cost of Carbon as a metric to evaluate public investment decisions and to inform regulatory impact analyses." The CAP references "True Cost Pricing" on page 15 and commits the agency to "establish a policy foundation to start to implement true cost pricing" but does not tie this to the social costs of emissions or how this might affect capital and regulatory decision-making where emissions are involved. Despite the loss of eight years from STS to CAP, it offers neither commitment to nor timeline for implementing True Cost Pricing, nor whether it would be binding, advisory or somewhere in between, nor what range of decisions – investment, operational, regulatory – it might apply to.

- Pricing: While ODOT is has authority for and is considering congestion pricing in the Portland metro area, the actual design and purposes remain unspecified while planning for the Rose Quarter Project – where congestion pricing might initially add value by deferring a major capital investment – proceeds. The OREGO demo project is continued but there is still no proposal for putting a price on Vehicle Miles Traveled (VMT), still less on a "VMT X vehicle efficiency" model that might dis-incent inefficient, GHG-emitting internal combustion-powered vehicles (although ODOT did support adding fees for high-efficiency vehicles in the 2021 session – see Vehicle Electrification, above). There is no reference in the CAP to pricing parking, although the STS and many other transportation efficiency analyses have identified free parking as incenting more commuting VMT.

- ODOT Revenue Projections: Joe Cortright, consulting economist and Principal at Impresa Consulting, examined ODOT revenue forecasts that the agency based on gas and diesel taxes through 2029[4]. Based on those forecasts, Cortright calculated that ODOT projects fuel consumption and emissions to remain at today's high levels through that year, notwithstanding the interventions referenced in the CAP and reductions required to be on track to meet the 2035 target set by the Governor's EO. In the

[3] OGWC Biennial Report to the Legislature, page 22

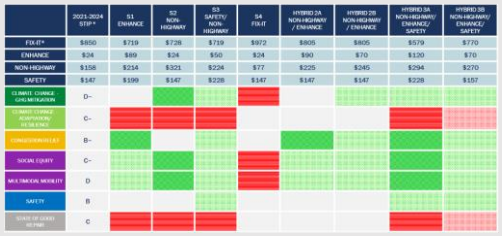
[4] "Public comment on greenhouse gas emissions and highway expansion" submitted to the Metro Council; Joe Cortright; August 2, 2021

revenue projection fuel consumption and emissions would be approximately 70% higher than the level that a linear compliance with the EO would imply. ODOT may be using the fuel projection as a proxy for a modified revenue plan based on a VMT fee or other alternative revenue source. But in neither the revenue projections shared with the bond market nor the CAP issued to the rest of us does it disclose such an alternative strategy or reconcile the anomalous gap between the two documents. This is concerning especially in the context of its adopted and recently affirmed Performance Measurements (next).

- ODOT Performance Measurements: While formally adopted ODOT Performance Measurements are less important to emissions reductions than actual Department regulatory and funding actions, it's hard to dismiss them as unimportant to agency governance and direction especially when they are explicitly approved by the Legislature at the agency's request. In September 2020, I wrote to Amanda Pietz (with copies to Kris Strickler and Kristen Sheeran) observing that based on the PM's then in place, ODOT appears to prioritize "DMV Field Office Wait Time" over GHG reduction. Amanda, to her credit, responded promptly with the assurance that the OTC and ODOT were aware of this incongruity and would "consider" modifying it, presumably to be more in line with the Governor's EO. So it was with some distress that I observed that the PM's being reaffirmed this year (as published on 5/25/2021 4:43 PM) without any changes. DMV wait time and customer satisfaction are presumptively ranked above transportation GHG emissions, climate change effects on Oregonians, and the clear directions from the Governors EO. I would discount much of this as words without consequences except that there are consequences of to explicitly stated and Commission adopted priorities. These are demonstrated in the following two ODOT figures and the timeline I developed that links ODOT action or inaction to the progress and regress of transportation emissions. It's hard to draw any inference other than that the Department's priorities are fairly reflected in its reaffirmed Performance Measurements.

Program Allocation

Amount of Money Between Programs



	2021-2024 STIP*	24-27 FINAL SCENARIO
FIX-IT*	$850	$800
ENHANCE	$24	$65
NON-HIGHWAY	$158	$255
SAFETY	$147	$147
CLIMATE CHANGE - GHG MITIGATION	D– Most trips drive alone in low MPG cars	Slight GHG reductions anticipated *(modest improvements above baseline)*
CLIMATE CHANGE - ADAPTATION/ RESILIENCE	C– Slow progress with preservation projects	A few less adaptation projects *(marginal decline from baseline)*
CONGESTION RELIEF	B– Select, legislative bottleneck projects in development	Bit of funding to supplement needs *(some funding to supplement larger projects)*
SOCIAL EQUITY	C– Few low cost travel options	Small increase in access for all users *(more multimodal projects than 2A, but less than 3B)*
MULTIMODAL MOBILITY	D Many connectivity gaps	Small increase in bikeways, walkways, TDM programs *(more multimodal projects than 2A, but less than 3B)*
SAFETY	B Focus on fatalities and serious injuries	No change from baseline *(safety funding flat, consistent with baseline and 21-24 STIP)*
STATE OF GOOD REPAIR	C Several assets and areas deteriorating	Small decline from baseline *(slight decline from baseline which indicates trend of deteriorating conditions over time)*

Notable improvement | Modest improvement | Similar to baseline | Modest decline

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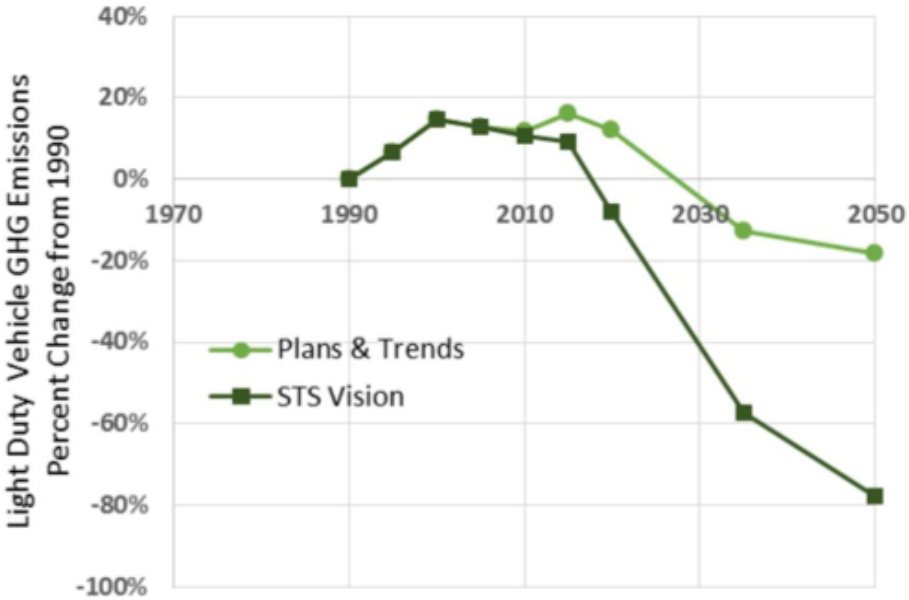
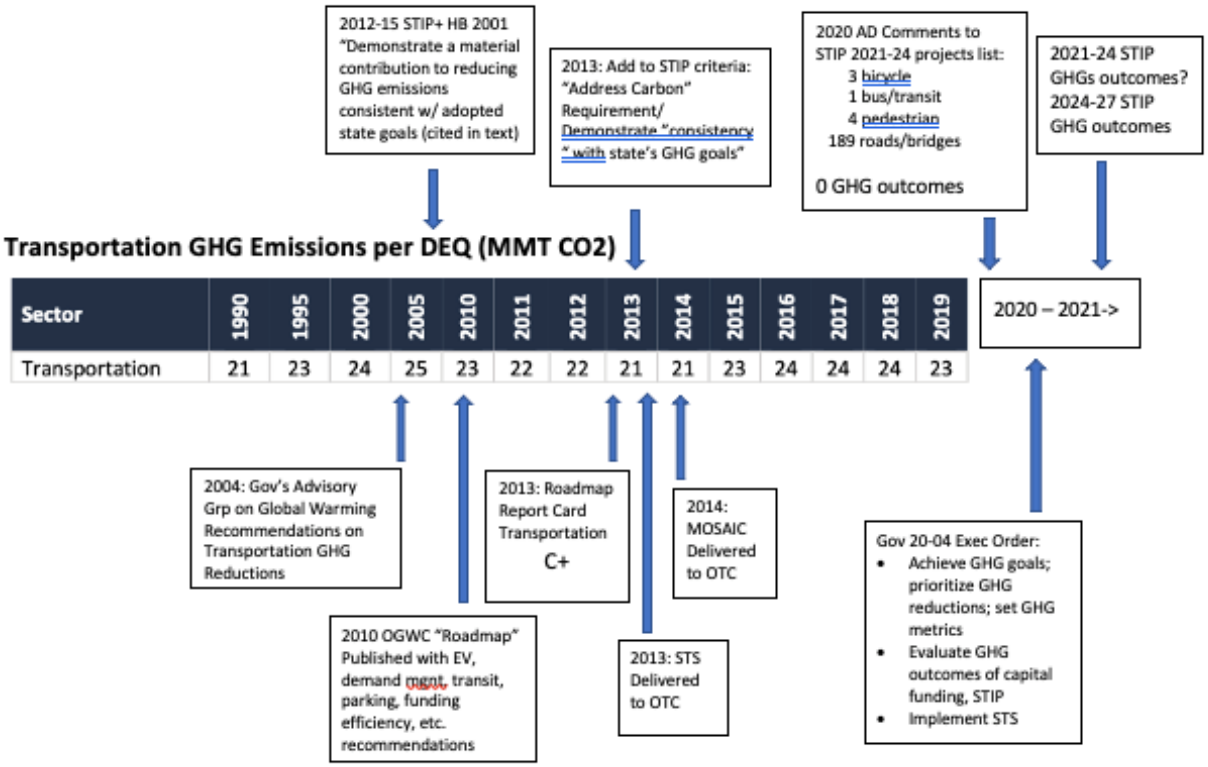
Figure 8: Transportation Business as Usual Projection Compared to GHG Emission Reductions in the State Transportation Strategy Vision[52]




2012-15 STIP+ HB 2001 "Demonstrate a material contribution to reducing GHG emissions consistent w/ adopted state goals (cited in text)
2013: Add to STIP criteria: "Address Carbon" Requirement/ Demonstrate "consistency" with state's GHG goals"
2020 AD Comments to STIP 2021-24 projects list:
3 bicycle
1 bus/transit
4 pedestrian
189 roads/bridges
0 GHG outcomes
2021-24 STIP GHGs outcomes? 2024-27 STIP GHG outcomes
Transportation GHG Emissions per DEQ (MMT CO2)
Sector 1990 1995 2000 2005 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Transportation 21 23 24 25 23 22 22 21 21 23 24 24 24 23
2020 – 2021->
2004: Gov's Advisory Grp on Global Warming Recommendations on Transportation GHG Reductions
2013: Roadmap Report Card Transportation C+
2014: MOSAIC Delivered to OTC
2010 OGWC "Roadmap" Published with EV, demand mgnt, transit, parking, funding efficiency, etc. recommendations
2013: STS Delivered to OTC
Gov 20-04 Exec Order:
Achieve GHG goals; prioritize GHG reductions; set GHG metrics
Evaluate GHG outcomes of capital funding, STIP
Implement STS

Climate Engagement – 2022 Special

26 January 2022

Climate Engagement

TO: Chair Cathy Macdonald, Oregon Global Warming Commission
Members of the Commission

26 January 2022

Climate Engagement

Better Energy LLC endeavors to help clarify issues facing Oregonians who take the growing risks and threats from climate damage seriously.

We do not invoice our work.

We are devoted to fact rather than opinion and prefer numbers to narrative.

We take the Oregon Global Warming Commission as a consistent source of fact.

In this filing we develop a perspective guided by Oregon's energy profile and successful legislation to date.

Climate Engagement – 2022 Special

26 January 2022

Climate Engagement

Better Energy LLC endeavors to help clarify issues facing Oregonians who take the growing risks and threats from climate damage seriously.

We have not seen Oregon State Agencies integrating state policy with our state emissions profile as done here.

Likewise environmental decarbonization activists and policy research staffs.

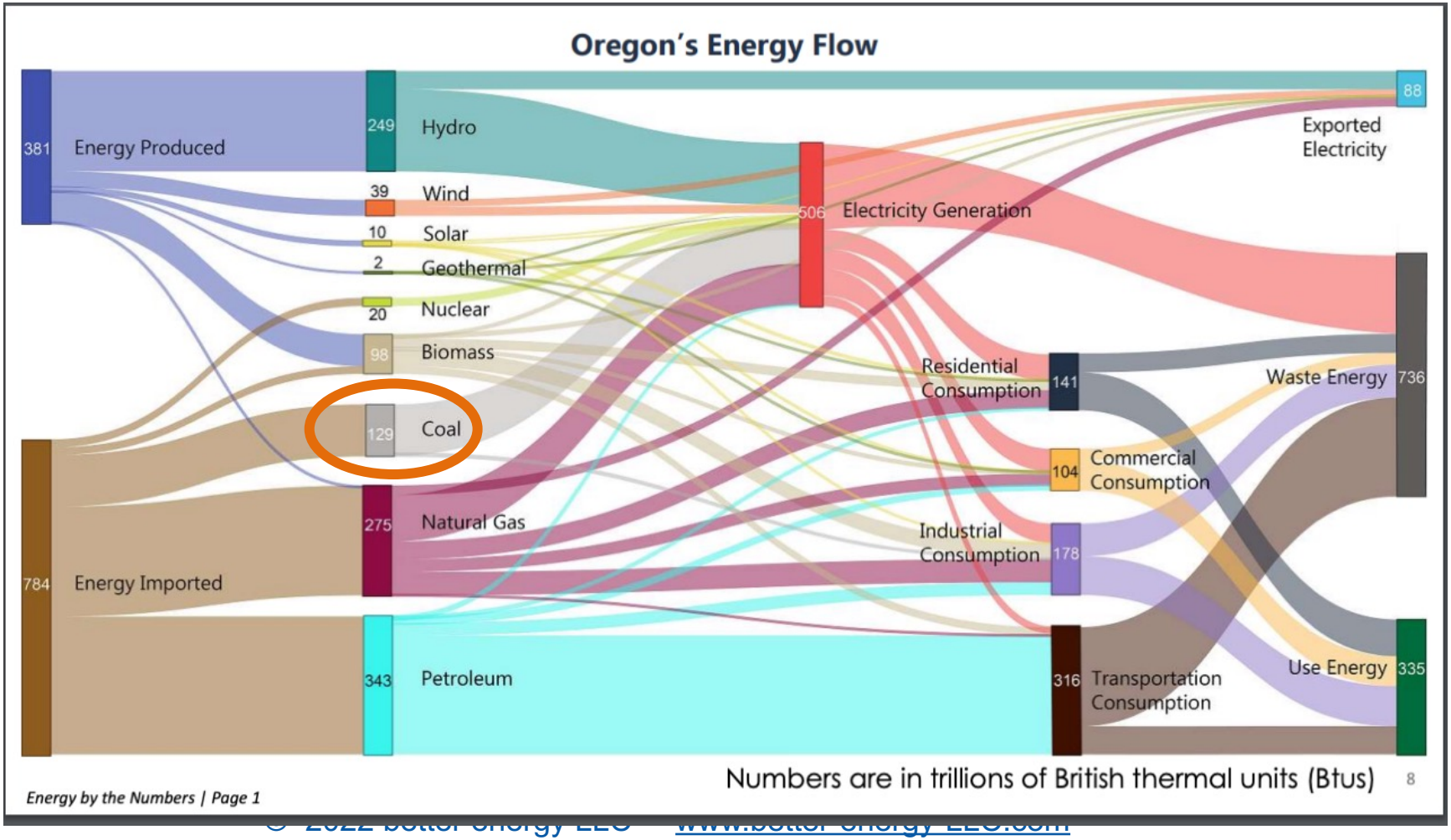
Climate Engagement – 2022 Special

Legislation must be relevant

26 January 2022

Start with Coal

Climate Engagement



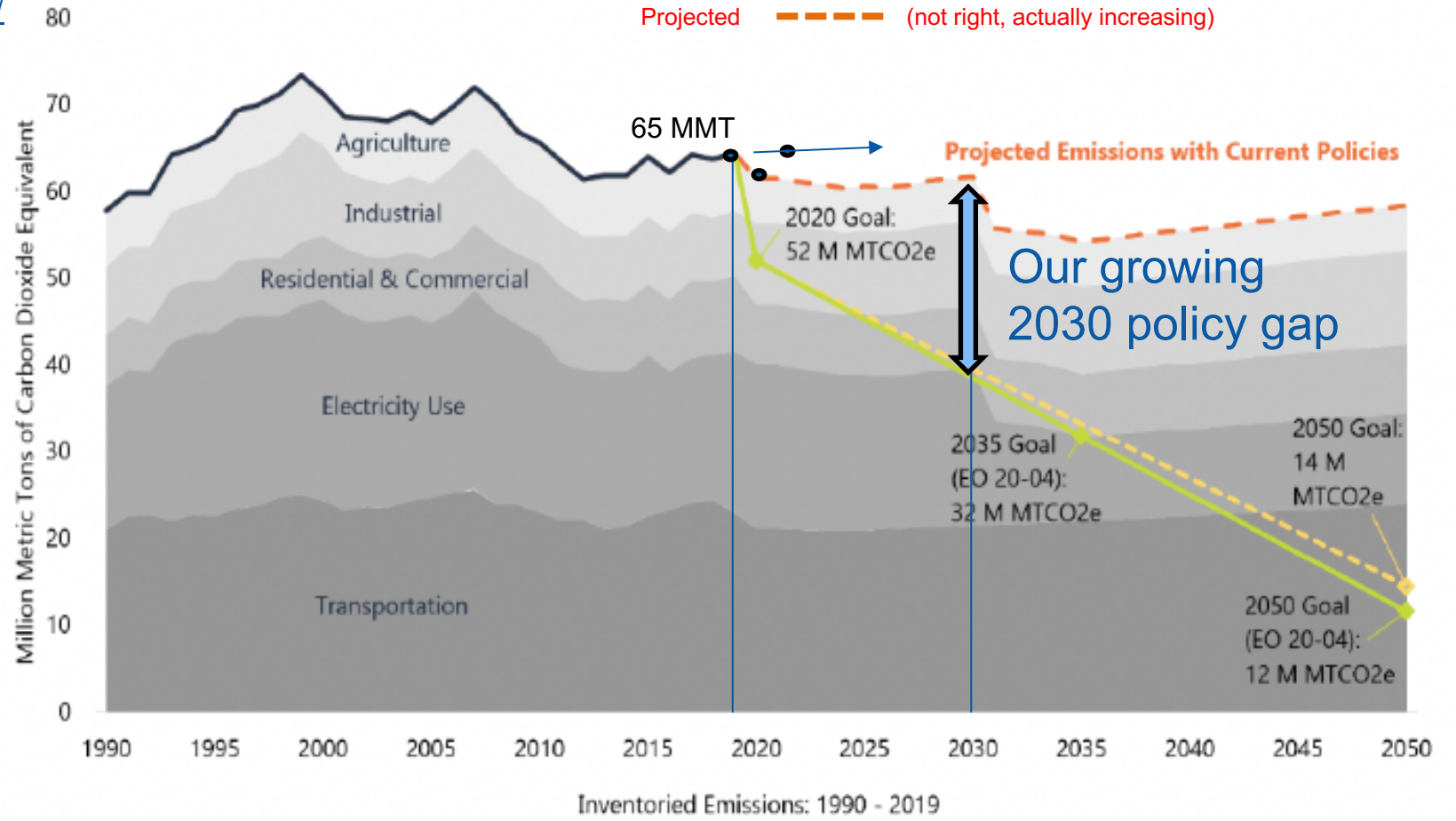
Climate Engagement – 2022 Special

26 January 2022

The gap between Projection and OR Policy is huge
Projections from 2019 on are erroneous
Emissions rebounded in 2021

Climate Engagement

https://insideclimatenews.org/news/10012022/us-emissions-surged-in-2021-heres-why-in-six-charts/



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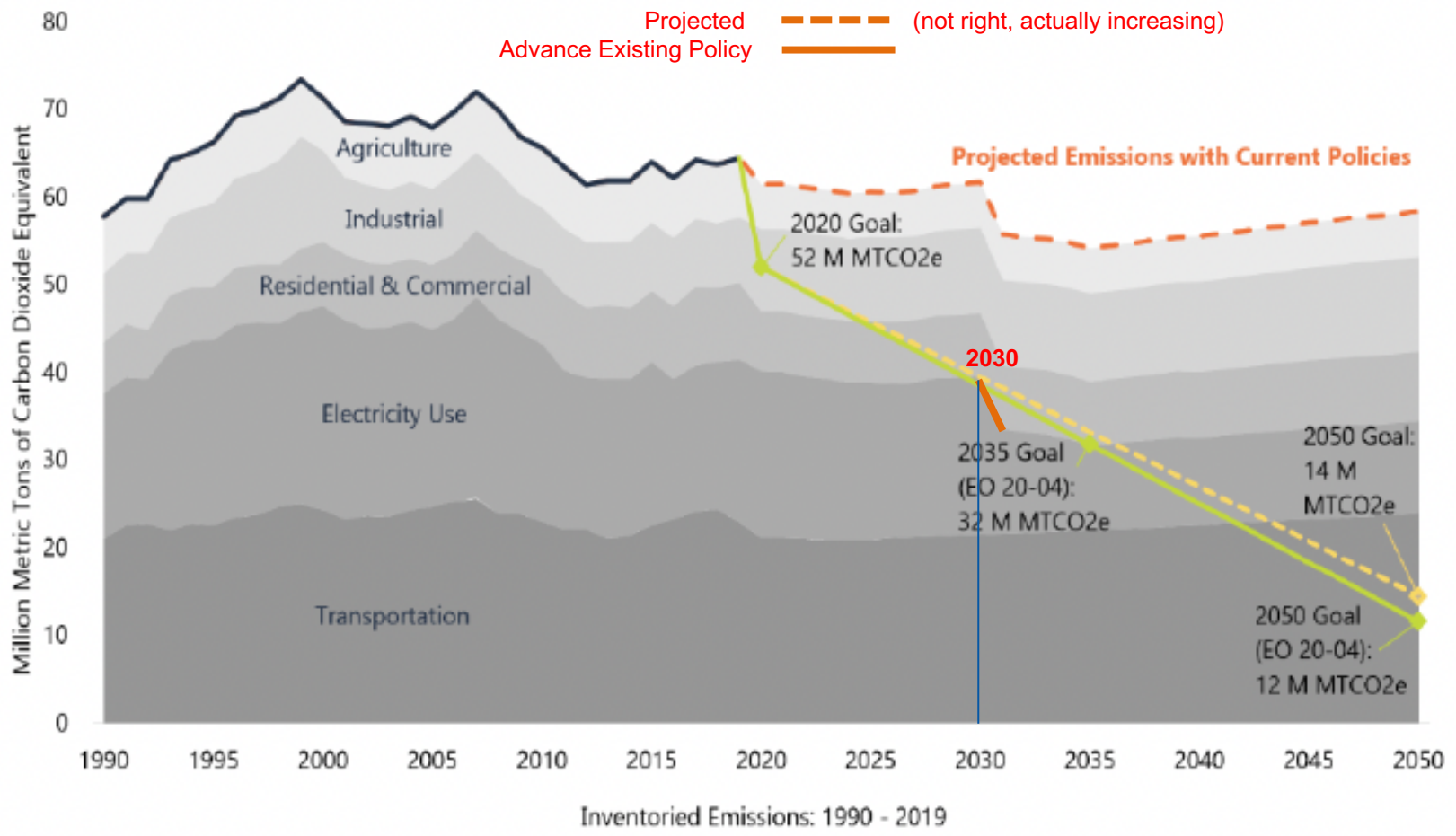
26 January 2022

HB 1547 Coal cutoff in 2030 is too late, go for 2025 **Climate Engagement**



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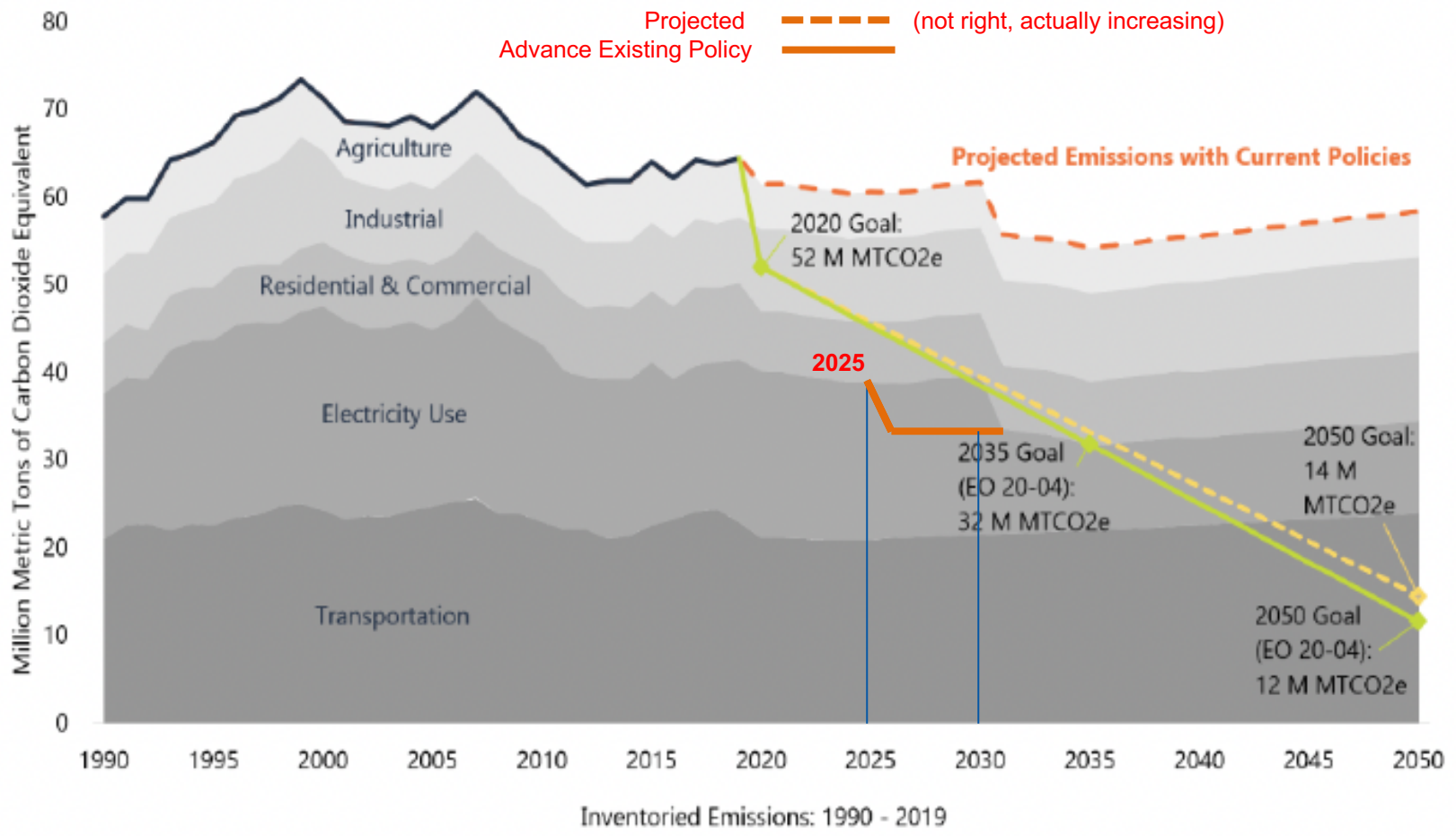

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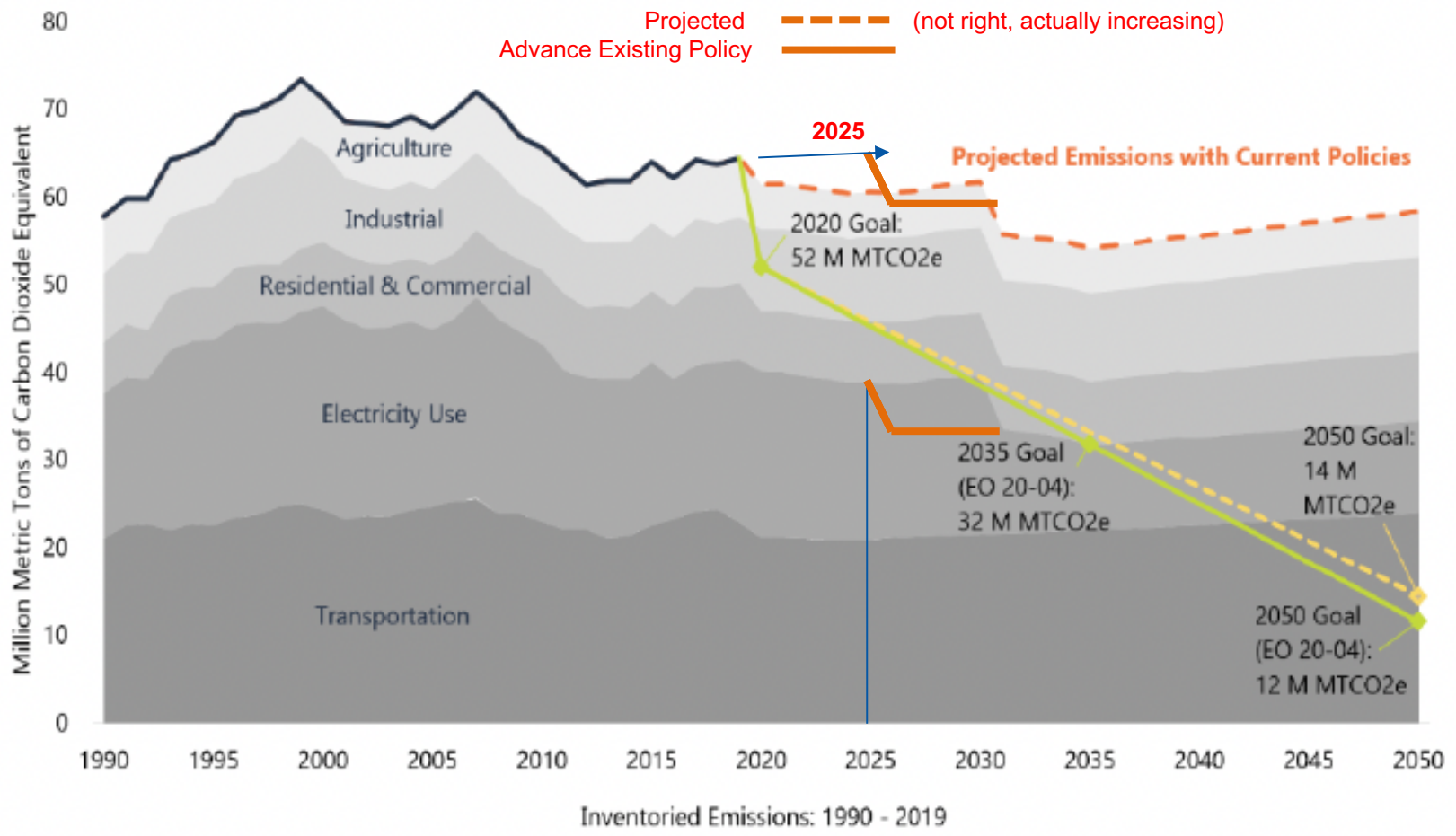

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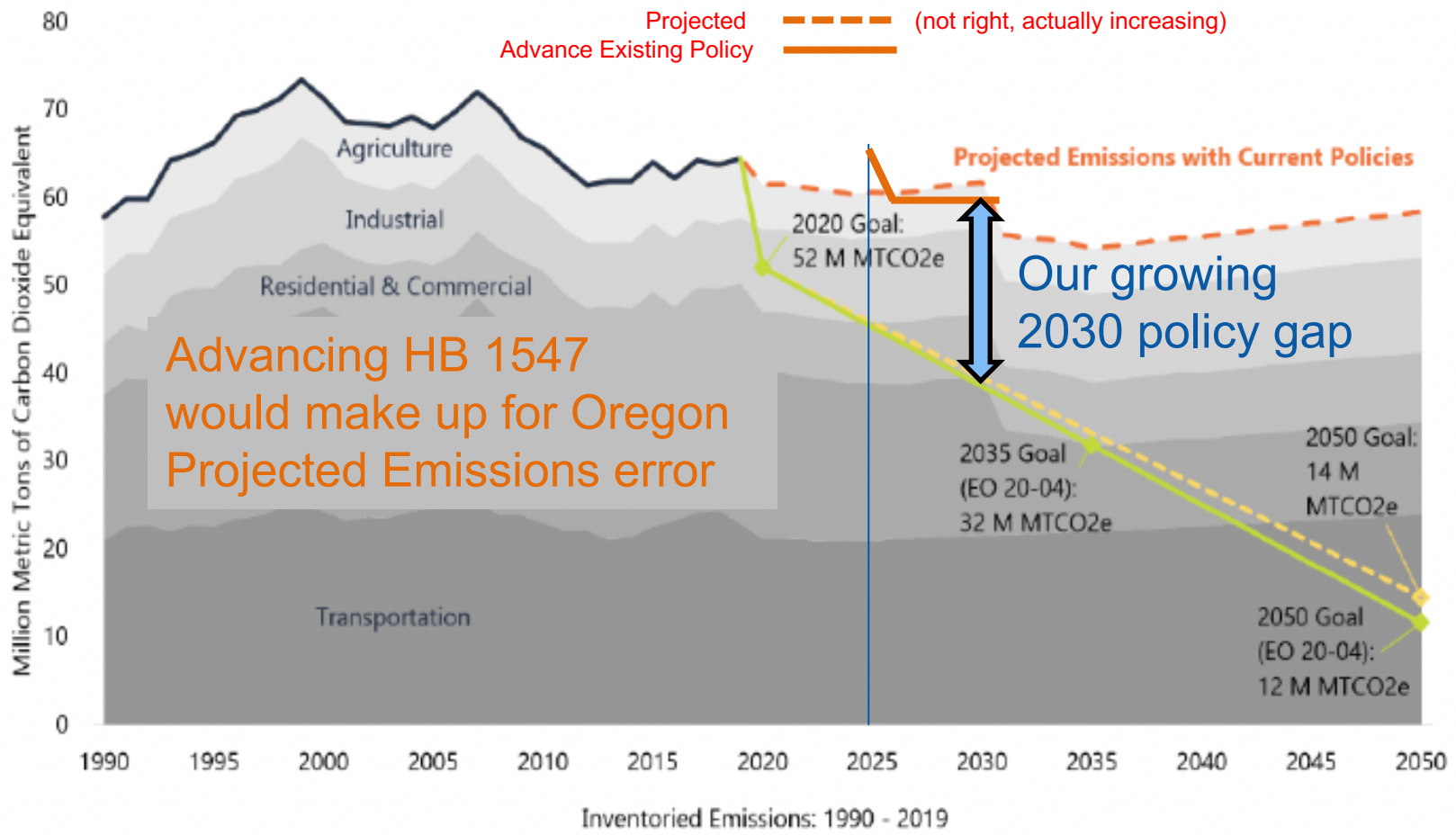

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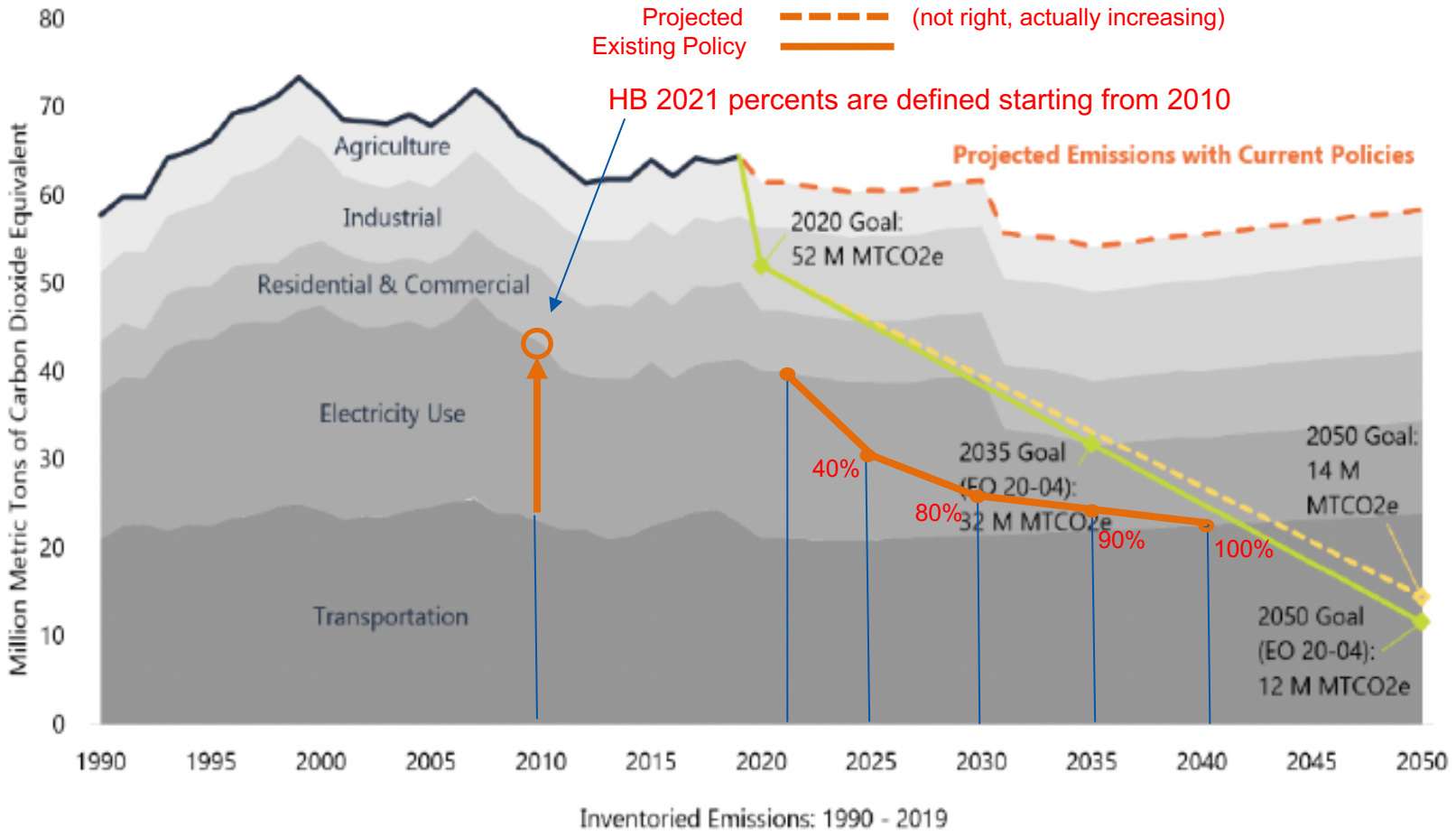
26 January 2022

About **HB 2021 -** Reduces coal and gas emissions **Climate Engagement**



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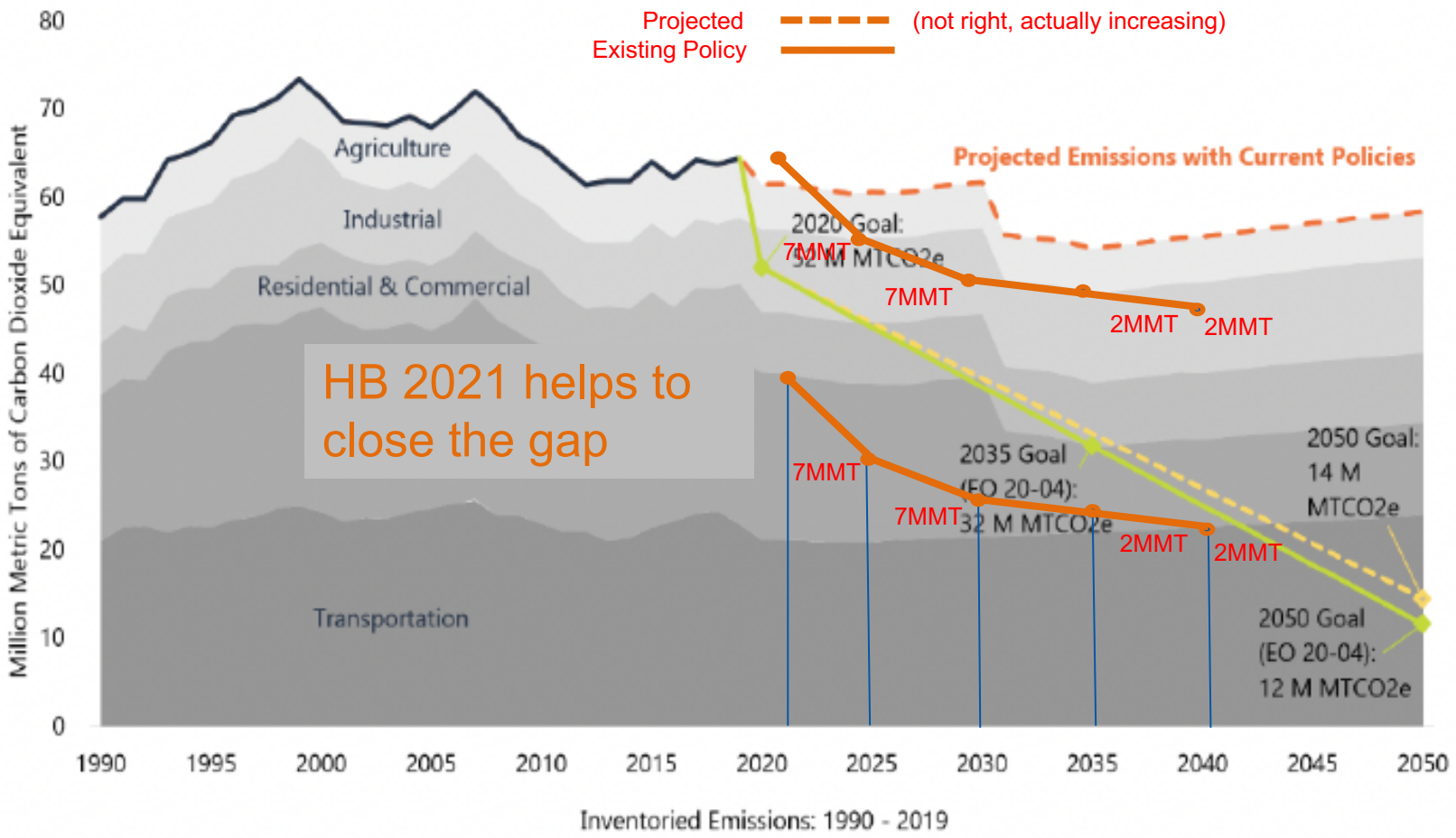

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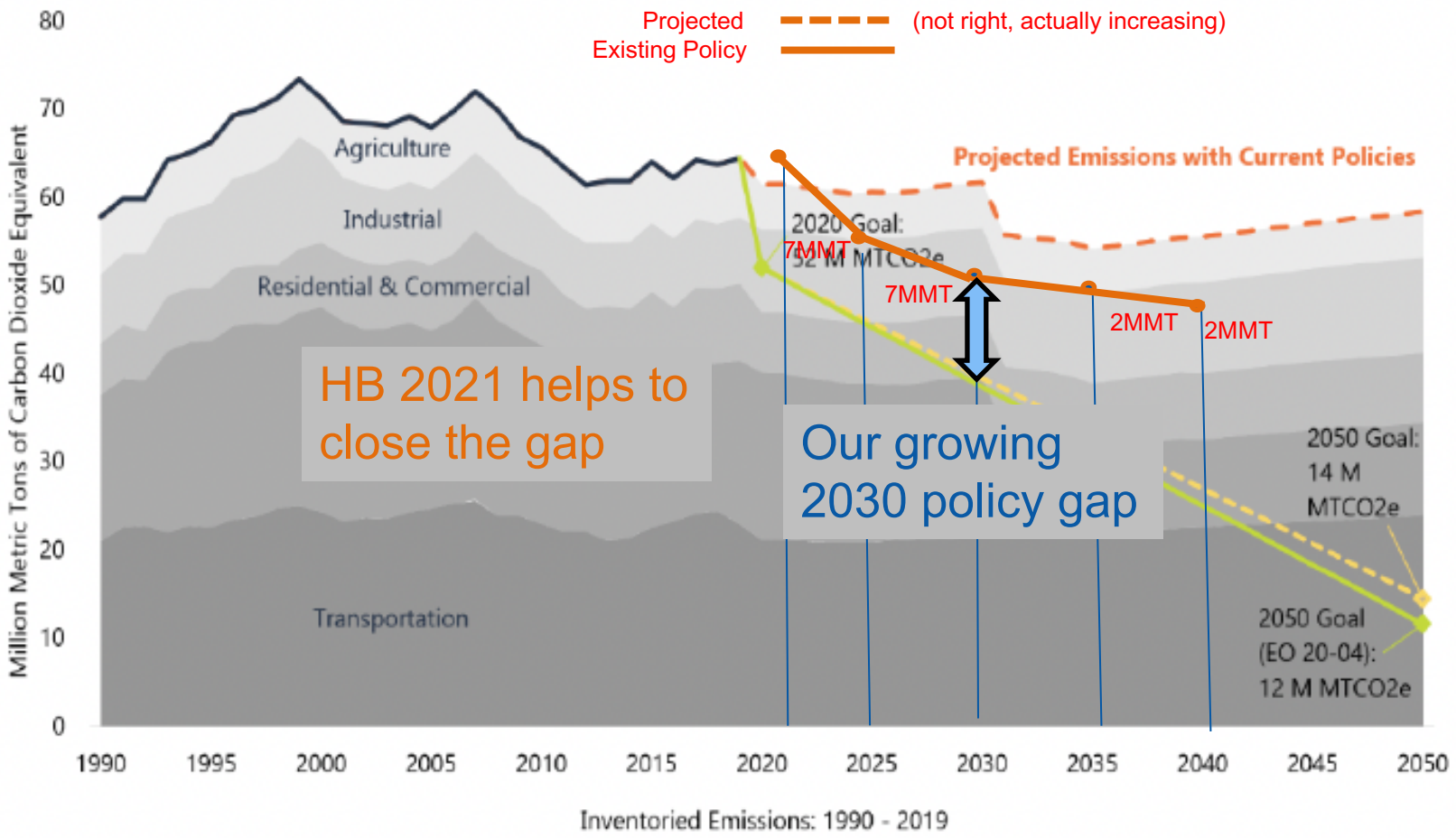

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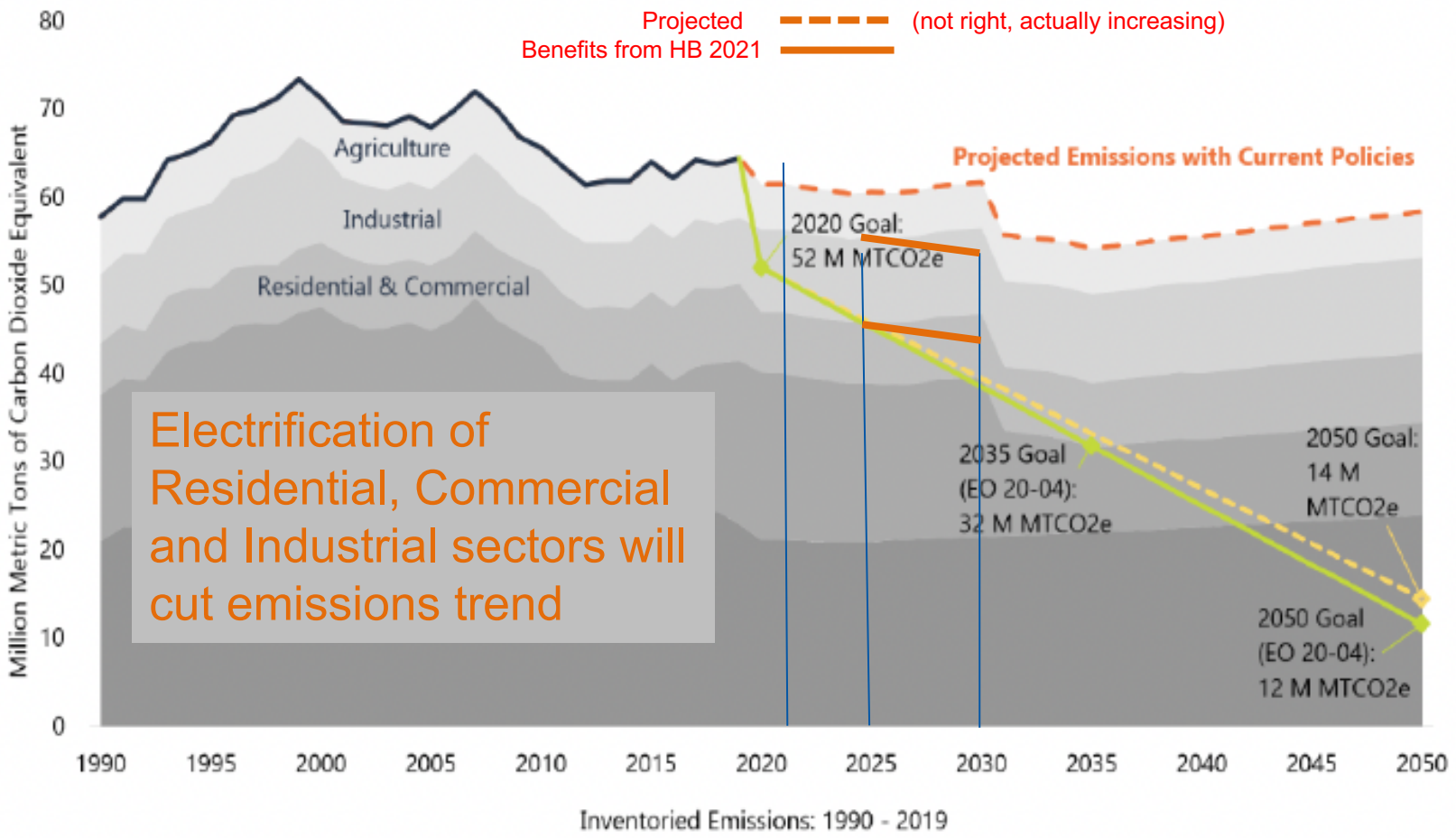

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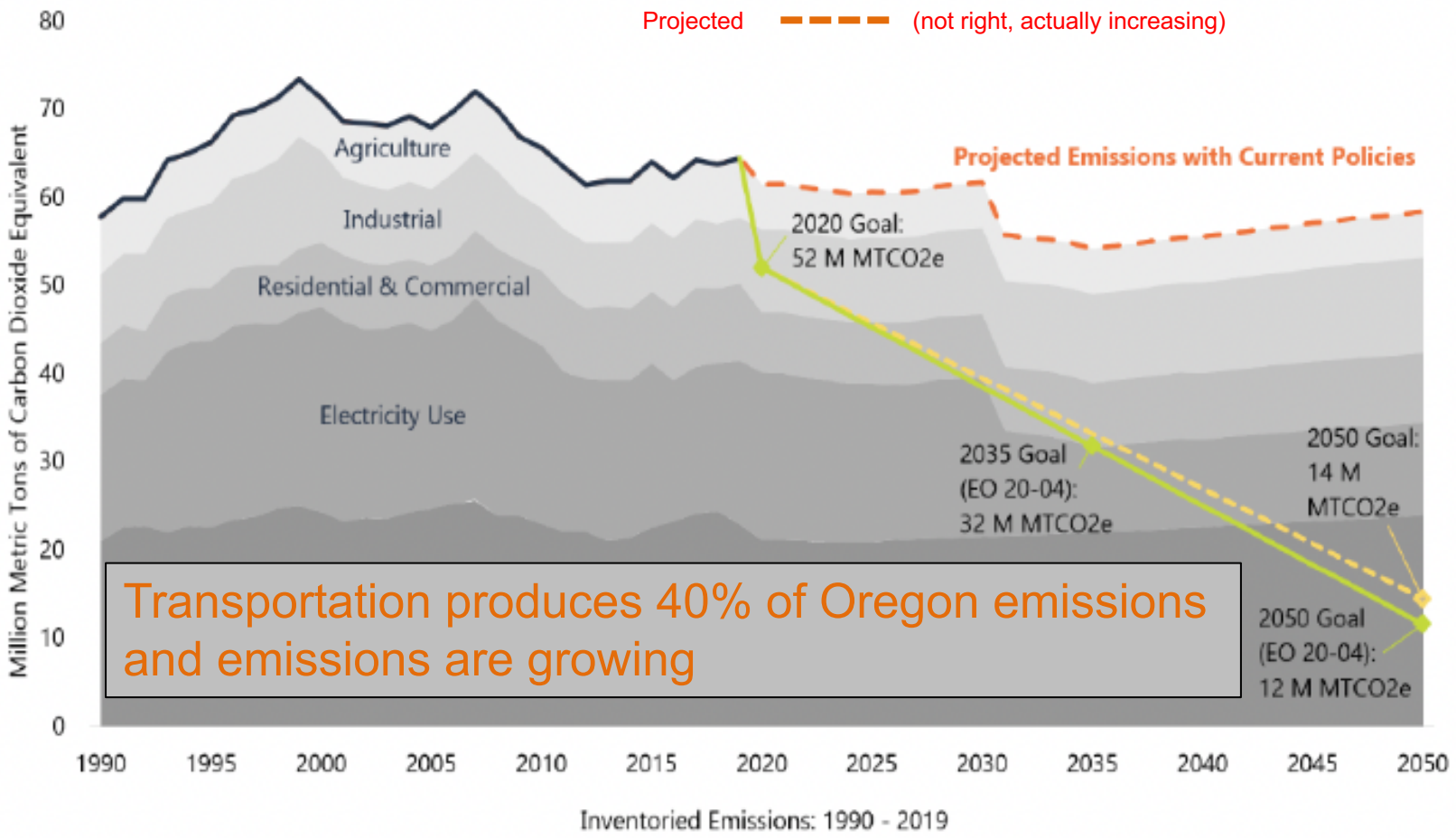
The gap between Projection and OR Policy is huge

26 January 2022

About **HB 2021 -** Reduces coal and gas emissions **Climate Engagement**



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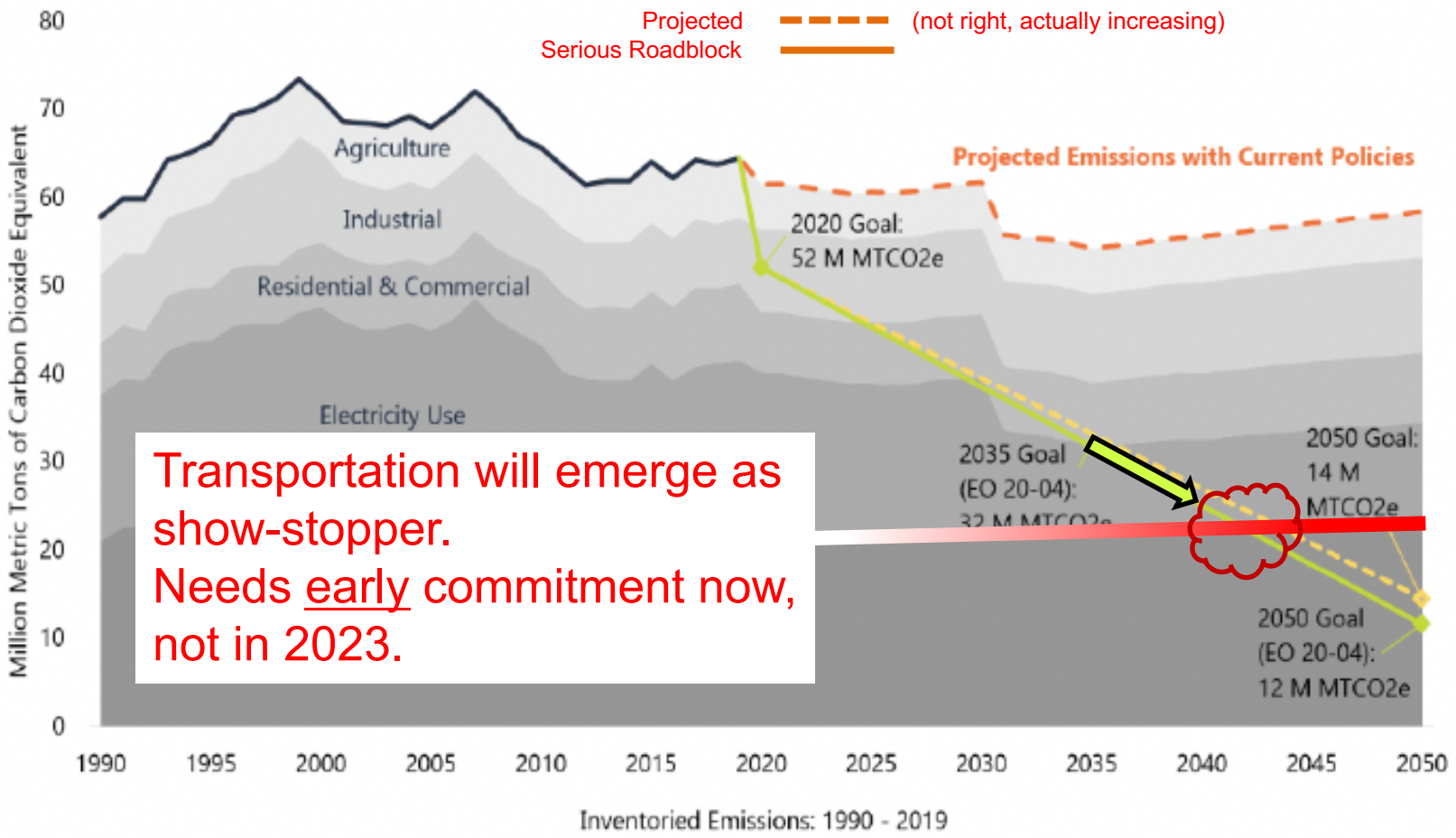

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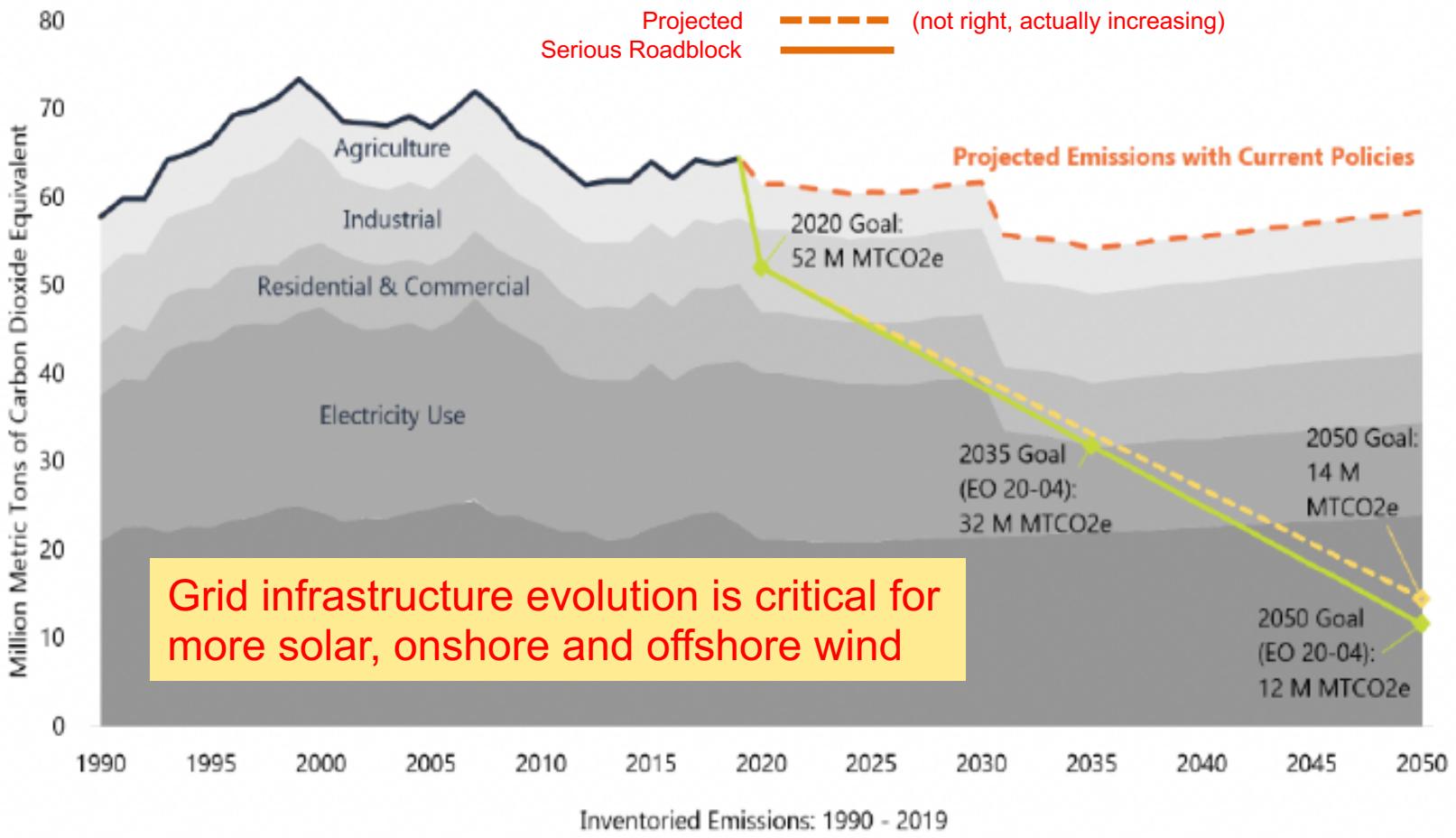

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Climate Engagement

Offshore wind development and deployment is capable of adding 3GW to the Oregon grid without investment in building transmission and distribution.

When additional clean energy potential must be provided to meet increased demand, increased offshore generation is feasible up to additional 20 GW with grid infrastructure growth.

Respectfully submitted,

Tracy Farwell, Sustainability Desk, Better Energy LLC

Ed Averill, Climate Justice Research, Engineers for a Sustainable Future

Oregon Global Warming Commission's Greenhouse Gas Emissions Reductions Plan Comments

Comment Record ID
2022-0056

Organization Name
Pompadour Lavender Farm

Organization Type

Feedback on draft list of actions

General Comment on Roadmap

I strongly support the OGWCs attempts to bring an effective and fair carbon sequestration program to Oregon. I also support SB 1534. Thank you for all your efforts. Attached (I hope) is an article I have written about many of the values associated with carbon sequestration. Ray Seidler Ashland, Oregon

IN DEFENSE OF SOIL CARBON SEQUESTRATION

Ray Seidler
rayseidler@msn.com/.

Introduction and Background.

There are reports that disparage the use of biological carbon sequestration practices. Soil carbon sequestration has multiple functional roles in food production, soil and planetary health, sustainability of food and fiber (trees) and, in reducing concentrations of the greenhouse gas, atmospheric carbon dioxide. These benefits are widely accepted throughout the world and the mitigation potential is significant. https://scholar.princeton.edu/sites/default/files/tsearchi/files/paustian_et_al._response_to_wri_soil_carbon_blog_.pdf

Major reasons for naysayer complaints seem to be grounded in various interpretations of aspects of legitimate carbon accounting", including an inability to measure soil carbon, and a mistaken impression that there are insufficient precedents to provide confidence that carbon accumulation is being done with best scientific practices. There also seems to exist a major misunderstanding of the word permanence as it applies to sequestered carbon, and a fundamental distrust for the concept of carbon offsets. During this global warming emergency, it is time for humanity to gather, envision, learn, and take actions that collectively reduce emissions as well as reduce greenhouse gases (GHG) already present in the atmosphere. It is my hope that my comments will clarify some of the misunderstandings.

Regarding precedents. There are currently (as of Sept. 2020) over 570 registered land-based carbon farming projects in Australia, covering **more than 47 million hectares**, (equivalent to nearly twice the entire land area of the State of Oregon). These contracted projects are in the process of generating 144 million tons of carbon dioxide abatement equivalent to erasing 2.4 years of ALL of Oregon's GHG emissions. These projects will inject more than $1.7 billion into rural, regional and remote Australian communities. https://climatefriendly.com/new-investment-in-carbon-farming/ Furthermore, as **leading soil scientists have already noted,there are hundreds of long-term field experiments across the world** (cited in **https://scholar.princeton.edu/sites/default/files/tsearchi/files/paustian_et_al._response_to_wri_soil_carbon_blog_.pdf)**

including several in California – that document how practices like cover cropping, tillage reduction, and diverse crop rotations increase soil carbon stocks.
https://calclimateag.org/regenerative-agricultures-climate-mitigation-potential-a-california-perspective/

There are Rules in the carbon market including the need to validate and verify that carbon dioxide sequestration is occurring. In 2014 the U.S. **Supreme Court ruled (again) that EPA can regulate greenhouse gas emissions, with some limits, from stationary sources.**
https://www.washingtonpost.com/politics/supreme-court-limits-epas-ability-to-regulate-greenhouse-gas-emissions/2014/06/23/c56fc194-f1b1-11e3-914c-1fbd0614e2d4_story.html Since the flow of carbon dioxide in the U.S. as a pollutant is regulated through the Federal Clean Air Act, it provides empowering incentives for landowners, corporations, and individuals who want to do the "right thing"(i.e., offset their carbon footprint) , to make sure third party companies are involved to validate and verify the amounts of carbon claimed to have been sequestered as a means of due diligence.

Carbon market brokers that bring farmers, polluters, and carbon buyers together (like Nori, Indigo Ag, and others) insist that due diligence be involved to assure the carbon has been sequestered, it is not being sold twice, it's been properly measured, etc. https://www.offsetguide.org/high-quality-offsets/ A condition of farmer acceptance into a carbon market sequestration program usually includes assurances that

farming practices implemented are new to their operation, i.e., are in addition (are different) to what had previously been carried out prior to the startup of carbon sequestration measurements. https://nationalaglawcenter.org/considering-carbon-overview-of-carbon-market-composition/ Some carbon marketplace companies may pay for previously adopted carbon-sequestering practices but only for a limited number of years of practice. https://agecon.ca.uky.edu/carbon-markets-101 The third-party company will verify practices by going through a thorough history of farmer land management records.

Offsets. A simplistic definition of offsets is: GHG *emission reductions* or *removals* that compensate for CO_2 emissions. If an industry cannot reach its regulatory requirements to lower pollution of GHG emissions, there are often opportunities to offset this pollution by purchasing a specific amount of soil carbon through the carbon market that a land owner may have previously sequestered into forests or agricultural soils. Surveys show reasons many land owners are hesitant to join a carbon marketplace program despite all their co-benefits include: a need for more information on conducting the practices, start-up costs of project validation, and not knowing how to join a commercial marketplace.

The purposes of this commentary is to attempt to clarify the nature of the carbon sequestration "problems" and to reassure interested readers that soil carbon sequestration provides a credible opportunity because it has been happening naturally over geological periods of time, it can be quantified using the basic laws of chemistry and physics and carbon persists within the soil and is not lost in significant amounts even after occasional physical soil disturbances to control weeds.

What is soil organic matter (SOM)?

There probably isn't any successful farmer or rancher that could not estimate the health of his or her soil by looking and sniffing it. Healthy, fertile soil is in that condition because of its increased soil organic matter content. Soil organic matter is derived from all living and dead materials present in the soil and on the soil surface including plant roots, shoots, leaves, living plant root exudates, microbes, worms, insects, arthropods and much more that are alive or recently died. But, all SOM is not the same.

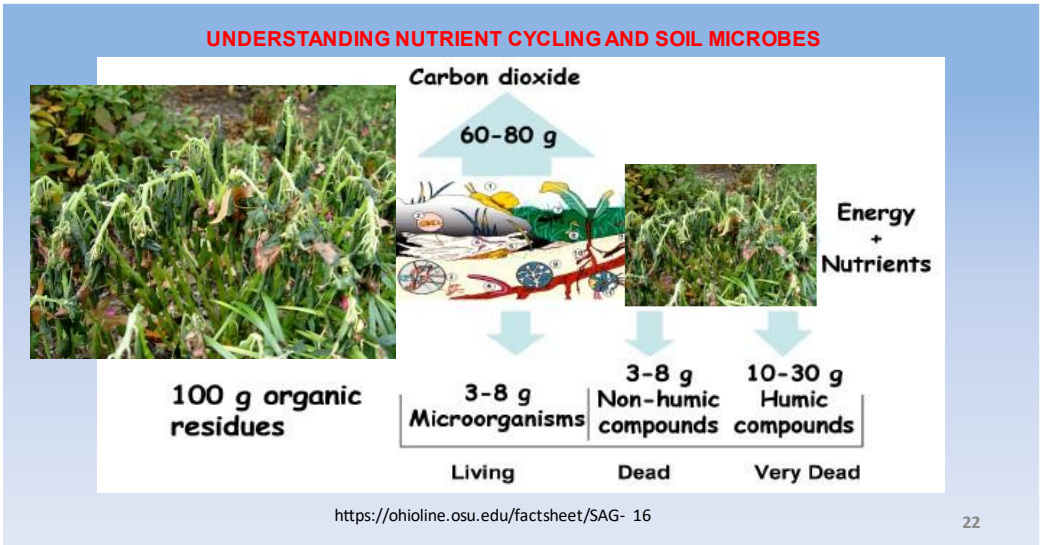
SOM contains about 58% carbon. The beginning source of this carbon was the atmospheric gas, carbon dioxide. That carbon now appears in the soil as organic matter converted from a gas into visible material through the processes of photosynthesis

Labile soil organic matter on the soil surface **can be readily decomposed**. It contains all the molecules and nutrients found within living organisms that have died including, nitrogen, minerals, and numerous proteins, DNA, RNA, complex cell wall components, water, and much more. Over time a significant percentage, approximately two-thirds or more, of these materials decompose within a few months to years (Figure 1). The relatively quick (months to 1-2 years) decomposition of recently dead **soil surface organic matter** has mistakenly led some to believe that soil carbon in general, is not stable. This labile surface material is NOT sequestered soil organic matter!

Every 1% of SOM weighs approximately 10 tons (20,000 lbs) per acre and most is found in the upper 7 inches (17.5 cm) of soil .This massive amount of carbon in soil (https://earthobservatory.nasa.gov/features/CarbonCycle) means that the processes of soil sequestration are a normal and integral part of the earth's massive carbon cycling system, and have been occurring naturally over geological times. Notably, carbon dating studies have found SOM in soil thousands of years old.

Figure 1.Scientists understand and account for the fact the only 20-40 percent of the decomposing agricultural residues enter into the soil and become SOM. The larger component is decomposed and carbon re-enters the atmopshere as carbon dioxide. https://ohioline.osu.edu/factsheet/SAG-16 For example, each acre of corn residues (stover, without corn kernels) weighs approximately 6,000—9,000 lbs dry weight.When just 20% of these residues enter the soil, it adds approximately 1,200-1,800 lbs of

sequestered SOM.The remaing weight of the larger component (the 60-80%) has never been part of the soil carbon matrix and these residues re-enter the atmosphere as gaseous CO2 without ever having been “sequestered”.



Soil Organic Matter Is Measurable.

There are four generally accepted ways to measure soil carbon. These are

1- Loss on ignition and combustion,
2- A chemical test called the Walkley-Black technique,
3- A spectral technique that uses near infrared technology.
4- A desk top approach to measuring soil carbon involves a nationally recognized computer model system called COMET-Farm. The raw data used to develop the computer program are derived from thousands of soil samples collected from nearly every county in the United States. COMET-Farm was developed through a partnership between the USDA Natural Resources Conservation Service and Colorado State University. There is more than a decade of model development experience reflected in COMET-Farm and it is the official greenhouse gas quantification tool of the USDA. The program estimates carbon sequestration amounts for a large number of agricultural practices for each county in the U.S. Nori corporation, a carbon marketplace company, allows land owners to estimate their carbon sequestration using the COMET program and does not require in field soil measurements.

https://comet-farm.com/#:~:text=COMET%2DFarm%20is%20a%20whole,including%20alternative%20future%20management%20scenarios.&text=is%20COMET%2DFarm%3F-,COMET%2DFarm%20is%20a%20whole%20farm%20and%20ranch,and%20greenhouse%20gas%20accounting%20system.

Figure 2 illustrates a full soil core showing the top mulch/organic material (black material) that sits on top of the soil, not within it.
https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9251.pdf Top mulch and any plant growth must be scraped off the surface soil layer before a soil core is taken for SOM analyses. This is not part of the “sequestered” soil organic matter. Soil specimens collected over time must be done consistently, preferably by the same person and use the same measurement technology. ***Comparison analyses of the physical/chemical methods (1-2 above) suggests that combustion, loss on ignition, and Walkley-Black function reliably in measuring soil carbon changes over time.***

There are projects under way to develop direct in the field measurements using Near Infrared spectroscopy and one prototype portable instrument called “Yard Stick” seems to be field ready and is coming to the market in 2022. See Figure 3. **Direct in the field measurements will likely increase convenience and speed of measurements and data acqusition at lower costs to the farmer.**
https://techcrunch.com/2021/02/17/yard-stick-provides-measurement-technology-to-combat-climate-change/.Agency.Energy
The resistance sensors on the probe calculate the density of the soil. With those two inputs, (soil density and carbon content) Yard Stick says it can calculate the amount of carbon sequestered in a particular area of soil.

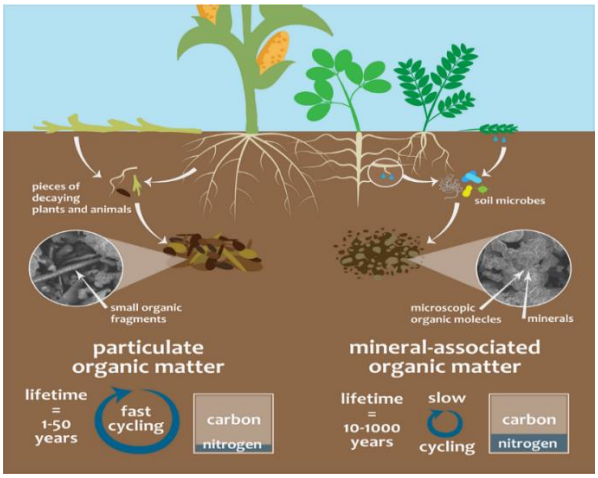
Figure 3. Yard Stick is a miniaturized technology used with a simple handheld drill. The tip of the probe contains a small camera that uses wavelengths to sense the presence of organic carbon the way our eyes sense differences in shades of blue when looking at the sky.

In separate studies, Kusumo and colleagues (2018) used infrared technologies(NIFR) to examine soil carbon taken from soil cores in New Zealand. The relationship between soil C measured by the conventional combustion laboratory method and predicted by Vis-NIRS technique showed a high correlation at all depths measured (down to 50cm).
https://iopscience.iop.org/article/10.1088/1755-1315/129/1/012023/pdf

When something is chemically measurable it is real, traceable, can be monitored, and therefore, can become verified as additional, and unlikely to be overestimated.

On the persistence of SOM.

Figure 4. Sequestered carbon is not all the same. https://source.colostate.edu/soil-carbon-is-a-valuable-resource-but-all-soil-carbon-is-not-created-equal/



Fate of organic matter on and within the soil. Resistant, particulate and mineral-associated SOM (Figure 4) consists of approximately 80% of the soil carbon and decomposes over tens to fifty to thousands of years while living organisms (plant roots, microbes, invertebrates, plant root exudates) may comprise about 10% of the near surface soil organic matter. When SOM is added to the soil faster than it leaves, (e.g., every year), SOM will accumulate. **https://www.agric.wa.gov.au/measuring-and-assessing-soils/what-soil-organic-carbon**

Depending on environmental factors (temperature, moisture), around 30-50% of common crop residues left undisturbed on soil surfaces actively decompose within 12 months. Further accelerated decomposition (over months) continues after this time as well. These are surface residues and although the remaining remnants impact soil health, the CO2 released from surface residues over short periods since deposition (months to a year+/-), are **never part of the fraction deemed as soil organic matter**. This released carbon is ultimately considered to be part of the 60-80% of surface residues illustrated in Figure 1. The remnants (20-40%) of the partially decomposed residues comprise the particulate organic matter (Figure 4) and, after further weathering and living creatures moving organic matter further into the upper soil layers, it becomes components of mineral associated (formerly “humus”) long-lived soil organic matter and the “resistant” organic matter. See Table 1 found here. https://www.agric.wa.gov.au/measuring-and-assessing-soils/what-soil-organic-carbon.

The papers of Conant and others (cited in Conant, et al Dimassi et al., 2013), provide key information as to the relationships between organic matter actually within the soil and the consequences of physical disturbance of the soil (tillage, plowing). https://controverses.sciences-po.fr/climateblogs/tillage/files/2012/04/07-Conant-impacts-of-periodic-tillage-on-soil-C-stocks-a-synthesis.pdf
For example, Conant, et. al. reviewed the science and found that **most (80%) of the soil carbon gains from no till (NT) treatments can still be realized when no till is coupled with biannual shallow cultivating or ripping for weed control.** “ If those tillage activities are the most common in an otherwise long-term NT system, impacts on soil C stocks will be minimal”. In other words, there will be no “massive” release of sequestered carbon. Factors impacting the amounts of soil carbon loss due to tillage are a function of the soil type, the frequency and intensity of tillage, depth of the tillage events, and the weather. https://environmentalevidencejournal.biomedcentral.com/articles/10.1186/s13750-017-0108-9 Other studies that showed an increased and “dramatic” release of “sequestered carbon” after tillage or plowing were likely due to high intensity soil treatment, and tilling or plowing at depths below 1-2 inches of the surface. https://environmentalevidencejournal.biomedcentral.com/articles/10.1186/s13750-017-0108-9

In separate studies, Sanderman, et al. noted through historical comparisons of agricultural land with native vegetation that only 14-28% of SOC loss occurred over the last 200 years due to industrial agricultural practices involving intense plowing and or yearly multiple deep tillage treatments that highly disturb the soil. https://www.pnas.org/content/114/36/9575#F1 Such data demonstrate that if a farmer

was to abandon carbon sequestration and change back to industrial agriculture practices, there would not be sudden massive loss of previously sequestered carbon over the succeeding tens to 100 years.. https://www.pnas.org/content/114/36/9575#F1

Further proof of SOM persistence has been demonstrated at the Rothamsted long-term agricultural experiment station, wherein farmyard manure was applied to a cereal cropping system for twenty years in the late nineteenth century and then stopped. Nearly 150 years later, this soil still contains about 2.5 times as much SOM as soil that never received manure (Johnston et al., 2009, cited in https://www.frontiersin.org/articles/10.3389/fenvs.2020.514701/full#Box1) Collectively all these studies have called into question the necessity for 100-year permanence requirements in the practices that sequester carbon. Some contracts currently allow 25 year periods of carbon sequestration efforts.

Fate of carbon dioxide in the atmosphere. A "quality" carbon offset credit, refers to the *level of confidence* that a landowner carbon credit issued for 1 ton GHG removed will fulfill the basic principle that their sequestration will completely *substitute* for (offset) 1 ton of GHG emitted by the polluter. But, scientists have estimated, using many different computer modeling systems, that following a "pulse" of carbon dioxide emission into the atmosphere by polluters, after 100 years, 75% of the GHG has left the atmosphere to continue its journey in the carbon cycle, perhaps even becoming photosynthesized again. Why should we ask and expect land owners to "permanently" sequester carbon when nature cannot do this? As stated above, to be put into perspective, after 200 years the amounts of SOM in soil may be overall reduced just 14-28% on average due to industrial agricultural practices, https://www.pnas.org/content/114/36/9575#F1 (see Figure 1a, solid black line.

Further dissemination of these facts and education that addresses policy maker concerns may lead to broader support for adoption of carbon sequestration programs. https://www.frontiersin.org/articles/10.3389/fenvs.2020.514701/full#Box1

Putting science into action. Innovative field applications from the lessons learned from Conant and colleagues can be found within the Australian Carbon Farming Emissions program. A large sized device was built and tested for making healthy soil, called the "Soil Kee" Renovator (Figures 5-7). https://soilkee.com.au/Soilkee-Renovator/

This device simultaneously provides minimal tillage soil disturbance (perhaps upper 1 inch of soil) and a means for replanting of pasture, or row crops with a single pass over the field. **Minimum till** disturbance is achieved by widely spaced blades about 14 inches apart, (Figure 6). This process creates a **competition free seed bed** for **successful germination** and leaves around 80% of the pasture or field undisturbed (Fig.7). The undisturbed portion of the field acts as a **cover crop.**

Figure 5. The Soil Kee renovator/ Planting system used in Australia to facilitate carbon sequestration

Fig.6. Widely spaced blades on the Soil Kee

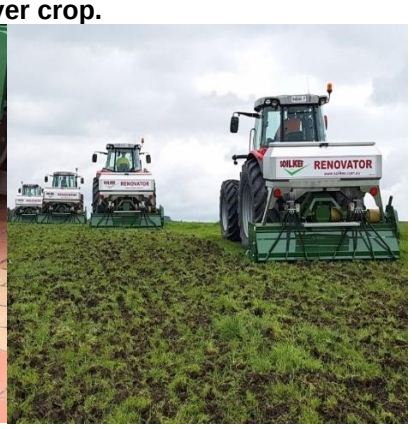


Fig. 7. Field perspective

Carbon sequestration projects are worthless without validation and verification.

Authentication of project transparency and integrity are key components for a land holder if they anticipate selling carbon credits publicly. Landholders should not be financially incentivized unless their project is verified and validated to comply with international standards for sale in the open market.

Third party verifiers offer the carbon purchasers a kind of due diligence in the assessment and identification of "good quality" offsets. This ensures offsetting provides the desired additional environmental benefits, and avoids reputational risk associated with poor quality offsets. https://en.wikipedia.org/wiki/Carbon_offset A successful verification provides reasonable assurance that the GHG assertion is without material misstatement file:///C:/Users/Owner/Downloads/ACR%20VV%20Guideline%20v1%201%20(1).pdf Third party verifiers like SCS Global Services or Aster Global, Inc. and others https://www.theclimateregistry.org/our-members/list-of-verifiers/ work closely with project land owners to provide third-party authentication which have already been used on hundreds of carbon sequestration projects.

It is critical that in any financially incentivized program that policy makers, land owners and polluters, be knowledgeable with these quality carbon sequestration requirements and the available rules that reference these issues. Easy reference and clear rules might facilitate the processes and encourage new carbon sequestration projects that really will help to mitigate the impacts of global warming on food production, soil sustainability, and financial health of the land.

SUMMARY: The science is clear that regenerative agriculture can in fact contribute significant agricultural emission reductions and CO_2 removal, as well as improve soil health. There is an extensive literature describing hundreds of long-term field experiments across the globe that document the capability of these practices, e.g., cover crops, (Abdalla et al. 2019, Poeplau and Don 2015), tillage reduction (Ogle et al. 2005, Franzluebbers 2010, Kravchenko and Robertson 2011), perennials (Conant et al. 2016, Ogle et al. 2005, Guo and Gifford 2002) to increase soil C content. Of course, results vary for different combinations of climate and soil types and management systems but in general “we understand the variability in responses from region to region and professionals can design regionally-appropriate climate-smart regenerative agroecosystems”. All citations here: **https://static1.squarespace.com/static/5c3780907c9327dc2a2e8c64/t/5edf6c3063b8cc74f6f4fff9/1591700528217/Response+to+WRI+-+FINAL.pdf**

The longer-term sequestered carbon in the form of SOM, persistently accumulates over time, keeping the soil fertile and healthy. The biannual gentle physical disturbance of the upper soil layer using light tillage to remove weeds, (like with the SoilKee) may remove a small percentage of the short-lived near surface SOM but not the deeper sequestered carbon.

If just 25% of Oregon’s 16 million farmed acres were to enter a carbon sequestering practice, the potential exists to remove about 6 million tons of CO_2 per year from the atmosphere, equivalent to approximately the total published Oregon agricultural emissions per year.. This assumes 0.4 tons as C is sequestered per acre per year, well within the average ranges reported in the literature for a variety of agricultural practices.*
https://drawdown.org/solutions/conservation-agriculture/technical-summary;
see page 31 and Appendix C here: https://www.chelseagreen.com/product/the-carbon-farming-solution/?
see pages 174-182 here https://www.goodreads.com/book/show/39027958-a-finer-future
*Calculations of carbon sequestration potential in Oregon: **25% X16 million (M) ac= 4 M ac X 0.4 t/ac as C=1.6 Mt C X 3.67 =5.9 Mt as CO2 equiv. removed from the atmosphere. THE VALUE OF THIS PROCESS IS $90 MILLION/YR IN THE CURRENT CARBON MARKEPLACE; funds would largely go to rural, underrepresented regions of the State of Oregon.**