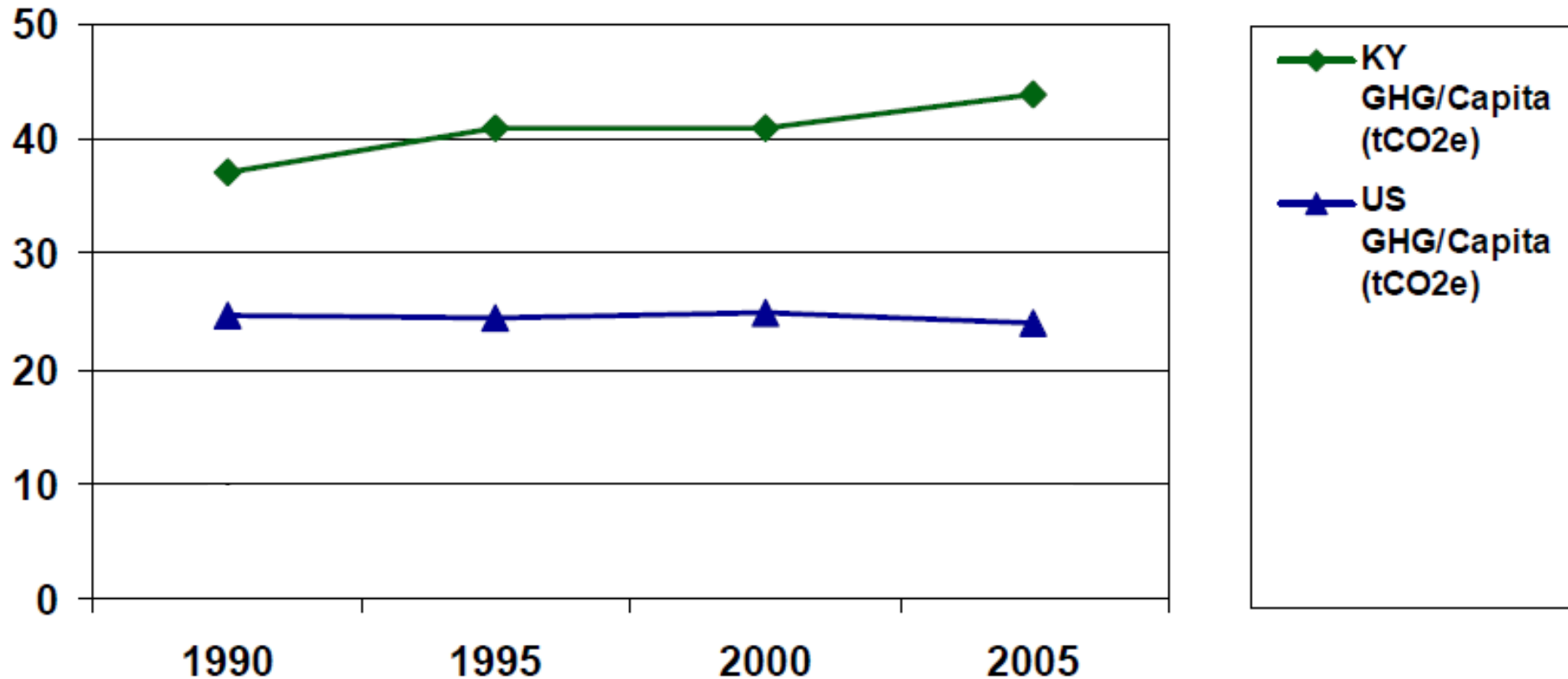




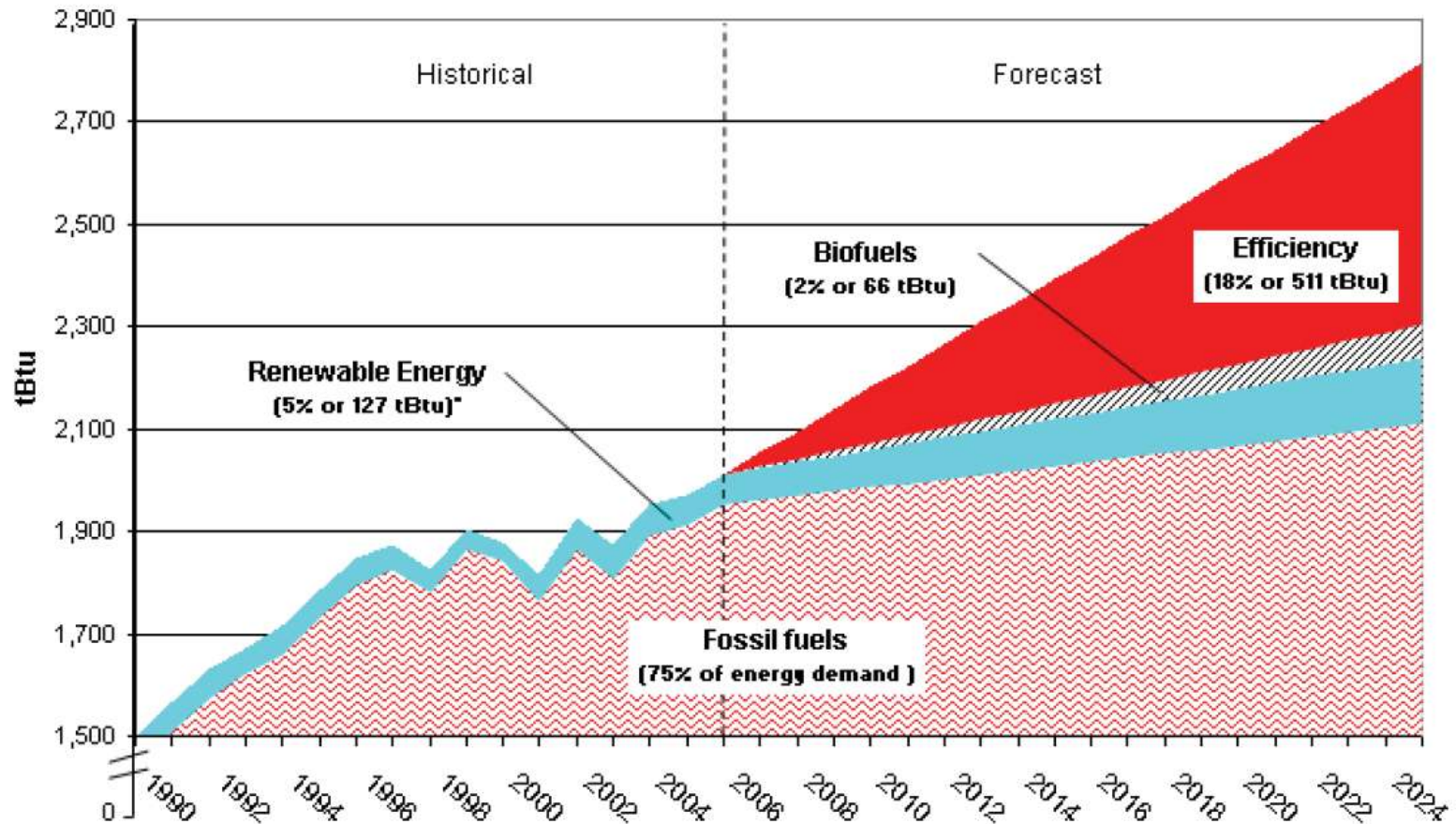
# Potential of Kentucky Freeway Rights of Way to Displace Fossil Fuel Consumption through Production of Prairie Switchgrass

Michael Bomford, Tamara Sluss,  
Sharmali Hansford and Ken Bates

# Ky GHG emissions are twice US average and growing



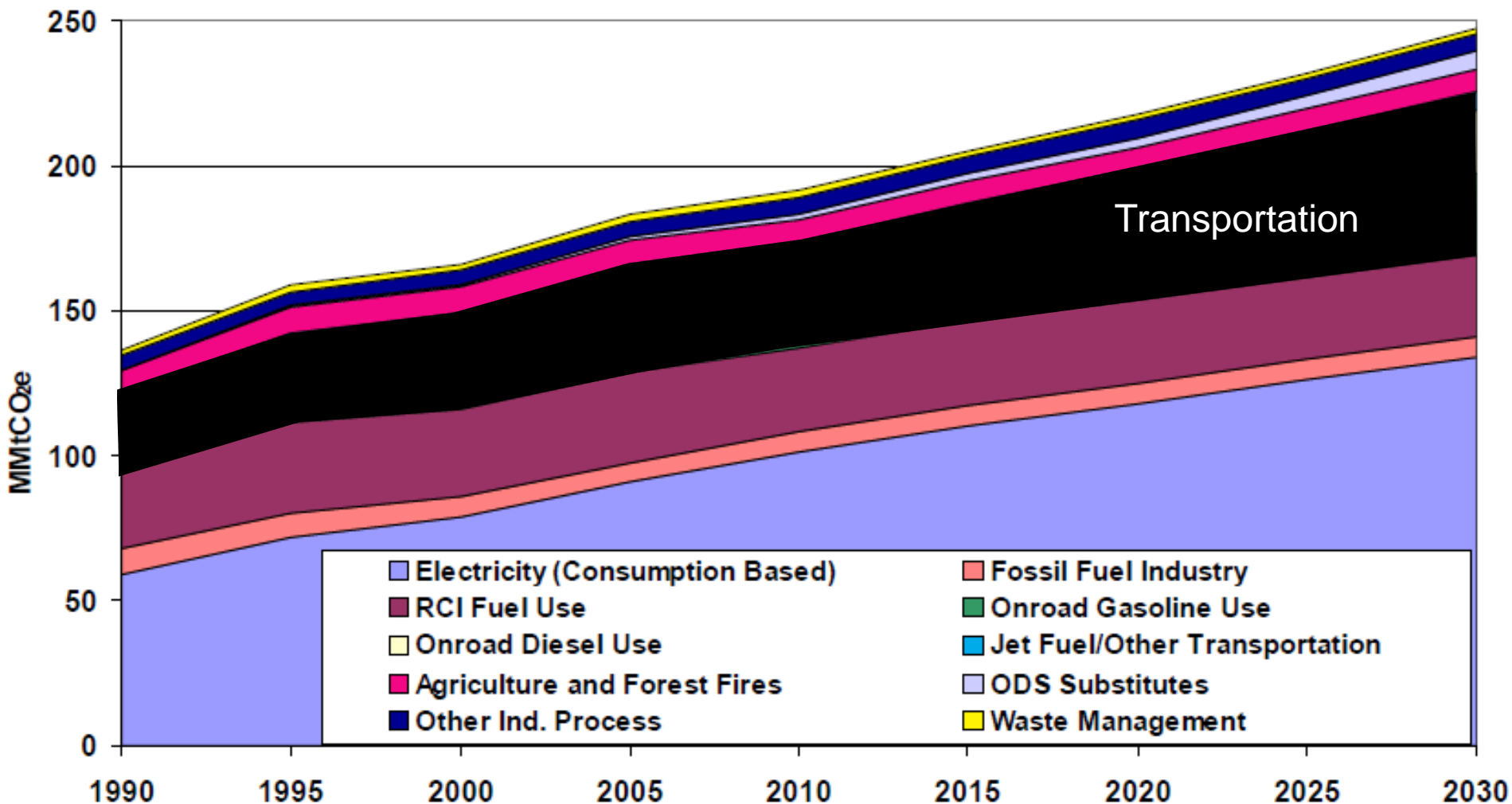
# KY Plans to Increase Fossil Fuel Use, but Offset Some Of the Increase with Biofuels



\* Historical renewable energy was derived from hydroelectric (52-75%) and biomass (24-46%); remainder was unspecified "other."  
 (Source: EIA, [http://www.eia.doe.gov/emeu/states/sep\\_use/total/use\\_tot\\_ky.html](http://www.eia.doe.gov/emeu/states/sep_use/total/use_tot_ky.html))

Figure 10: Kentucky Total Energy Consumption and Savings Potential (2025 Goal)

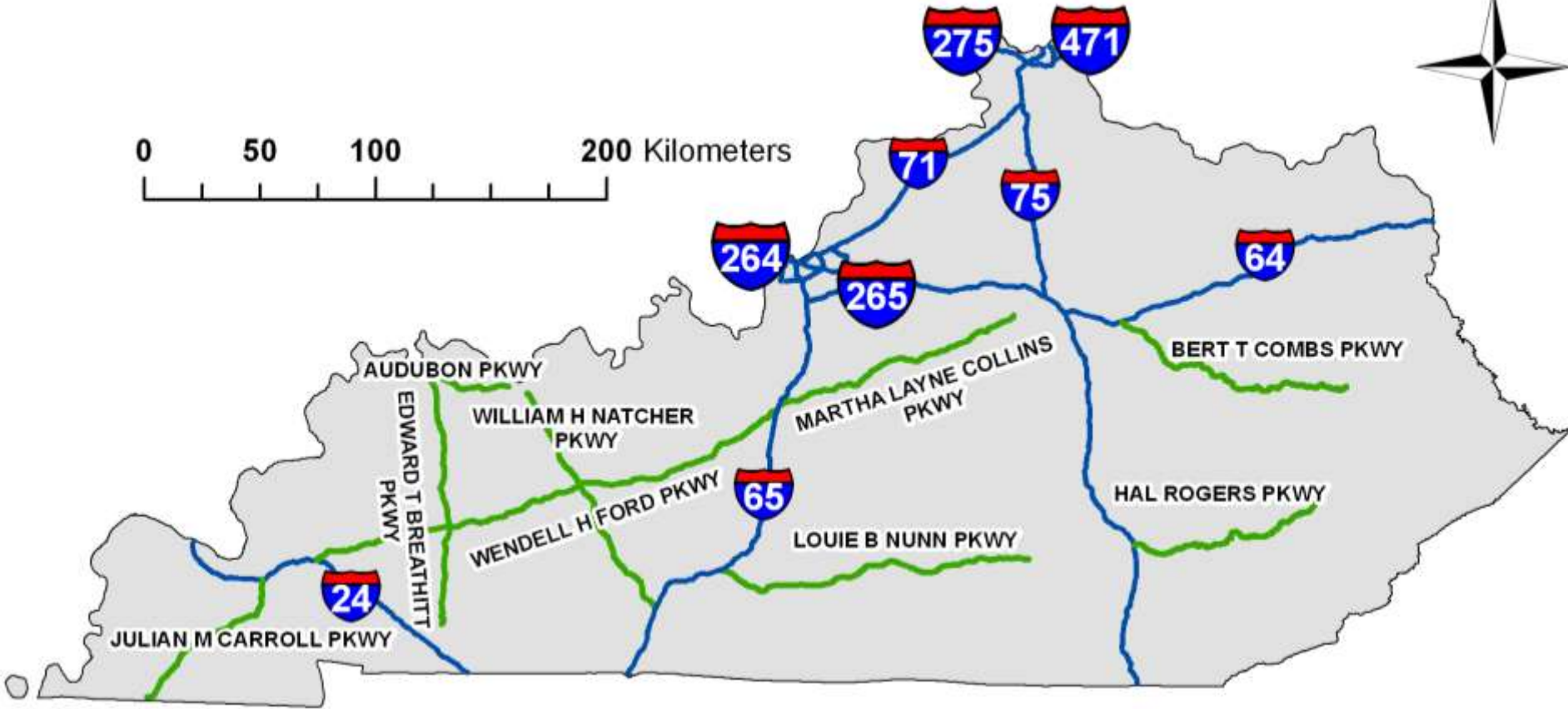
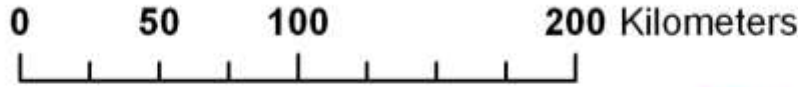
# Transportation Projected to Become Second Largest Source of GHG in KY after Electricity



# Kentucky freeways

- 9 interstates; 9 parkways
- One-third of vehicle distance traveled in state
- One-fifth of transportation system energy use
- Require guardrails or roadside recovery areas, free of fixed objects, along shoulders and between opposing lanes
- Disturbed, homogenous environment
- Annual mowing cost ~\$4 million
- Some states allow hay harvest along freeways

# Kentucky freeways



## Questions & Context

- How much biomass could be produced if currently mowed areas were used for switchgrass production?
- How much ethanol or electricity could be made from this switchgrass?
- What proportion of the fuel used on Kentucky freeways could be offset by switchgrass grown in their rights of way?

# Methods

- Total mowed area of freeway medians and shoulders determined using GIS





# Variables

	<b>Variable</b>	<b>Unit</b>	<b>Source</b>
Freeway length	$D$	km	This study
Mowed area	$A$	ha	This study
Annual traffic volume	$V$	vehicles	KYTC Traffic Counts System 2010

# Assumptions

	Constant	Value	Unit	Source
Switchgrass yield	<i>Y</i>	15	Mg ha <sup>-1</sup> y <sup>-1</sup>	1
Net ethanol yield	<i>E</i>	0.33	L kg <sup>-1</sup>	2-4
Net electricity yield	<i>L</i>	1.0	W h g <sup>-1</sup>	2-4
Highway ethanol consumption	<i>F</i>	0.17	L km <sup>-1</sup>	Fuel consumption (5) converted to EtOH equiv.
Highway electricity consumption	<i>W</i>	0.32	kW h km <sup>-1</sup>	Consumption of existing elec. vehics. compared to conventional eqivs. (4)

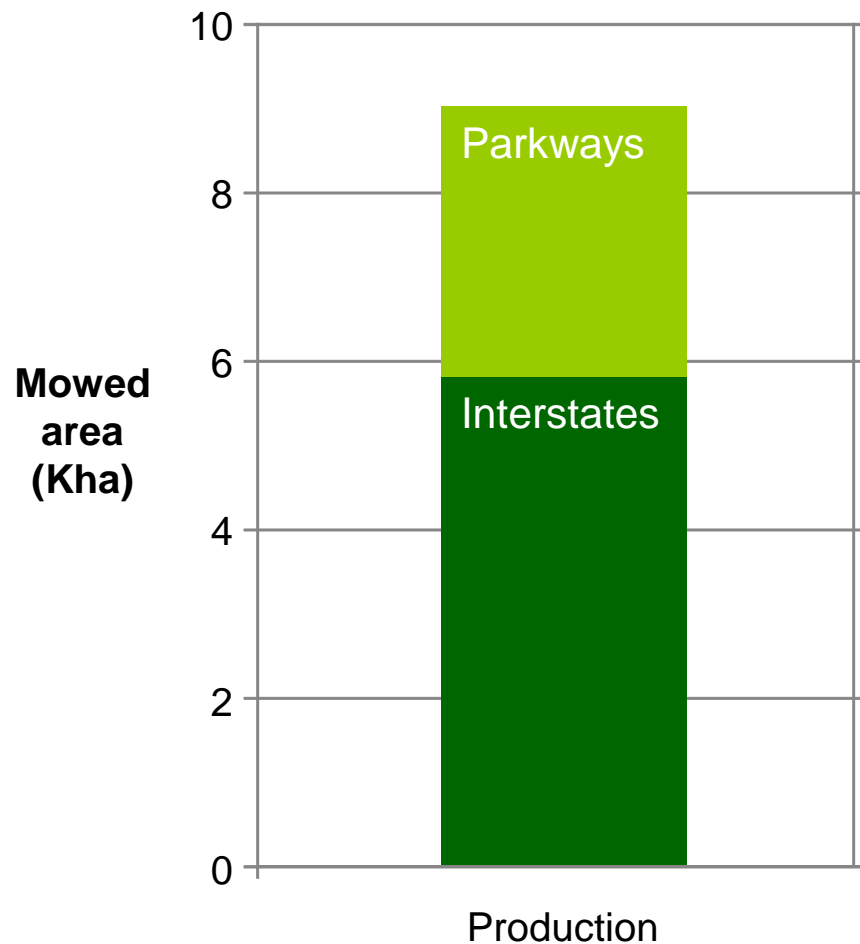
1. Fike et al. 2006. Switchgrass production for the upper southeastern USA: Influence of cultivar and cutting frequency on biomass yields. *Biomass and Bioenergy* 3: 207-213.
2. Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (Argonne National Laboratory, 2010)
3. Energy and Resources Group Biofuel Analysis Meta-Model (Berkeley, 2007)
4. Campbell et al. 2009. Greater Transportation Energy and GHG Offsets from Bioelectricity than Ethanol – Supporting Online Material. *Science Express*.
5. USDOT – Federal Highway Administration. Highway Statistics Series (2009)

# Calculations

	Calculation	Unit
Switchgrass production	$AY$	$\text{Mg y}^{-1}$
Ethanol production	$10^3 AYE$	$\text{L y}^{-1}$
Electricity production	$AYL$	$\text{MW h y}^{-1}$
Vehicle distance traveled	$DV$	$\text{Km y}^{-1}$
Ethanol production/consumption	$10^3 AYE / DVF$	%
Electricity production/consumption	$10^3 AYL / DVW$	%

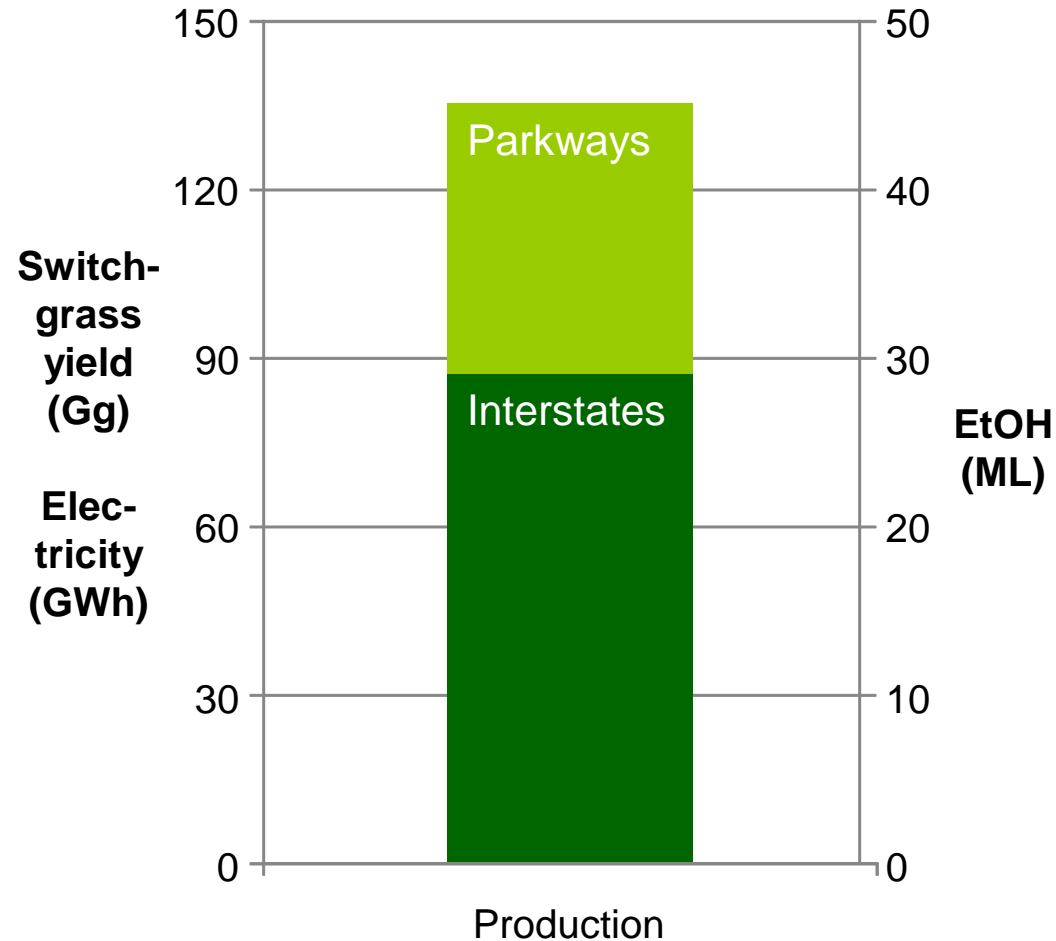
# Results

- 9,151 ha of mowed grass along 2,260 freeway Km



# Results

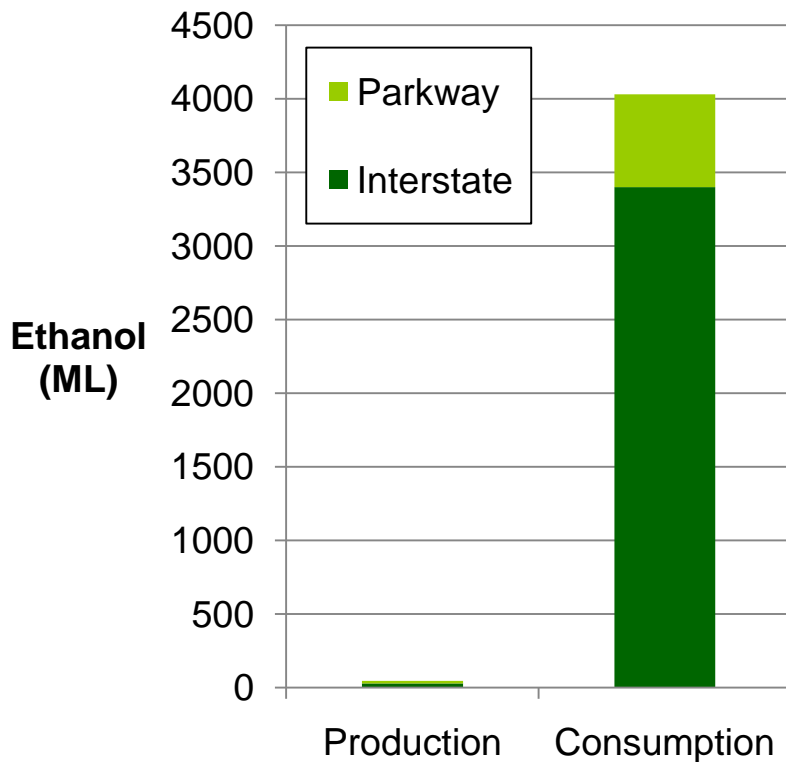
- 9,151 ha of mowed grass along 2,260 freeway Km
- Switchgrass potential:  
137,000 t y<sup>-1</sup>
  - 45 million L ethanol
  - 137 GWh electricity



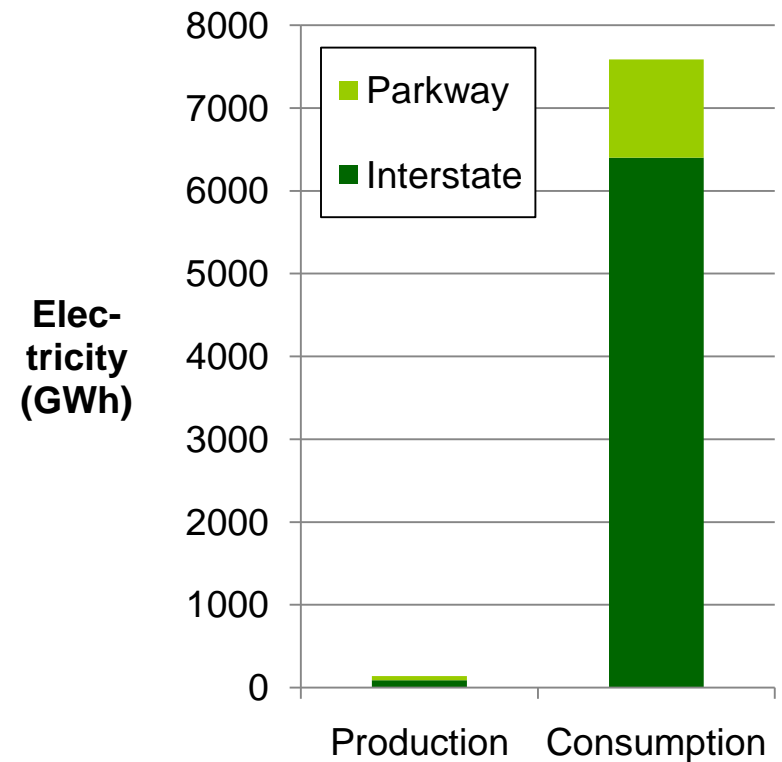
# Potential production and consumption of Ky freeways

(assumes no change in traffic volume or vehicle efficiency)

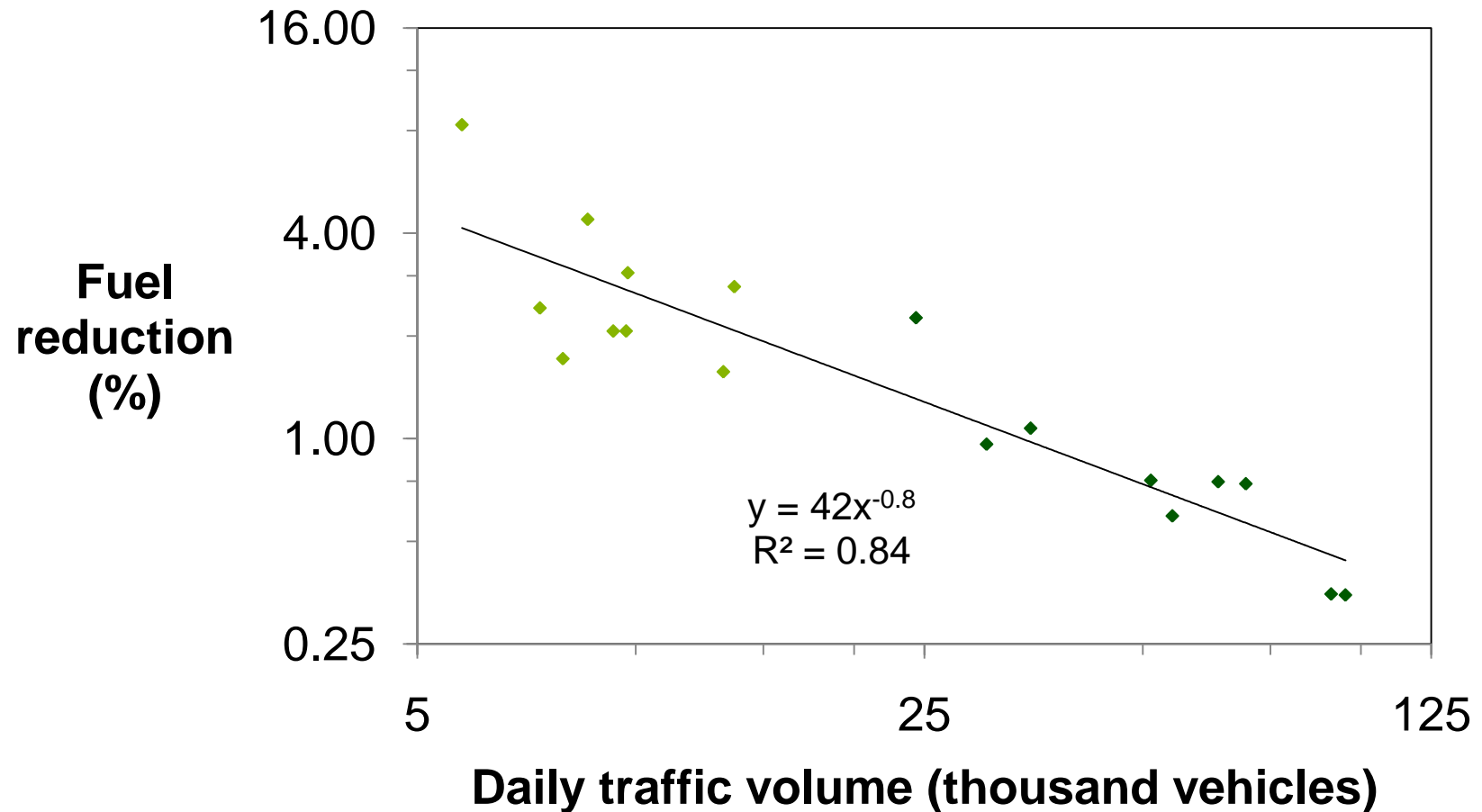
## Ethanol pathway – 1.1%



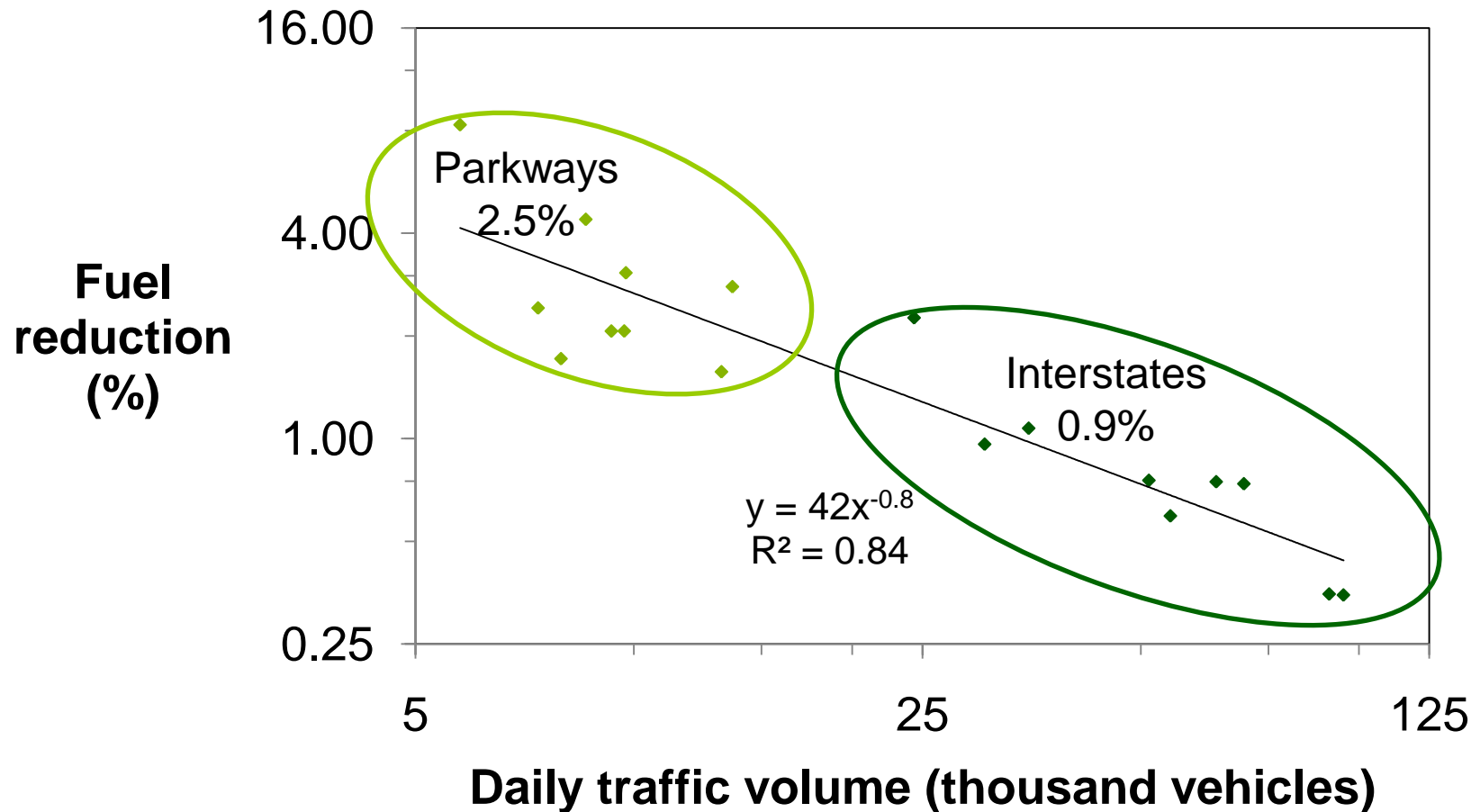
## Electricity pathway – 1.8%



# Relationship between traffic volume and fuel reduction potential for Ky freeways growing switchgrass converted to ethanol (log scales)



# Relationship between traffic volume and fuel reduction potential for Ky freeways growing switchgrass converted to ethanol (log scales)





# Conclusions

- Ky freeway rights of way have about 9,000 ha (22,000 ac.) of mowed land
- Switchgrass grown on this land could make
  - Enough ethanol to offset 1.1% of freeway fuel use
  - Enough electricity to offset 1.8% of freeway fuel use(Assuming no change in traffic volume or efficiency)
- Differences in traffic volume have much greater effect on fuel offset potential than differences in mowable area

# Acknowledgements...

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