Economic tradeoff of alternative forest management activities to enhance carbon sequestration efforts in Pennsylvania and Maryland.

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Forest Carbon Management: climate considerations

- Lots of terms!: climate-smart forestry, carbon stewardship, adaptive management, adaptive silviculture
- Carbon is just one management goals among other goals
- Optimizing carbon means balancing climate trade-offs with other traditional management goals in the context of ecosystem integrity and climate adaptation

Modeling climate-smart forestry in MD and PA

Carbon Budget Model – Canadian Forest Sector (CBM-CFS3)

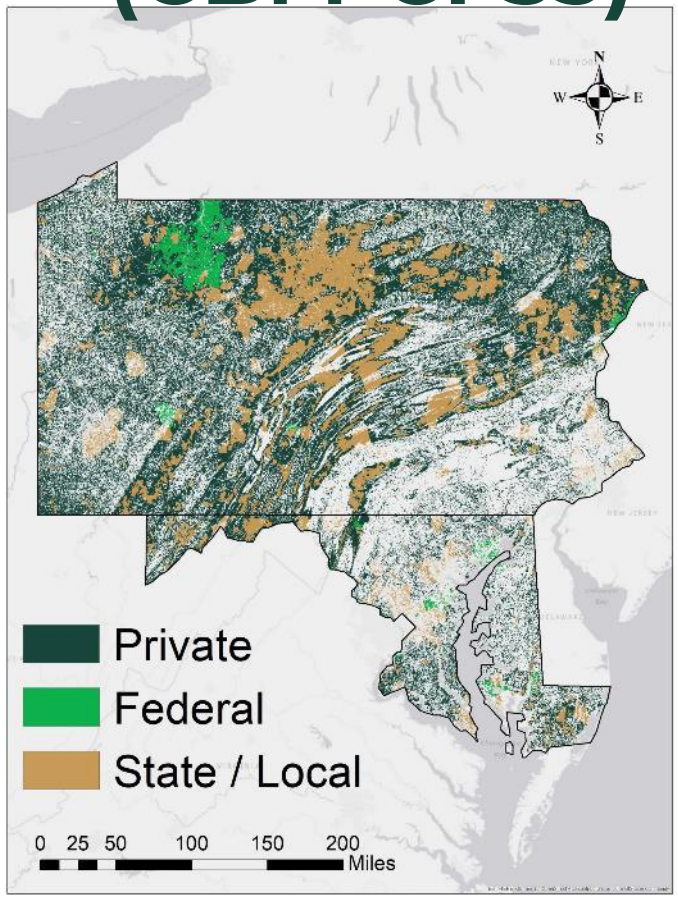

TABLE 1 Percentage of forestland by ownership.

Ownership	MD (%)	PA (%)
USFS	--	3.06
Other federal	2.70	0.88
State/local	24.34	26.85
Private/tribal	72.96	69.20

TABLE 2 Percentage of forestland by forest type group.

Forest type group	MD (%)	PA (%)
White/red/jack pine group	1.42	2.63
Loblolly/shortleaf pine group	16.26	0.48
Other softwoods group	0.58	0.35
Oak/pine group	7.82	1.65
Oak/hickory group	59.81	53.89
Oak/gum/cypress group	4.70	0.13
Elm/ash/cottonwood group	3.91	2.31
Maple/beech/birch group	3.75	31.43
Aspen/birch group	--	1.74
Other hardwoods group	1.22	4.74
Nonstocked	0.66	0.67

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Modeling climate-smart forest management and wood use for climate mitigation potential in Maryland and Pennsylvania

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Timber Products

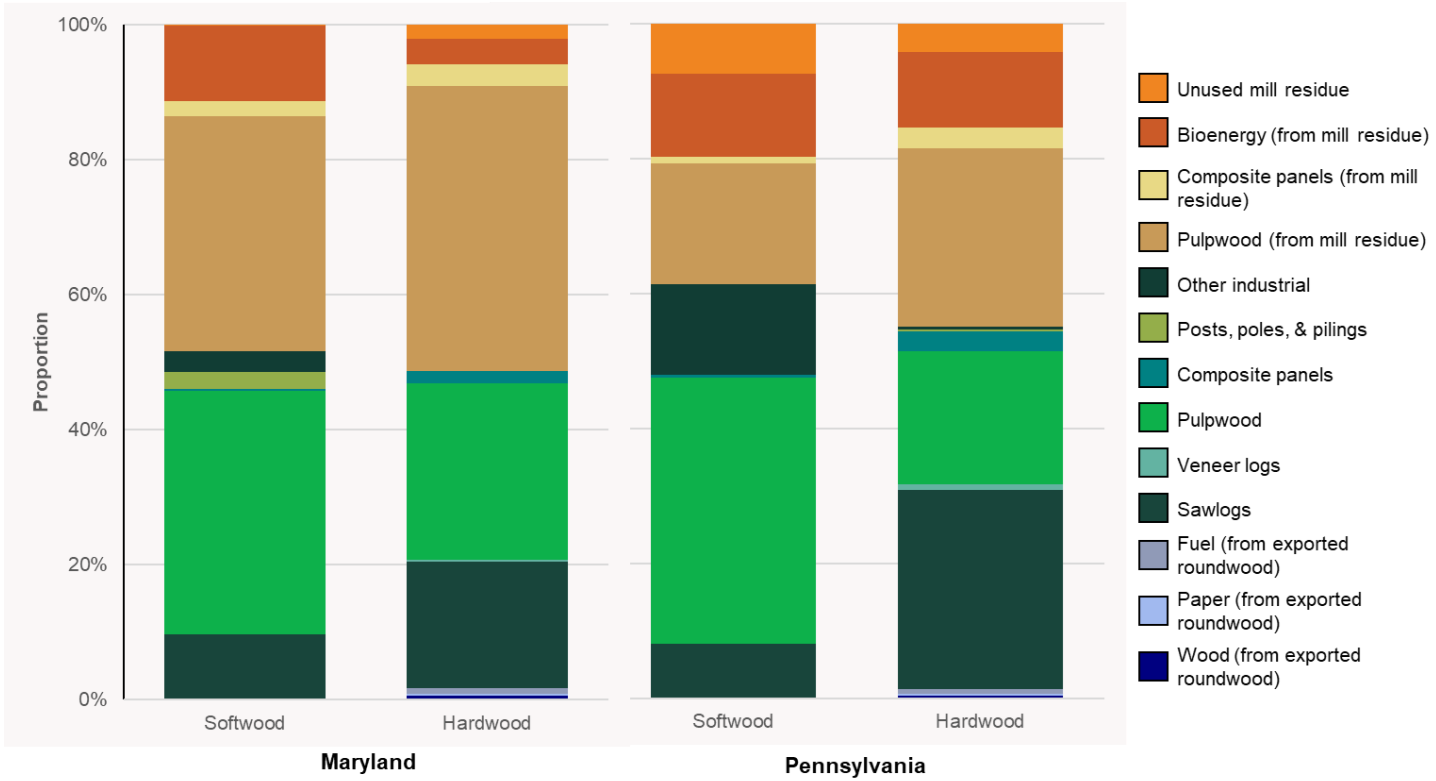
Data obtained from HWPs model in different product stream categories

State-level trade & commodity data from:

- USFS RPA Assessments (2021)
- US Commodity Flow Surveys (US Census, 2020)
- US ITC data (2021)
- Peer-reviewed sources (Howard & Liang, 2019)
- National averages (if no local data)

FAOSTAT (2021) for export data

Product half-lives from literature (Smith et al., 2006; Skog, 2008)



Primary product ratios for commodities produced in Maryland and Pennsylvania differentiated between softwood and hardwood inputs shown as a proportion of total volume harvested.

Economic Tradeoffs of Carbon and Timber Products Estimation

To quantify financial tradeoffs of carbon and timber products resulting from the CBM-CFS management scenarios, Net Present Value for each modeled scenario were estimated and compared to BAU scenario.

$$NPV = \sum \frac{R}{(1+i)^t} - \sum \frac{C}{(1+i)^t}$$

R is the revenue generated from the harvested wood products and/or carbon credits under each management scenario for a certain duration [Short term (2023 to 2032), Medium term (2023 to 2050), Medium-long term (2023 to 2070) and Long term (2023 to 2100)]
C is the costs associated with implementing each modeled management scenario including BAU for the same duration
i is the minimum acceptable real rate of return (RoR) and t is the time in years during the period considered.

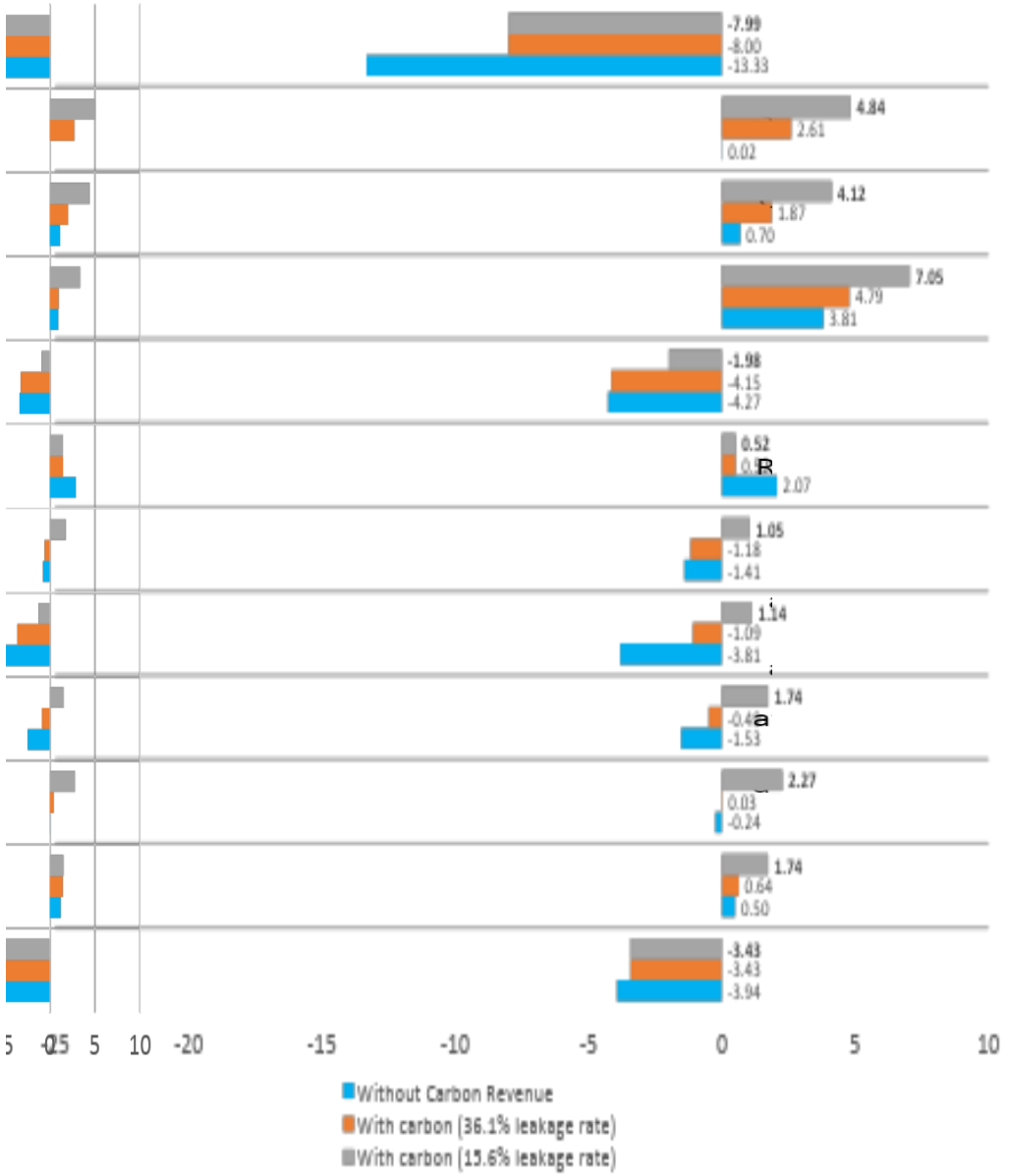
- Stumpage Price for revenue estimation from State agencies
- Management Cost for different prescriptions from Environmental Quality Incentives Program's (EQIP) payment schedule 2022
- Carbon Price from Live Carbon Prices today- Price per ton of CO_2 equivalent = $8.29 dollars for year 2022

Alternative Management Scenarios

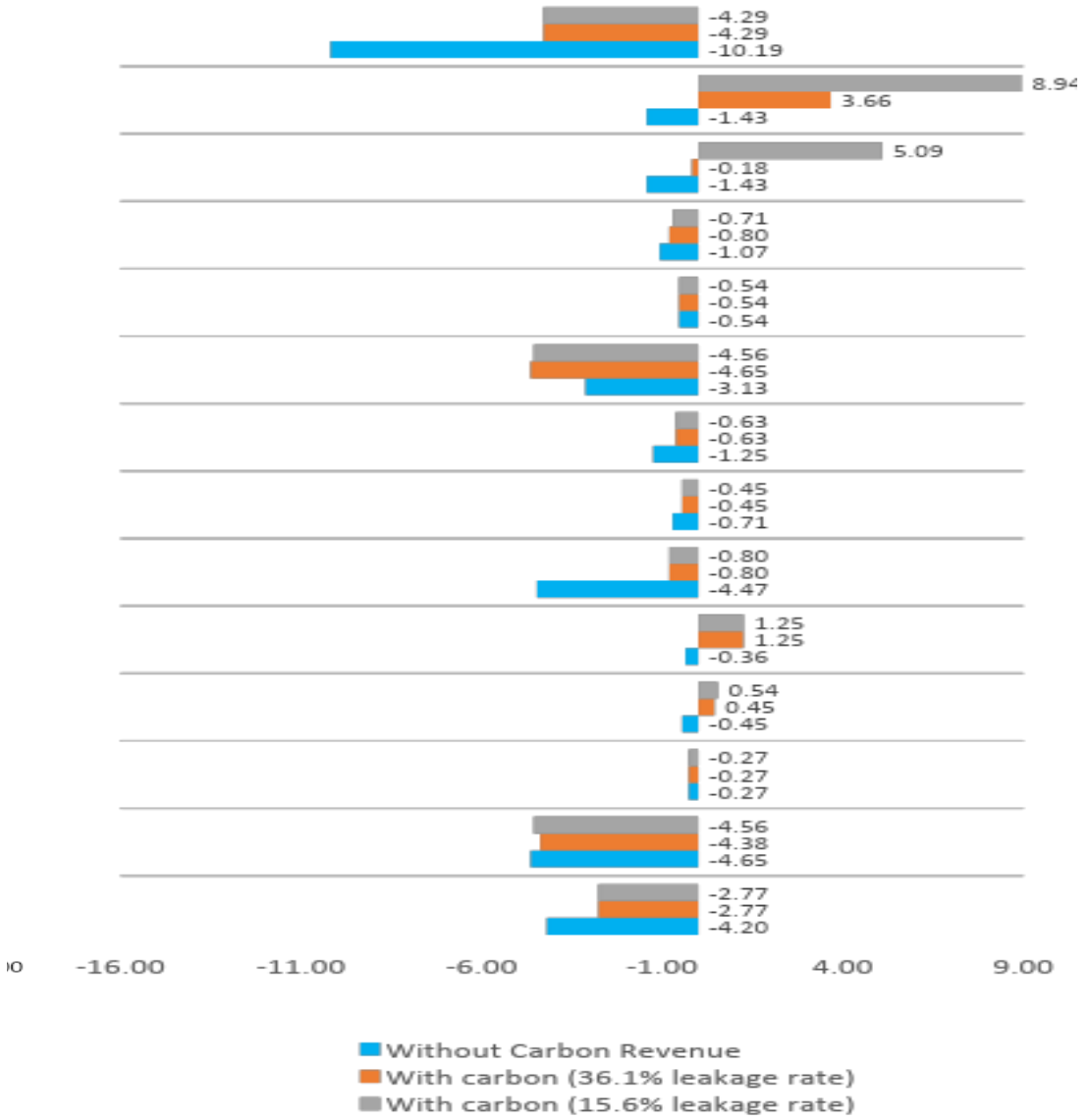
1	**Baseline/ BAU**	Represents continuation of current management practices (harvests, thinning, and prescribed burn).
2	Altered rotations	Increased / decrease in the average harvest age of stands
3	Altered rotations alt.	Increase/decrease in the average harvest age of stands
4	**afGGRA2030**	Increase in the annual rate of afforestation until 2030
5	**afGGRA2050**	Increase in the annual rate of afforestation until 2050
6	**afSU2030**	Increase in the annual rate of afforestation until 2030
7	**afSU2050**	Increase in the annual rate of afforestation until 2050
8	Restocking	Increase annual rate of stands being restocked through active planting until 2030
9	Restocking alt.	Increased annual rate of stands being restocked through active planting until 2050
10	Timber stand improvement (TSI)	Increase in the annual rate of commercial thinning and prescribed burns
11	Reduced deforestation	Decrease in the annual rate of deforestation
12	Reduced diameter-limit-cuts (DLCs)	Decrease in the annual rate of diameter limit cuts (DLCs) until zero acres (i.e., high-grading)
13	**Control DB**	Increase in the annual rate of fencing to control deer browse
14	**Silvopasture**	Increase in the rate of silvopasture adoption on pastureland
15	No harvest activities†	Complete reduction in all harvesting activities

Percentage change in NPV for alternative carbon management scenarios compared to business as usual

Pennsylvania(2023-2100)

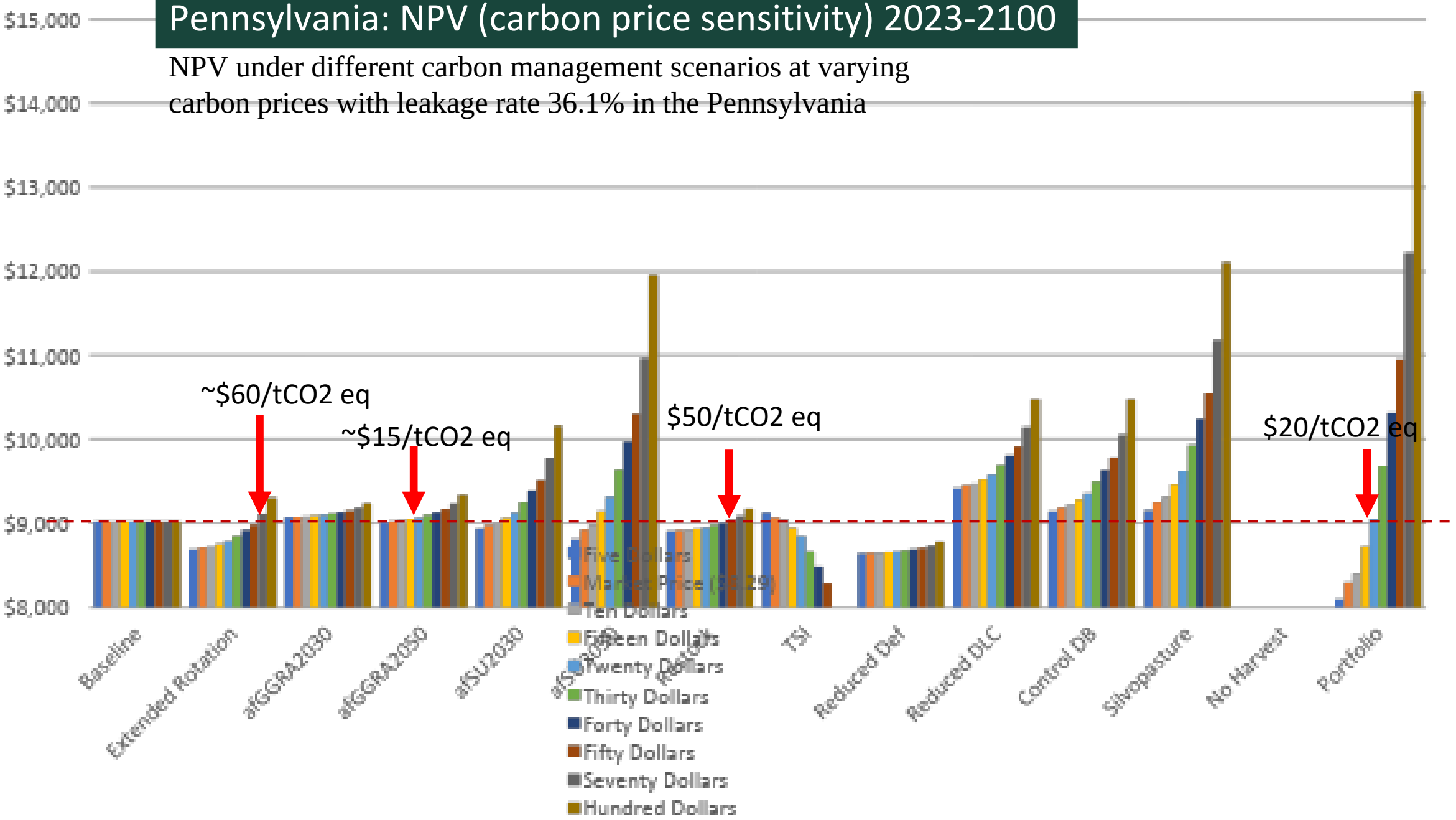


Maryland (2023-2100)



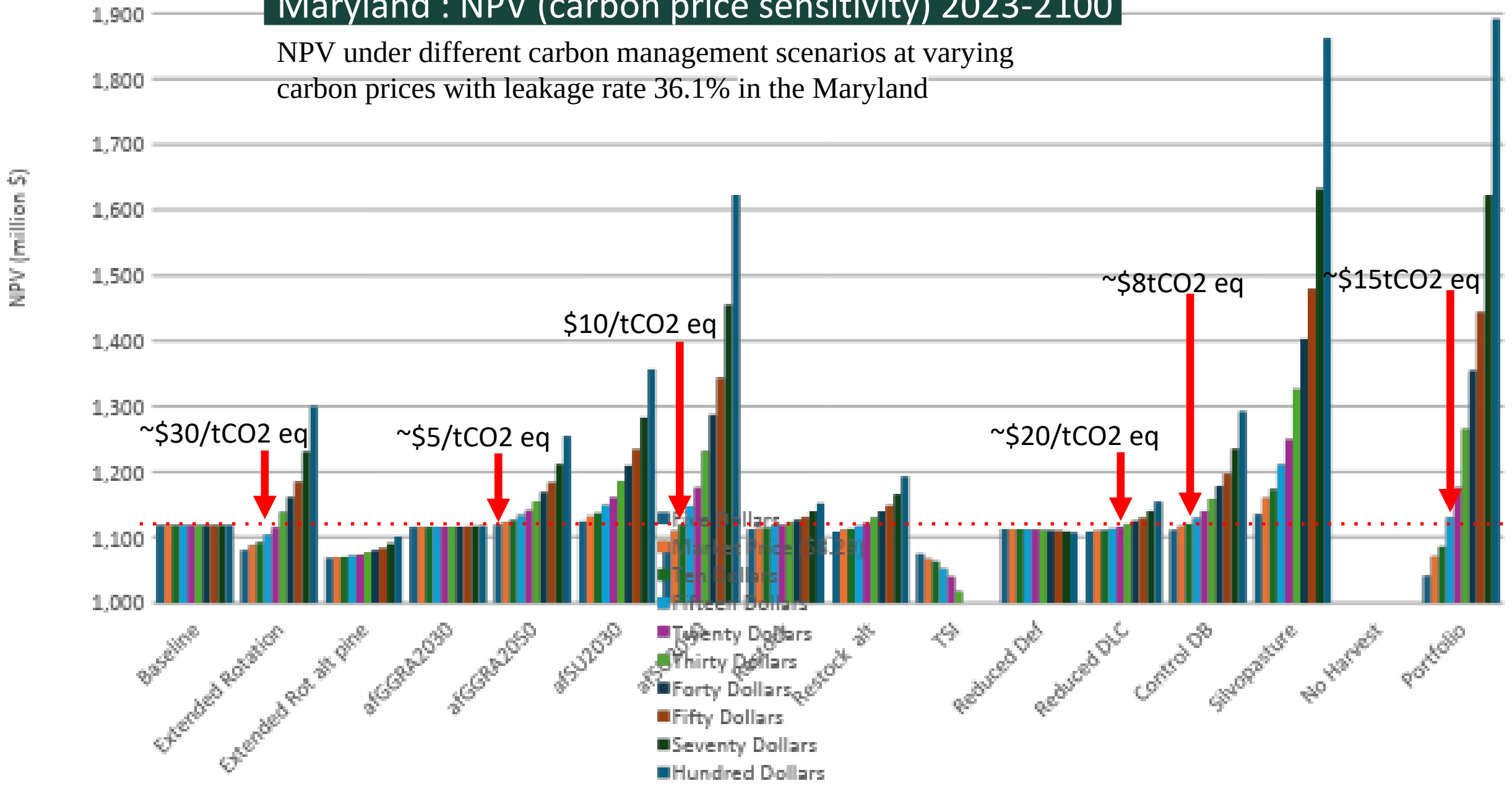
Pennsylvania: NPV (carbon price sensitivity) 2023-2100

NPV under different carbon management scenarios at varying carbon prices with leakage rate 36.1% in the Pennsylvania



Maryland : NPV (carbon price sensitivity) 2023-2100

NPV under different carbon management scenarios at varying carbon prices with leakage rate 36.1% in the Maryland



Key Takeaways

- Extended or Altered Rotation negatively affect economics of forest management
- Silvopasture development, control deer browse can produce carbon as well as economic return at lower payment for carbon
- Afforestation and restocking only works when there is payment for carbon with lower leakage rates
- TSI and reduced DLC can provide economic as well as carbon benefits when done right
- States with robust forestry sector needs higher payment for carbon compared to states where there is less robust forest product markets.

Thank you !

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Estimate tradeoff of extending rotation on your land-

https://www.canr.msu.edu/FERM/Tools/Forest-Carbon-Calculator/

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