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New Jersey EV Market Study

Study Results Review
For BPU EV Working Group
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Electric Vehicles: Why Now?

1914 Detroit Electric

2018 Detroit Electric

A New Generation Of Electric Vehicles Will Enable Profound And Beneficial Changes In Our Energy Ecosystem

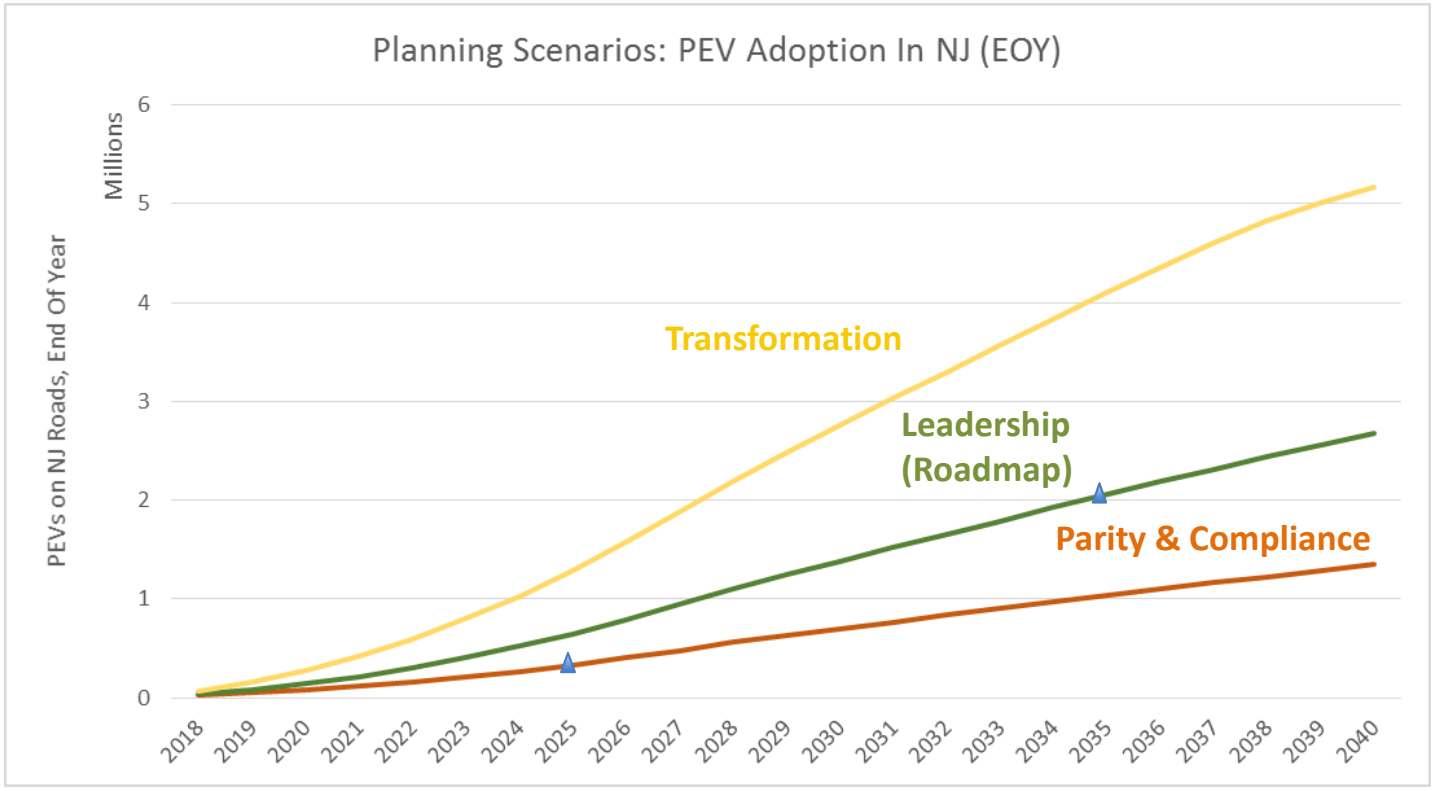
Study Goals And Scope

- **Key Questions:**
  - Where is the NJ EV market today?
  - What are the opportunities for growth?
  - What are the costs and benefits of expanded EV adoption?
  - What are the implications for infrastructure and utilities?

Focus For Today

- **Scope**
  - Focus on light duty vehicles
  - Consider various scenarios from 2018-2050
  - Evaluate economic impacts:
    - ✓ Projected Benefits (utility customers, EV drivers, society at large)
    - ✓ Potential costs (market development, grid reinforcement, etc)
    - ✓ Net benefit tests (Utility Customer NPV, broader Societal Cost Test (SCT)
  - Evaluate environmental impacts
    - ✓ CO2, NOx, SOx emissions
    - ✓ Two different emission accounting methods
  - Specifically consider "natural" and "managed" vehicle charge scheduling
  - Results based on detailed simulation of energy markets and the physical utility distribution system

New Jersey Adoption Scenarios



The PEV Adoption Scenarios Implicitly Incorporate The ZEV Framework Scaled To NJ Conditions

▲ = ChargEVC Roadmap Goals

Under Scenario Two (Leadership) – Approximately 31.5% of Fleet Is A Plug-In By 2035. Global Leadership Benchmarks Are Fleet 30% Penetration By 2030 (mostly in Europe).

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Findings: Highlights

Finding Highlights:

- **Untapped Opportunity, Potential For Growth In New Jersey**
  - New Jersey could increase its EV adoption by a factor of TWO to FOUR

- **Simple Test: NET Economic Benefits For Utility Customers**
  - NET Benefits (after costs) for the Leadership Scenario are **$2.84** nominal sum, **$975.7M** NPV, By 2035 (managed)
  - This simple test matches potential utility customer costs with utility customer electricity savings
  - Benefits scale strongly with EV adoption - benefit increases through 2050 (S2, Managed): **$17.1B** nominal sum, **$3.8B** NPV
  - This test addresses questions about cross-subsidization between utility customers: ALL customers benefit

- **Societal Cost Test (SCT): NET Economic Benefits For Many Impacted Populations**
  - Considers broader portfolio of costs and benefits for utility customers, EV owners, society at large, and other participants
  - NET SCT Benefits for the Leadership Scenario (managed) are **$16.9B** nominal sum, **$11.3B** NPV, By 2035
  - NET SCT Benefits grow long term: **$98.7B** nominal sum, **$50.7B** NPV by 2050 (Leadership Scenario, managed)

- **Environmental Benefits**
  - Every electrically fueled mile is **69% - 79% cleaner** than an average gasoline fueled mile
  - Light Duty Vehicle CO2 emissions are projected to be 31.9 M tons in 2018, but could drop by 22.4 M tons by 2050 (S3)
  - Both CO2 and NOx are reduced dramatically with increased EV use, necessary to achieving state goals (GWRA, NOx)
  - Improvements in air quality directly affect public health, especially in the urban core and along high-travel corridors

- **Significant Implications For Infrastructure And Utilities**
  - Utility will realize increased revenues, cost efficiencies that reduce rates, and ***strategic opportunities for load optimization***
  - "Managed Charging" makes a big difference on benefits and costs, should be a top strategic priority
  - Past 5-10% penetration, grid reinforcement will be necessary, supports other modernization efforts

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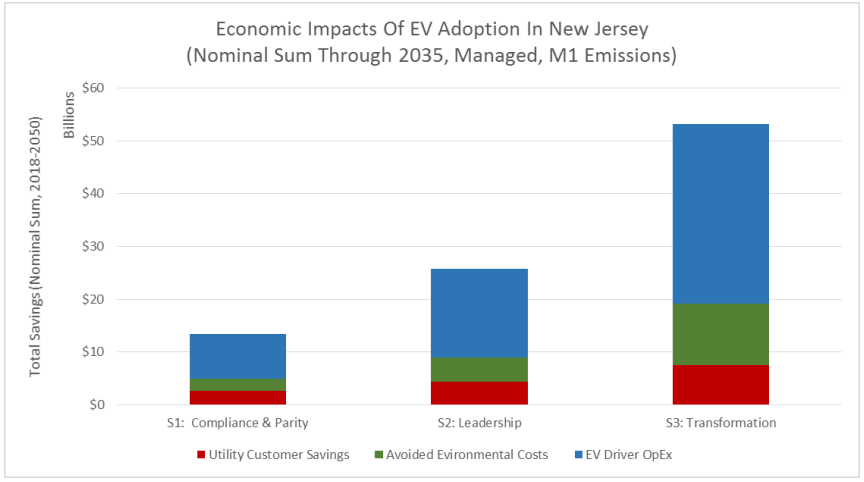
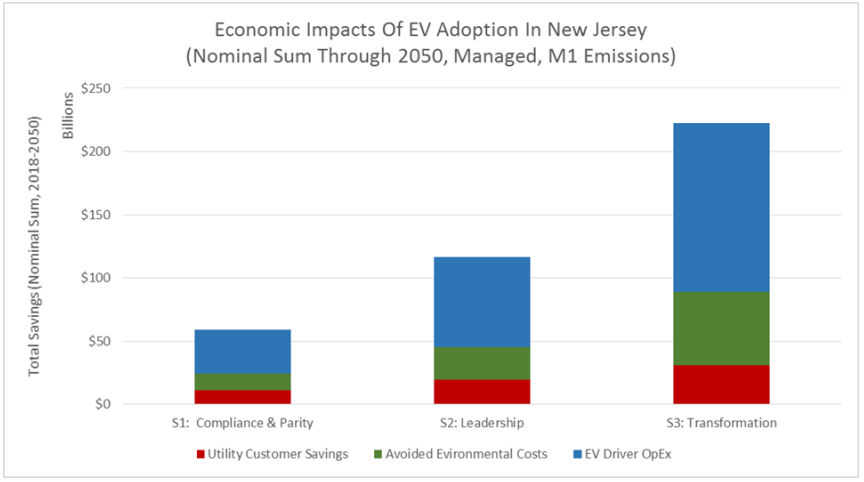
Findings: Economic Benefits

- **Avoided Costs For All Electric Utility Customers (S2, Managed, total thru 2035): $4.3B**
  - Wholesale energy costs go down as a greater fraction of MWHRs are in cheaper off-peak times
  - Fixed costs (capacity, transmission, distribution) dilute as MWHR volume increases
  - Energy cost impacts could increase substantially if V2G capabilities used to shave peak load
  - Actual impact on rates will depend on numerous other factors (contracts, tariff design, etc)
- **Economic Value Of Reduced Emissions (S2, Managed, M1, total thru 2035): $4.6B**
  - Based on federal factors applied against CO2 emission reductions
  - NOx and SO2 impacts not quantified, but would likely expand benefits
- **Avoided Operating Expense For EV Owner (S2, Managed, total thru 2035): $16.8B**
  - At today's prices, 4.49 cents/mile for electricity (BEV), vs 10.67 cents/mile for gasoline

EV Benefits Continue To Growth With Adoption, 2050 Benefits 4X 2035 Benefits





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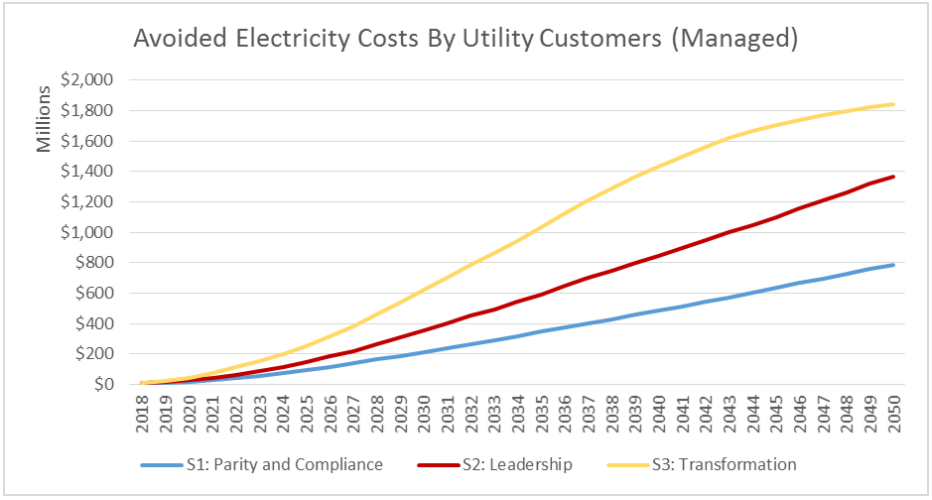
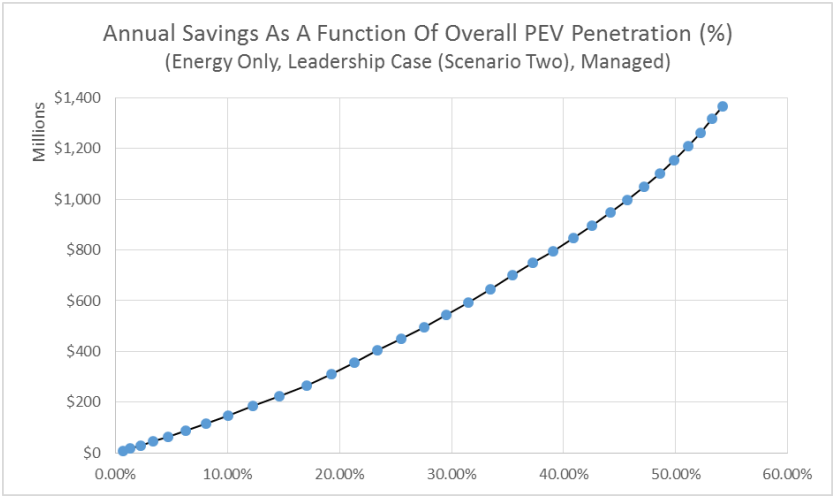
Findings: Focus On Utility Customers

- **Avoided Costs For Utility Customers Are Substantial (S2 Average: $587M/Year Thru 2050)**
- **Benefits Scale Strongly With PEV Adoption Level: More PEVs, More Savings**
- **Managed Charging Increases Economic Benefit Over Natural Charging (~35%)**
- **(Note: Managed Charging Most Impactful If It Shifts Start Time AND Extends Duration)**

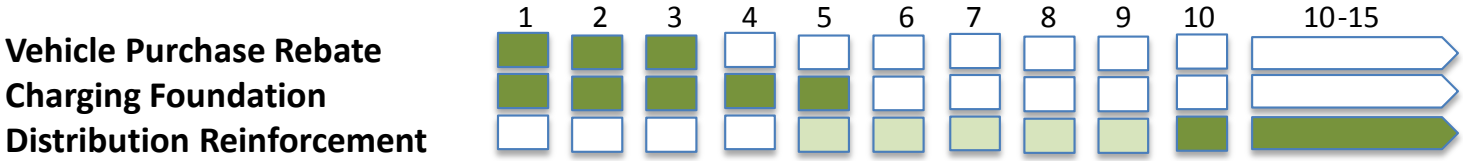
- **These Impacts Are Realized By All Utility Customers, Not Just EV Drivers**





Findings - Potential Costs

- **<u>POTENTIAL</u> Costs That <u>MIGHT</u> Impact Utility Customers**
  - Market Development Costs – e.g. ChargEVC Roadmap ($700M over five years)
    - Vehicle purchase rebate ($300M)
    - DCFC Critical Mass: Essential Public Charging Network ($150M)
    - A Foundation For Residential Managed Charging ($150M)
    - Seeding The Market: Non-Residential L2 Programs ($100M)
    - Note: these investments are all structured around early market development needs
  - Distribution System Reinforcement Costs (upgrade all 1-Ph xFrmrs, $2.2B over 15-20 years)
    - Note: system reinforcement can potentially deliver benefits beyond handling EV-load
  - Investment Timing



- **Other Costs For Other Market Participants**
  - Vehicle purchase premiums
  - Charging infrastructure investments

Findings - Benefit Test: Utility Customer NPV

- **Simple Avoided Electricity Costs For Utility Customers (DRIPE)**
  - $1.9B for Scenario 1 by 2035, $8.8B by 2050
  - $4.3B for Scenario 2 by 2035, $19.4B by 2050
  - $7.5B for Scenario 3 by 2035, $30.9by 2050

- **Potential Costs That MIGHT Impact Utility Customers**
  - Market Development Costs – e.g. ChargEVC Roadmap ($700M over five years)
    - Vehicle purchase rebate ($300M)
    - Charging foundation ($400)
  - Distribution System Reinforcement Costs (upgrade all 1-Ph xFrmrs, $2.2B over 15-20 years)

- **This Test Under-Represents Real Benefits, But Reflects Benefits That Apply To All Utility Customers Through Reduced Electricity Costs**

- **Simple Net Benefit Test For Utility Customers**

		By 2035		By 2050	
	Charging	**B/C Ratio**	**NPV**	**B/C Ratio**	**NPV**
Scenario 1	Natural	2.71	$529 M	4.55	$1.7 B
Scenario 2	Managed	1.99	$975 M	4.28	$3.8 B
Scenario 3	Managed	2.26	$1.9 B	5.44	$6.7 B

Findings - Benefit Test: Social Cost Test (SCT)

- **Portfolio Of Benefits**
  - Avoided Electricity Costs By Utility Customers
  - EV Owner Avoided Operating Expense (NET savings)
  - Economic Value Of Reduced Environmental Emissions
  - Federal Tax Incentives

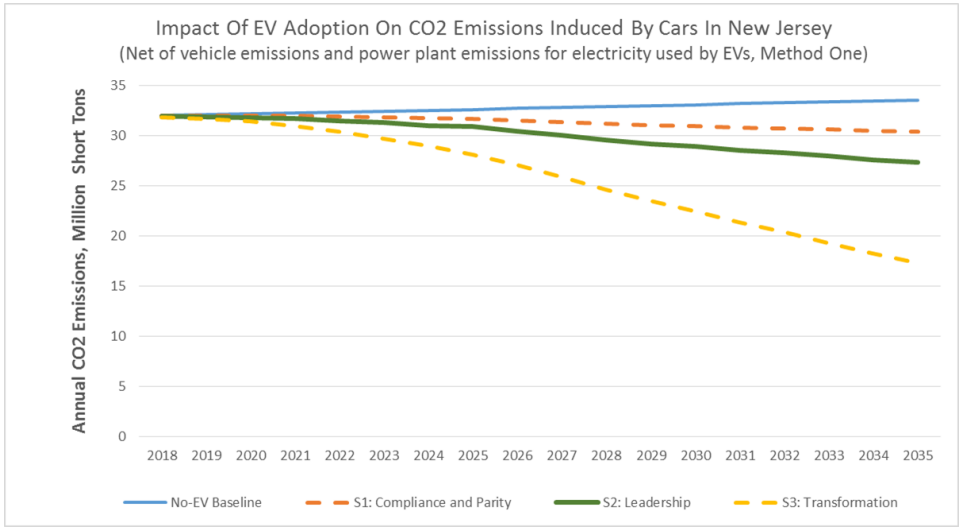
Vehicle Operating Expense Savings Is A Key Source Of Real Cash Benefit For All EV Owners

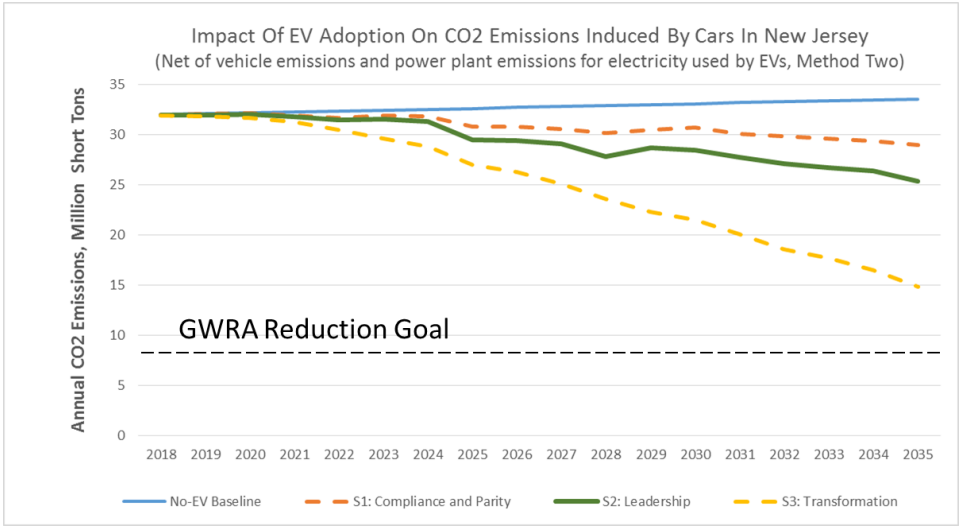
- **Estimated Costs**
  - Market Development Costs
  - Distribution System Reinforcement Costs
  - Vehicle Purchase Premiums
  - Non-Utility-Customer-Funded Charging Infrastructure Investments

- **Social Cost Test:**

		By 2035		By 2050	
	Charging	**B/C Ratio**	**NPV**	**B/C Ratio**	**NPV**
Scenario 1	Natural	2.18	$ 5.5 B	4.42	$ 24.3 B
Scenario 2	Managed	2.19	$11.3 B	4.63	$ 50.7 B
Scenario 3	Managed	2.26	$23.8 B	5.95	$100.1 B

Findings: CO2 Impacts
(transportation only)

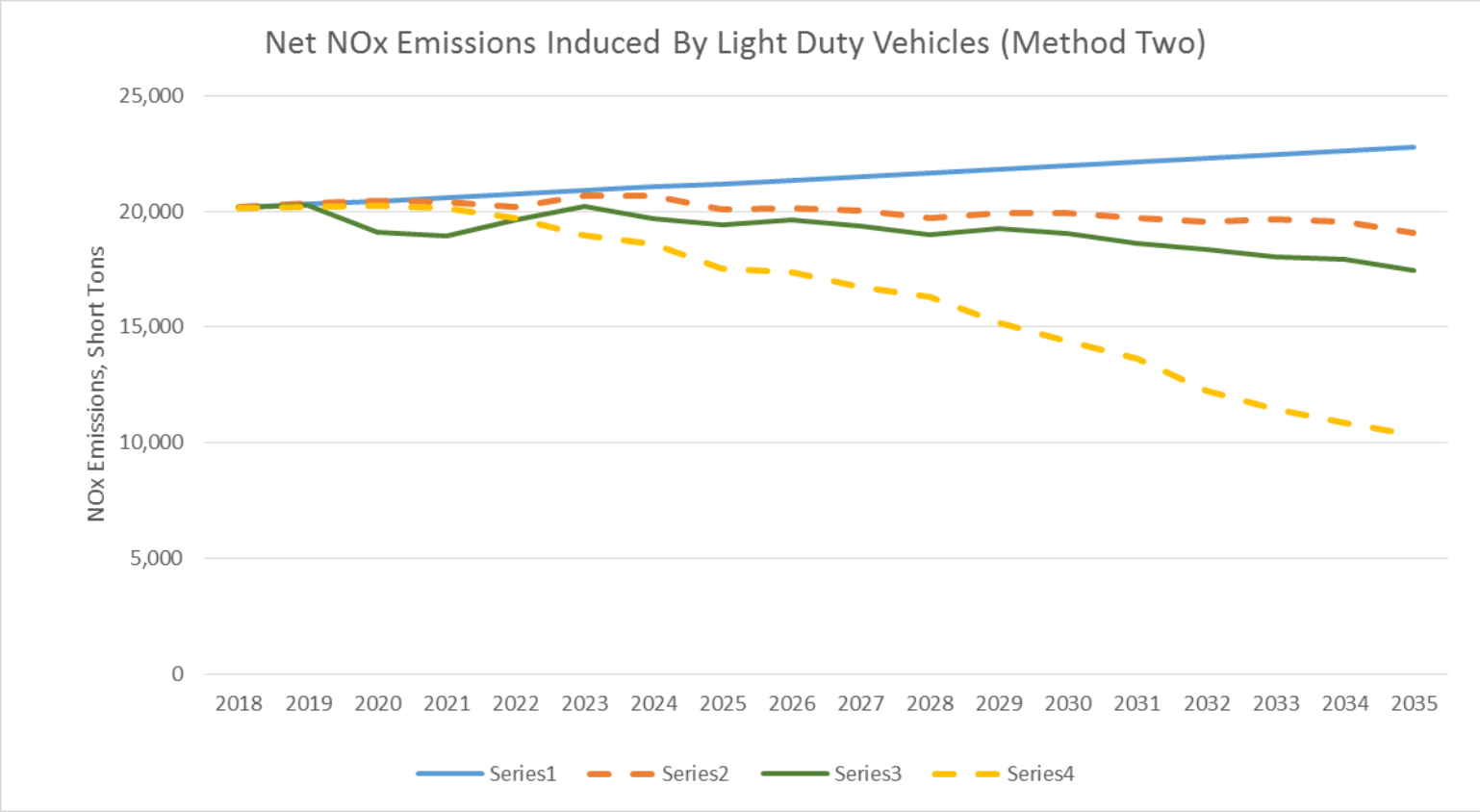




Significant Reductions In Net CO2 Emissions

- No significant difference between managed or natural charging schedule results
- Method Two shows slightly higher beneficial impact
- By 2040, For Roadmap Case (S2, M2):
  - C02 reduced by 33% wrt baseline in 2040
  - CO2 reduced by 29% wrt baseline in 2018
- For GWRA Goals:
  - Gas CO2 emissions must reduce to 8.4M tons
  - By 2050 (using method two):
    - S1: 28.1 M tons
    - S2: 21.7 M tons
    - S3: 10.3 M tons
    - These results assume BAU generation
  - **Transition to Scenario Three AND further Grid De-Carbonization Needed To Achieve Full GWRA Goals**

Findings: NOx Impacts
(transportation only)



Note: In contrast to CO2 and NOx changes, SO2 increases slightly

Note: Other pollutants, such as particulates and volatiles, probably decrease as well

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Findings: Public Health Impacts

Health Incidence Category	Scenario One			Scenario Two			Scenario Three		
	Total	% Change	Avg/Year	Total	% Change	Avg/Year	Total	% Change	Avg/Year
Premature Mortality (deaths)	-168	-10.2%	-5.1	-269	-16.4%	-8.2	-548	-33.4%	-16.6
Morbidity									
Respiratory Emergency Room Visits	-54	-10.1%	-1.6	-87	-16.2%	-2.6	-176	-32.9%	-5.3
Acute Bronchitis & Respiratory Symptoms	-4,844	-10.0%	-146.8	-7,789	-16.1%	-236.0	-15,824	-32.8%	-479.5
Minor Restricted Activity Days	-73,467	-10.0%	-2,226.3	-118,163	-16.1%	-3,580.7	-240,004	-32.6%	-7,272.8
Work Loss Days	-12,255	-9.9%	-371.3	-19,721	-16.0%	-597.6	-40,037	-32.4%	-1,213.3
Asthma Exacerbation	-6,830	-10.1%	-207.0	-10,978	-16.2%	-332.7	-22,310	-32.9%	-676.1
Hospital Admissions (Cardio and Respiratory)	-68	-10.3%	-2.1	-109	-16.5%	-3.3	-222	-33.6%	-6.7
Non-fatal Heart Attacks	-131	-10.3%	-4.0	-209	-16.6%	-6.3	-427	-33.7%	-12.9

This Initial Calculation Of Public Health Impacts Considers Only NOX Reductions

Findings: Infrastructure Impacts

Assuming Mostly Managed Charging

~ 10%
PEV Adoption
S2: ~2025

~ 30%
PEV Adoption
S2: ~2035

~ 2050
PEV Penetration
S2: ~60%

NOW

~ 5 – 10 Yrs — Phase I

~ 10 Yrs — Phase II

~ 15 Yrs — Phase III

Minimal, But Non-Zero:

- Mostly isolated xFmr impacts
- Service upgrades may be needed
- xFrmr upgrades probably within existing operations profile
- **Note: above 5% penetration, multiple Evs per xFrmr assured**
- **MANAGED CHARGING makes a big difference on when, and to what extent, impacts emerge**

Reinforcement Response:

- xFrmr upgrades becoming common, cluster impacts likely
- Initially mostly reactive, but transition to more proactive reinforcement.
- **Grid will need to be fully reinforced by ~30% penetration.**

Grid Optimization:

- EV loading now a significant fraction of consumption (20-30%). Can be used to optimize load shape.
- **Necessary grid reinforcements may be motivated by other factors (aging, loading, etc), and can be synergistic with other upgrades.**

Widespread EV Adoption, Combined With Smart Grid Integration, Are An Unprecedented Opportunity For Modernization And Load Optimization.

Immediate Opportunities

- **These Findings Demonstrate That:**
  - Vehicle electrification delivers A broad portfolio of economic, environmental, and health benefits
  - Those benefits can be accelerated and increased with appropriate investment
  - On A NET benefit basis, under all scenarios, benefits exceed costs
  - Costs that might impact utility customers are balanced by electricity cost savings
  - There is un-tapped opportunity for market development in new jersey

- **These Findings Suggest Several Short Term Focus Areas:**
  - Vehicle purchase rebates can accelerate and grow the market, and are cost justified
  - Managed charging (especially residential) makes a big difference
  - Start building that foundation NOW, and learning about optimization strategies, eventually V2G
  - Public charging, especially DCFC, is both necessary but challenging
  - The challenges arise from low utilization when PEV population is low
  - Develop programs to create a critical mass of public infrastructure, focus on next five years
  - Identify critical priorities for other infrastructure needs (e.G. multi-family)
  - Widespread EV adoption will impact the distribution system eventually, begin tracking & planning