Greenhouse Gas Benefits for Biofuels Depend on a Carbon Credit for Plant Growth

Source of fuel*	Producing Feedstock (crude oil or crop)	Refining	Tailpipe Emis-sions	Fermen t-ation emissions	Total GHGs & % Increase for Biofuel *Without Plant Credit*	Credit for Plant Growth	Total GHGs & % Savings for Biofuel
Gasoline	**+4.5**	**+8**	**+73.3**	-	**85.8**	-	**85.8**
EU Ethanol	***+40***	***+21.2***	~~***+71.4***~~	~~***+35.7***~~	***168.3 (+96%)***	~~***107.1***~~	***+61.2 (-29%)***

Greenhouse gas emissions and sinks (CO_2 eqv.) per mega joule of fuel (specific numbers from EU JRC)

Effect of switching from gasoline to biofuels grown on otherwise unproductive land – Reduced atmospheric CO_2 through increased plant growth

Unproductive land

CO_2 emission

Car, gasoline

Gasoline Use

New crop growth

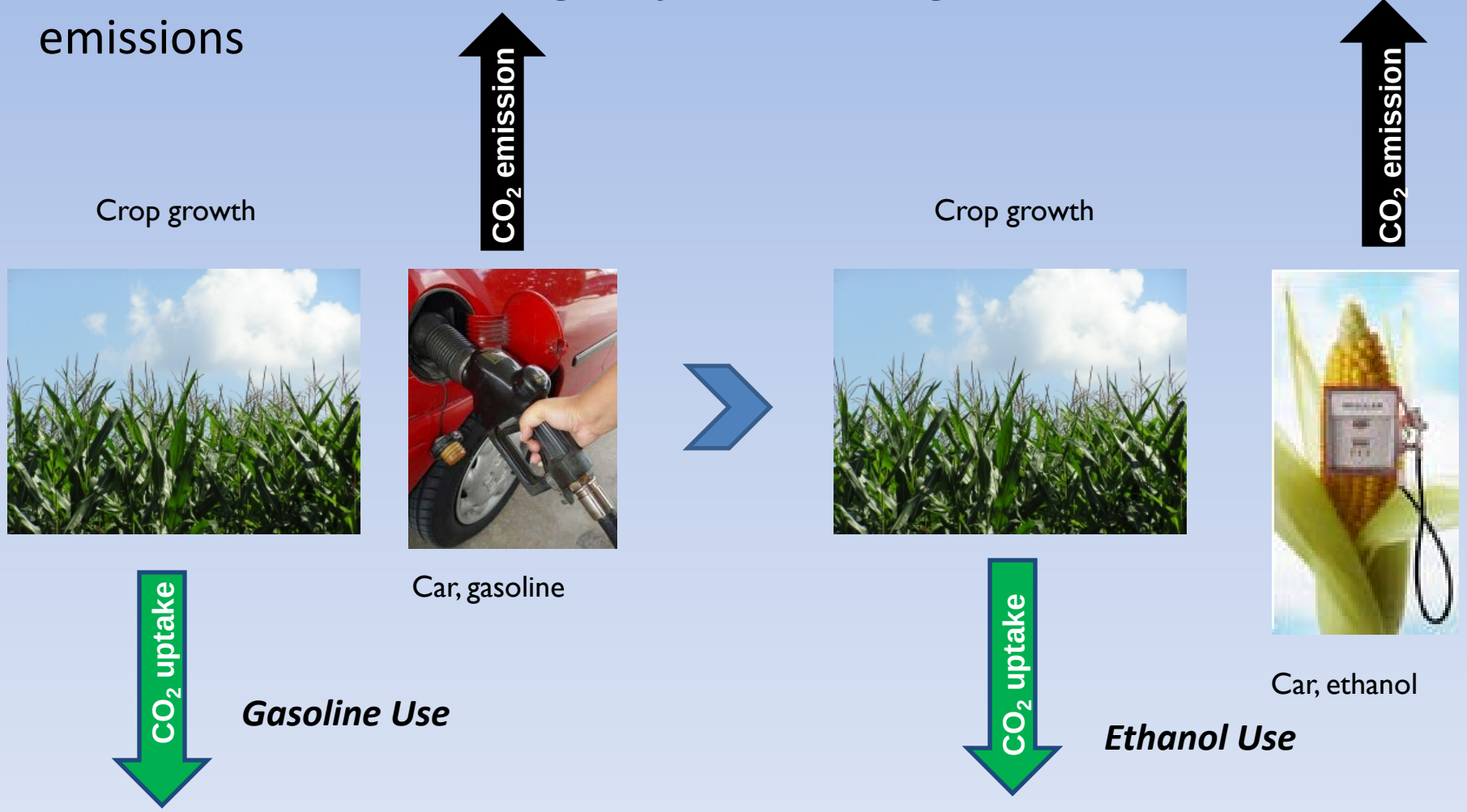
CO_2 uptake

CO_2 emission

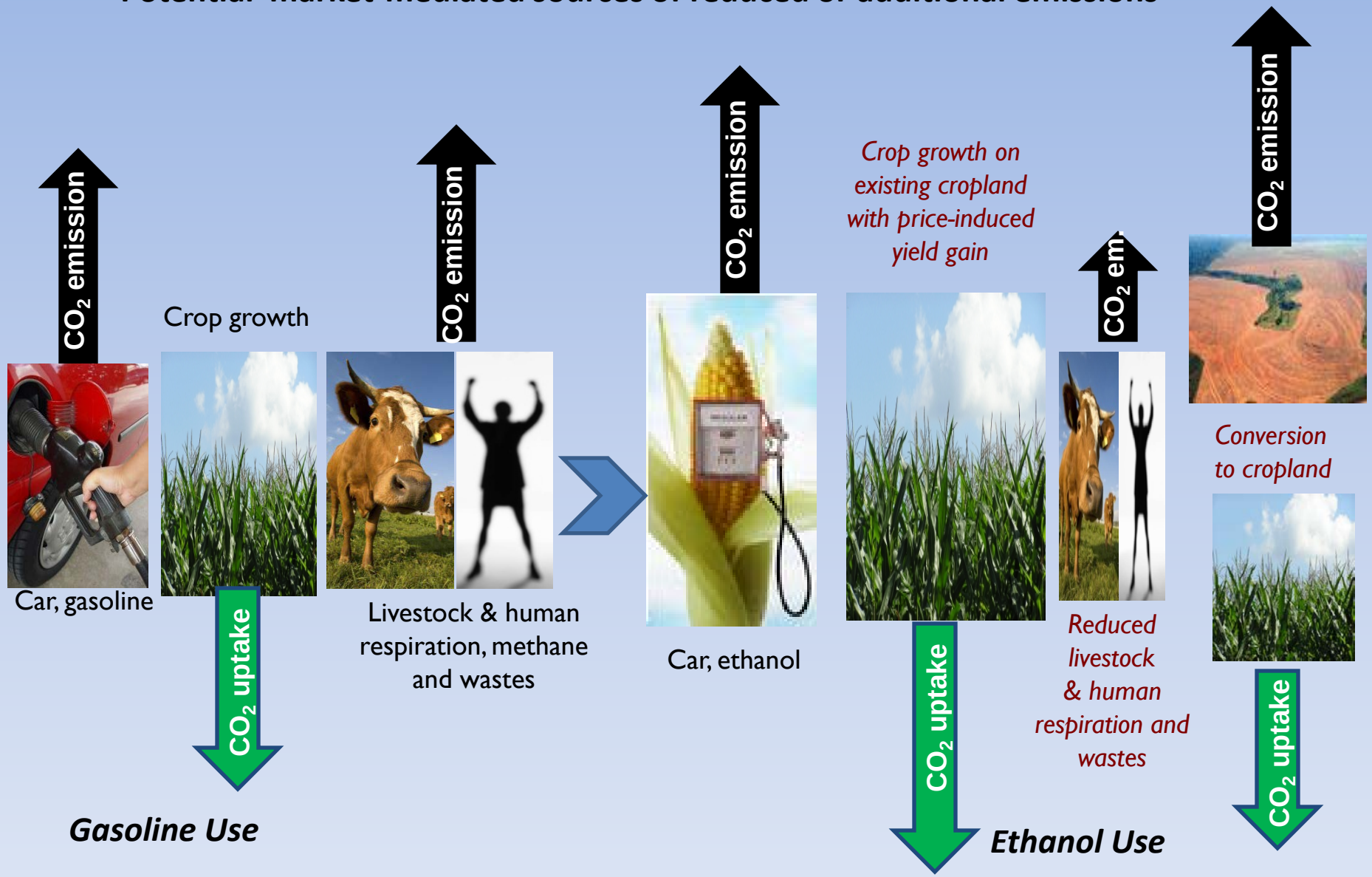
Car, ethanol

Ethanol Use

Figure 2 - Direct effect of switching from gasoline to biofuels that use existing crops – No change in emissions



Potential market-mediated sources of reduced or additional emissions



(*vertical arrows indicate carbon uptake and emissions;*
italics indicates uptake or emission change due to biofuel)

)

Benefit v. Cost of Using Land for Ethanol

Typical estimates of US corn ethanol savings **without** land use cost (1140 liters/hectare after crediting by-products)	High Yield Cellulosic ethanol saving with no land use cost and no net production emissions (17 t/ha & 100 gallons/t)	Allowing "Surplus" Land to Regrow Forest or Convert Tropical Savannah	Carbon cost of converting existing forest
~1 ton of carbon per hectare/year = 34 g CO_2/MJ	**~3 tons of carbon per hectare/year = 86 g CO_2/MJ**	**>3 tons of carbon per hectare per year = 86 gCO_2/MJ**	**5.5 to >10 tons of carbon per hectare per year =158 to 287 gCO_2/MJ**

Solar conversion efficiencies

Iowa corn

Ethanol , **0.125%**

Most optimistic location

future US switchgrass (DOE)

(24 tDM/ha and 100 gallons/tonne)

0.35%

Brazilian sugarcane

ethanol , 0.2%

PV – 16% gross;

11% net