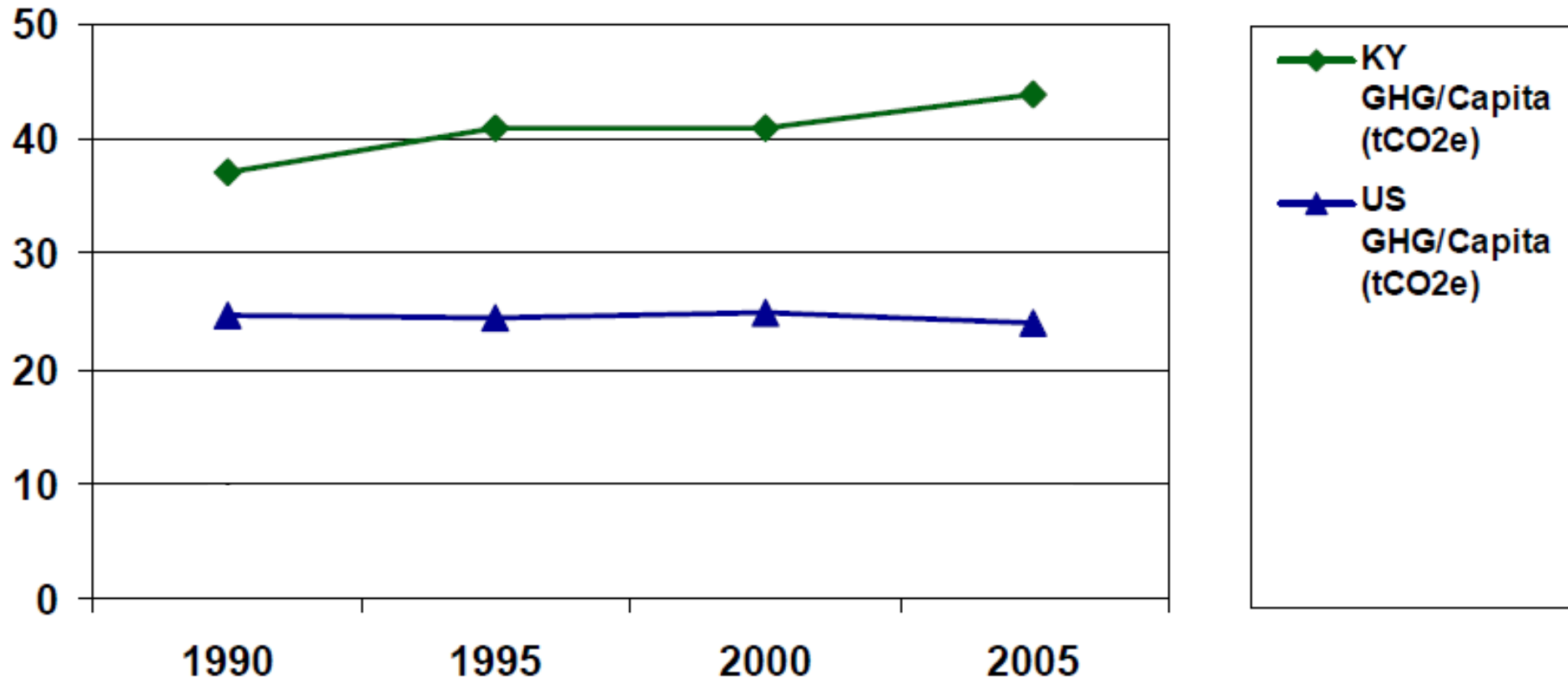




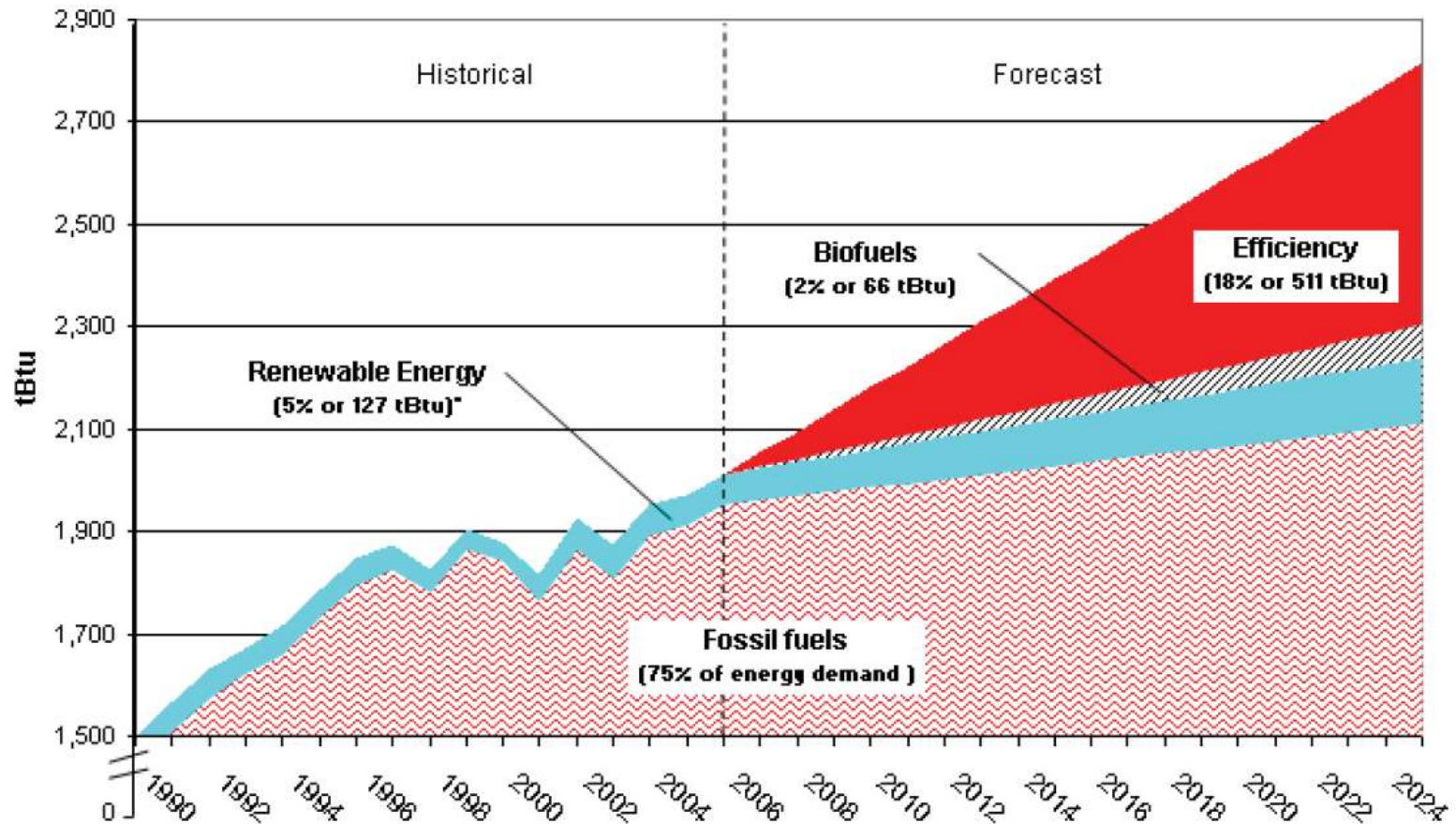
Potential of Kentucky Freeway Rights of Way to Displace Fossil Fuel Consumption through Production of Prairie Switchgrass

Michael Bomford, Tamara Sluss,
Sharmali Hansford and Ken Bates

Ky GHG emissions are twice US average and growing



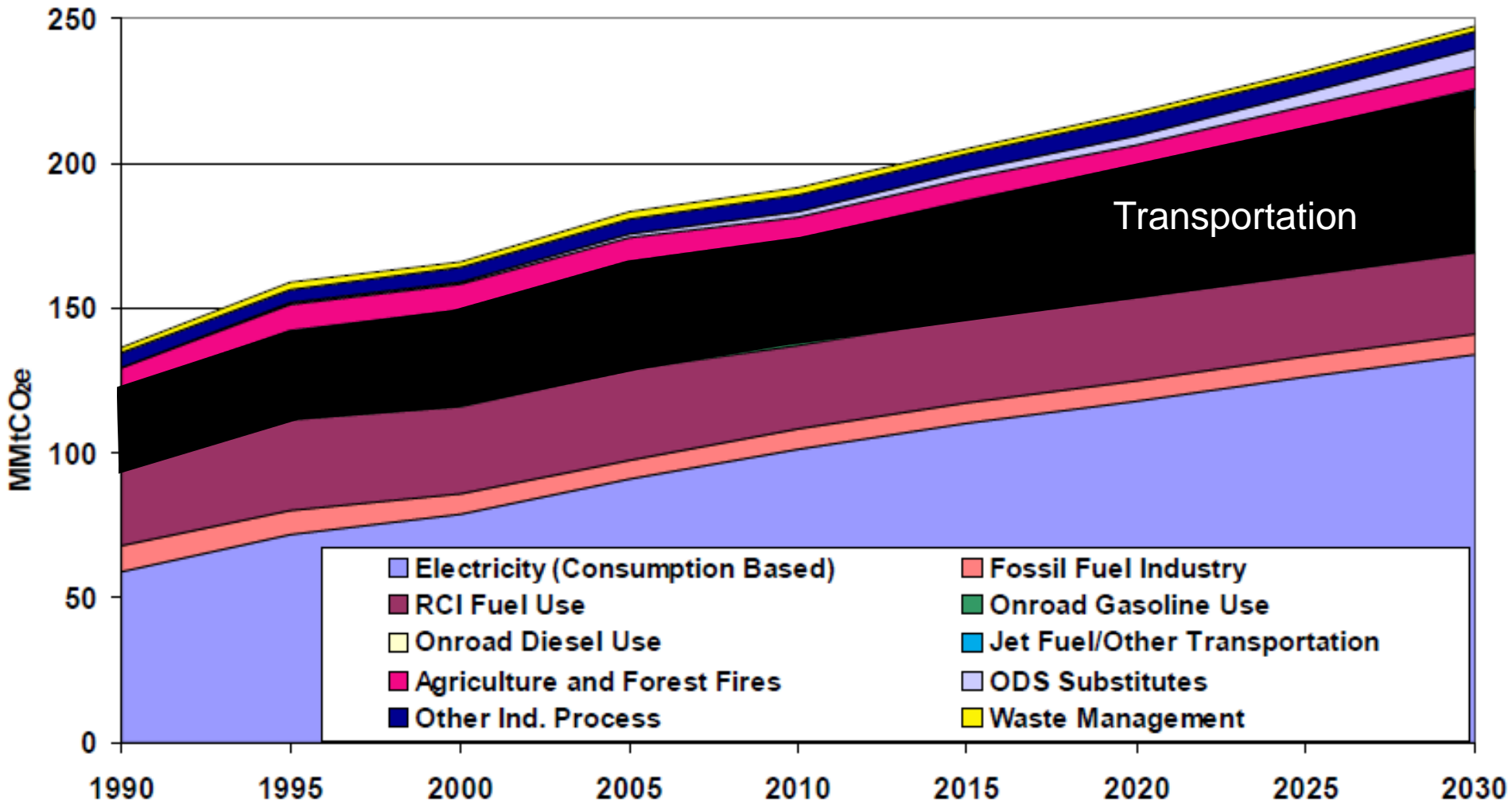
KY Plans to Increase Fossil Fuel Use, but Offset Some Of the Increase with Biofuels



* 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)

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

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



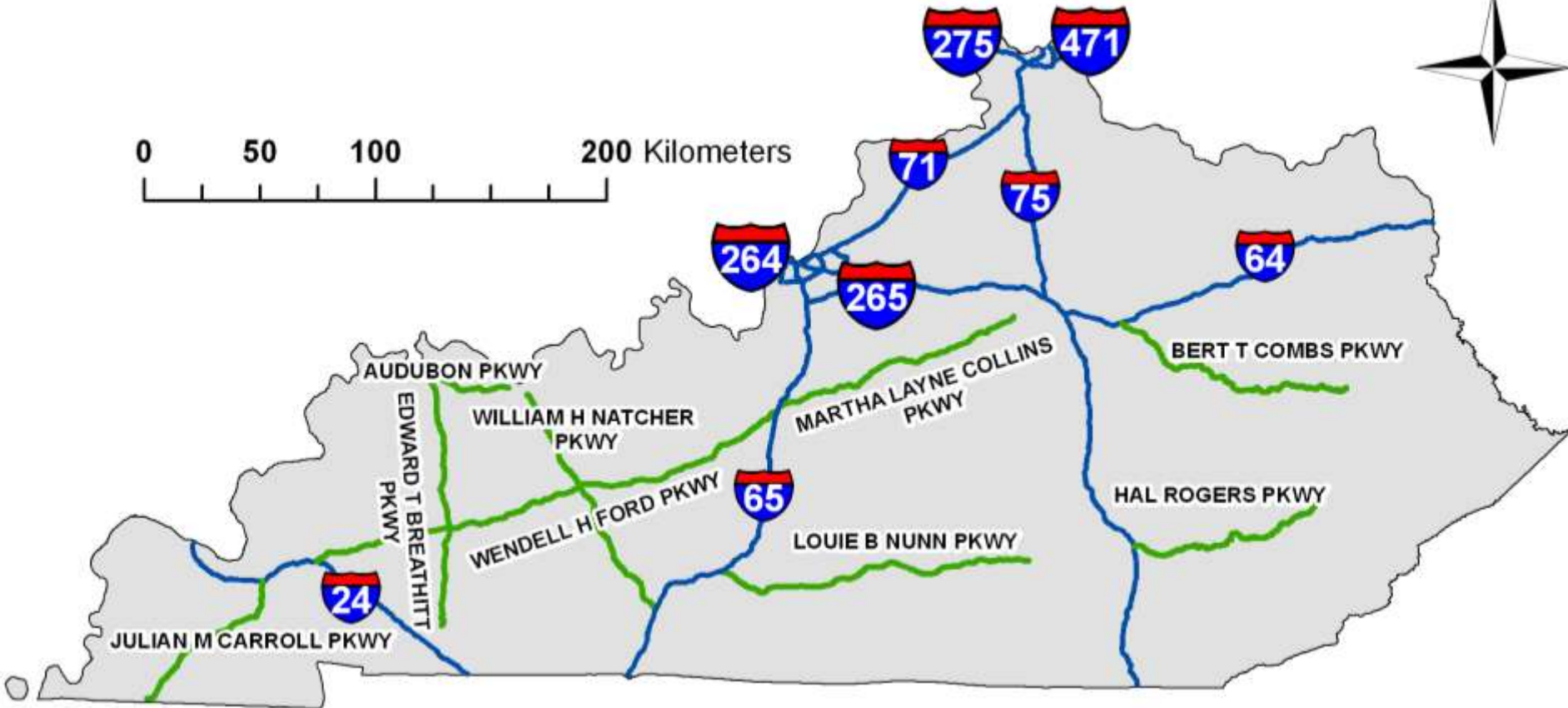
Kentucky freeways

- 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



0 50 100 200 Kilometers



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

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

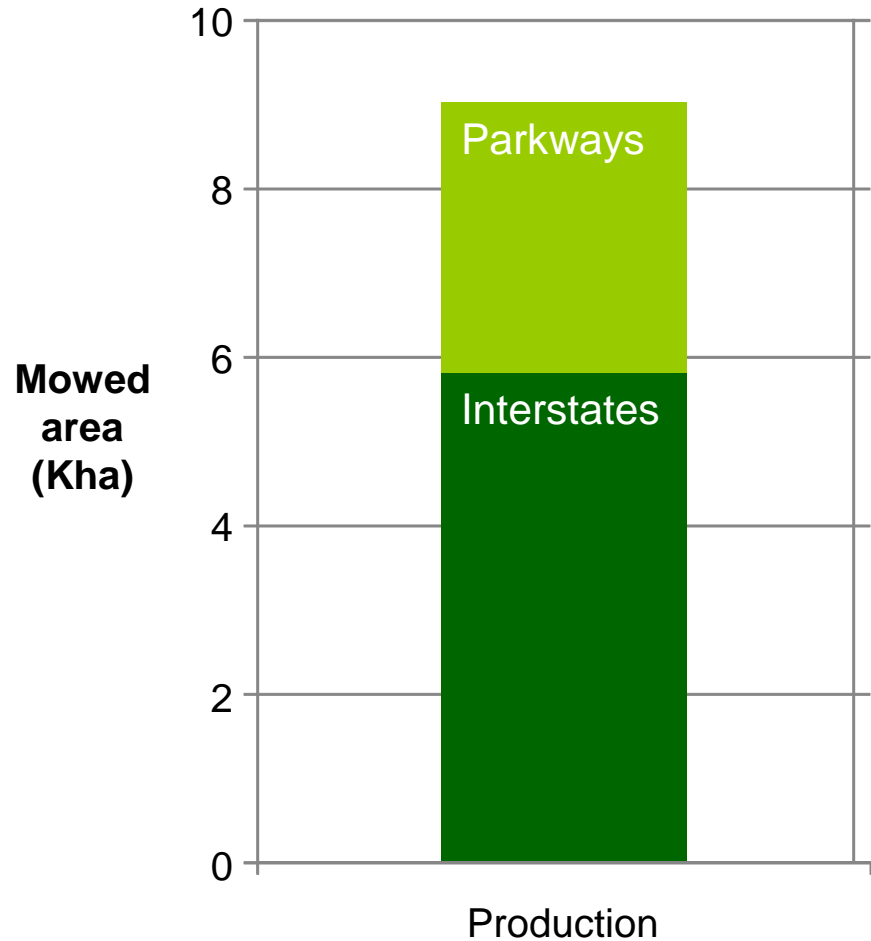
1. Fike et al. 2006. Switchgrass production for the upper southeastern USA: Influence of cultivar and cutting frequency on biomass yields. *Biomass and Bioenergy* 3: 207-213.
2. Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (Argonne National Laboratory, 2010)
3. Energy 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	Mg y^{-1}
Ethanol production	$10^3 AYE$	L y^{-1}
Electricity production	AYL	MW h y^{-1}
Vehicle distance traveled	DV	Km y^{-1}
Ethanol production/consumption	$10^3 AYE / DVF$	%
Electricity production/consumption	$10^3 AYL / DVW$	%

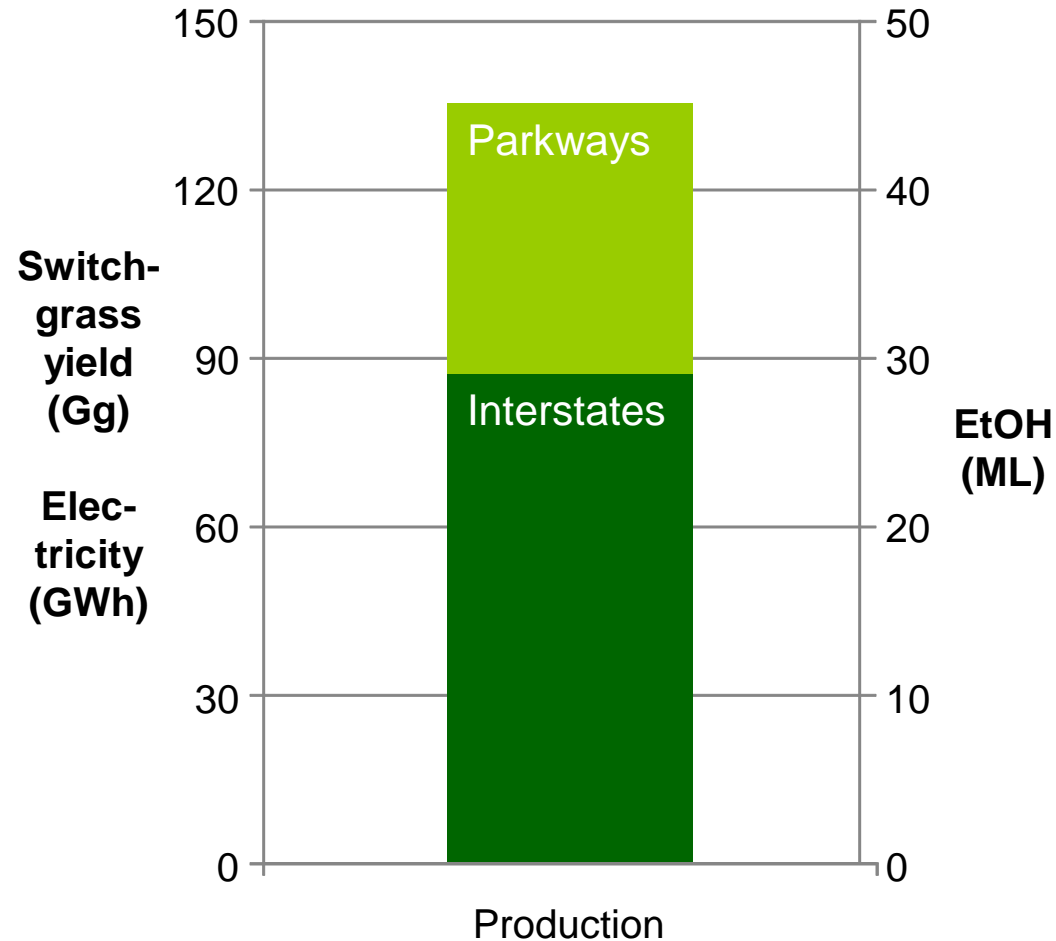
Results

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



Results

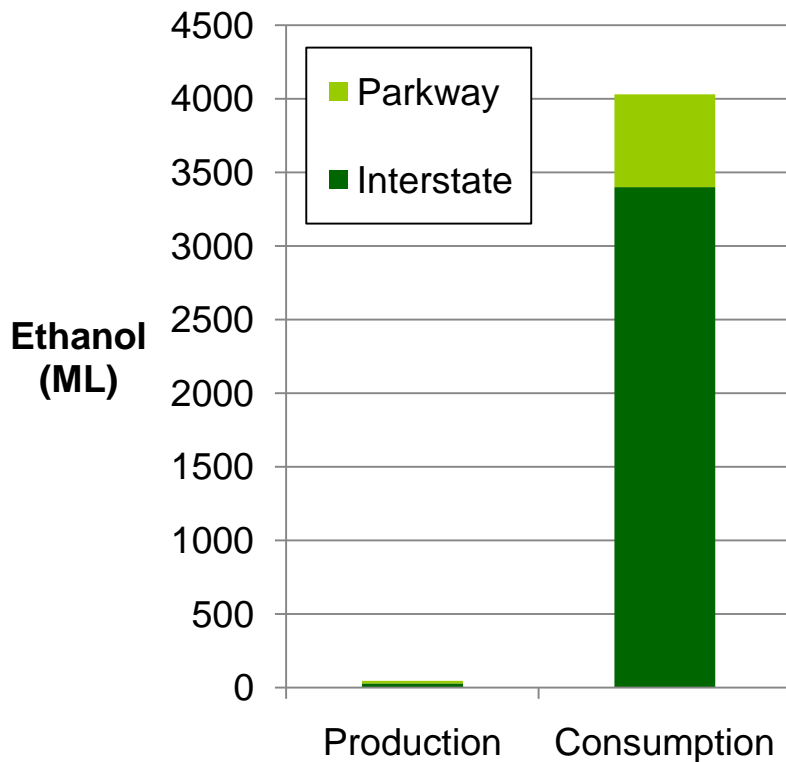
- 9,151 ha of mowed grass along 2,260 freeway Km
- Switchgrass potential:
137,000 t y⁻¹
 - 45 million L ethanol
 - 137 GWh electricity



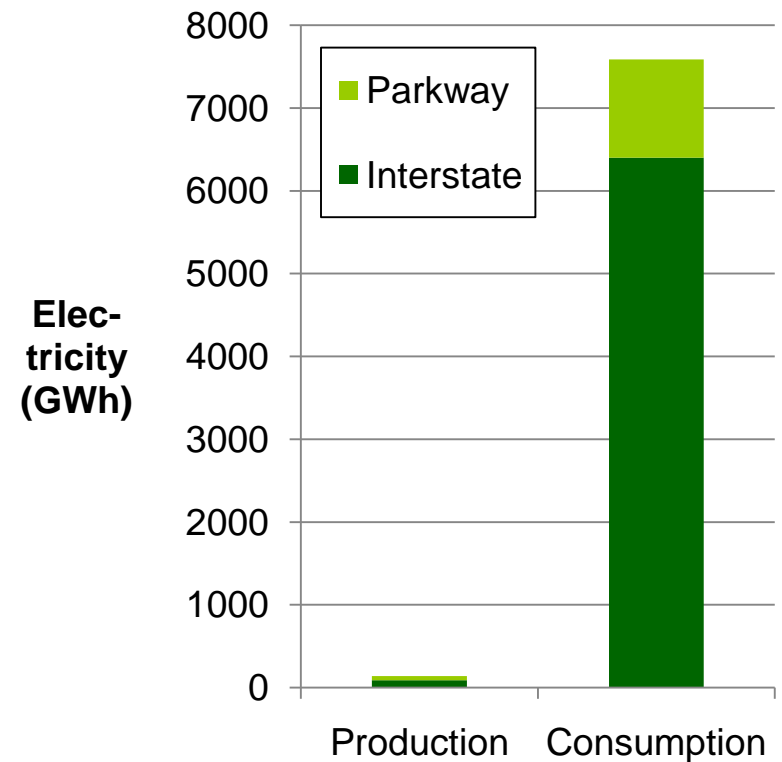
Potential production and consumption of Ky freeways

(assumes no change in traffic volume or vehicle efficiency)

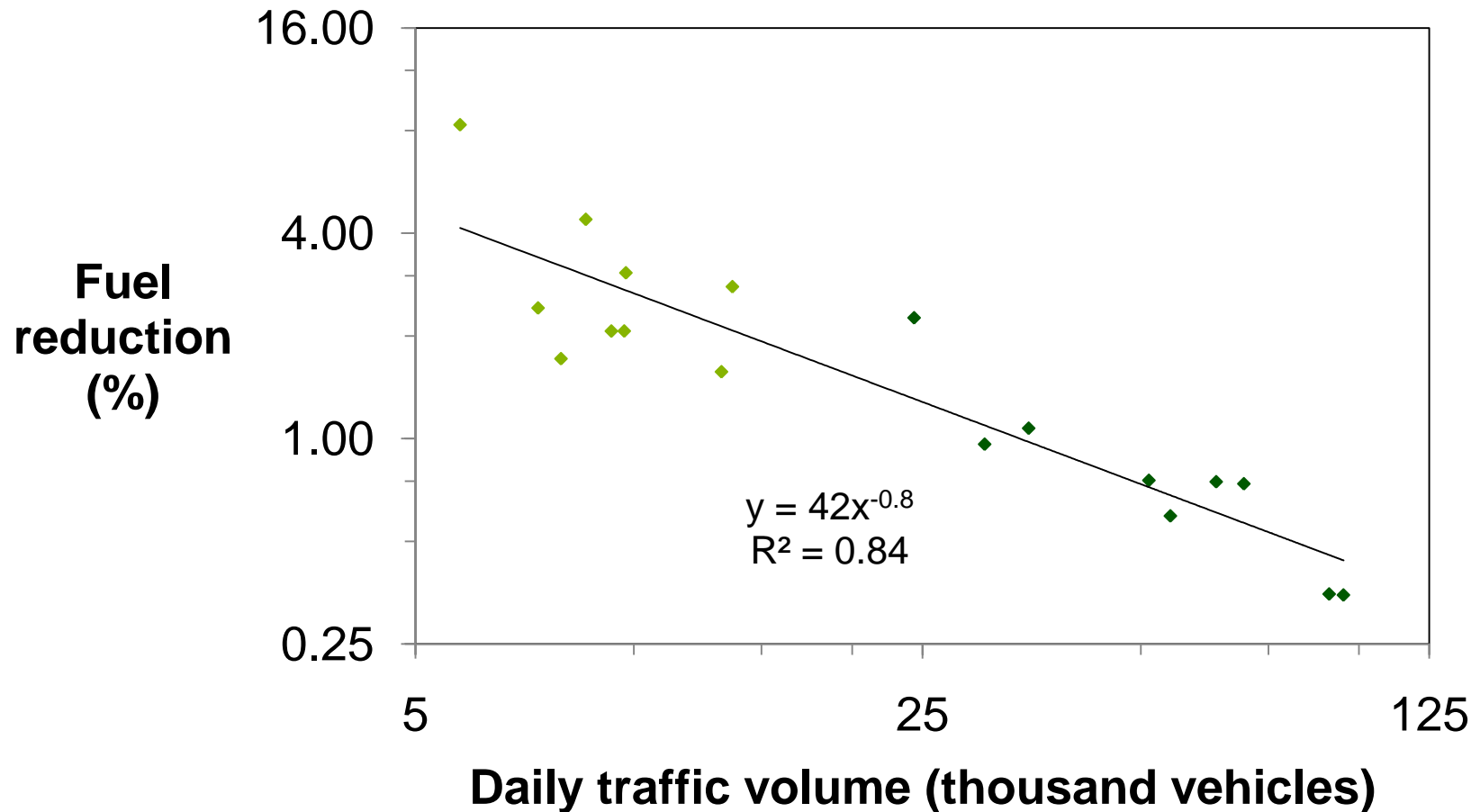
Ethanol pathway – 1.1%



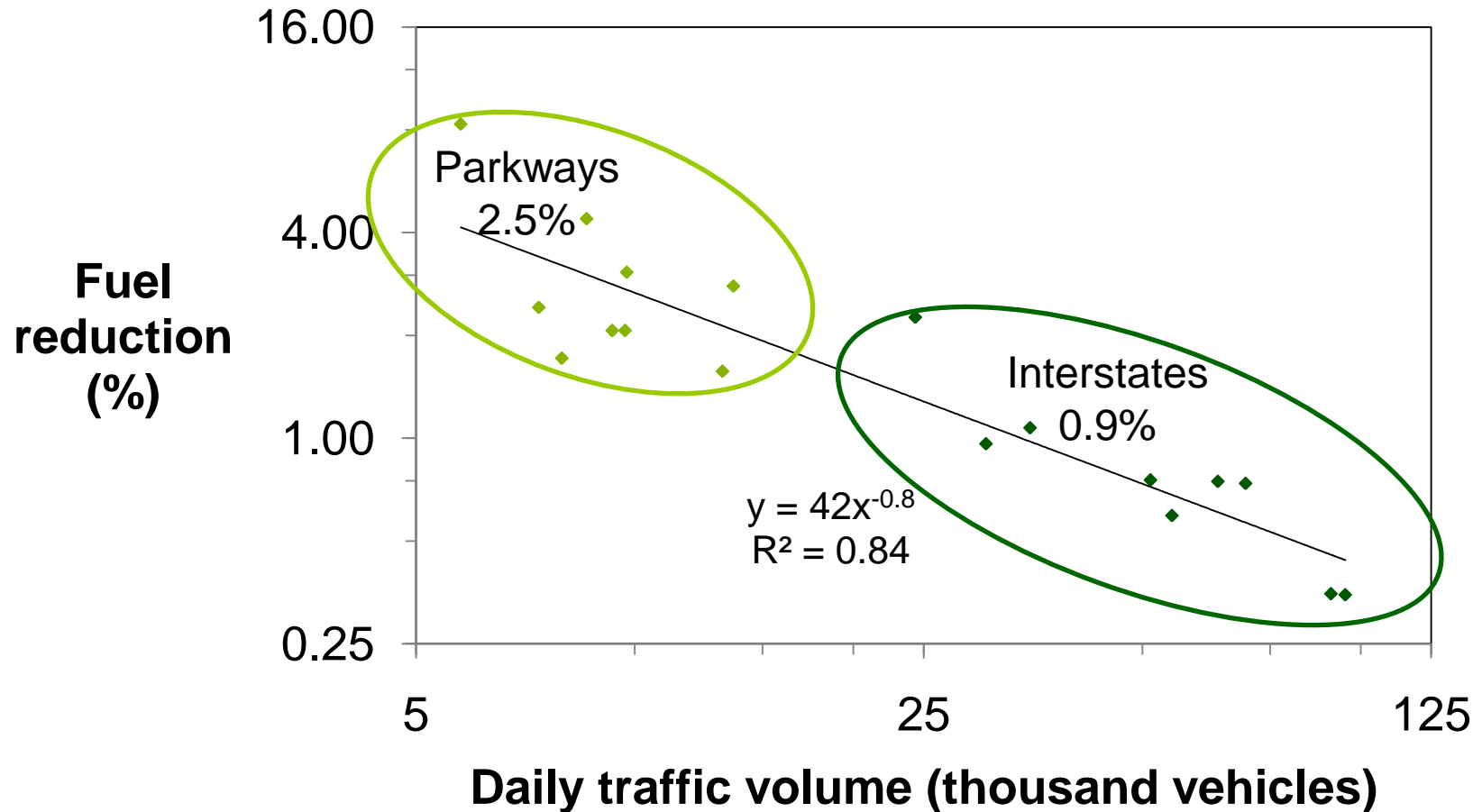
Electricity pathway – 1.8%



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

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