# Greenhouse Gas Emissions and Energy Impacts from Electric and Natural Gas Vehicle Penetration

## *Progress to date and questions*

*DVRPC Regional Technical Committee*
*February 9th, 2016*

*Robert Graff*
*Manager, Office of Energy and Climate Change Initiatives*

# Background

- Response to FHWA's “Solicitation for Greenhouse Gas and Energy Analysis Demonstration Projects”
- Added to FY2015 Planning Work Program in February 2015
- Project End Date: June 30, 2016
- $100,000 budget – 80/20 match

# Key Questions

What might future mobility needs look like?

What might the future fleet look like?

How much energy might it require?

What type of fuels might provide that energy?

What are the GHG implications of that fuel use?

dvrpc

# What do we want to end up with?

## A tool that allows regions and states to:

- Develop penetration scenarios for EVs and NGVs
  - Based on where people live and how they drive
  - Including appropriate trucks and buses
- Estimate implications for energy use and GHG emissions
  - Including accounting for:
    - Temperature Impacts
    - Emissions from electricity generation
    - Methane leakage

dvrpc

# What resources do we have?

US DOE Funded Electric Vehicle Readiness Plan

2012-2013 Household Travel Survey

Newly updated regional travel demand model

Database of all vehicles registered in Southeastern PA

US DOE Funded PA Partnership to Promote Natural Gas Vehicles

Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES)

Knowledge of other work through participation in TRB STF on Climate Change and Energy (A0020T) and conversations at TRB meetings, including 2016 Annual Meeting and 15th Biennial Conference on Transportation and Energy (August 2015)

Particular thanks to researchers at UC Davis ITS and Carnegie Mellon University, and my DVRPC colleague Adam Beam.

dvrpc

# EV Readiness Plan
# and
# PennDOT Registration Data

dvrpc

## PennDOT Registration Data for SE PA – May 2015

2.89 million vehicles

2.24 million passenger vehicles

~30,000 HEVs = 1.34%

1790 PEVs = 0.08%

- 1013 PHEVs
- 777 AEVs

1.51 million households, so 0.12% of HHs

dvrpc

# ~ 30,000 HEVs in Southeastern PA – May 2015
# Top Ten List

| Make | Model | # of Vehicles |
|---|---|---|
| Toyota | Prius | 16745 |
| Toyota | Camry Hybrid | 3884 |
| Honda | Civic Hybrid | 1981 |
| Ford | Fusion Hybrid | 1797 |
| Toyota | Prius v | 1375 |
| Toyota | Prius c | 1224 |
| Honda | Insight | 898 |
| Hyundai | Sonata Hybrid | 679 |
| Nissan | Altima Hybrid | 656 |
| Honda | Accord Hybrid | 483 |

dvrpc

# 1,013 PHEVs in Southeastern PA – May 2015

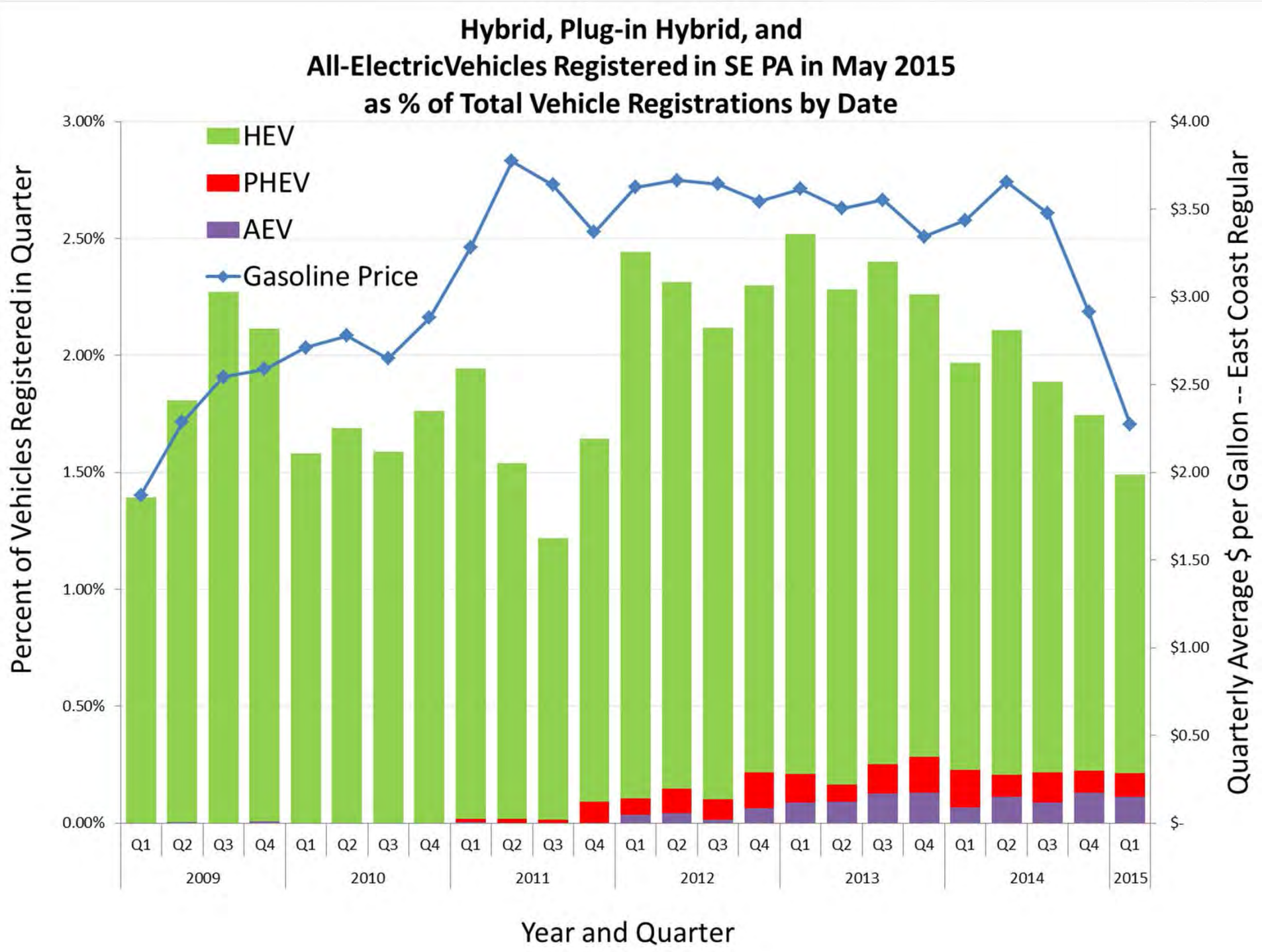
| Make | Model | # of Vehicles |
|---|---|---|
| Chevrolet | Volt | 636 |
| Toyota | Prius PHV | 175 |
| Ford | Fusion Energi | 103 |
| BMW | i3 REX | 48 |
| Porsche | Panamera S E-Hybrid | 25 |
| BMW | i8 | 15 |
| Fisker | Karma | 7 |
| Honda | Accord PHEV | 3 |
| Porsche | 918 Spyder | 1 |

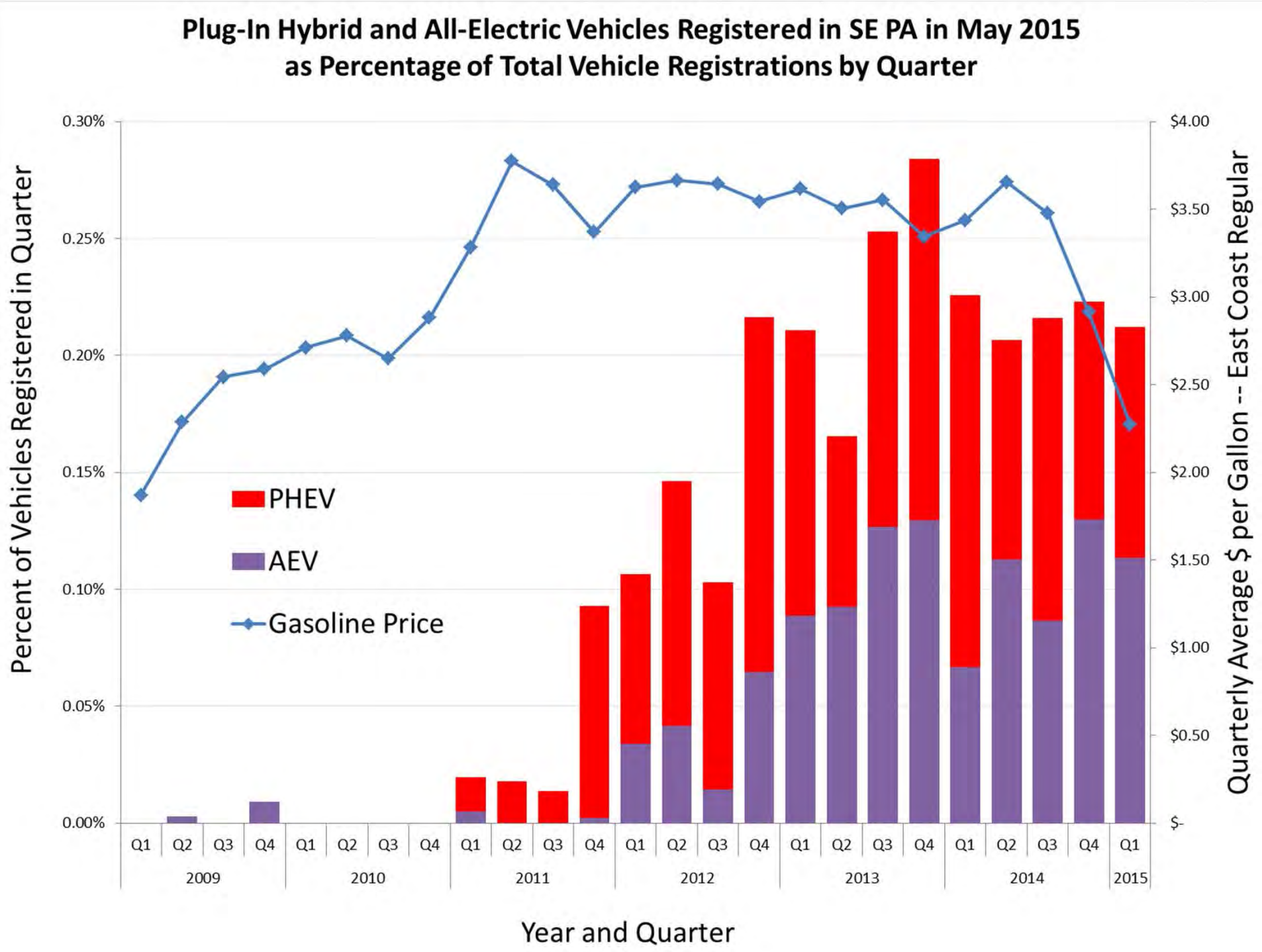
dvrpc

# 777 AEVs in Southeastern PA – May 2015

| Make | Model | # of Vehicles |
|---|---|---|
| Tesla | Model S, Model X, Roadster | 458 |
| Nissan | Leaf | 247 |
| Ford | Focus Electric | 28 |
| BMW | i3 | 18 |
| Smart | ED | 15 |
| Mitsubishi | i | 9 |
| Mercedes-Benz | B-Class Electric Drive | 1 |
| Toyota | RAV4 EV 2nd Generation | 1 |

dvrpc


Hybrid, Plug-in Hybrid, and
All-ElectricVehicles Registered in SE PA in May 2015
as % of Total Vehicle Registrations by Date
HEV
PHEV
AEV
Gasoline Price
Percent of Vehicles Registered in Quarter
Quarterly Average $ per Gallon -- East Coast Regular
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
$4.00
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$-
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1
2009
2010
2011
2012
2013
2014
2015
Year and Quarter


Plug-In Hybrid and All-Electric Vehicles Registered in SE PA in May 2015
as Percentage of Total Vehicle Registrations by Quarter
Percent of Vehicles Registered in Quarter
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
$4.00
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$-
Quarterly Average $ per Gallon -- East Coast Regular
PHEV
AEV
Gasoline Price
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1
2009
2010
2011
2012
2013
2014
2015
Year and Quarter

# Percentage of Vehicles that are PEVs, 2015

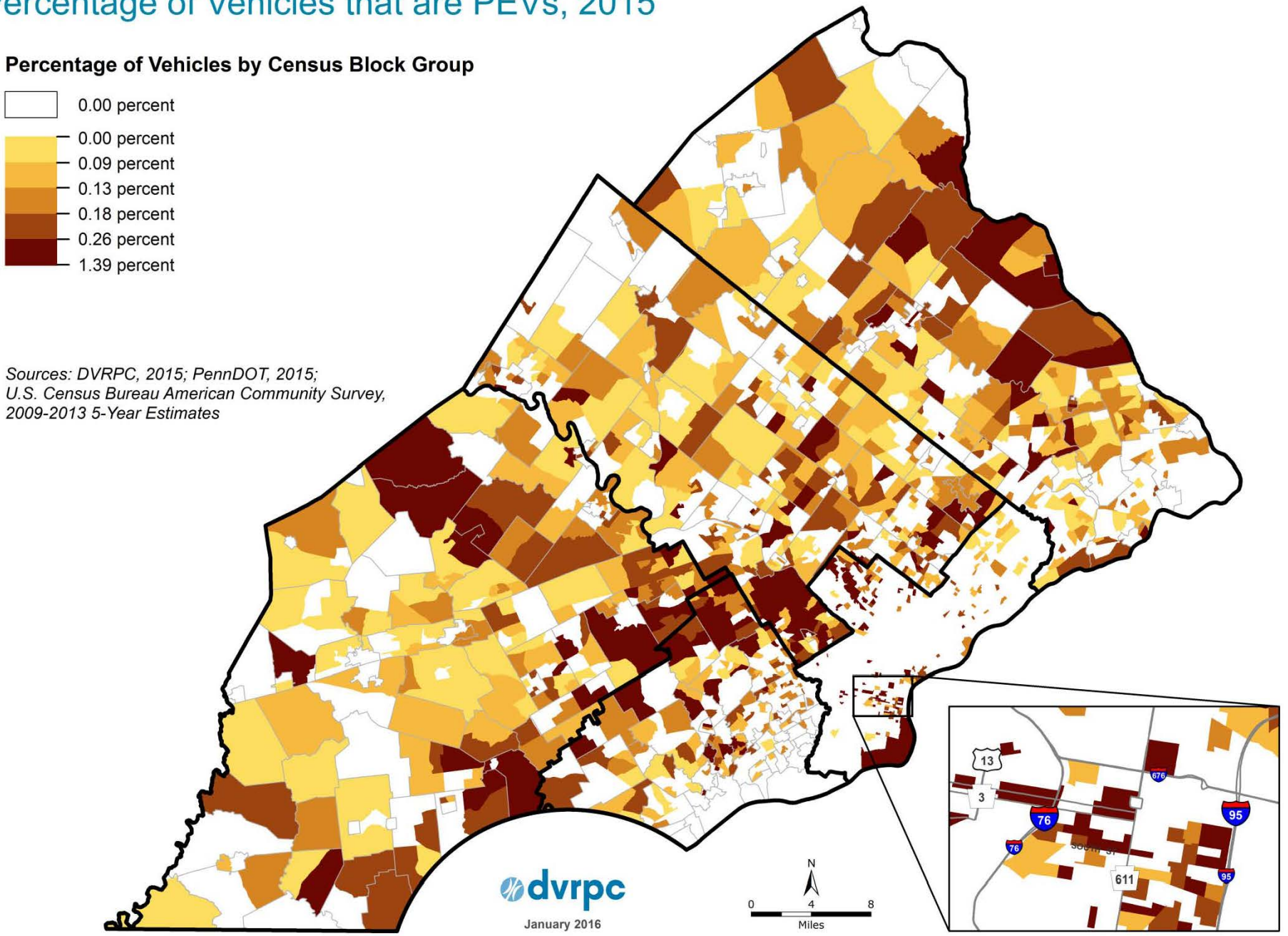
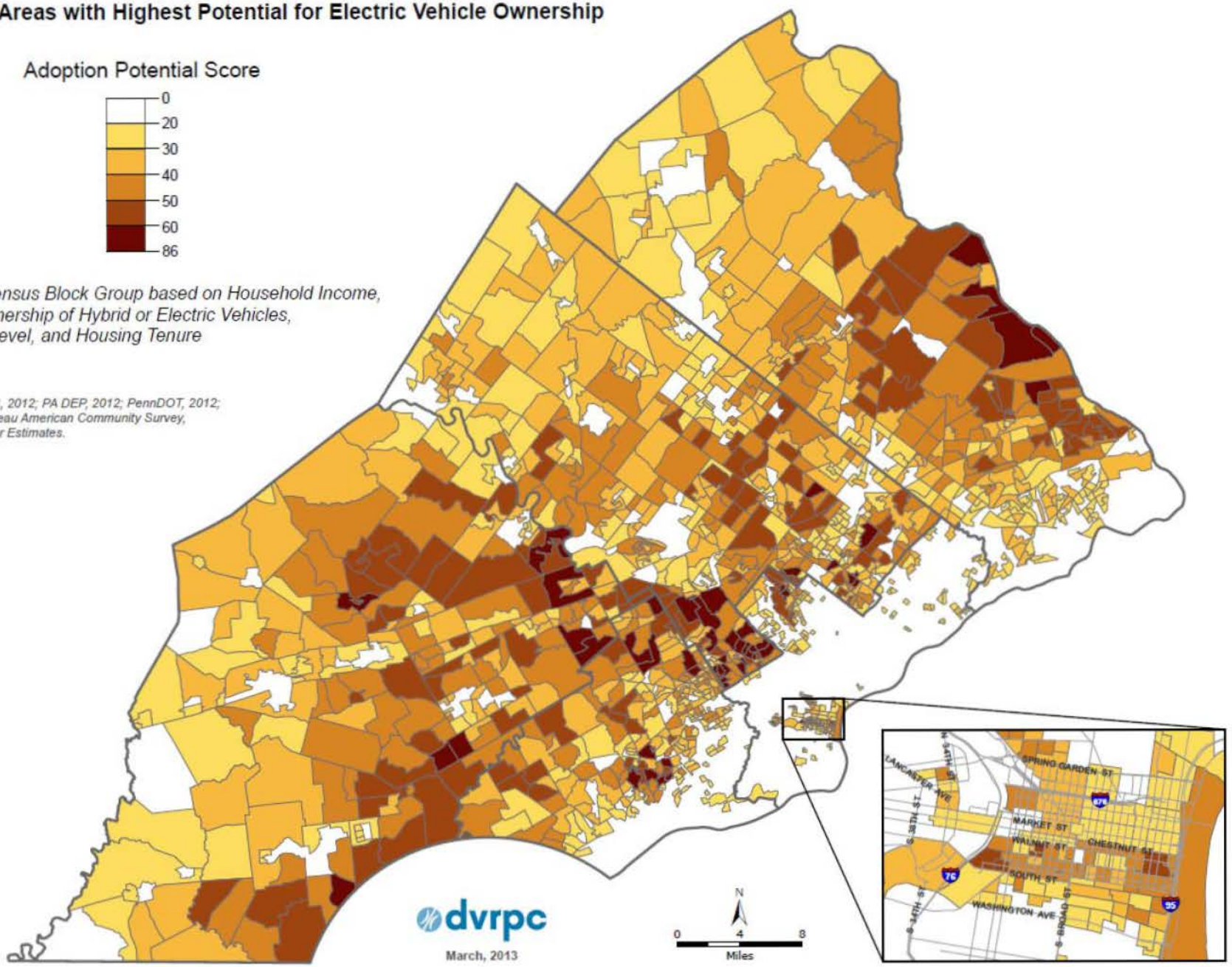
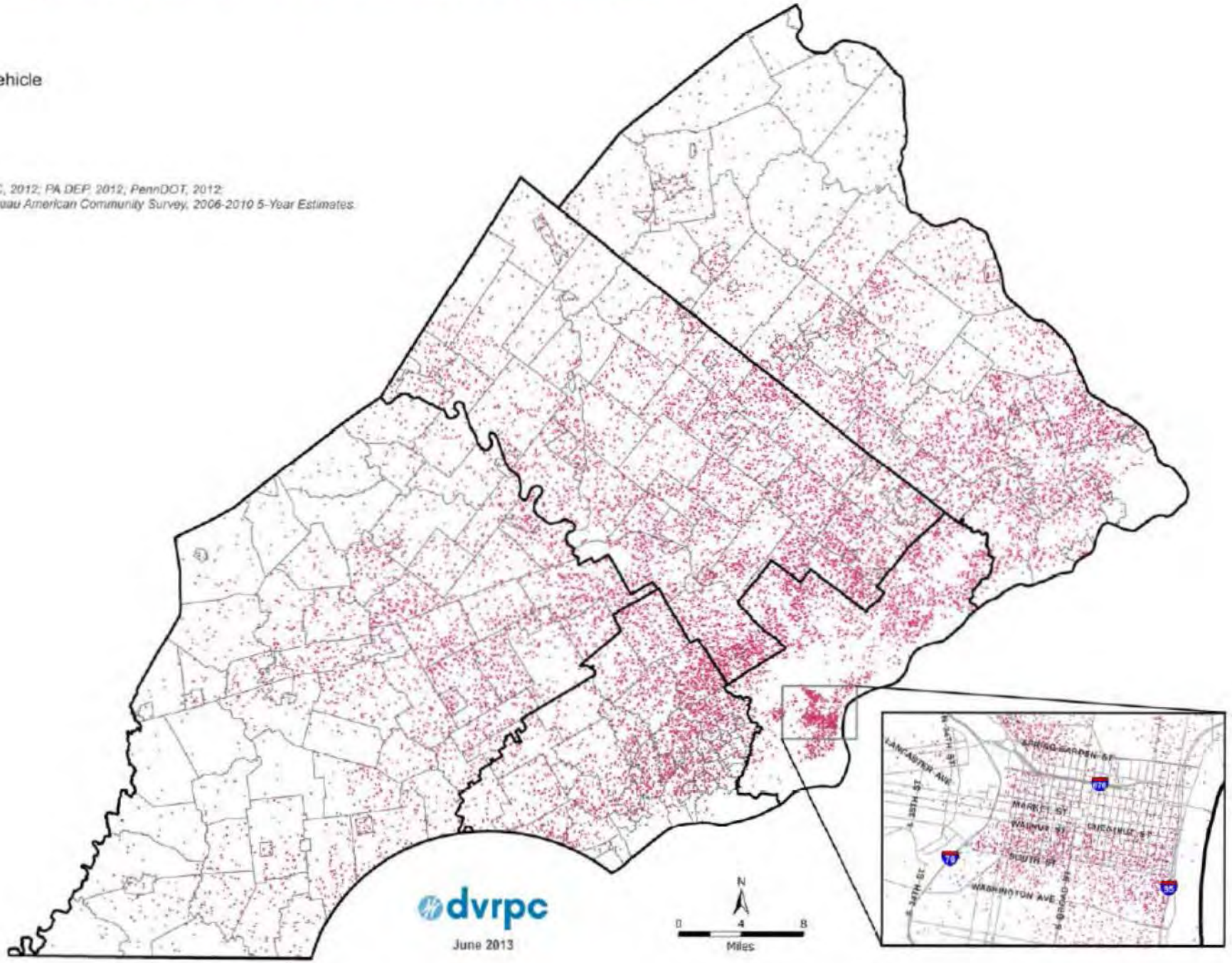


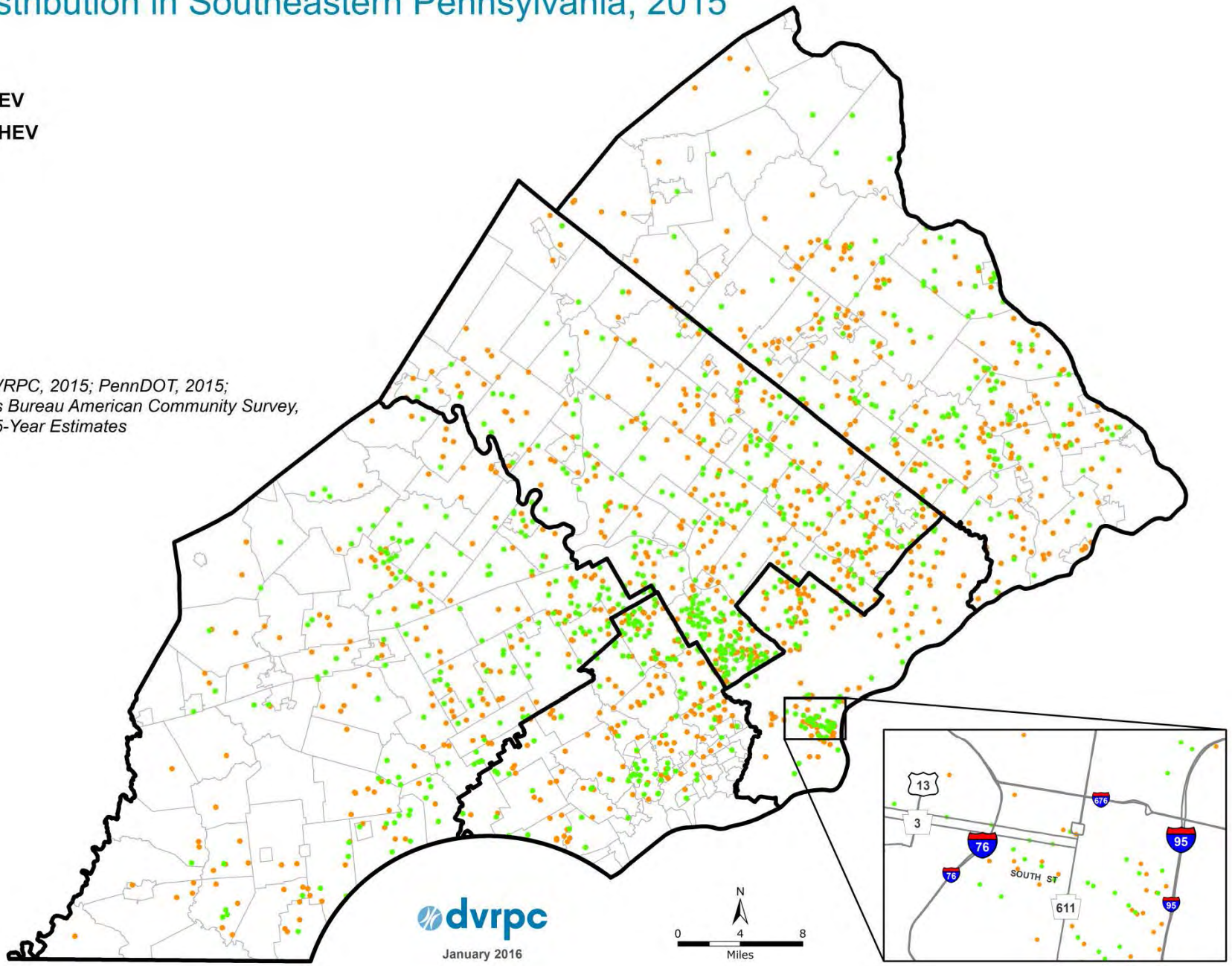
*Figure 2.* **Areas with Highest Potential for Electric Vehicle Ownership**



## Figure 5. Projected EV Distribution in Southeastern Pennsylvania, 2020

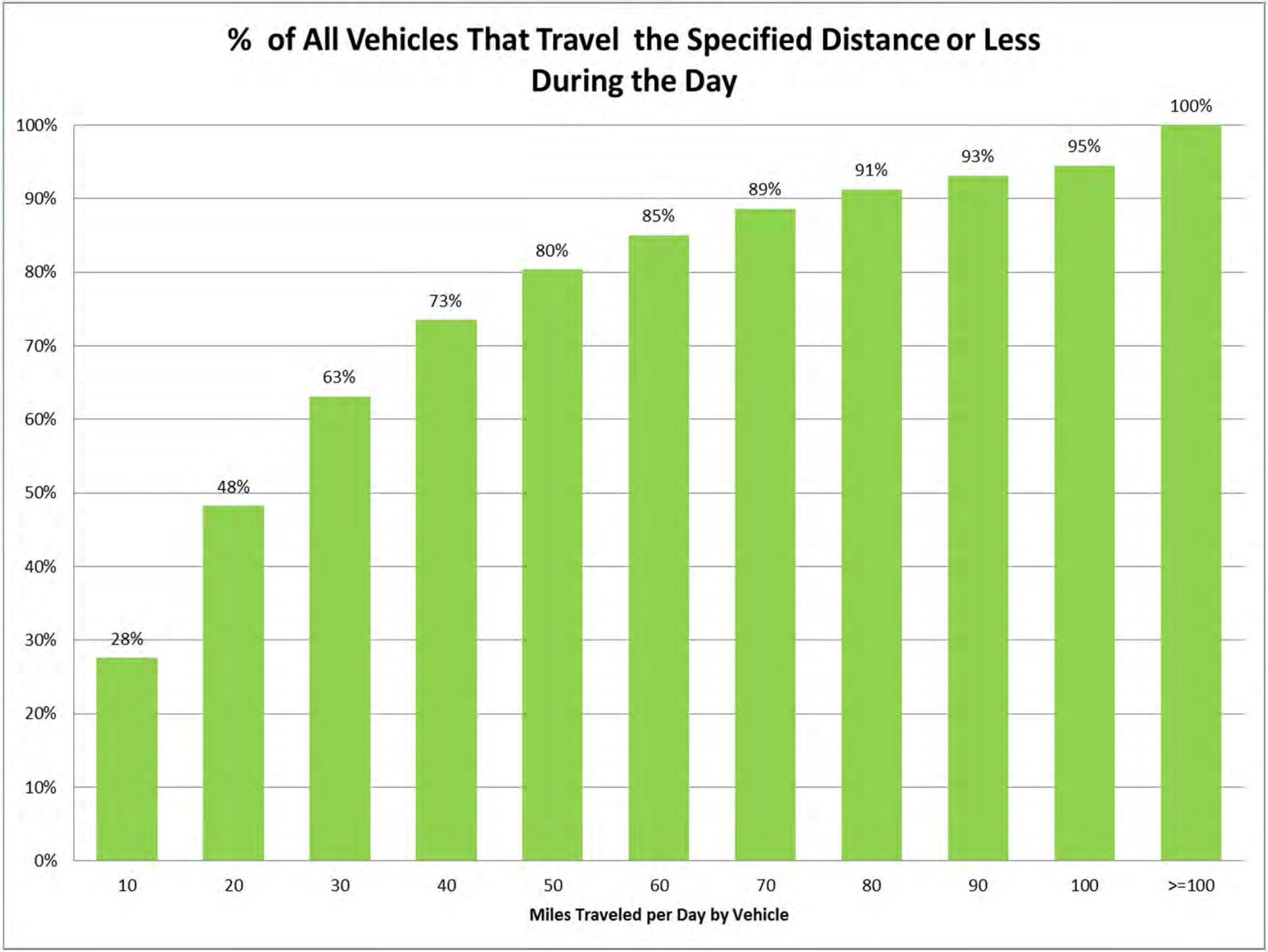


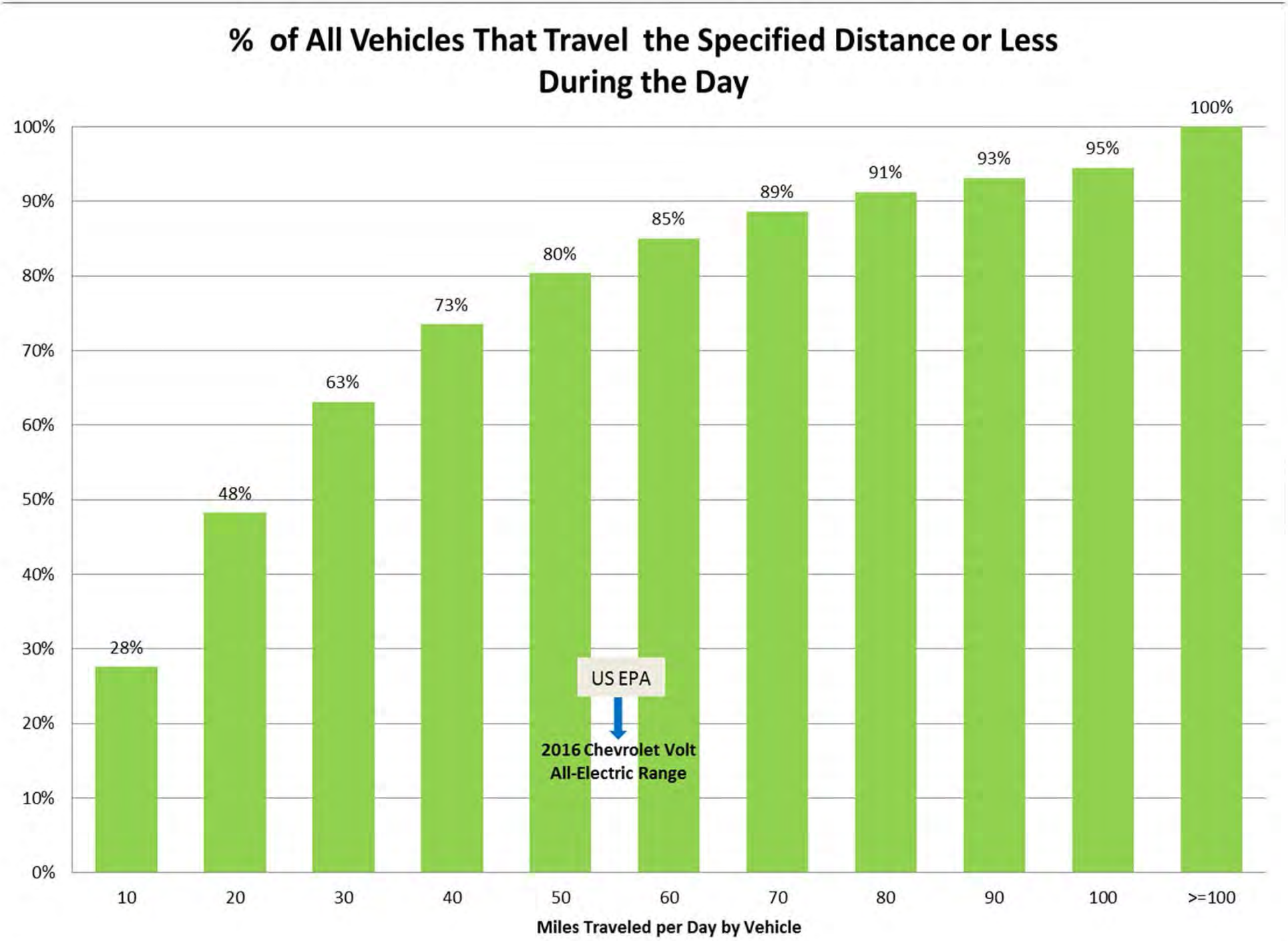
# PEV Distribution in Southeastern Pennsylvania, 2015

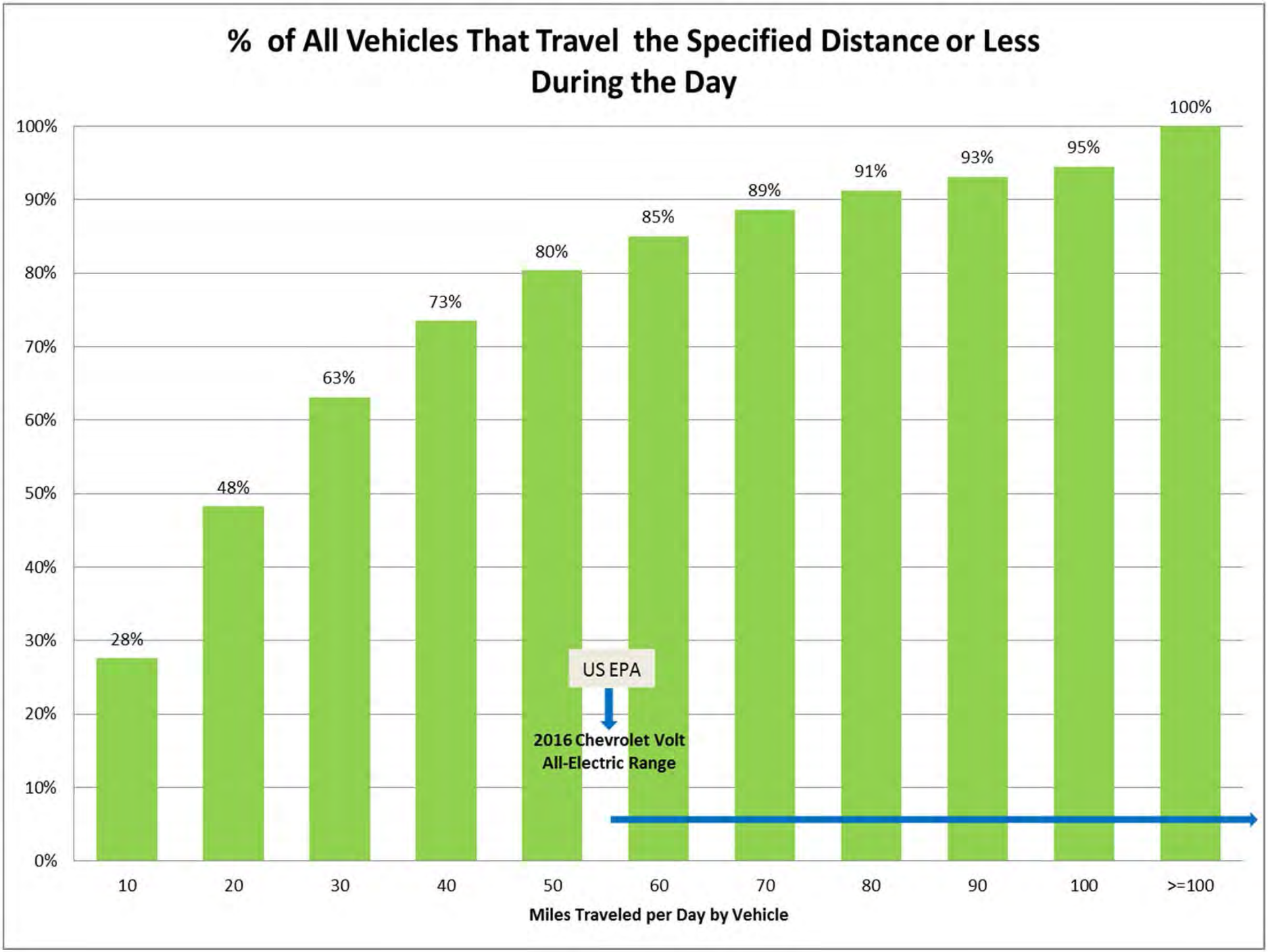


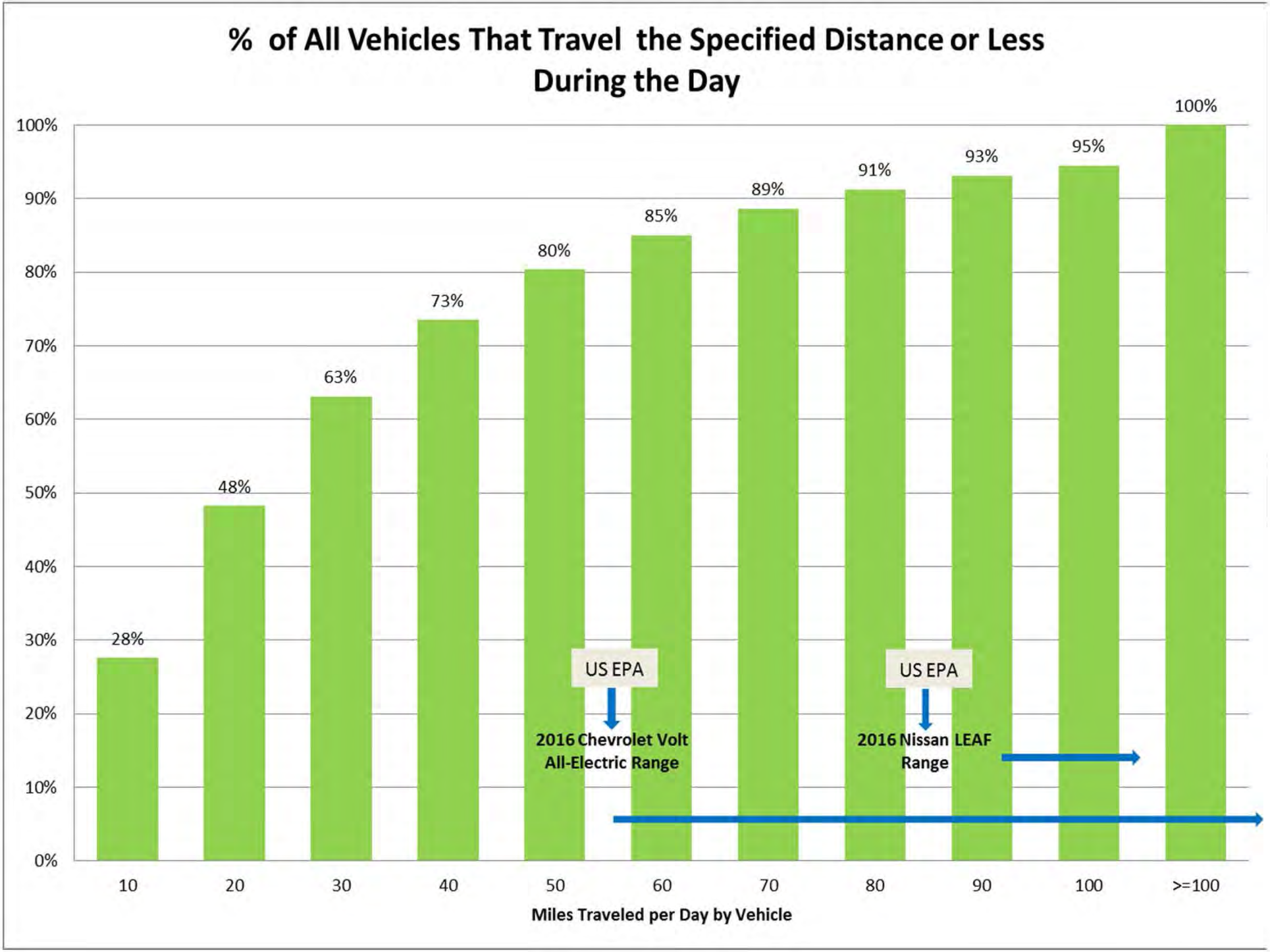
# Household Travel Survey

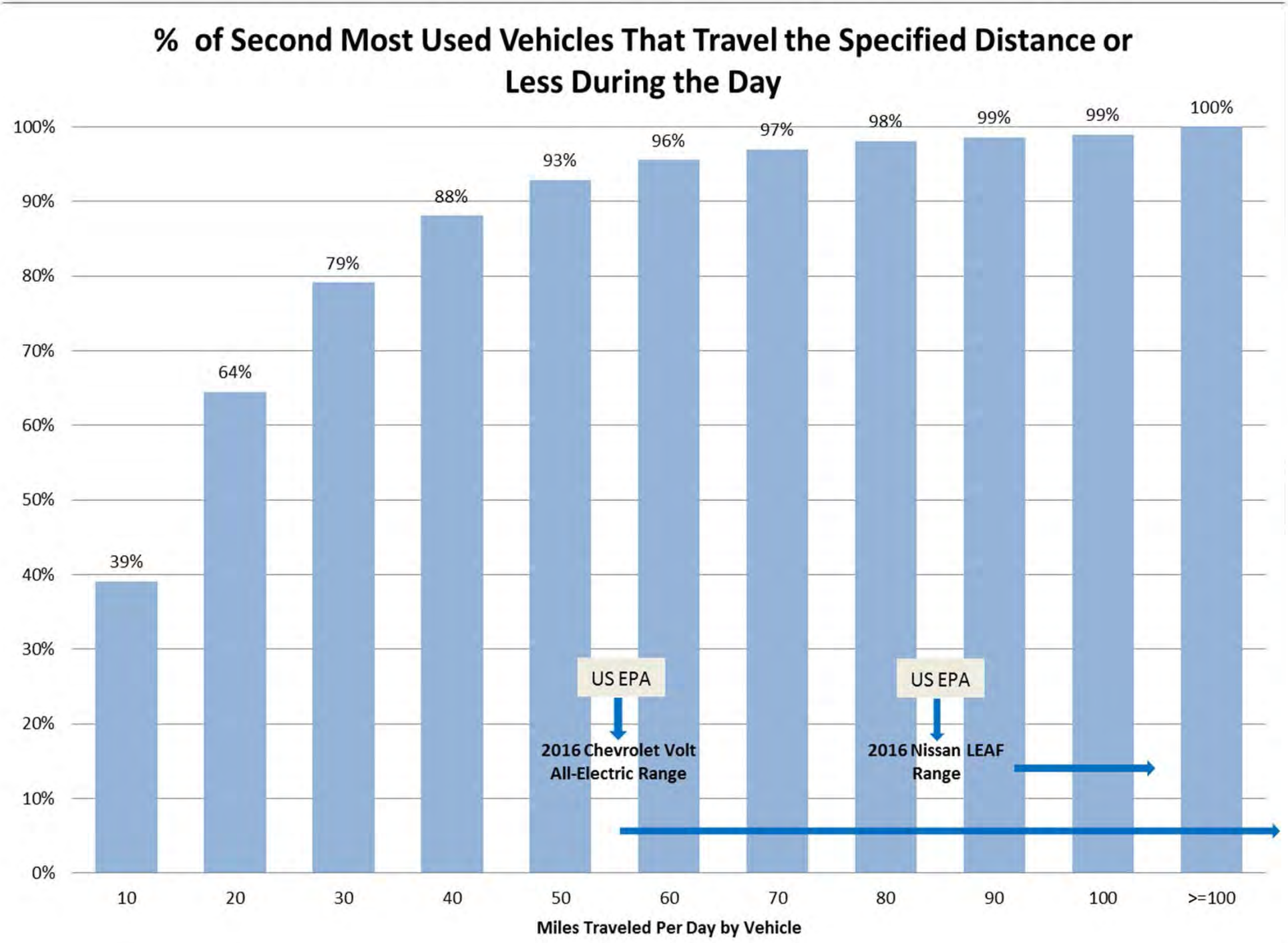
dvrpc

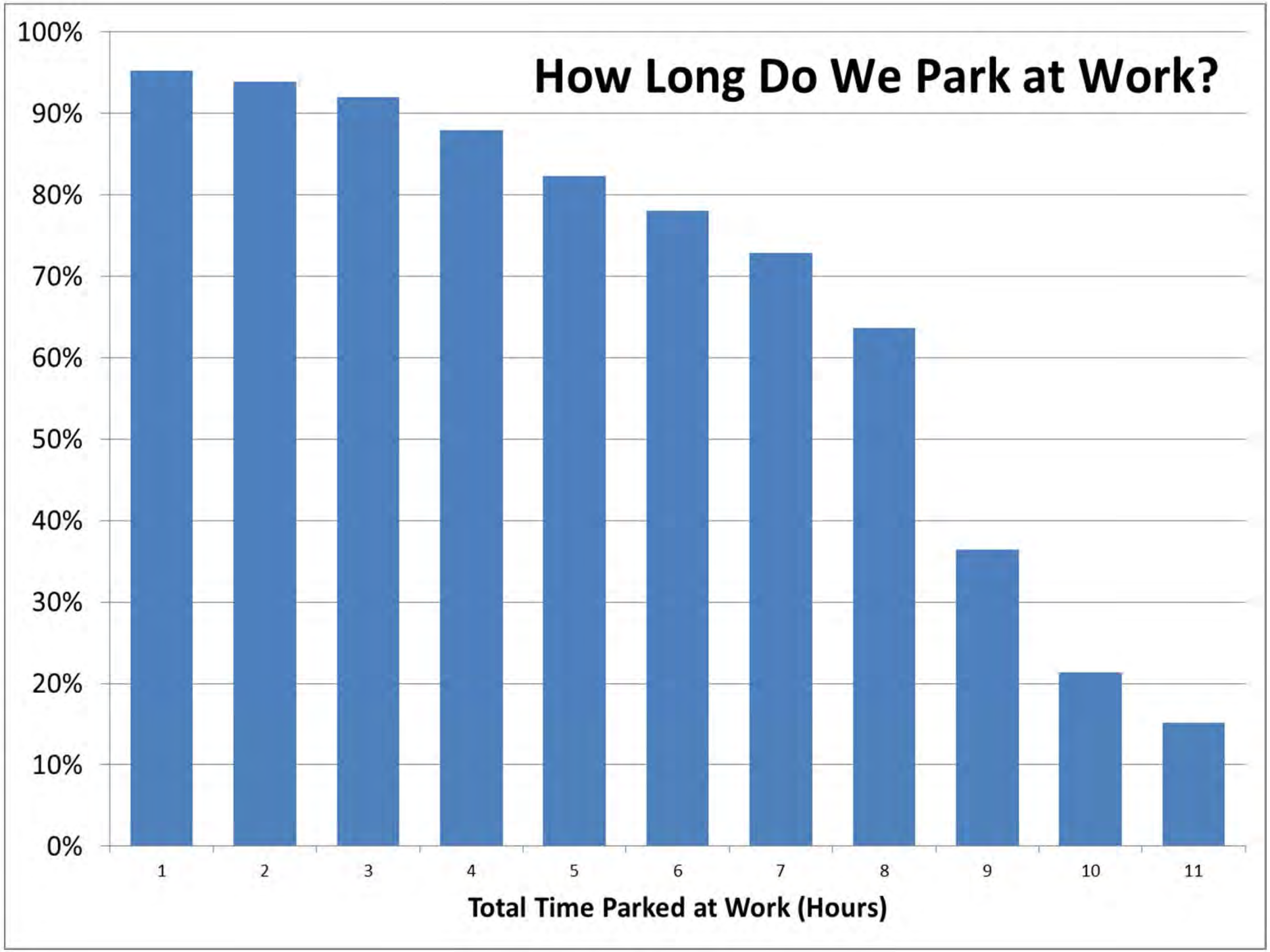

% of All Vehicles That Travel the Specified Distance or Less During the Day
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
28%
48%
63%
73%
80%
85%
89%
91%
93%
95%
100%
10
20
30
40
50
60
70
80
90
100
>=100
Miles Traveled per Day by Vehicle

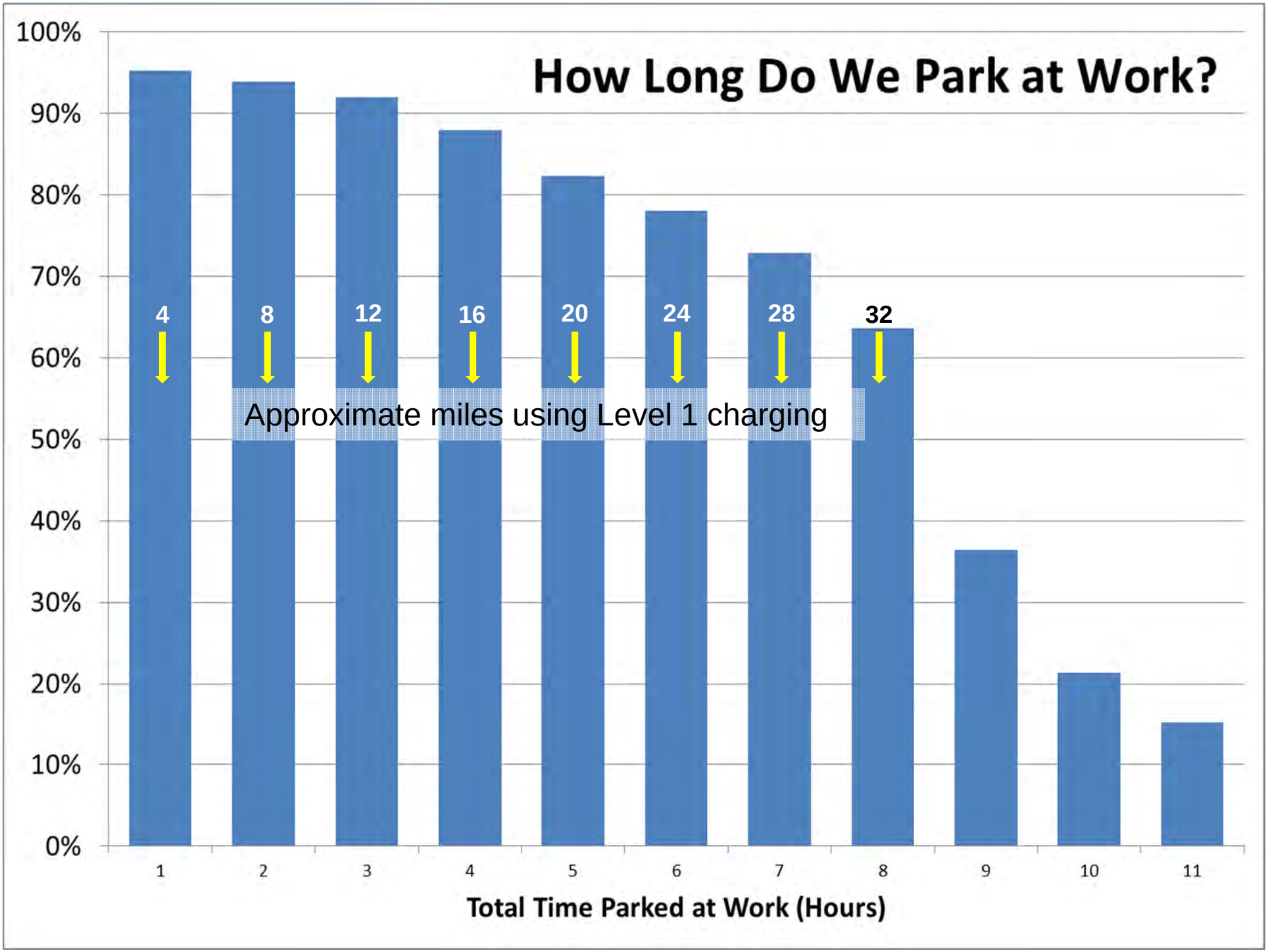

% of All Vehicles That Travel the Specified Distance or Less During the Day
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
28%
48%
63%
73%
80%
85%
89%
91%
93%
95%
100%
US EPA
2016 Chevrolet Volt All-Electric Range
10
20
30
40
50
60
70
80
90
100
>=100
Miles Traveled per Day by Vehicle

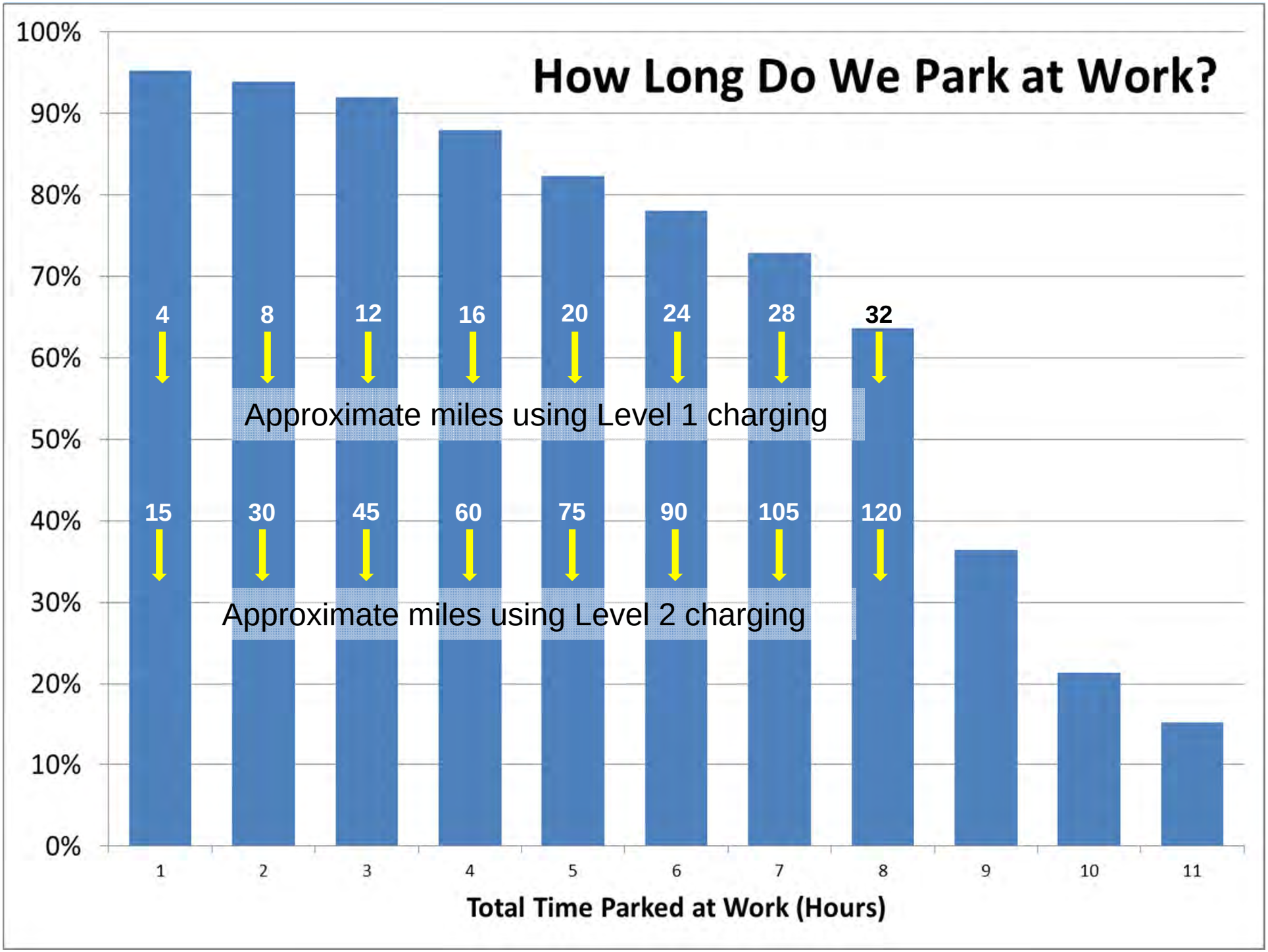

% of All Vehicles That Travel the Specified Distance or Less During the Day
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
28%
48%
63%
73%
80%
85%
89%
91%
93%
95%
100%
US EPA
2016 Chevrolet Volt All-Electric Range
10
20
30
40
50
60
70
80
90
100
>=100
Miles Traveled per Day by Vehicle

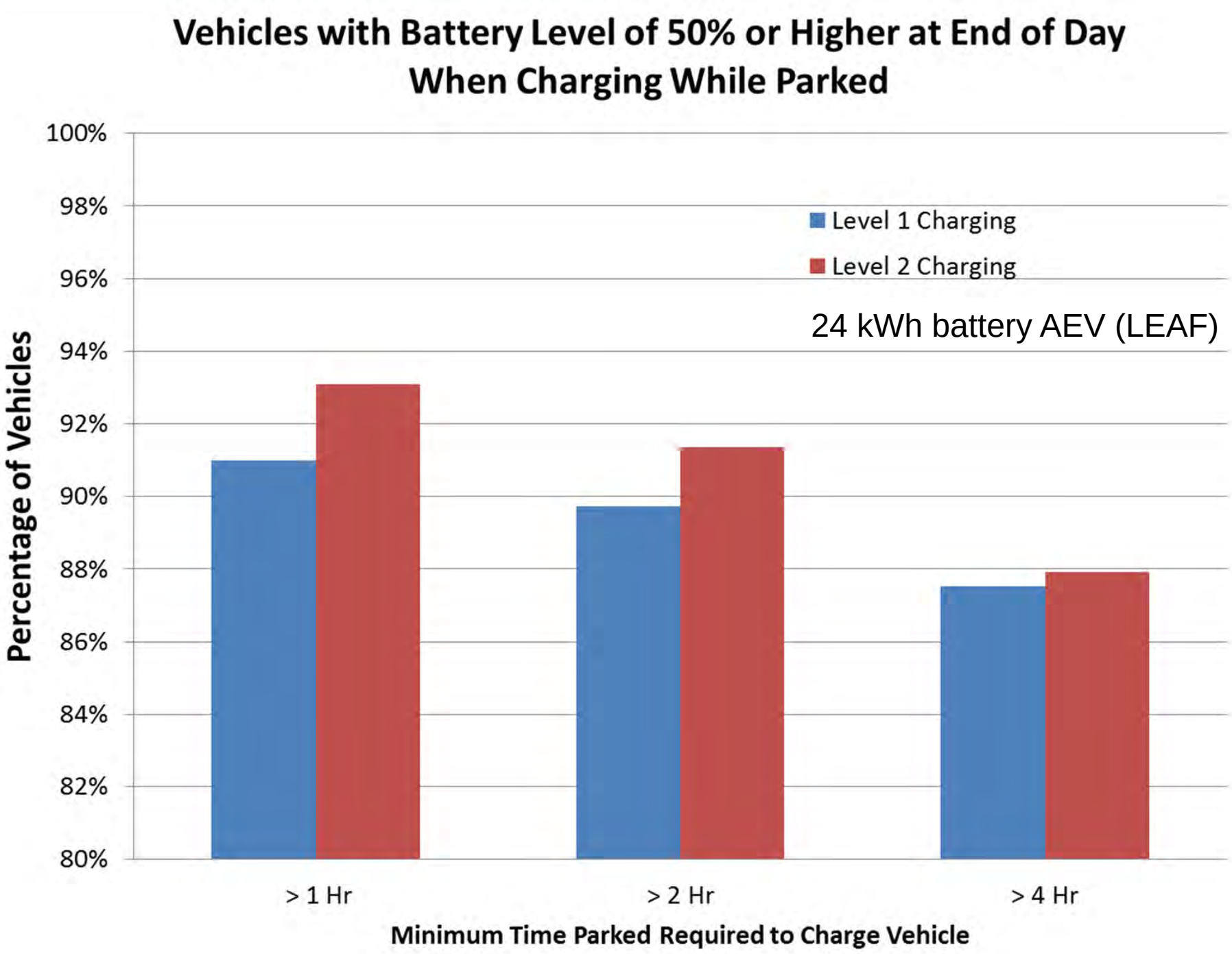

% of All Vehicles That Travel the Specified Distance or Less During the Day
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
28%
48%
63%
73%
80%
85%
89%
91%
93%
95%
100%
US EPA
2016 Chevrolet Volt All-Electric Range
US EPA
2016 Nissan LEAF Range
10
20
30
40
50
60
70
80
90
100
>=100
Miles Traveled per Day by Vehicle


% of Second Most Used Vehicles That Travel the Specified Distance or Less During the Day
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
39%
64%
79%
88%
93%
96%
97%
98%
99%
99%
100%
US EPA
2016 Chevrolet Volt All-Electric Range
US EPA
2016 Nissan LEAF Range
10
20
30
40
50
60
70
80
90
100
>=100
Miles Traveled Per Day by Vehicle


How Long Do We Park at Work?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
2
3
4
5
6
7
8
9
10
11
Total Time Parked at Work (Hours)


How Long Do We Park at Work?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
4
8
12
16
20
24
28
32
Approximate miles using Level 1 charging
1
2
3
4
5
6
7
8
9
10
11
Total Time Parked at Work (Hours)


How Long Do We Park at Work?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
4
8
12
16
20
24
28
32
Approximate miles using Level 1 charging
15
30
45
60
75
90
105
120
Approximate miles using Level 2 charging
1
2
3
4
5
6
7
8
9
10
11
Total Time Parked at Work (Hours)

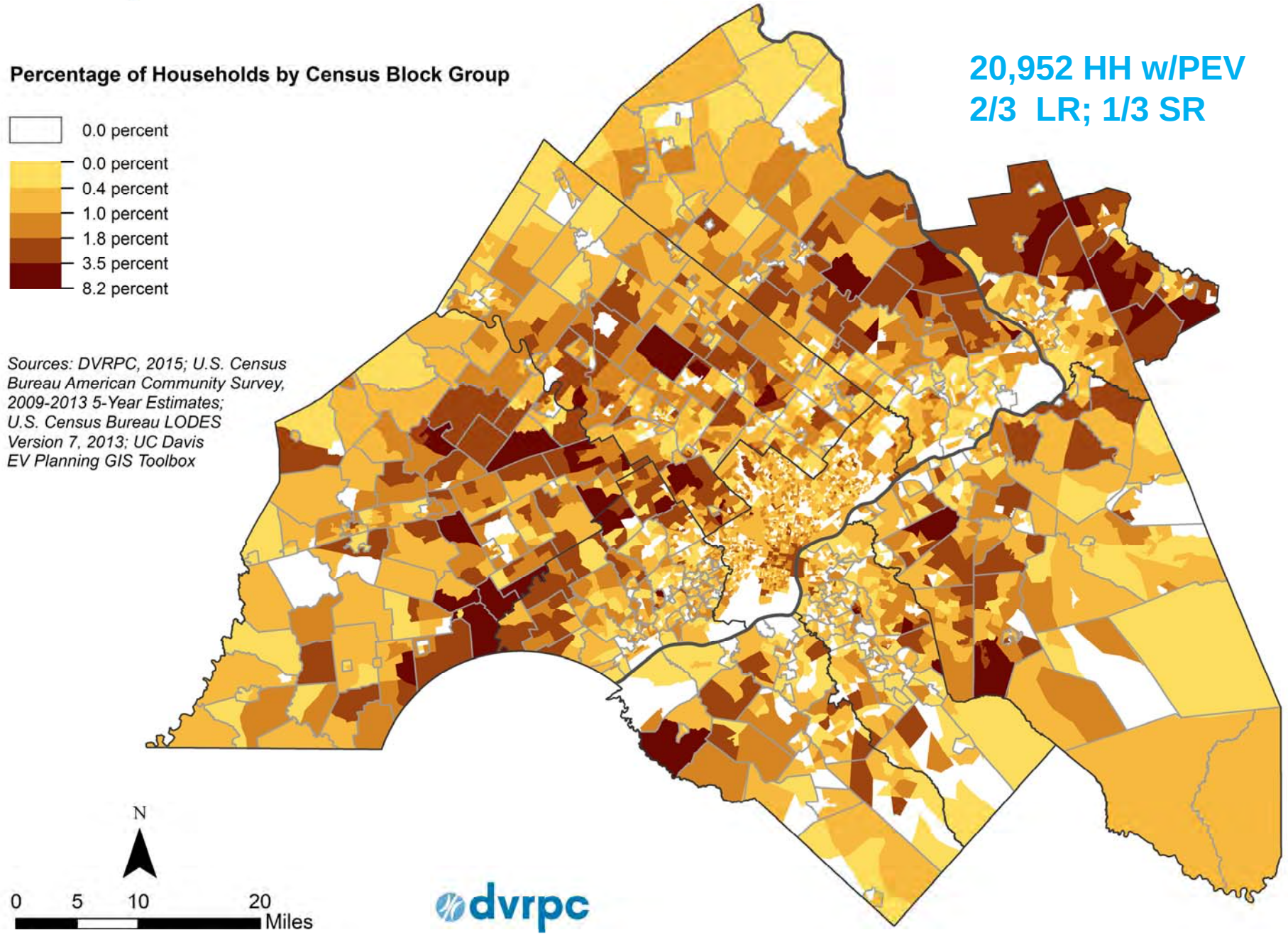

Vehicles with Battery Level of 50% or Higher at End of Day
When Charging While Parked
100%
98%
96%
94%
92%
90%
88%
86%
84%
82%
80%
Percentage of Vehicles
Level 1 Charging
Level 2 Charging
24 kWh battery AEV (LEAF)
> 1 Hr
> 2 Hr
> 4 Hr
Minimum Time Parked Required to Charge Vehicle

# UC Davis EV Toolkit

## UC Davis ITS PHEVRC

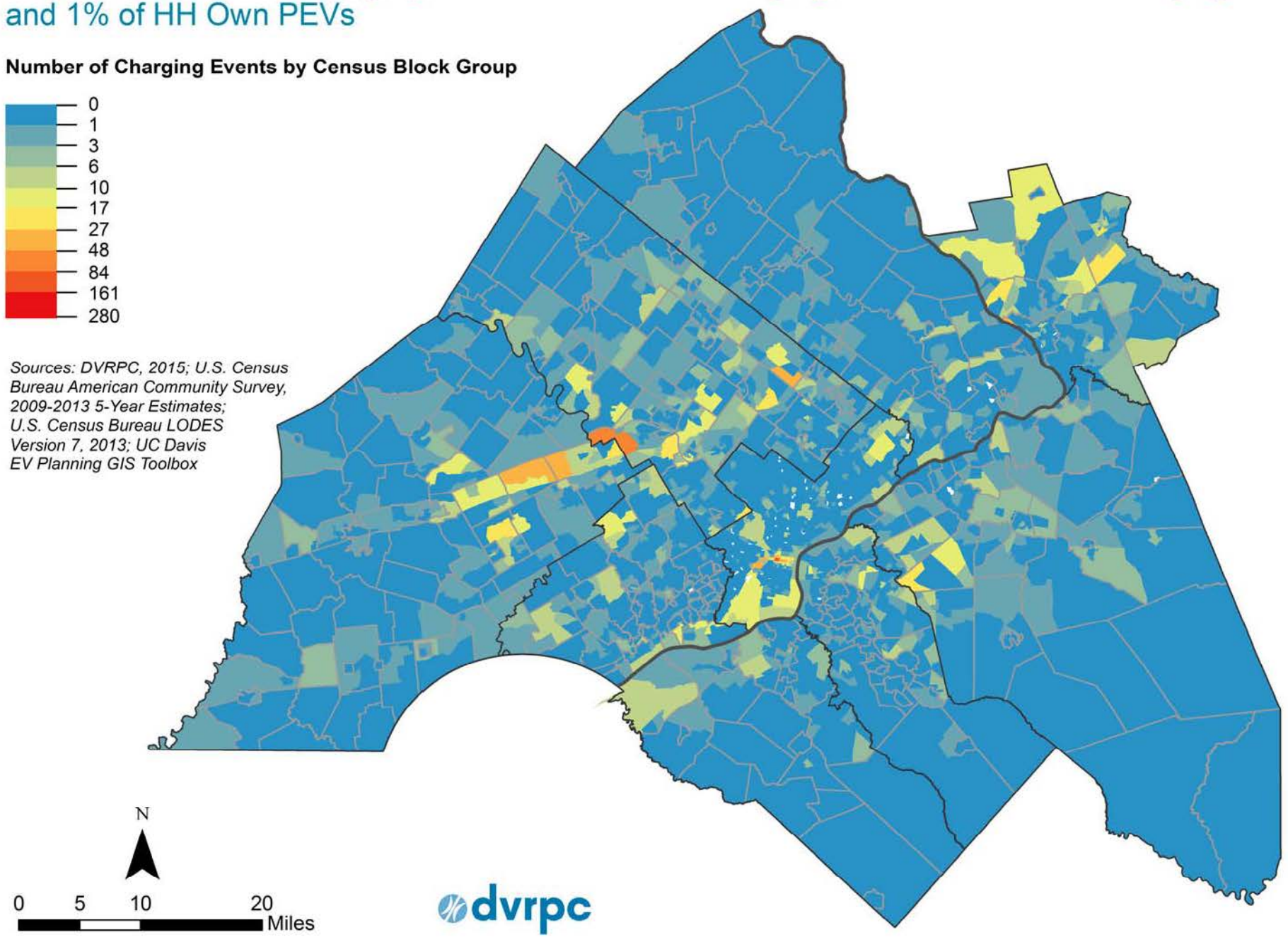
dvrpc

# Percentage of Households with PEVs When 1% of Total Households Own PEVs

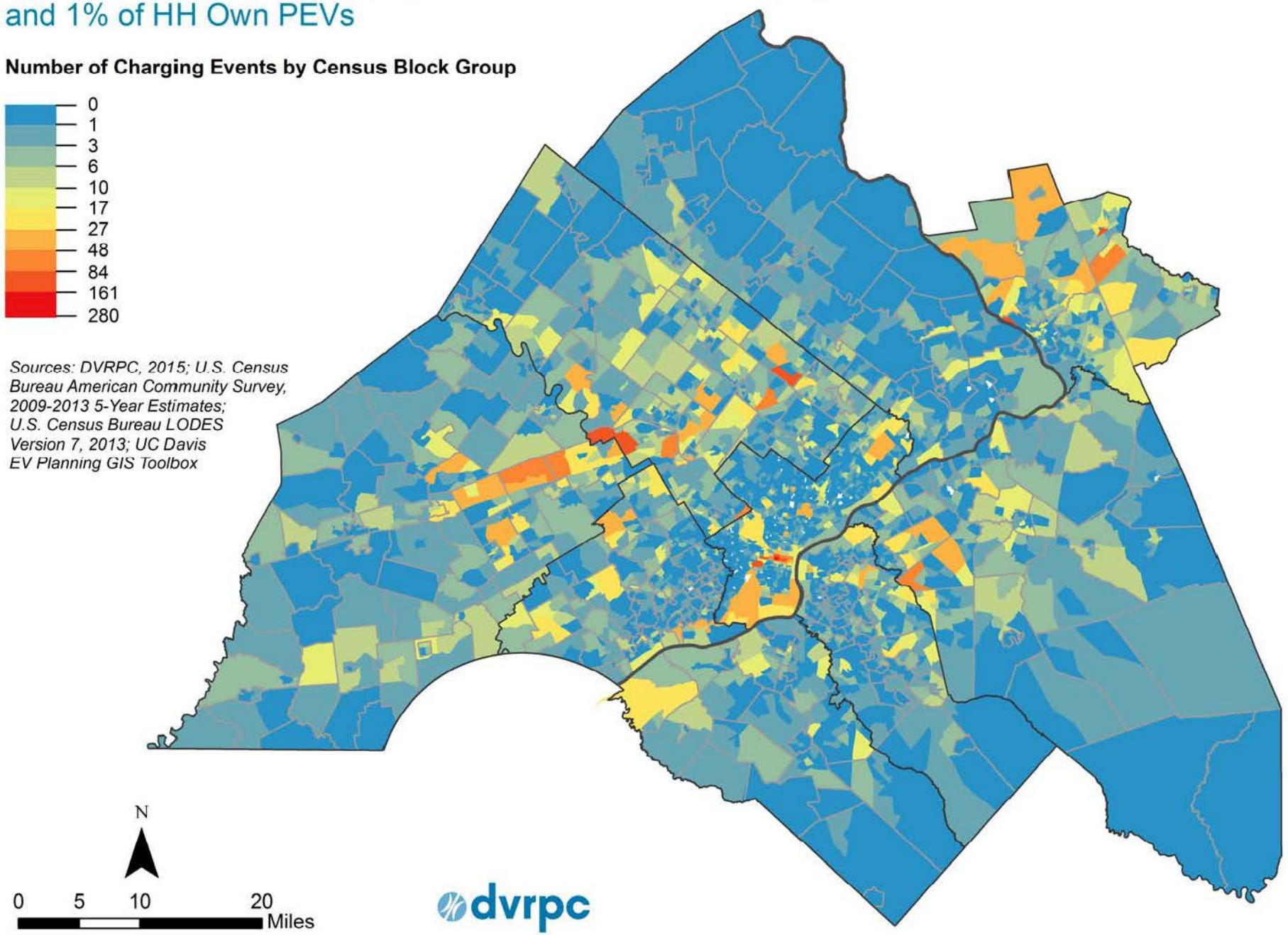



**20,952 HH w/PEV**
**2/3 LR; 1/3 SR**

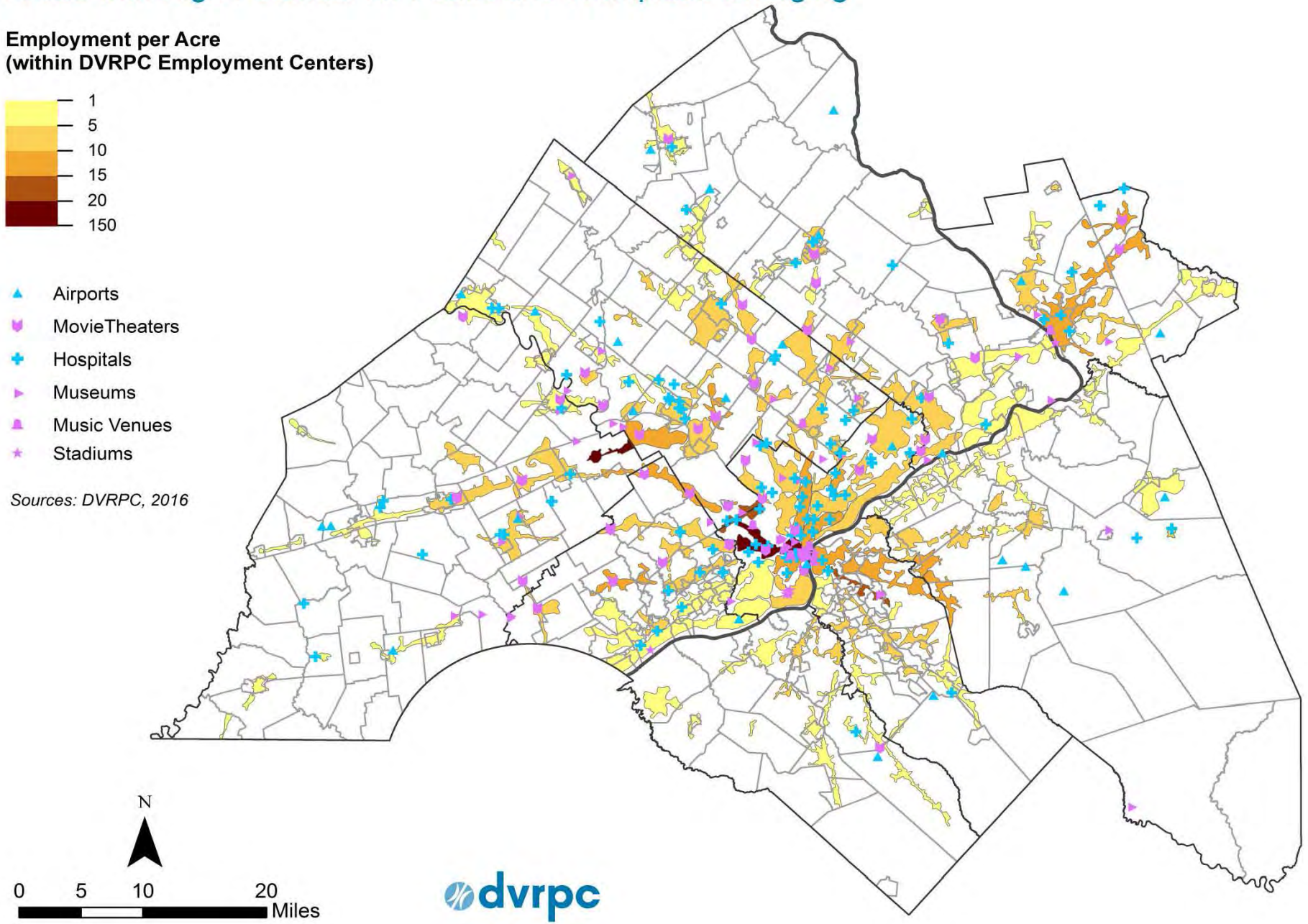
# Projected Number of Charging Events When Work Charging Costs Twice Home Charging and 1% of HH Own PEVs



# Projected Number of Charging Events When Work Charging Is Free and 1% of HH Own PEVs



# Areas with High Potential for Public and Workplace Charging



# Carnegie Mellon University

# Effects of Temperature on EV Performance

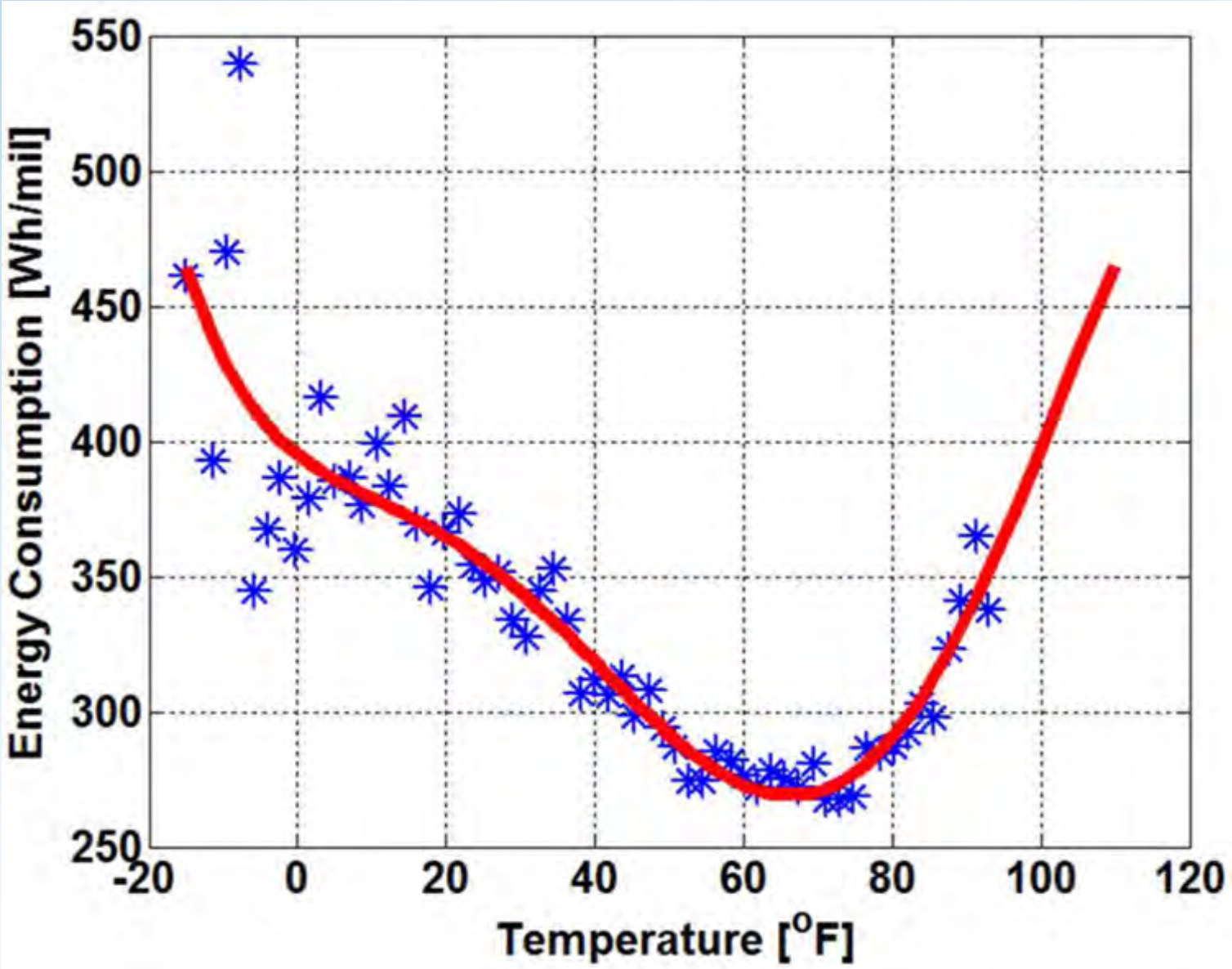
## Battery Performance

- Charging rate
- Charge capacity

## Energy Use per Mile Traveled

- Passenger Comfort – Heating and Cooling
- Idle Time – Congestion

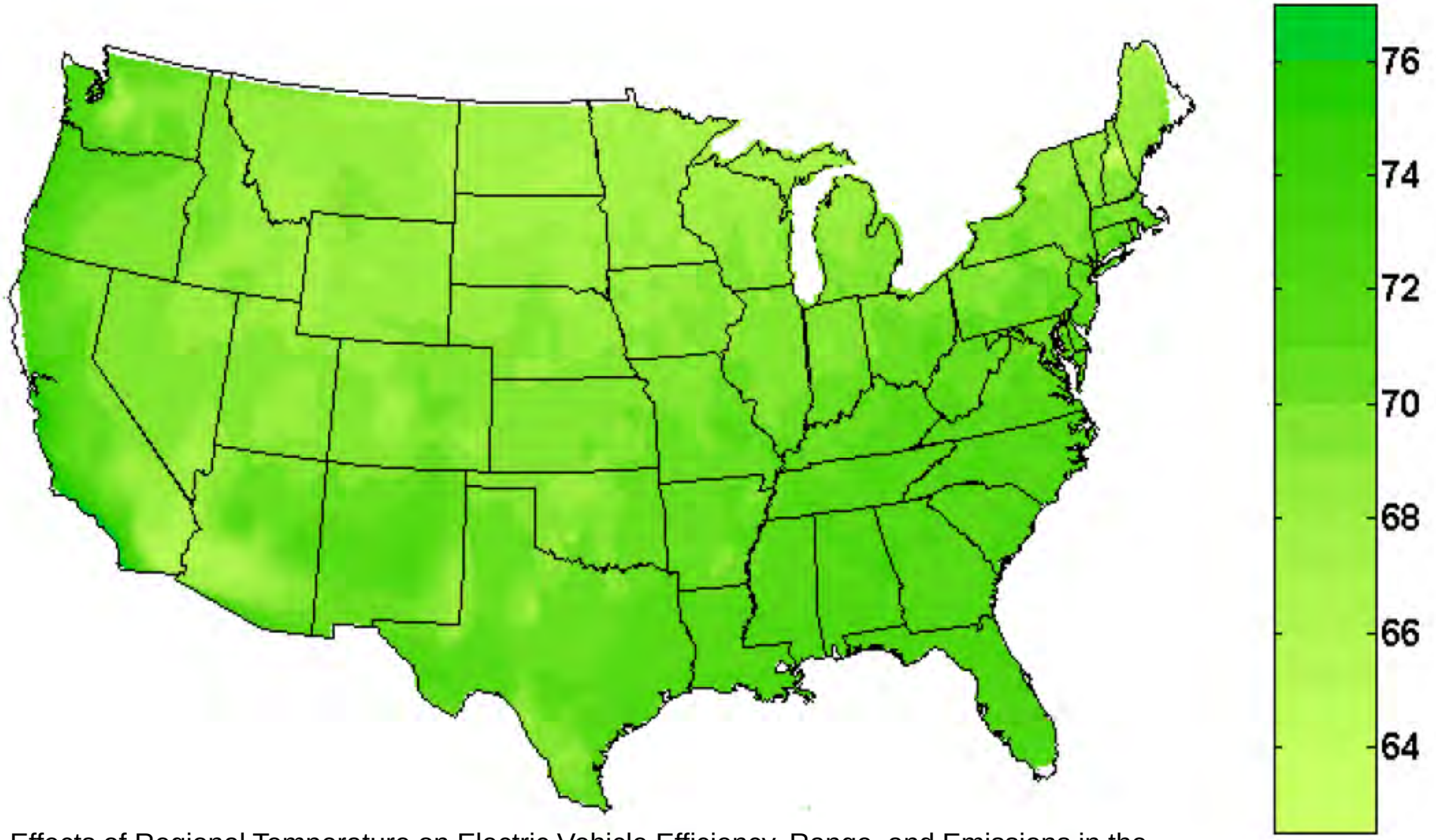
# Real World Data from FleetCarma for Nissan Leaf




Effects of Regional Temperature on Electric Vehicle Efficiency, Range, and Emissions in the United States Tugce Yuksel and Jeremy J. Michalek, Environmental Science & Technology, 2015.

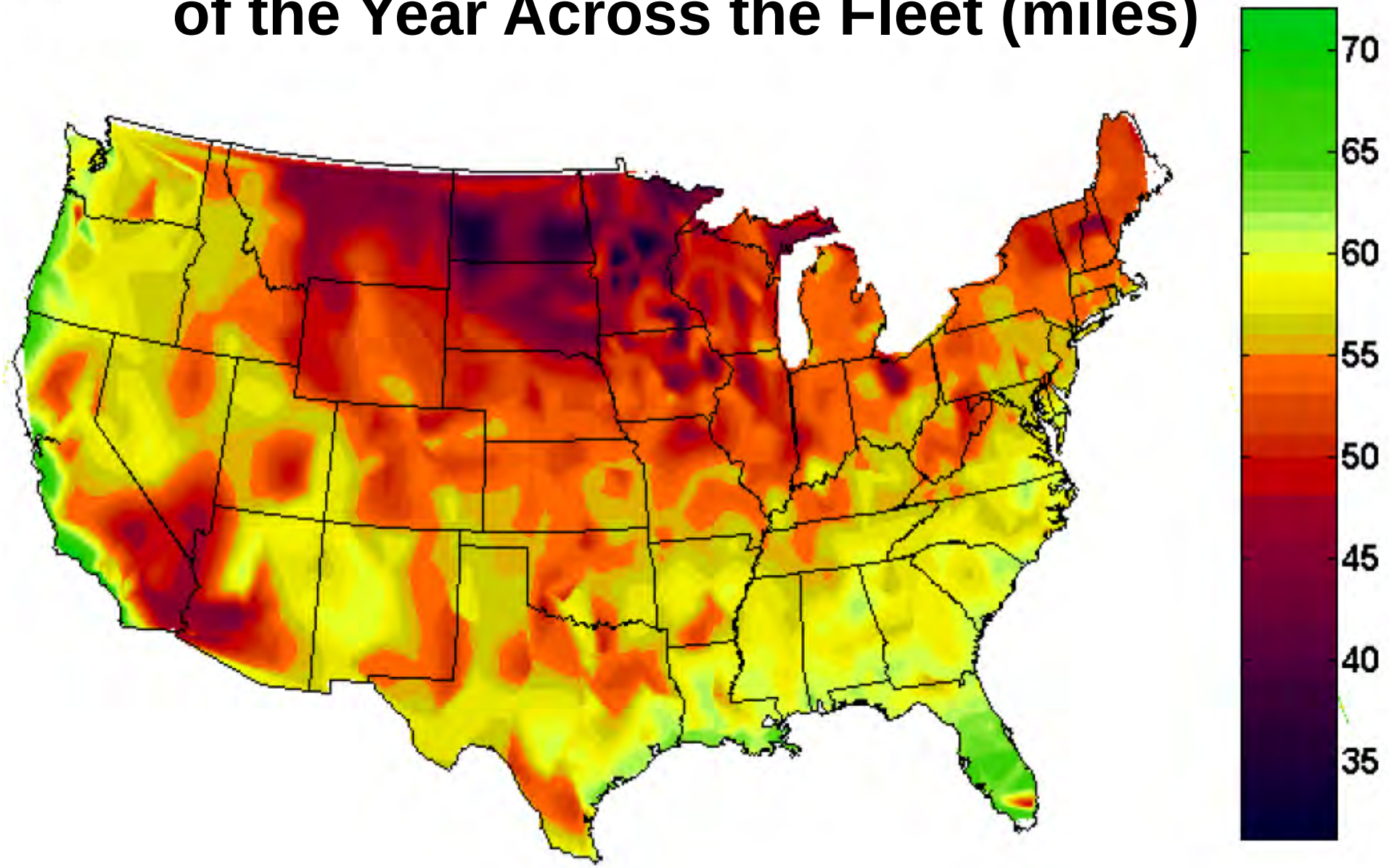
dvrpc

# Expected Range on an Average Day Across the Fleet (miles)



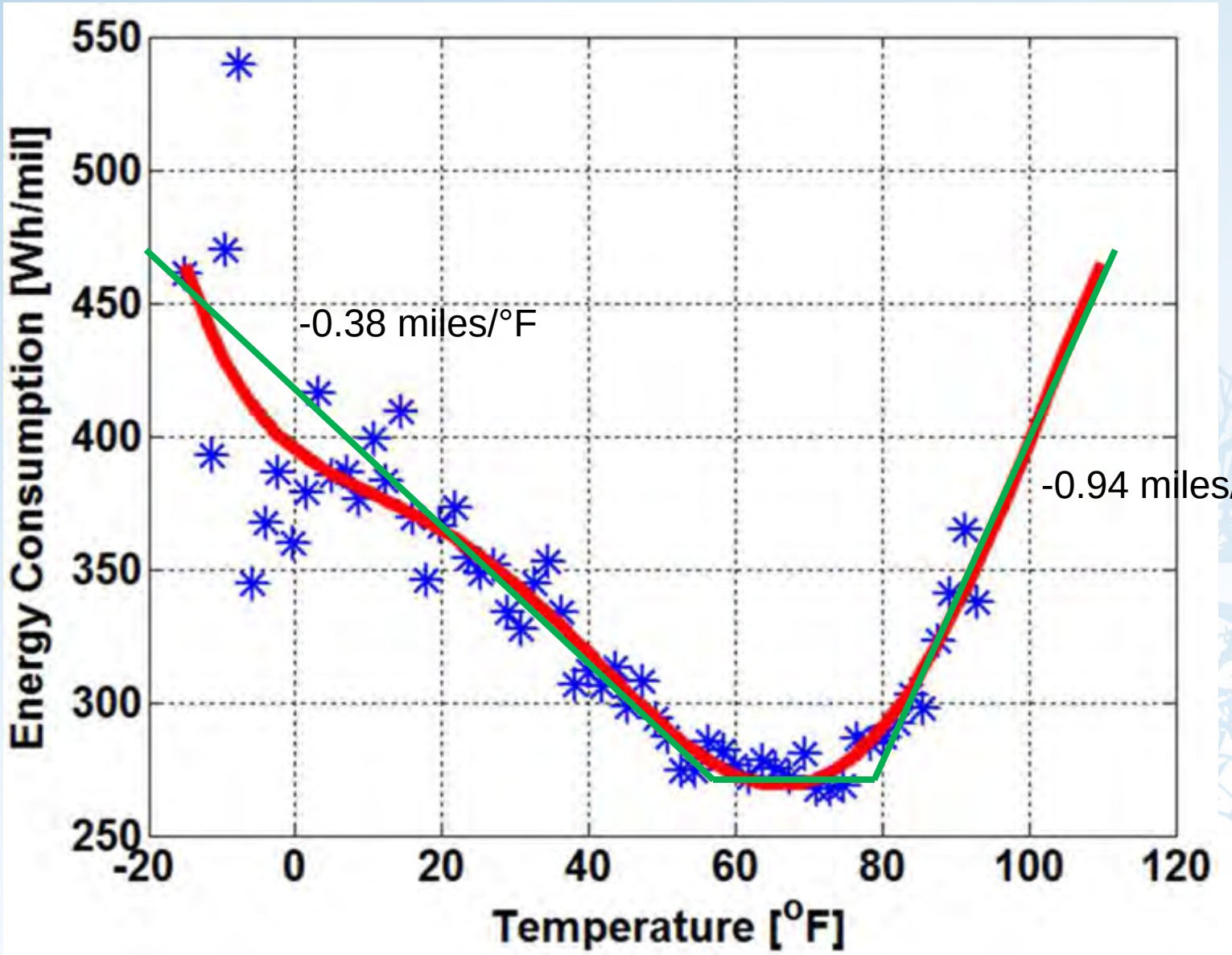

Effects of Regional Temperature on Electric Vehicle Efficiency, Range, and Emissions in the United States Tugce Yuksel and Jeremy J. Michalek, Environmental Science & Technology, 2015.

# Expected Range on the Worst Day of the Year Across the Fleet (miles)




Effects of Regional Temperature on Electric Vehicle Efficiency, Range, and Emissions in the United States Tugce Yuksel and Jeremy J. Michalek, Environmental Science & Technology, 2015.

# Real World Data from FleetCarma for Nissan Leaf




Effects of Regional Temperature on Electric Vehicle Efficiency, Range, and Emissions in the United States Tugce Yuksel and Jeremy J. Michalek, Environmental Science & Technology, 2015.

dvrpc

# AEV (LEAF) Range Loss Due to Cold Temperature Philadelphia

| Morning Commute | | Evening Commute | |
|---|---|---|---|
| Temp (°F) | Range (mi) | Temp (°F) | Range (mi) |
| 7 | 49 | 16 | 52 |
| 8 | 49 | 18 | 53 |
| 9 | 49 | 20 | 54 |
| 11 | 50 | 21 | 54 |
| 14 | 51 | 22 | 54 |
| 15 | 52 | 21 | 54 |
| 17 | 52 | 22 | 54 |
| 18 | 53 | 23 | 55 |
| 19 | 53 | 24 | 55 |
| 20 | 54 | 25 | 55 |
| | | 26 | 56 |

Source: DVRPC analysis of National Solar Radiation Data Base
1991- 2005 Update: Typical Meteorological Year 3

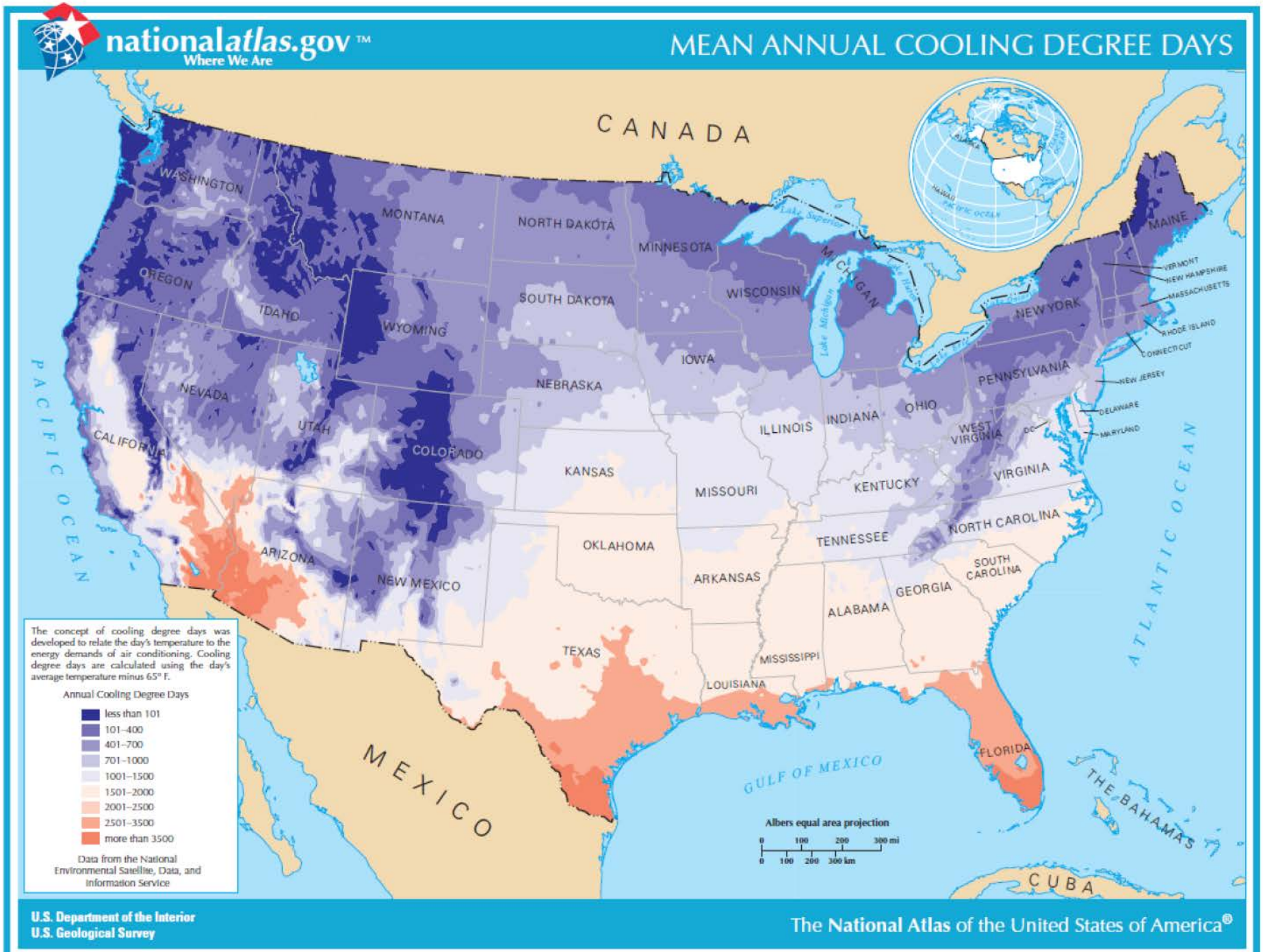
dvrpc

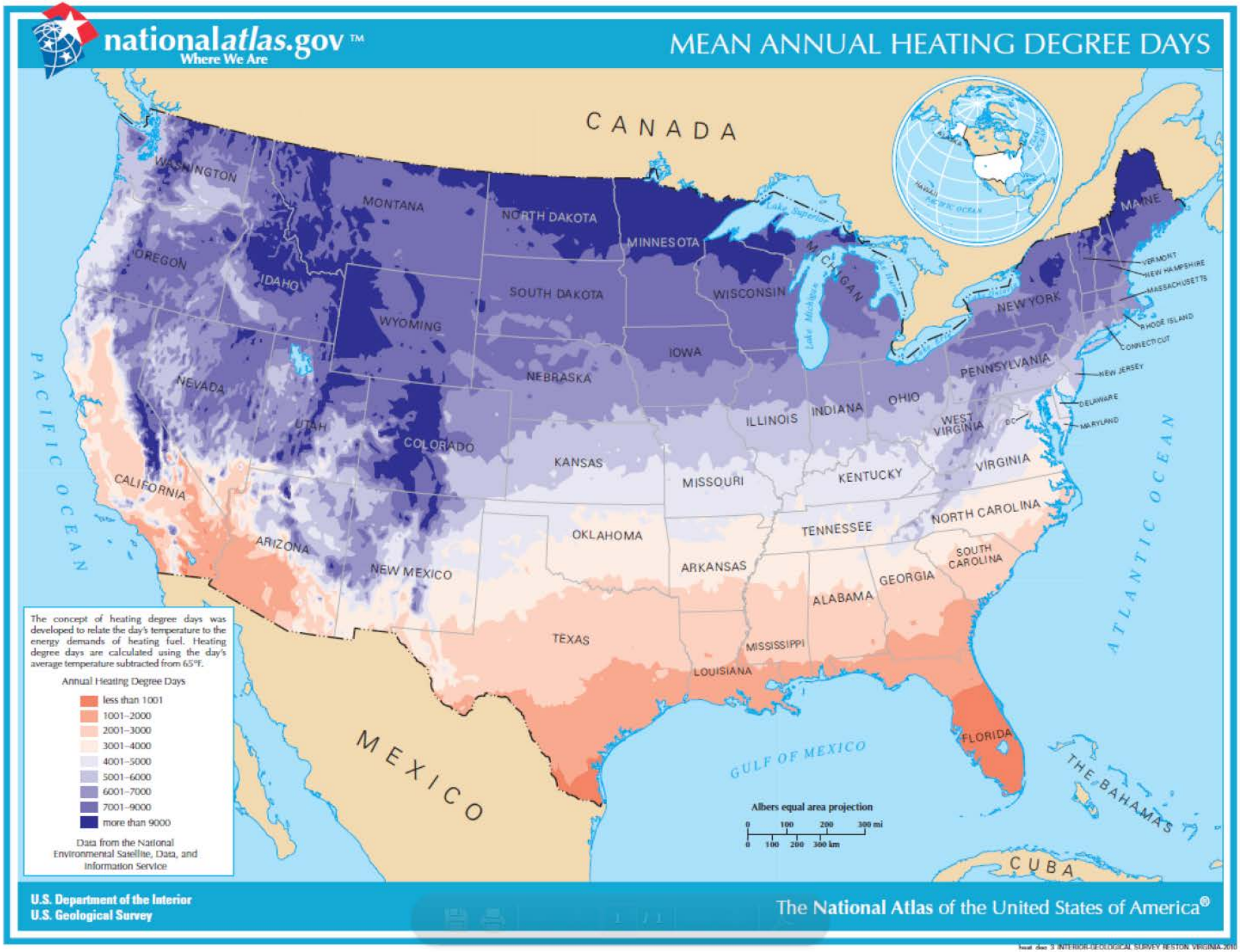
# AEV (LEAF) Range Loss Due to Hot Temperature Philadelphia

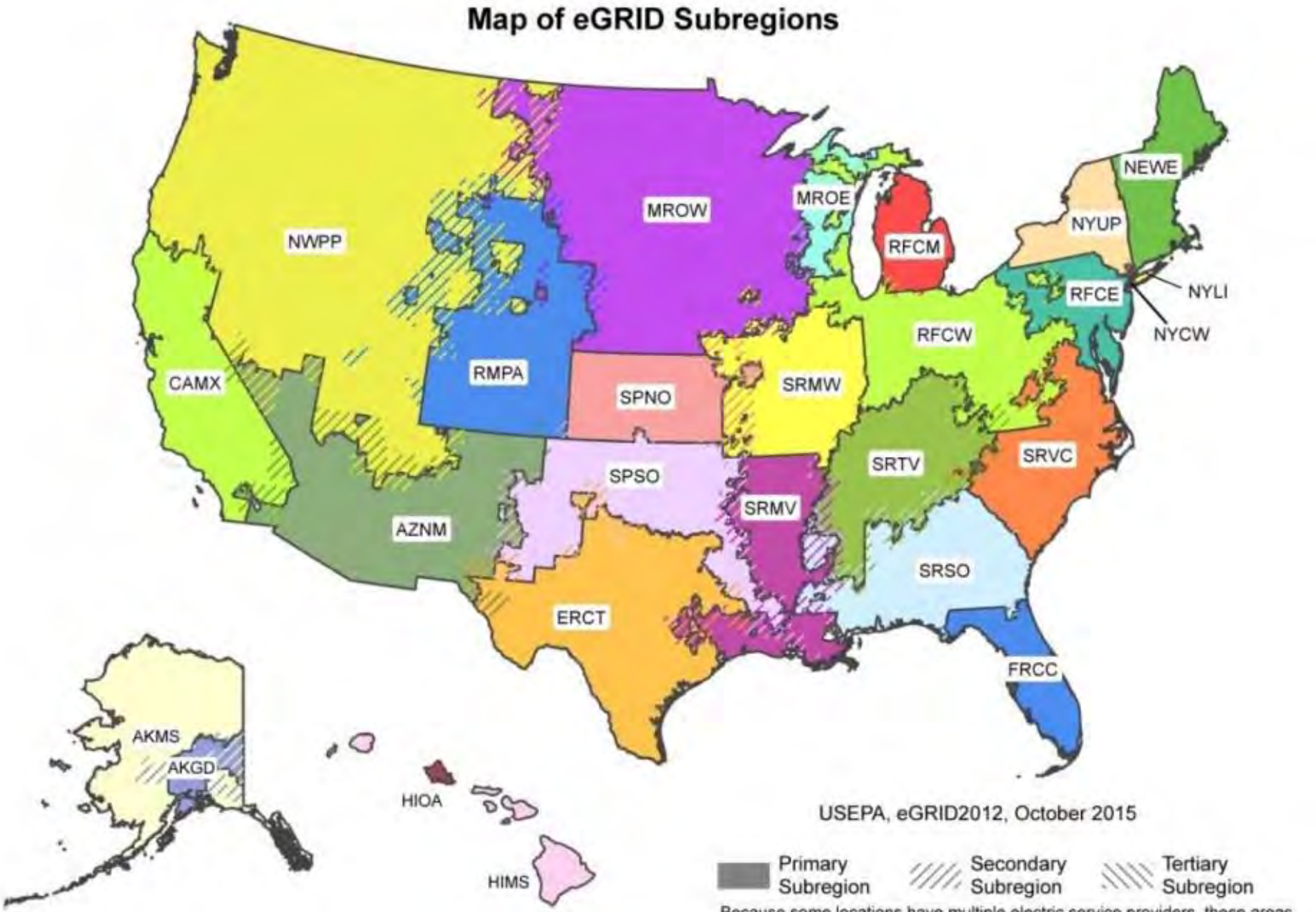
| Morning Commute | | Evening Commute | |
|---|---|---|---|
| Temp (°F) | Range (mi) | Temp (°F) | Range (mi) |
| 77 | 68 | 86 | 62 |
| 78 | 68 | 87 | 61 |
| 79 | 68 | 88 | 61 |
| 80 | 68 | 90 | 59 |
| 81 | 67 | 91 | 58 |
| | | 92 | 57 |
| | | 94 | 55 |

Source: DVRPC analysis of National Solar Radiation Data Base
1991- 2005 Update: Typical Meteorological Year 3

dvrpc


nationalatlas.gov ™
Where We Are
MEAN ANNUAL COOLING DEGREE DAYS
CANADA
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
COLORADO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
NEW JERSEY
DELAWARE
MARYLAND
DC
ARIZONA
NEW MEXICO
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
THE BAHAMAS
CUBA
Lake Superior
Lake Michigan
Lake Huron
The concept of cooling degree days was developed to relate the day's temperature to the energy demands of air conditioning. Cooling degree days are calculated using the day's average temperature minus 65° F.
Annual Cooling Degree Days
less than 101
101–400
401–700
701–1000
1001–1500
1501–2000
2001–2500
2501–3500
more than 3500
Data from the National Environmental Satellite, Data, and Information Service
Albers equal area projection
0 100 200 300 mi
0 100 200 300 km
U.S. Department of the Interior
U.S. Geological Survey
The National Atlas of the United States of America®


nationalatlas.gov ™
Where We Are
MEAN ANNUAL HEATING DEGREE DAYS
CANADA
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
NEW JERSEY
DELAWARE
MARYLAND
DC
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
CUBA
THE BAHAMAS
The concept of heating degree days was developed to relate the day's temperature to the energy demands of heating fuel. Heating degree days are calculated using the day's average temperature subtracted from 65°F.
Annual Heating Degree Days
less than 1001
1001–2000
2001–3000
3001–4000
4001–5000
5001–6000
6001–7000
7001–9000
more than 9000
Data from the National Environmental Satellite, Data, and Information Service
Albers equal area projection
0 100 200 300 mi
0 100 200 300 km
U.S. Department of the Interior
U.S. Geological Survey
The National Atlas of the United States of America®




US EPA: Emissions & Generation Resource Integrated Database (eGRID)

# 3. eGRID2012 Subregion Output Emission Rates – Greenhouse Gases

| eGRID subregion acronym | eGRID subregion name | Total output emission rates | | | Fossil fuel output emission rate | Non-baseload output emission rates | | |
|---|---|---|---|---|---|---|---|---|
| | | $CO_2$ (lb/MWh) | $CH_4$ (lb/GWh) | $N_2O$ (lb/GWh) | $CO_2$ (lb/MWh) | $CO_2$ (lb/MWh) | $CH_4$ (lb/GWh) | $N_2O$ (lb/GWh) |
| AKGD | ASCC Alaska Grid | 1,268.73 | 26.34 | 7.59 | 1,413.52 | 1,377.77 | 28.66 | 3.38 |
| AKMS | ASCC Miscellaneous | 481.17 | 18.65 | 3.55 | 1,400.38 | 1,404.49 | 55.64 | 10.70 |
| AZNM | WECC Southwest | 1,152.89 | 18.65 | 15.11 | 1,613.86 | 1,236.02 | 21.56 | 10.52 |
| CAMX | WECC California | 650.31 | 31.12 | 5.67 | 986.41 | 1,018.87 | 37.61 | 6.04 |
| ERCT | ERCOT All | 1,143.04 | 16.70 | 12.33 | 1,418.13 | 1,280.59 | 21.53 | 10.71 |
| FRCC | FRCC All | 1,125.35 | 40.05 | 11.85 | 1,216.71 | 1,333.93 | 38.81 | 13.79 |
| HIMS | HICC Miscellaneous | 1,200.10 | 68.08 | 12.68 | 1,656.12 | 1,331.47 | 96.82 | 17.15 |
| HIOA | HICC Oahu | 1,576.38 | 90.41 | 21.55 | 1,582.88 | 1,402.27 | 118.01 | 19.43 |
| MROE | MRO East | 1,522.57 | 24.30 | 25.55 | 2,077.12 | 1,739.00 | 30.17 | 26.26 |
| MROW | MRO West | 1,425.15 | 27.60 | 24.26 | 2,152.46 | 1,965.21 | 52.60 | 32.72 |
| NEWE | NPCC New England | 637.90 | 72.84 | 10.71 | 980.27 | 1,079.73 | 67.70 | 12.90 |
| NWPP | WECC Northwest | 665.75 | 12.60 | 10.38 | 1,858.75 | 1,579.07 | 38.30 | 22.84 |
| NYCW | NPCC NYC/Westchester | 696.70 | 25.51 | 2.93 | 1,175.61 | 1,081.11 | 22.50 | 2.32 |
| NYLI | NPCC Long Island | 1,201.20 | 78.20 | 9.87 | 1,129.27 | 1,303.42 | 31.40 | 3.56 |
| NYUP | NPCC Upstate NY | 408.80 | 15.59 | 3.83 | 1,085.63 | 1,228.56 | 39.00 | 13.04 |
| RFCE | RFC East | 858.56 | 26.44 | 11.49 | 1,469.42 | 1,492.01 | 32.74 | 18.69 |
| RFCM | RFC Michigan | 1,569.23 | 30.36 | 24.12 | 1,853.55 | 1,856.21 | 33.91 | 28.72 |
| RFCW | RFC West | 1,379.48 | 17.11 | 21.67 | 1,942.40 | 1,791.71 | 21.76 | 27.85 |
| RMPA | WECC Rockies | 1,822.65 | 21.66 | 28.13 | 2,094.71 | 1,669.58 | 22.89 | 20.66 |
| SPNO | SPP North | 1,721.65 | 20.22 | 27.14 | 2,149.67 | 2,112.08 | 26.11 | 30.63 |
| SPSO | SPP South | 1,538.63 | 23.75 | 19.98 | 1,729.36 | 1,590.13 | 27.60 | 16.19 |
| SRMV | SERC Mississippi Valley | 1,052.92 | 20.95 | 10.61 | 1,384.45 | 1,301.65 | 27.43 | 9.75 |
| SRMW | SERC Midwest | 1,710.75 | 19.58 | 27.50 | 2,069.72 | 1,917.96 | 23.29 | 28.84 |
| SRSO | SERC South | 1,149.05 | 22.66 | 15.49 | 1,518.99 | 1,696.79 | 28.17 | 24.83 |
| SRTV | SERC Tennessee Valley | 1,337.15 | 17.39 | 20.78 | 1,912.59 | 1,743.96 | 22.84 | 26.11 |
| SRVC | SERC Virginia/Carolina | 932.87 | 23.95 | 14.60 | 1,665.71 | 1,790.57 | 53.10 | 29.94 |
| **U.S.** | | **1,136.53** | **23.78** | **15.88** | **1,640.13** | **1,549.36** | **30.99** | **19.86** |

# Other Inputs

Future Electric Grid Mix

Methane Leakage Rates

Uptake of PEVs

Range of PEVs

Efficiency of PEVs

Changes in Regional VMT and Mode Mix

Similar Analysis with NGVs (trucks, school buses)

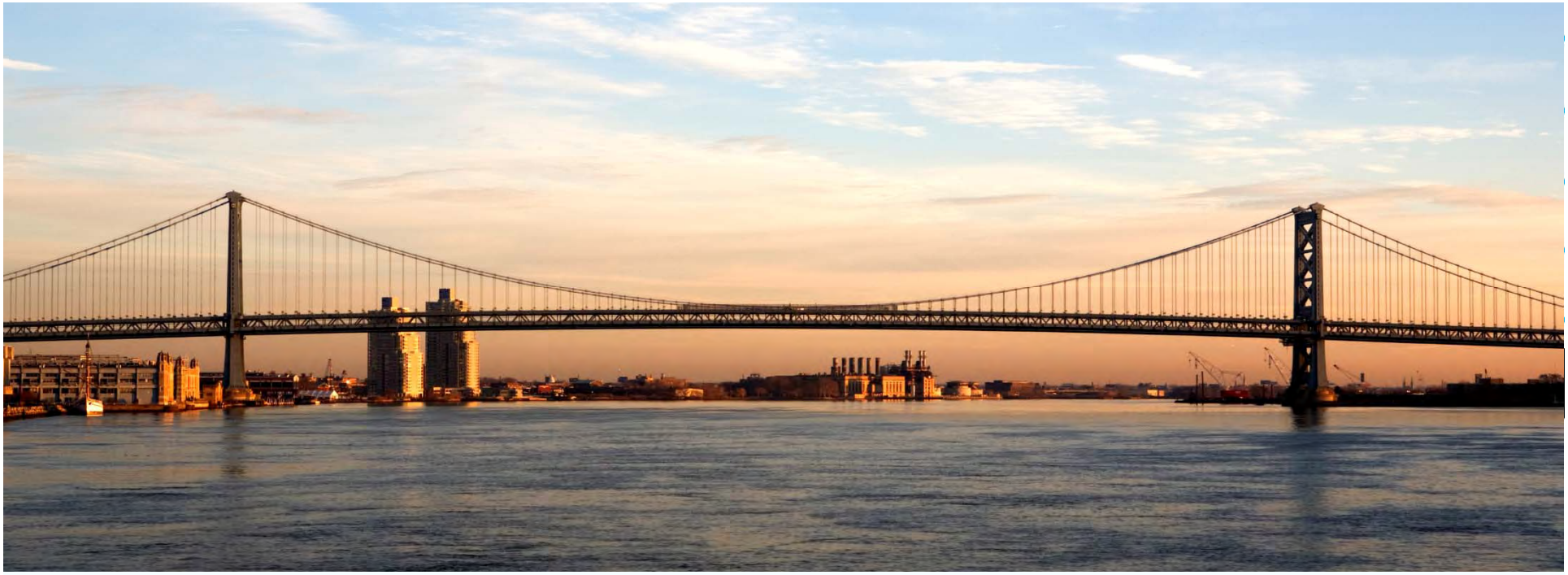
dvrpc

# Questions/Discussion

## Greenhouse Gas Emissions and Energy Impacts from Electric and Natural Gas Vehicle Penetration

***Progress to date and questions***

Robert Graff
Manager, Office of Energy and Climate Change Initiatives
rgraff@dvrpc.org
www.dvrpc.org/EnergyClimate
215-238-2826



# Addendum to the Transportation Conformity Demonstration: FY 2015 PA TIP

## Regional Technical Committee

February 8, 2016

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION 1965-2015

# Presentation

- Conformity Overview
- Emissions Analysis Results
- Motion

dvrpc

# Conformity Overview

Transportation Conformity is a federal requirement to control emissions of on-road, mobile sources in designated air quality Non-attainment or Maintenance Areas

# Conformity Overview

## Conformity Triggers

- Addition of regionally significant and non-exempt projects to the FY 2015 PA TIP
  - MPMS 17782 Adams Ave Connector
  - MPMS 57851 Plank, Otts Road, Intersection Imporovement

dvrpc

# DVRPC Region

Multiple Non-attainment and Maintenance Areas in Multiple Jurisdictions

- Non-Attainment
  - Ozone
    - Entire region in one NAA.
  - $PM_{2.5}$
    - Annual Std.
    - Delaware County is stand-alone NAA
- Maintenance Areas
  - $PM_{2.5}$
    - Annual and 24-Hour Stds
    - Region is in two different Maintenance Areas
      - Philadelphia – Wilmington (8 DVRPC Counties + NCC, DE)
      - New York – Northern NJ – Long Island (Mercer County)

# Ozone Emissions Results

## VOC Results

| | | SIP 2008 MVEB† | 2017 | 2020 | Revised 2020 | 2025 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|
| PA | Emissions from MOVES 2014 | - | 35.18 | 29.93 | 29.92 | 20.32 | 12.52 | 11.06 |
| | Adjustments from Off-Network Calculation‡ | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Estimated Total Emissions | 61.09 | 35.18 | 29.93 | 29.92 | 20.32 | 12.52 | 11.06 |

## $NO_x$ Results

| | | SIP 2008 MVEB† | 2017 | 2020 | Revised 2020 | 2025 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|
| PA | Emissions from MOVES 2014 | - | 64.97 | 47.01 | 46.98 | 33.74 | 19.29 | 17.77 |
| | Adjustments from Off-Network Calculation‡ | - | 0.0 | 0.0 | 0.0 | -0.1 | -0.1 | -0.1 |
| | Estimated Total Emissions | 108.78 | 64.97 | 47.01 | 46.98 | 33.73 | 19.28 | 17.76 |

dvrpc

# $PM_{2.5}$ Emissions Results

| | | 2017 | 2017 | 2020 | Revised 2020 | 2025 | 2025 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|---|---|
| | | SIP MVEB† | Estimated Emissions* | Estimated Emissions* | Estimated Emissions | SIP MVEB† | Estimated Emissions* | Estimated Emissions* | Estimated Emissions* |
| Direct $PM_{2.5}$ | DVRPC—PA* | 1,679 | 937 | 727 | 727 | 1,316 | 529 | 342 | 351 |
| $PM_{2.5}$ Precursor ($NO_x$) | DVRPC—PA* | 37,922 | 23,253 | 16,734 | 16,727 | 25,361 | 11,261 | 7,166 | 5,040 |

dvrpc

# Emissions Analysis Results

The Amended PA TIP:

- "Conforms" to the corresponding SIP and the current final conformity guidance under CAAA including all applicable NAAQS requirements
- Transportation investments identified the TIPs do not impede efforts to attain NAAQS

Conformity Results

- Meet the 8-hour ozone, daily and annual $PM_{2.5}$ SIP requirements
- Amends the existing conformity finding of September 2015

dvrpc

# Public Comment

## Public Comment Period

- January 13 through February 16, 2016
- Documents were available at public 17 public libraries and online

## Comments were accepted:

- Via email at tip-plan-comments@dvrpc.org
- Online at www.dvrpc.org
- Via mail and fax

# Requested Action

That the RTC recommend that the DVRPC Board adopt the amendments to conformity findings of the FY 2015 Pennsylvania TIP for Ozone, $PM_{2.5,}$ and CO in the Pennsylvania portion of the DVRPC planning area.


Questions
Sean Greene
Manager, Air Quality Programs
sgreene@dvrpc.org
DELAWARE VALLEY
dvrpc
REGIONAL
PLANNING COMMISSION
1965-2015

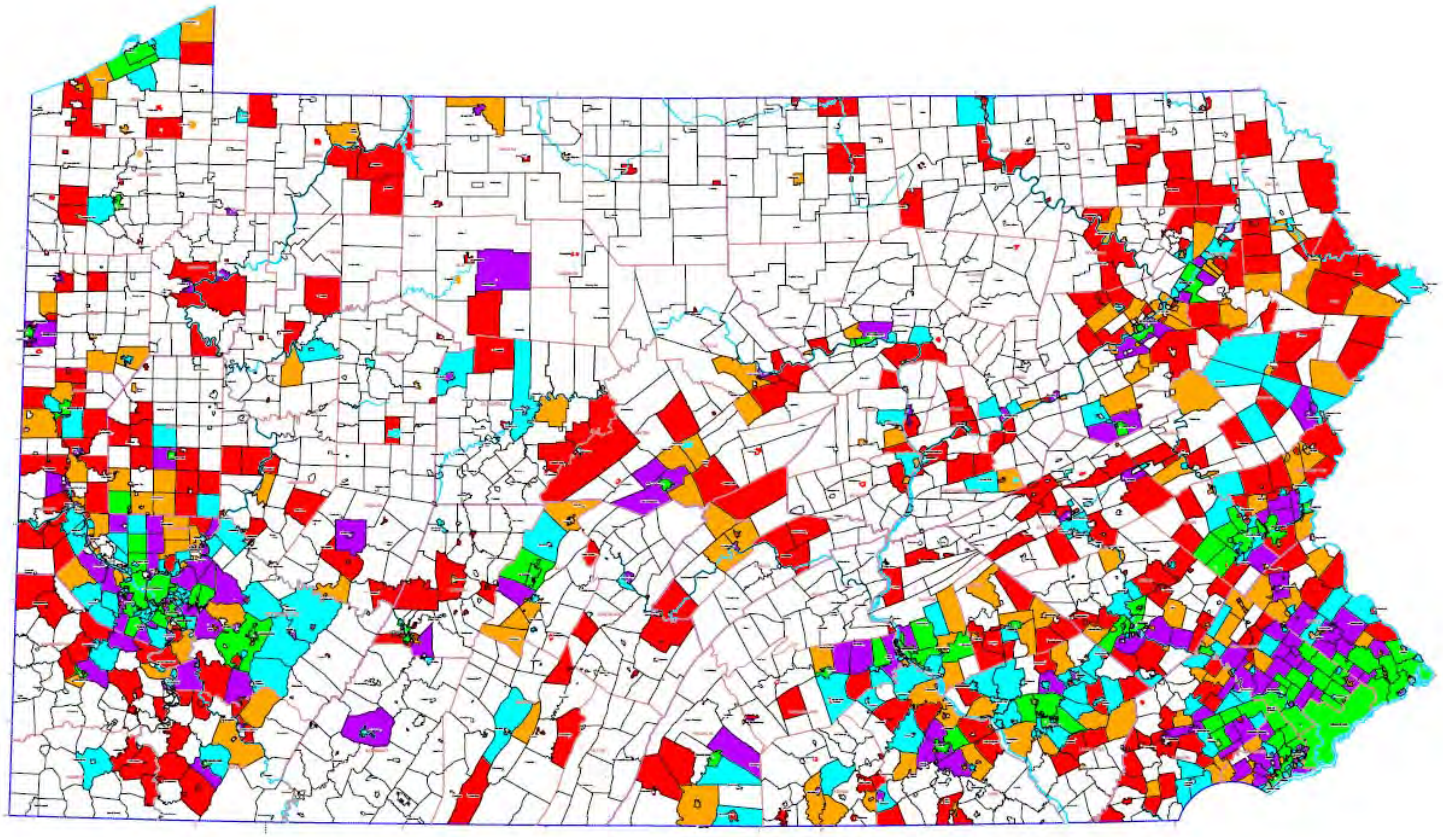
# PennDOT District 6-0 Signal Retiming Initiative – The Route 611 Story

Presented By

**David Adams, PE**
**PennDOT District 6-0**

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# Traffic Signals in Pennsylvania



- 1 or 2 Traffic Signals
- 3 to 5 Traffic Signals
- 6 to 10 Traffic Signals
- 11 to 25 Traffic Signals
- Greater than 25 Traffic Signals

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# Traffic Signals in Pennsylvania

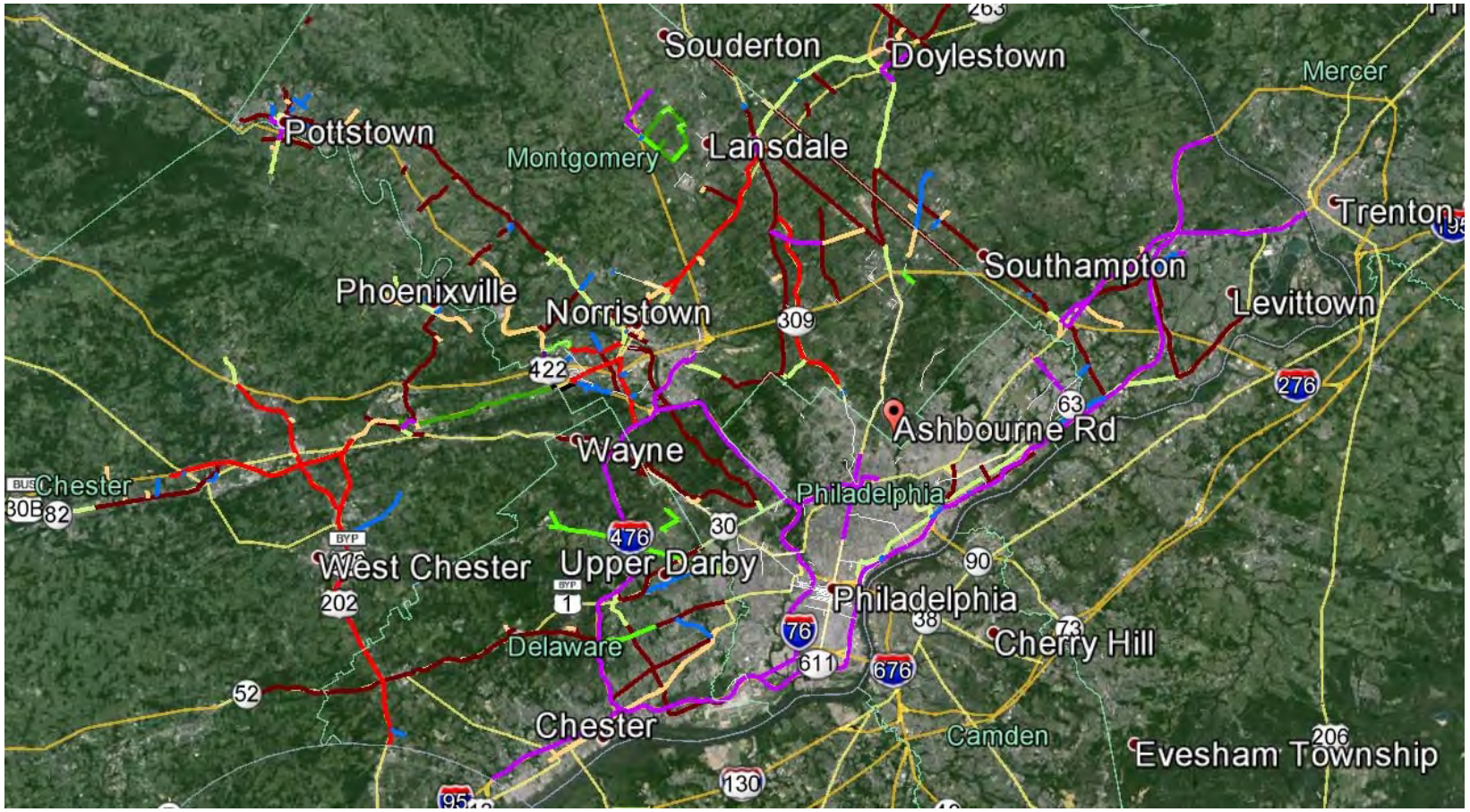
- Signals are owned, operated, and maintained by local municipalities
- PennDOT acts as a permitting agency
- Projects types include:
  - State contract project
  - Highway occupancy permit
  - Municipal

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# Closed Loop Systems

- Closed loop systems gradually installed over past 15 years
- Approximately 1500 signals enabled with remote communications
- Central server systems more common over past 5 years
- Extensive fiber backbone utilizing OTN Sonet network

# Communications Network




pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# What's the Problem?

- Varying levels of expertise on initial timing development
- Counts old by the time of implementation
- Engineering services not funded to optimize system in the street
- Varying levels of system monitoring and maintenance

# Signal Retiming Initiative

- Started through DVRPC and PennDOT Central Office
- Additional collaboration through PennDOT District 6-0 and Counties
- Funded as a TIP line item with CMAQ funds
- Open-Ended Contract
- FY 13-14, $350,000
- FY 15-16, $350,000

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# Project Team

Taylor Wiseman & Taylor
ENGINEERS | SURVEYORS | SCIENTISTS

Albeck Gerken, Inc.
Transportation Engineers
ALBECK + ASSOCIATES

DRIVE ENGINEERING

Fe

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# Retiming Process

- Select Corridor
- Stakeholders Meeting and Coordination Throughout Process
- Memorandum of Understanding and Concept of Operations
- Before Study
- Rapid Field Assessment
- Implementation
- Analysis, Recommendations
- After Study
- Performance Evaluation

# Project Goals

- Reduce travel time and delay
- Efficient use of taxpayer resources
- Team implements times
- Do not burden Municipality with additional maintenance
- Educate
- Municipal satisfaction
- Help identify future enhancements

# Route 611 Corridor

# Route 611 Corridor History

- York Road built in 1700's
- Connected Philadelphia with Elizabethtown Point (now Elizabeth, NJ)



pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

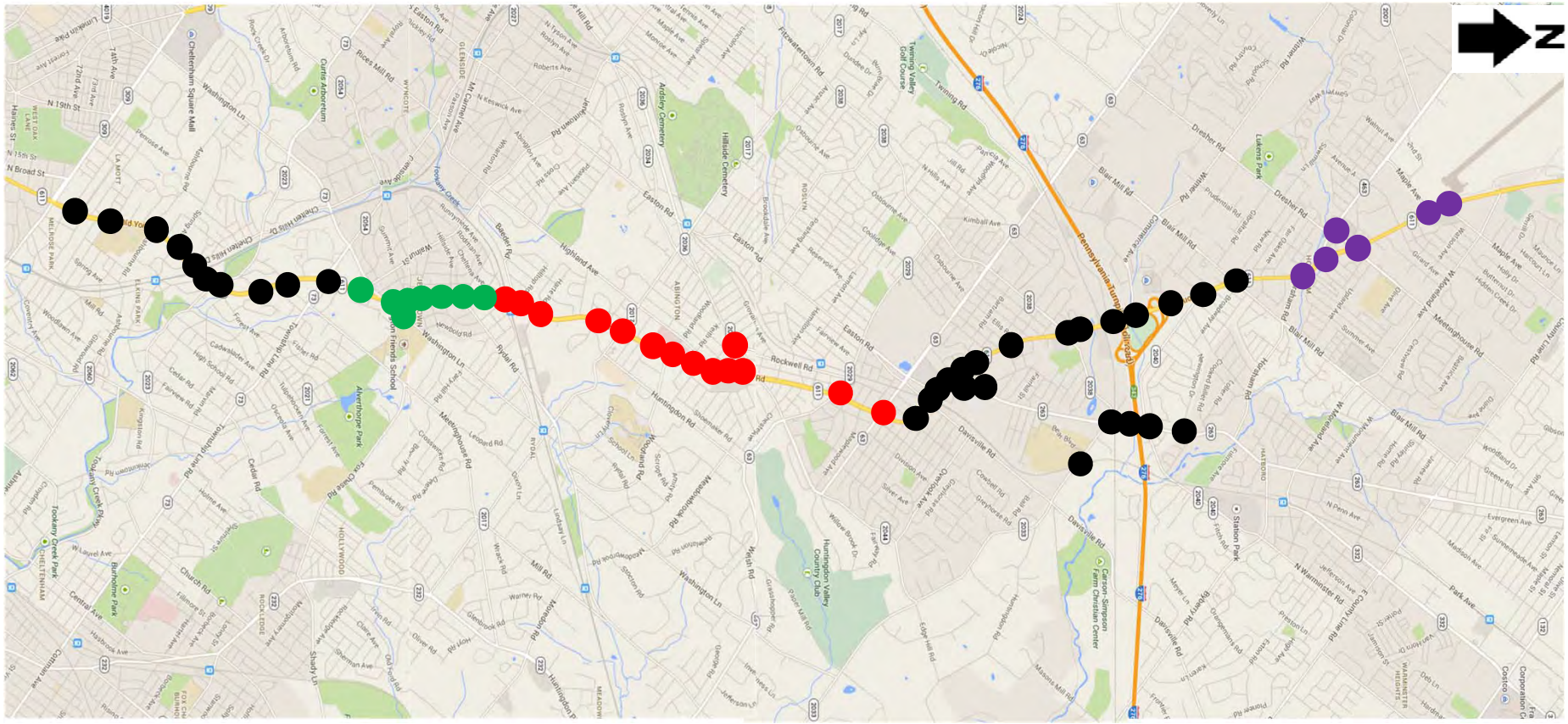
# Route 611 Corridor History

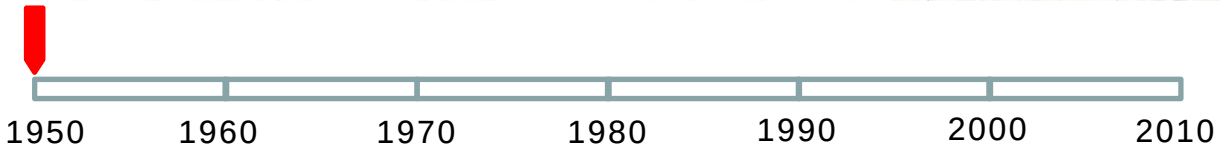
Route 611
**1942**

Route 611
**2011**

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# Route 611 Corridor History




pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# Signal System Construction

- SR 0611-Q01 State Contract Project
- Cheltenham, Abington, Upper Moreland, Horsham
- $4.3 Million
- Completed November 2009

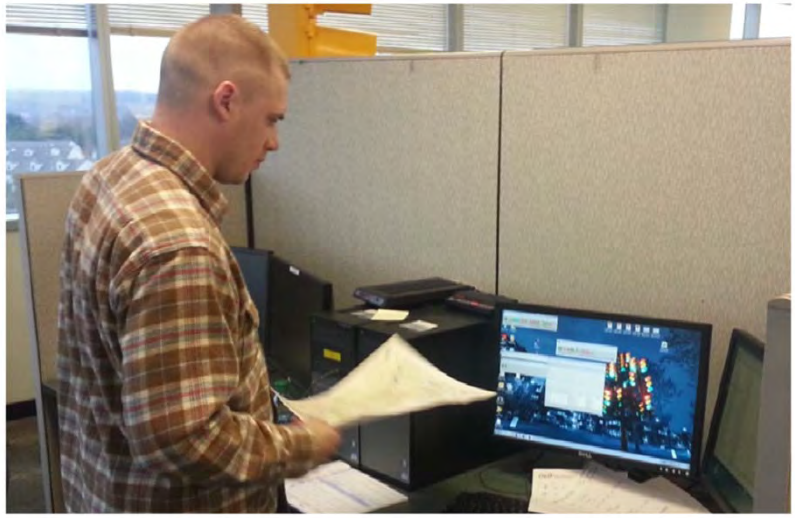
# Signal System Construction

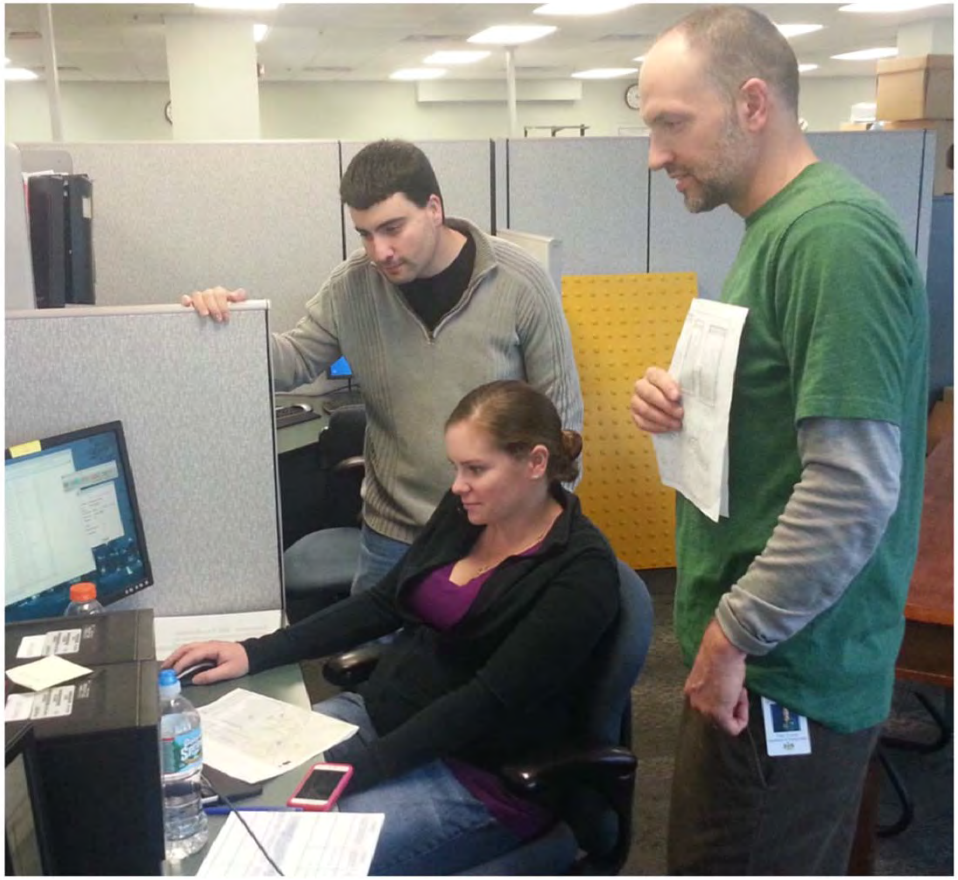
- County Jump Start Project
- Jenkintown
- $633k Construction Project
- Completed October 2010

# System Communications

- Spread spectrum radio utilized south of 611/Maryland and on 263 spur
- Fiber optic cable from 611/Maryland on north into Horsham
- Master located in each municipality
- Master broadcasts date/time every 255 seconds
- GPS Time Clock at each master
- 59 Signals

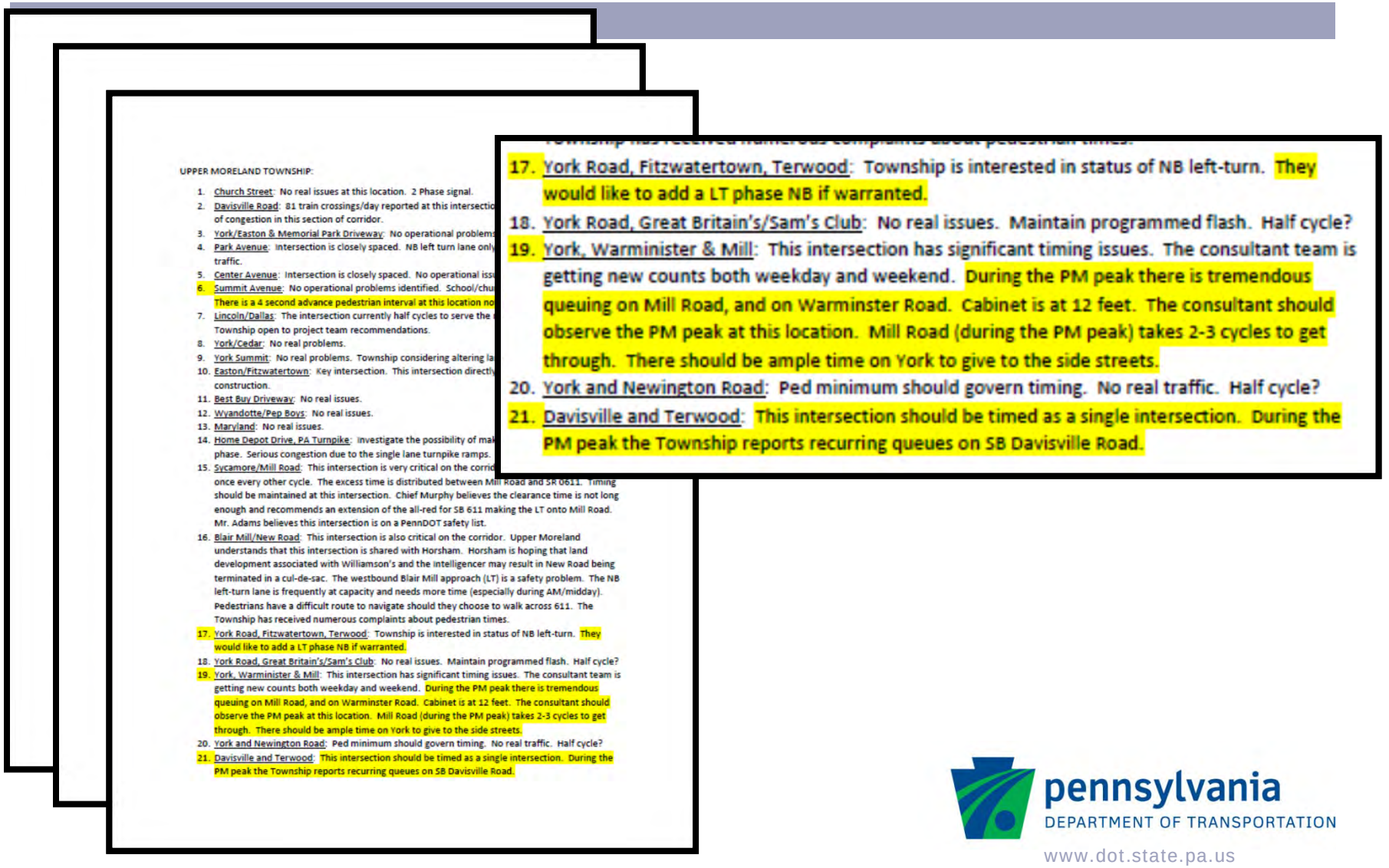
# Naztec StreetWise





pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# Summary of Concerns



UPPER MORELAND TOWNSHIP:

1. Church Street: No real issues at this location. 2 Phase signal.
2. Davisville Road: 81 train crossings/day reported at this intersectio
of congestion in this section of corridor.
3. York/Easton & Memorial Park Driveway: No operational problems
4. Park Avenue: Intersection is closely spaced. NB left turn lane only
traffic.
5. Center Avenue: Intersection is closely spaced. No operational iss
6. Summit Avenue: No operational problems identified. School/chu
There is a 4 second advance pedestrian interval at this location no
7. Lincoln/Dallas: The intersection currently half cycles to serve the
Township open to project team recommendations.
8. York/Cedar: No real problems.
9. York Summit: No real problems. Township considering altering la
10. Easton/Fitzwatertown: Key intersection. This intersection directl
construction.
11. Best Buy Driveway: No real issues.
12. Wyandotte/Pep Boys: No real issues.
13. Maryland: No real issues.
14. Home Depot Drive, PA Turnpike: Investigate the possibility of mak
phase. Serious congestion due to the single lane turnpike ramps.
15. Sycamore/Mill Road: This intersection is very critical on the corri
once every other cycle. The excess time is distributed between Mill Road and SR 0611. Timing
should be maintained at this intersection. Chief Murphy believes the clearance time is not long
enough and recommends an extension of the all-red for SB 611 making the LT onto Mill Road.
Mr. Adams believes this intersection is on a PennDOT safety list.
16. Blair Mill/New Road: This intersection is also critical on the corridor. Upper Moreland
understands that this intersection is shared with Horsham. Horsham is hoping that land
development associated with Williamson's and the Intelligencer may result in New Road being
terminated in a cul-de-sac. The westbound Blair Mill approach (LT) is a safety problem. The NB
left-turn lane is frequently at capacity and needs more time (especially during AM/midday).
Pedestrians have a difficult route to navigate should they choose to walk across 611. The
Township has received numerous complaints about pedestrian times.
17. York Road, Fitzwatertown, Terwood: Township is interested in status of NB left-turn. They
would like to add a LT phase NB if warranted.
18. York Road, Great Britain's/Sam's Club: No real issues. Maintain programmed flash. Half cycle?
19. York, Warminister & Mill: This intersection has significant timing issues. The consultant team is
getting new counts both weekday and weekend. During the PM peak there is tremendous
queuing on Mill Road, and on Warminster Road. Cabinet is at 12 feet. The consultant should
observe the PM peak at this location. Mill Road (during the PM peak) takes 2-3 cycles to get
through. There should be ample time on York to give to the side streets.
20. York and Newington Road: Ped minimum should govern timing. No real traffic. Half cycle?
21. Davisville and Terwood: This intersection should be timed as a single intersection. During the
PM peak the Township reports recurring queues on SB Davisville Road.

17. York Road, Fitzwatertown, Terwood: Township is interested in status of NB left-turn. They would like to add a LT phase NB if warranted.
18. York Road, Great Britain's/Sam's Club: No real issues. Maintain programmed flash. Half cycle?
19. York, Warminister & Mill: This intersection has significant timing issues. The consultant team is getting new counts both weekday and weekend. During the PM peak there is tremendous queuing on Mill Road, and on Warminster Road. Cabinet is at 12 feet. The consultant should observe the PM peak at this location. Mill Road (during the PM peak) takes 2-3 cycles to get through. There should be ample time on York to give to the side streets.
20. York and Newington Road: Ped minimum should govern timing. No real traffic. Half cycle?
21. Davisville and Terwood: This intersection should be timed as a single intersection. During the PM peak the Township reports recurring queues on SB Davisville Road.

# Deploy Signal Timing Plans

- **Download Plans**: Via system, direct connect, front panel
- **Verify:** Clock time for controllers
- **Drive:** Using Tru-Traffic - determine if patterns are functioning as desired
- **Observe**: Never allow pattern to operate unobserved
- **Goal:** Ensure local controllers are operating correctly prior to fine-tuning

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# Before vs After PM Video

# Route 611 Results

- AM Peak
- 14% Reduction in Travel Time
- 30% Reduction in Stops
- PM Peak
- 9% Reduction in Travel Time
- 27% Reduction in Stops
- Saturday Peak
- 7% Reduction in Travel Time
- 18% Reduction in Stops
- Approximately $3,000 per intersection
- Benefit/Cost – 82:1

# Other Results – Route 100 West Whiteland

- AM Peak
- 26% Reduction in Travel Time
- 60% Reduction in Stops
- PM Peak
- 27% Reduction in Travel Time
- 36% Reduction in Stops

# Other Results – Route 320
# Marple and Springfield

- AM Peak
- 21% Reduction in Travel Time
- 43% Reduction in Stops
- PM Peak
- 28% Reduction in Travel Time
- 52% Reduction in Stops

# Thank You for Your Support

Questions?

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us


DELAWARE VALLEY
dvrpc
REGIONAL
PLANNING COMMISSION

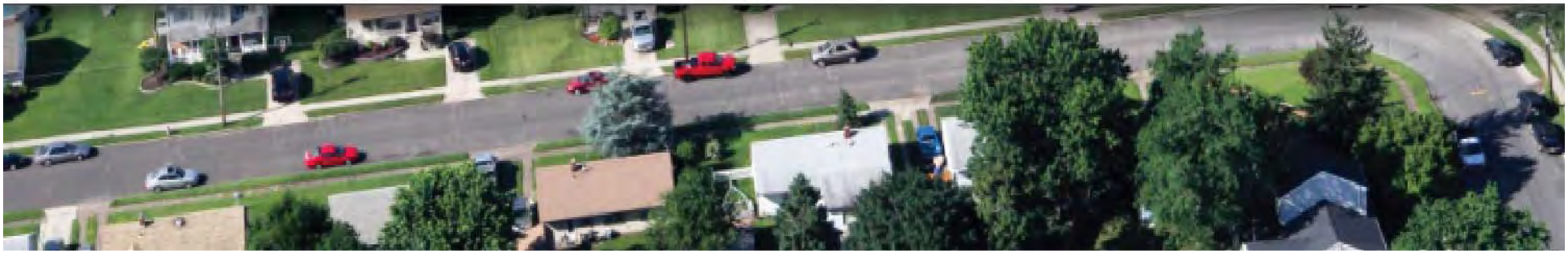
# TIP Actions

## Transportation Improvement Program

Pennsylvania TIP (FY2015-2018)

New Jersey TIP (FY2016-2019)

*February 2016*



# I-95 & Aramingo Ave., Adams Ave. Connector
## *Philadelphia I Advance Construction (CON)*

Amend the PA TIP by:

- Advancing CON from FY19 and FY20 to FY16, FY17, and FY18
- Increase overall CON cost by $196,000 and change funding type from $19,104,000 ($15,284,000 STU/$3,820,000 State 581) to $19,300,000 State 581.

- ✓ 30 day public comment period (1/13/16 – 2/16/16) for TIP Amendment and new AQ conformity determination (2020M).
- ✓ Project will let in October 2016 with I-95 Section BS4 as a package.
- ✓ New roadway will connect Torresdale and Aramingo Avenues.


Source:
Paul Shultes, PennDOT

# Plank Road/Otts Road/MeyersRoad/Seitz Road Intersection Improvements

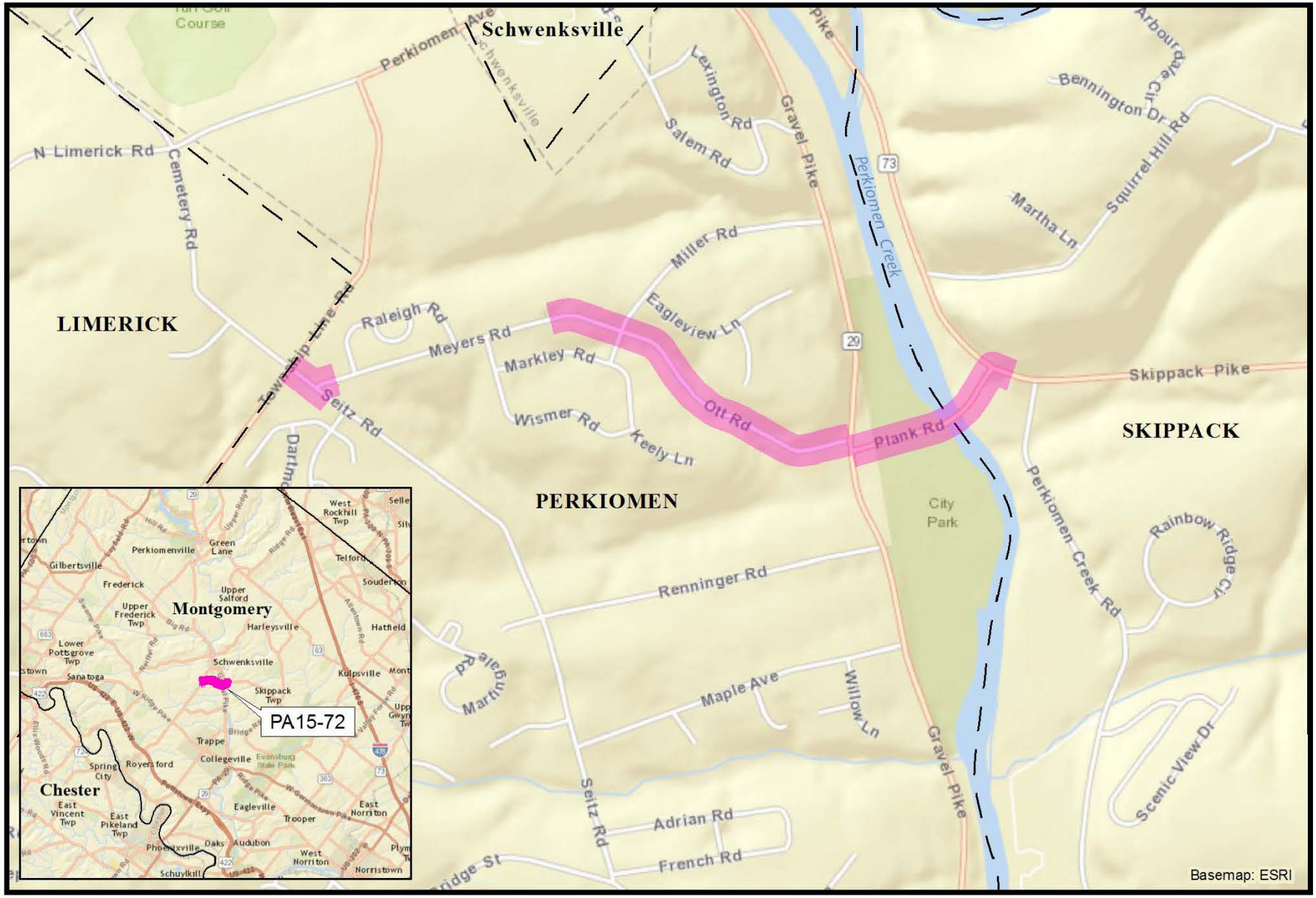
## *Montgomery County I Advance Construction (CON)*

Amend the PA TIP by:

- Advancing CON from FY19 and FY20 to FY16 and FY17.
- Decrease overall CON cost by $4,216,000 from $16,716,000 ($13,372,000 NHPP/$3,344,000 State 581) in FY19 and FY20 to $12,500,000 ($5,981,000 CAQ/$2,500,000 State 581) in FY16 and FY17.

- ✓ 30 day public comment period (1/13/16 – 2/16/16) for TIP Amendment and new AQ conformity determination (2020M).
- ✓ Project is ready for CON earlier than anticipated.
- ✓ Safety and traffic operations around a rapidly developing & congested area will improve through realignment of several offset intersections.

# PA15-72: Plank Road/Otts Road/Meyers Road/Seitz Road Intersection Improvements




N W E S

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

0 0.25 0.5
Miles

# Proposed TIP Actions | PA

## *Amend the PA TIP for the following projects:*

I-95 & Aramingo Ave., Adams Ave. Connector, Philadelphia

- Advance CON from FY19 and FY20 to FY16, FY17, and FY18
- Increase overall CON cost by $196,000 and change funding type from $19,104,000 ($15,284,000 STU/$3,820,000 State 581) to $19,300,000 State 581.

Plank Road/Otts Road/MeyersRoad/Seitz Road Intersection Improvements, Montgomery County

- Advance CON from FY19 and FY20 to FY16 and FY17.
- Decrease overall CON cost by $4,216,000 from $16,716,000 ($13,372,000 NHPP/$3,344,000 State 581) in FY19 and FY20 to $12,500,000 ($5,981,000 CAQ/$2,500,000 State 581) in FY16 and FY17.

# Adams Avenue Bridge Over Tacony Creek
## *Philadelphia | Advance Construction (CON)*

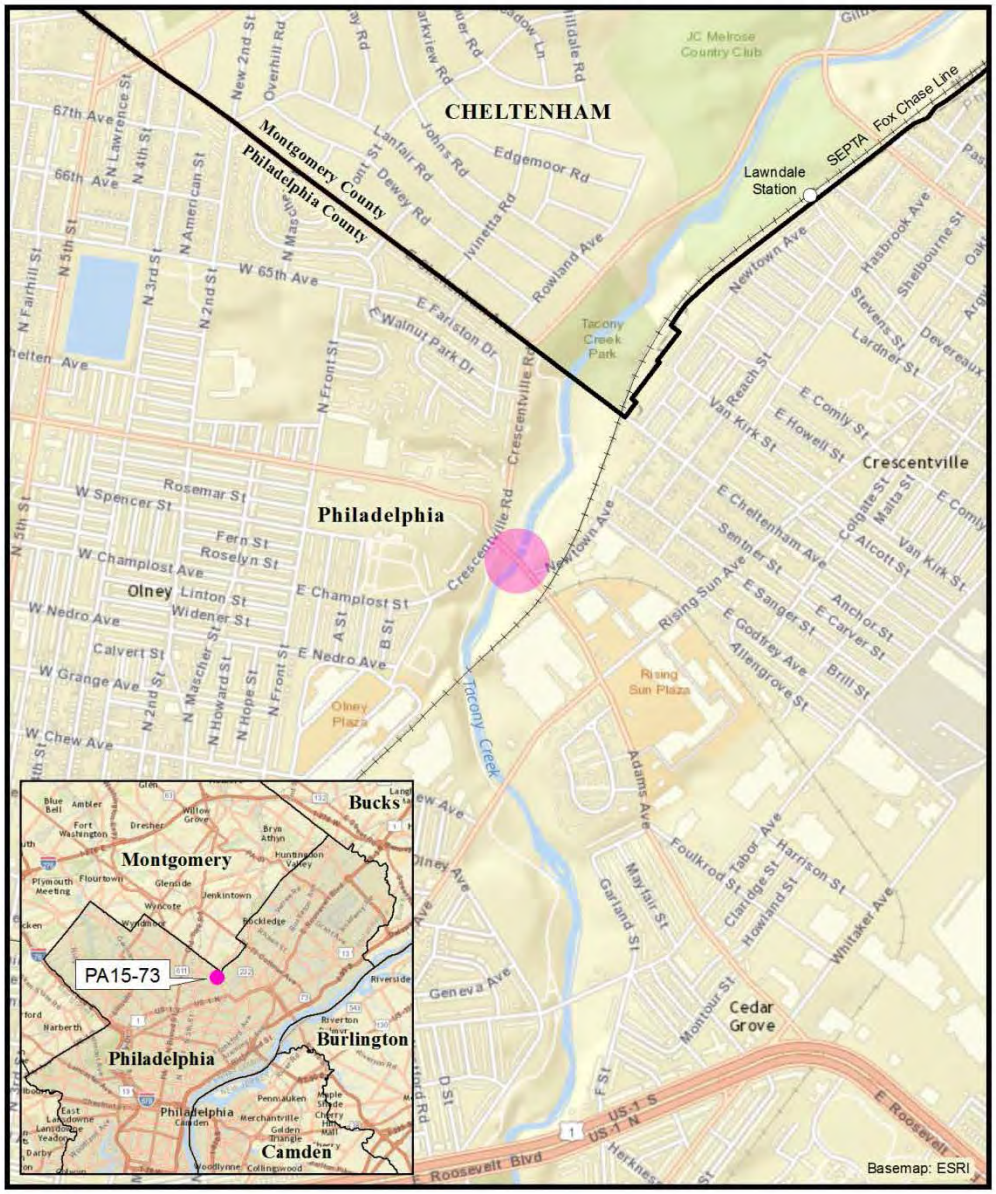
Amend the PA TIP by:

- Advancing CON from FY19 to FY16 ($1,001,301 State 185), FY17 ($495,937 State 185), and FY18 ($2,502,762 State 185).
- Increase overall CON cost by $99,000 from $3,901,000 ($3,121,000 NHPP/ $780,000 State 185) to $4,000,000.

✓ Structurally deficient, historic bridge will be rehabilitated.

✓ Bridge carries roughly 16,600 vehicles per day.

# PA15-73: Adams Avenue Bridge Over Tacony Creek




# US 30 Sinkhole Repairs

## *Chester County | Add Proposed Project to the PA TIP*

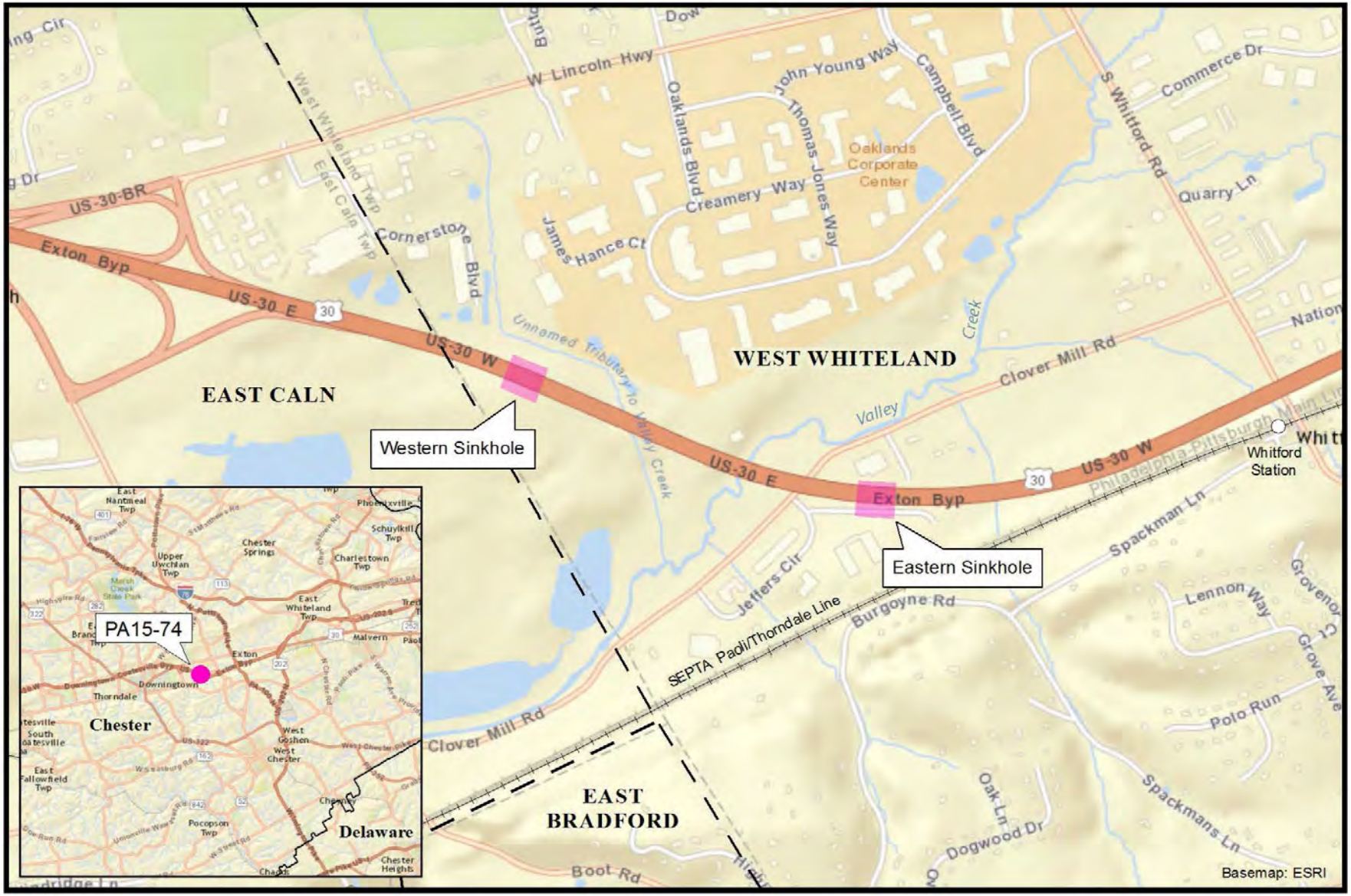
- Amend the PA TIP by adding a new $3,000,000 State 581 funded project, US 30 Sinkhole Repairs, to the PA TIP for FY16 CON.

- Permanent sinkhole repairs will be provided at two locations along US 30 between the Business 30 interchange and Clover Mill Road in West Whiteland Township.

- Sinkholes are considered a serious geologic hazard in central and eastern Pennsylvania.

Source: Michael Price. *Mainline Media News.* April 16, 2014

# PA15-74: US 30 Sinkhole Repairs




N
W E
S

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

0 0.25 0.5
Miles

# Proposed TIP Actions | PA

## *Amend the PA TIP for the following projects:*

Adams Avenue Bridge Over Tacony Creek, Philadelphia

- Advance CON from FY19 to FY16, FY17, and FY18.
- Increase overall CON cost by $99,000 from $3,901,000 ($3,121,000 NHPP/ $780,000 State 185) to $4,000,000.

US 30 Sinkhole Repairs, Chester County

- Add a new $3,000,000 State 581 funded project (US 30 Sinkhole Repairs) to the PA TIP for FY16 CON.

Source: Mainline Media News (Michael Price, April 16, 2014)


dvrpc

# SEPTA Bus Purchase Program

## *SEPTA I Increase Cost*

- Modify the PA TIP by increasing the SEPTA Bus Purchase Program by an overall $21,292,000 ($18,748,000 Section 5307/ $2,462,000 State 1514/ $82,000 Local), which will specifically:
  - Increase the FY16 Purchase of Equipment (PUR) phase by $23,435,000 from $37,688,000 to $61,123,000
  - Decrease the FY19 PUR phase by $2,143,000 from $52,918,000 to $50,775,000.

- ✓ Funding increase is due to FAST Act which increased funding to the FTA Formula programs.
- ✓ Program is a continuous process that replaces buses that have exceeded their useful life.

# Proposed TIP Action | PA

***Modify the PA TIP for the following project:***

## SEPTA Bus Purchase Program , SEPTA

Increase the SEPTA Bus Purchase Program by an overall $21,292,000 ($18,748,000 Section 5307/ $2,462,000 State 1514/ $82,000 Local), which will specifically:

- Increase the FY16 Purchase of Equipment (PUR) phase by $23,435,000 from $37,688,000 to $61,123,000
- Decrease the FY19 PUR phase by $2,143,000 from $52,918,000 to $50,775,000.

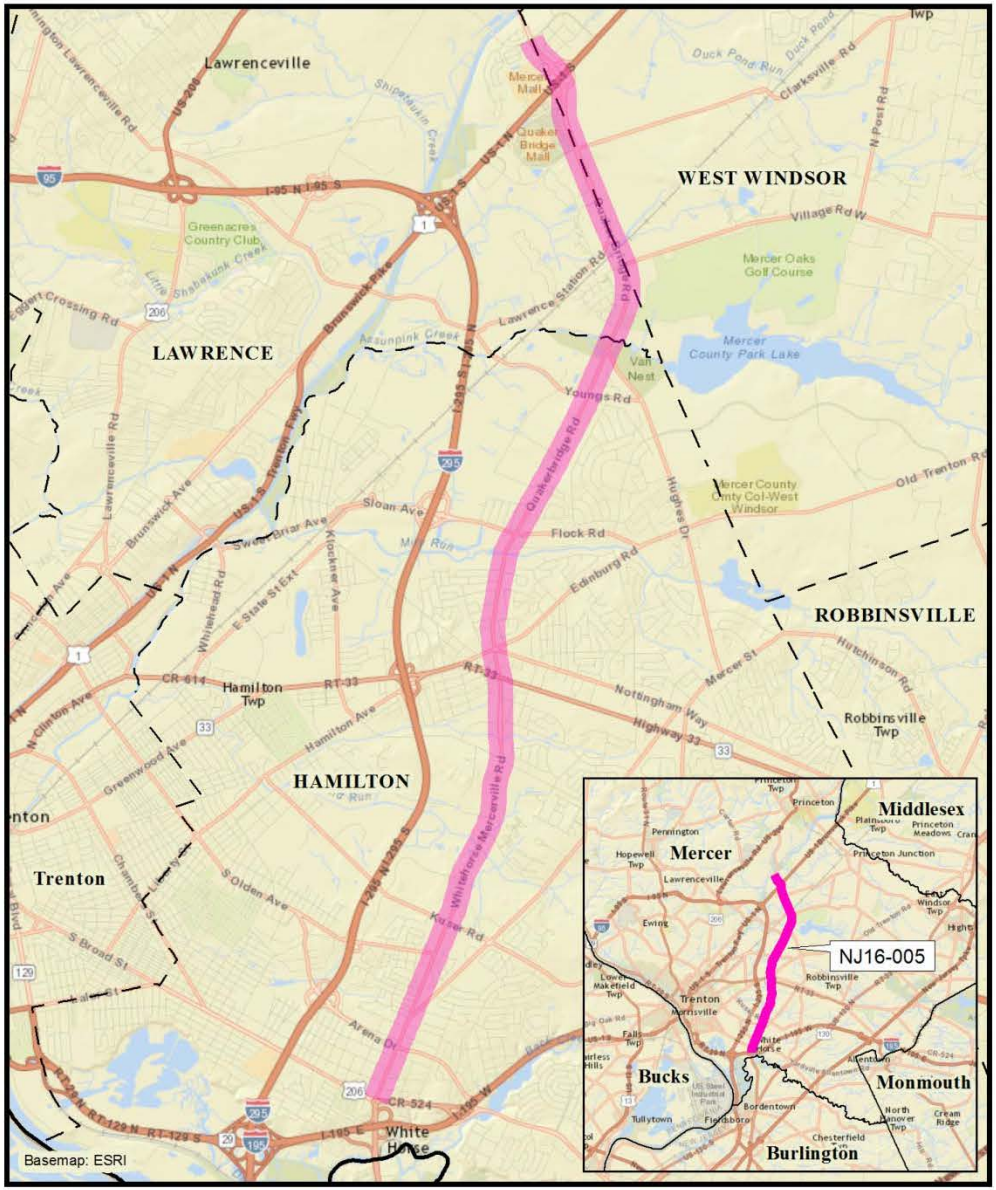
# Mercer County Signal Project, CR 533

## *Mercer County | Add Project Back into NJ TIP*

- Add a $6,500,000 FY14 STATE-DVRPC funded project (Mercer County Signal Project, CR 533) back into the NJ TIP for encumbrance in FY16 to advance FY16 construction.
- There is no change in project scope or cost.

The construction phase will implement the operations plans and signal timing plans and improve turning radii and pedestrian safety at several intersections in order to improve traffic signal coordination for 21 existing signalized intersections on CR 533 from the Whitehorse Circle to Nassau Park Boulevard.

# NJ16-005: Mercer County Signal Project, CR 533




N W E S

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

0 1 2 Miles

NJ TIP

# Proposed TIP Action | NJ

***Amend the NJ TIP for the following project:***

- Mercer County Signal Project, CR 533, Mercer County

Add a $6,500,000 FY14 STATE-DVRPC funded project (Mercer County Signal Project, CR 533) back into the NJ TIP for encumbrance in FY16 to advance FY16 construction.


Transportation Improvement Program

TIP

# Thank You!

www.dvrpc.org/TIP

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

# Activity-Based Travel Model Status

Regional Technical Committee Meeting

2/9/2016

Matt Gates

# Travel Models - Overview

- TIM1.0
  - First VISUM model, completed in 2009
- TIM 2.0
  - Best-in-class 4-step model
  - Used for all current studies
- Tim 3.0
  - Fully disaggregate microsimulated activity based

# Travel Demand Model Comparison

- TIM 2.0
  - Groups households in traffic zones
  - 3,400 traffic zones
  - Discreet trips
- TIM 3.0
  - Individual households
  - 100,000 microzones
  - Trips “chained” into tours

# New Requirements and Challenges

- New policy questions to answer:
  - Congestion pricing
  - Operations planning: highway and transit
  - Effects of bicycle and pedestrian improvements
  - Effect of mixed-use, transit oriented development
  - Climate change impacts of travel patterns
  - Emergency and evacuation planning
- Advances in the tools and in the practice of MPO modeling
  - Faster, better assignment algorithms
  - New data sources for model development and testing
  - Non-motorized travel demand models

# Calibration and Validation Data Sources

- Household survey on travel and demographics
- Census data on housing, household and person distributions, journey to work
- Transit on-board survey data on transfer rates, sub-mode/access, line/stop/station counts
- Traffic counts by time of day and vehicle class
- Traffic speeds by time of day
- Park-and-ride lot volumes and trip lengths

# Calibration Measures: Long-Term Choices

- Household Vehicle Availability
  - Household county/district
  - Income group
  - Number drivers
- Person Work, K-12 School & College Locations
  - Trip-length and duration distributions
  - District-to-district flows
  - Number persons working/going to school at home
- Transit Pass
  - Transit pass holders

# Calibration Measures: Activity & Tour Based

- Tours by Primary Purpose
  - Work, school, escort, personal bus., shopping, meal, soc./rec.
  - Joint activity tours
  - Tours by person type
  - Arrival time distribution
  - Departure time distribution
  - Duration distribution
- Stops Per Tour by Primary Purpose
- Primary Tour Mode by Primary Purpose

# Calibration Measures: Trip-Based

- Trips by Purpose
  - Work, school, escort, personal bus., shopping, meal, soc./rec.
  - For comparison with TIM 2, can be reformulated as home-based, non-home-based
- Calibration Metrics
  - Frequencies
  - Trip-Length Distributions
  - O-D Movement Summaries
  - Mode Shares
  - Park-and-Ride Volumes and Occupancies

# Validation Measures for the System

- Traffic Count Validation
  - Volumes by facility type, time-of-day, district, screenline
  - Vehicle miles traveled by facility type
- Transit Count Validation
  - Boardings by submode, operator, route
  - Boardings and alightings at key stations
  - Loads at screenlines
  - Unlinked transit trip lengths
  - Transfer rates by mode

# Current Status

- Calibrate each model component
  - ✓ Usual Work and School Location
  - ✓ Auto Ownership
  - ✓ Day Pattern
  - ✓ Tour Destination
  - ✓ Tour Mode
  - ✓ Tour Time-of-Day
  - ✓ Park-and-Ride
  - ✓ Transit Pass
  - ✓ Trip Mode
  - ✓ Intermediate Stop Timing
- Validate the integrated modeling system
  - Highway Assignment
  - Transit Assignment

# After Validation

- Reasonableness checks
  - Response to policy scenarios
  - Changes to activity/tour duration, peak spreading, mode shifts, trip distances, activity frequencies
  - System performance (convergence properties, run times)
- Back-casting exercises
  - Before and after study for a recently built project
  - Highway example: US 202 Parkway
  - Transit example: NJT River Line

# Next Steps

- RSG finishes validation for 2010 base year
- DVRPC staff reviews validation
- Steering Committee update, review, and comment
- Back-casting exercises
  - US 202 Section 700 Parkway
  - NJ Transit RiverLINE
- Re-validation for 2015 base year
- Code TIP and LR Plan projects
  - 2025, 2035, 2045 analysis years
- Use TIM3.0 for all new studies & conformity determinations

# After TIM 3.0

- Special generators (airport, sport complex)
- Truck and taxi model
- External travel
- Multiclass assignment
- Dynamic traffic assignment
- Microscopic simulation
- Land-use model
- Mobility model
- Operational transit model
- Economic analysis model