

Improving the Ingeo™ Eco-Profile

February, 2009

ingenious materials from plants not oil



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ingenious

natural selection

Evolving the Ingeo™ eco-profile

Further future improvements associated with:

- Production using new carbohydrate feedstock
- Further process optimization
- On site renewable energy (e.g. wind, biomass)
- Plant II

FUTURE
Long term

PRESENT
Ingeo in 2009

Ingeo 2009 represents the Next Generation, cradle-to-pellet Ingeo production system based on the implementation of new lactic acid process technology. On-line now in 2009.

PAST
Ingeo in 2005

We created an entirely new production system for polymers based on renewable resources. Ingeo 2005 represents the 2005 cradle-to-pellet Ingeo production system (= the benchmark).

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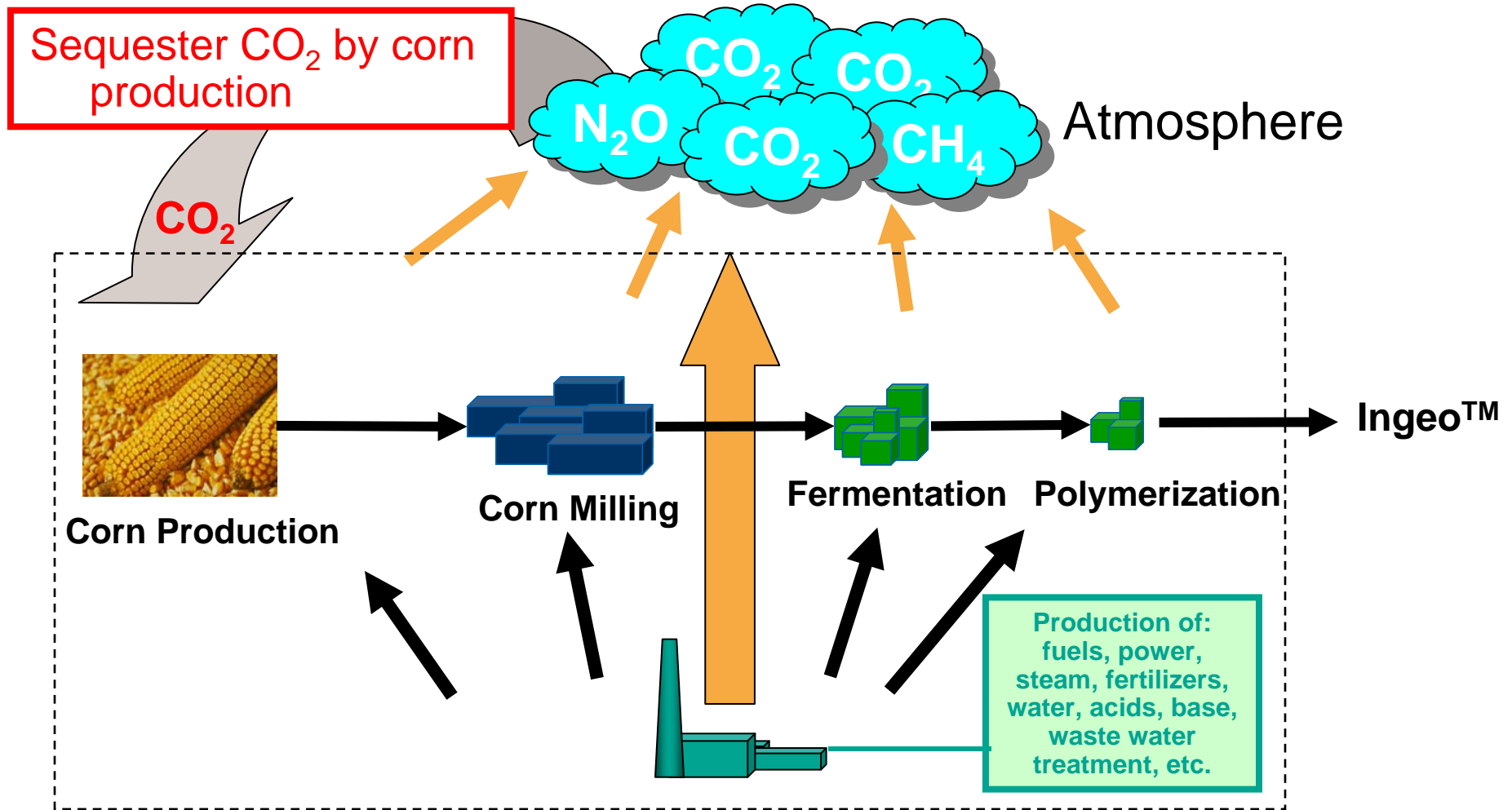


Agenda

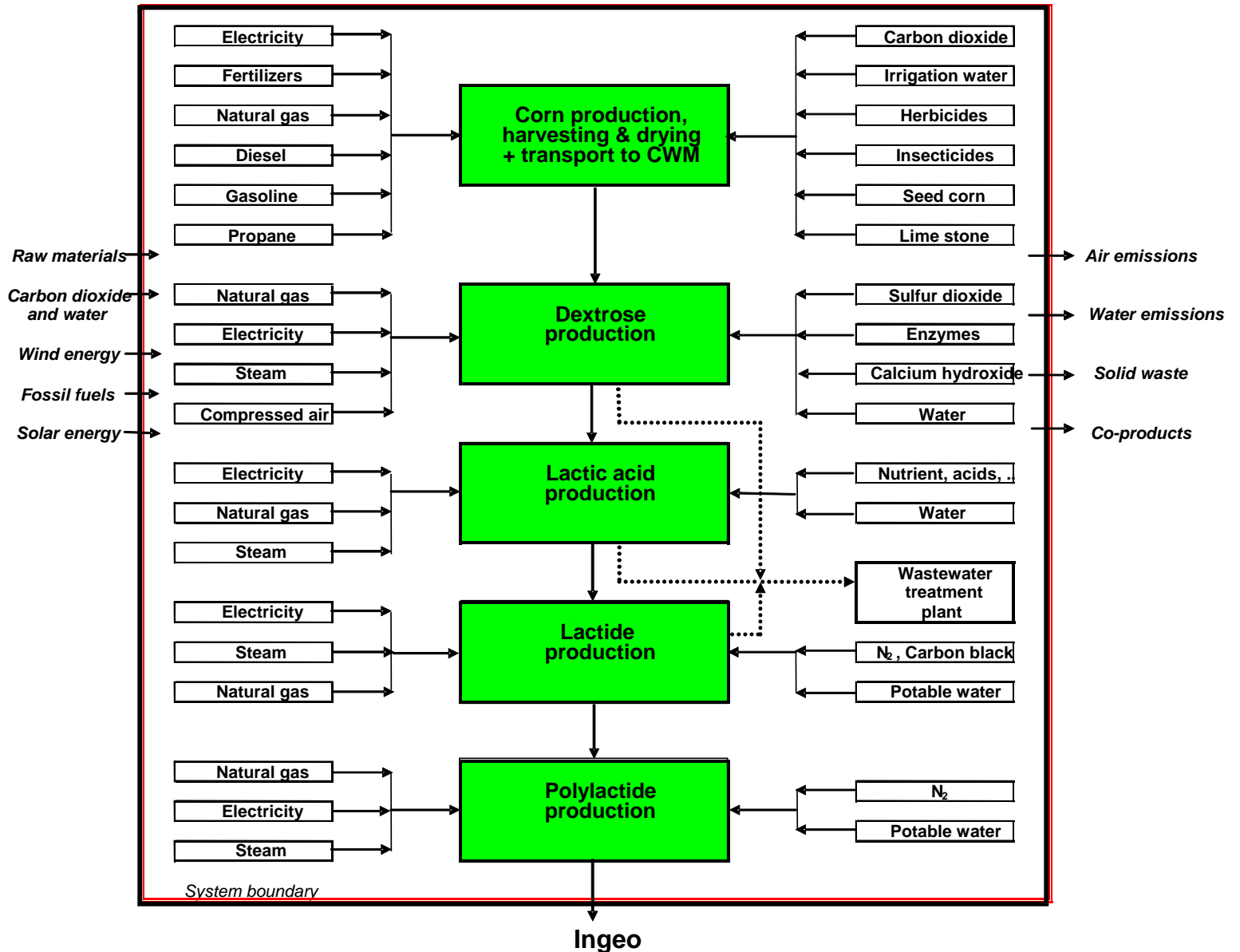
- “Eco-Profile 101”
- 2005 Ingeo™ Eco-Profile
- 2009 Ingeo™ Eco-Profile
- Green Power Options



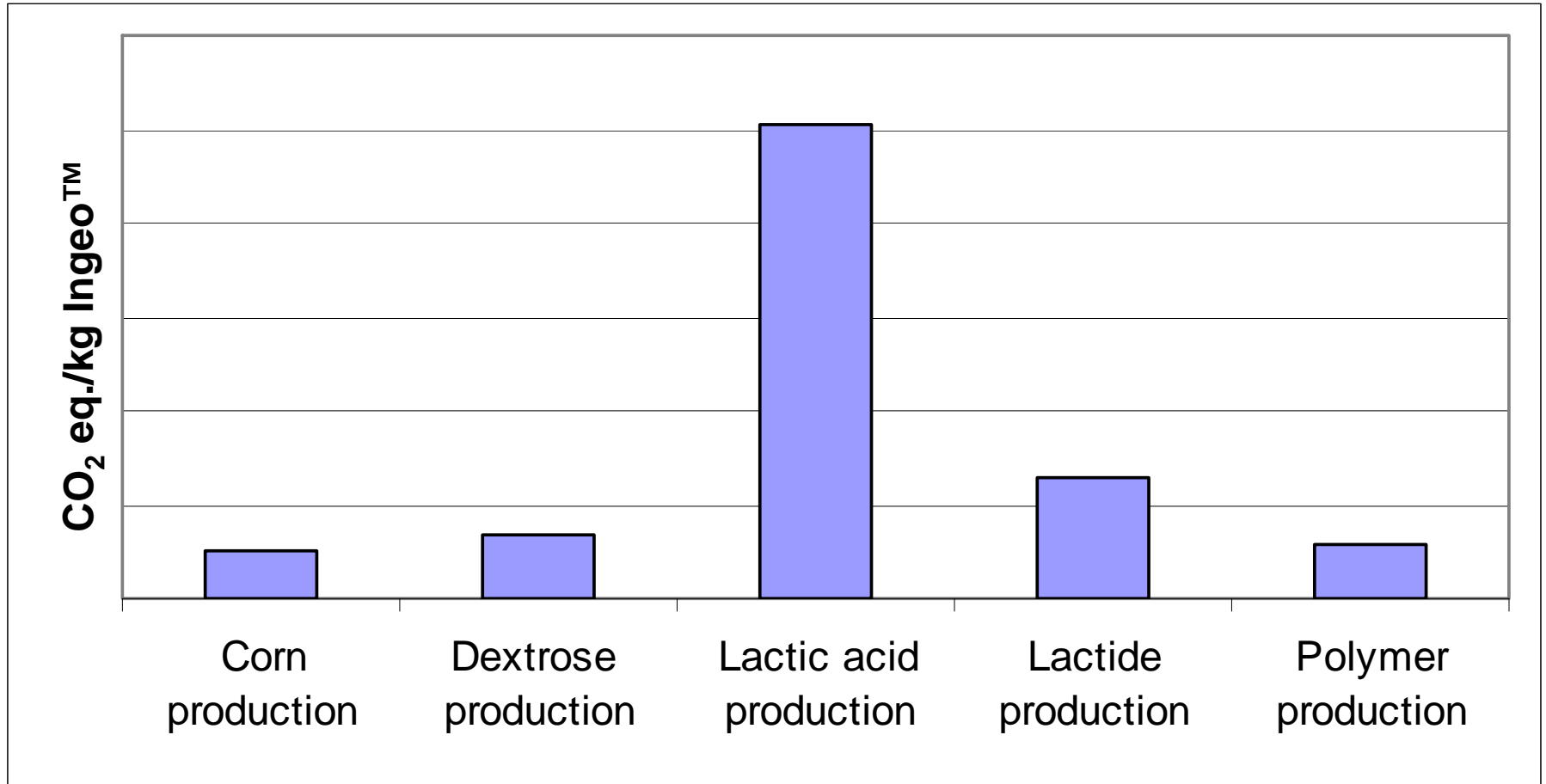
Greenhouse gas (GHG) emissions within the Ingeo™ production system



- **Calculation of the eco-profile means drawing a 'box' around the process from field to factory gate, and rigorously identifying and including anything which crosses the system boundary**



Results of GHG mapping process



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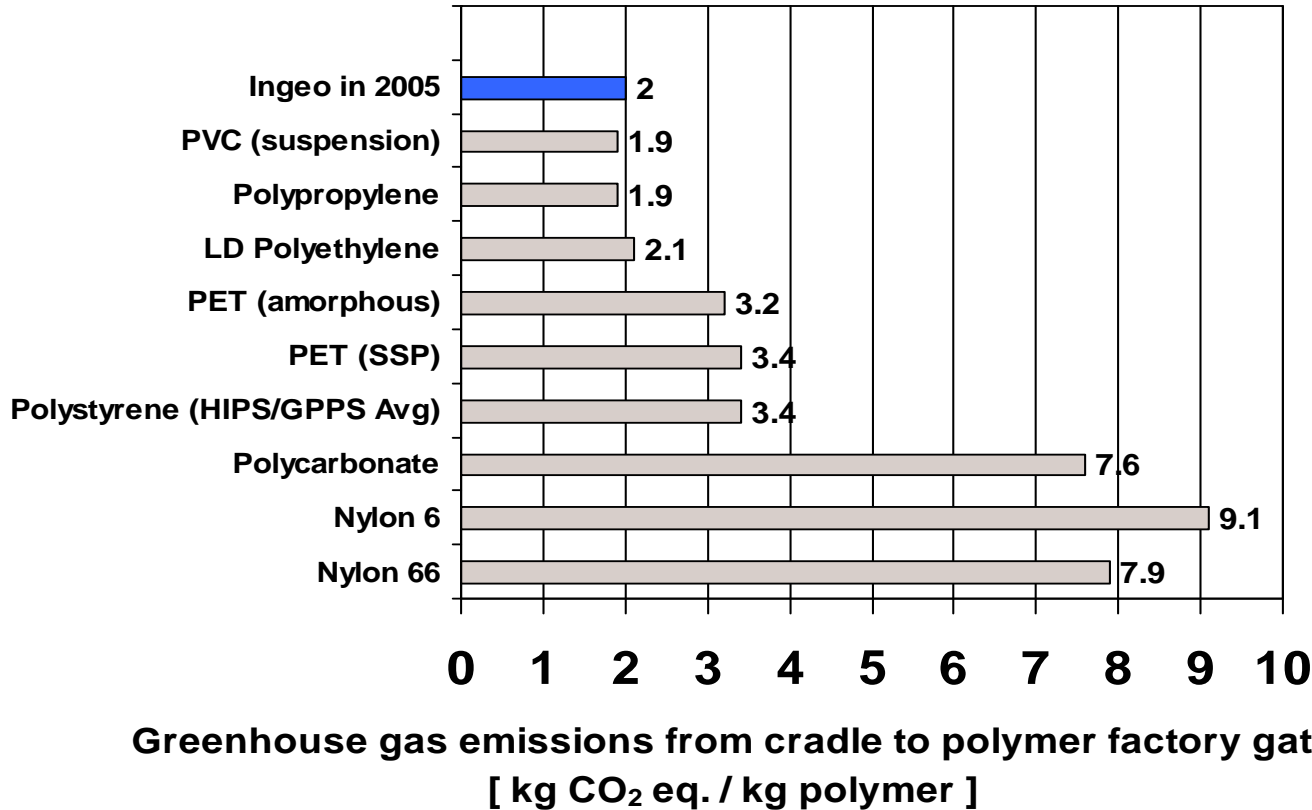


Results of GHG mapping process

Scope	Emission sources	CO ₂ eq. (kg/kg Ingeo)
1	NatureWorks/Cargill site, direct emissions	1.038
2	Indirect emissions from electricity production	1.561
3	Fuel, material, corn production, reclamation	1.244
	Corn feedstock - CO ₂ uptake	-1.820
	Total:	2.023



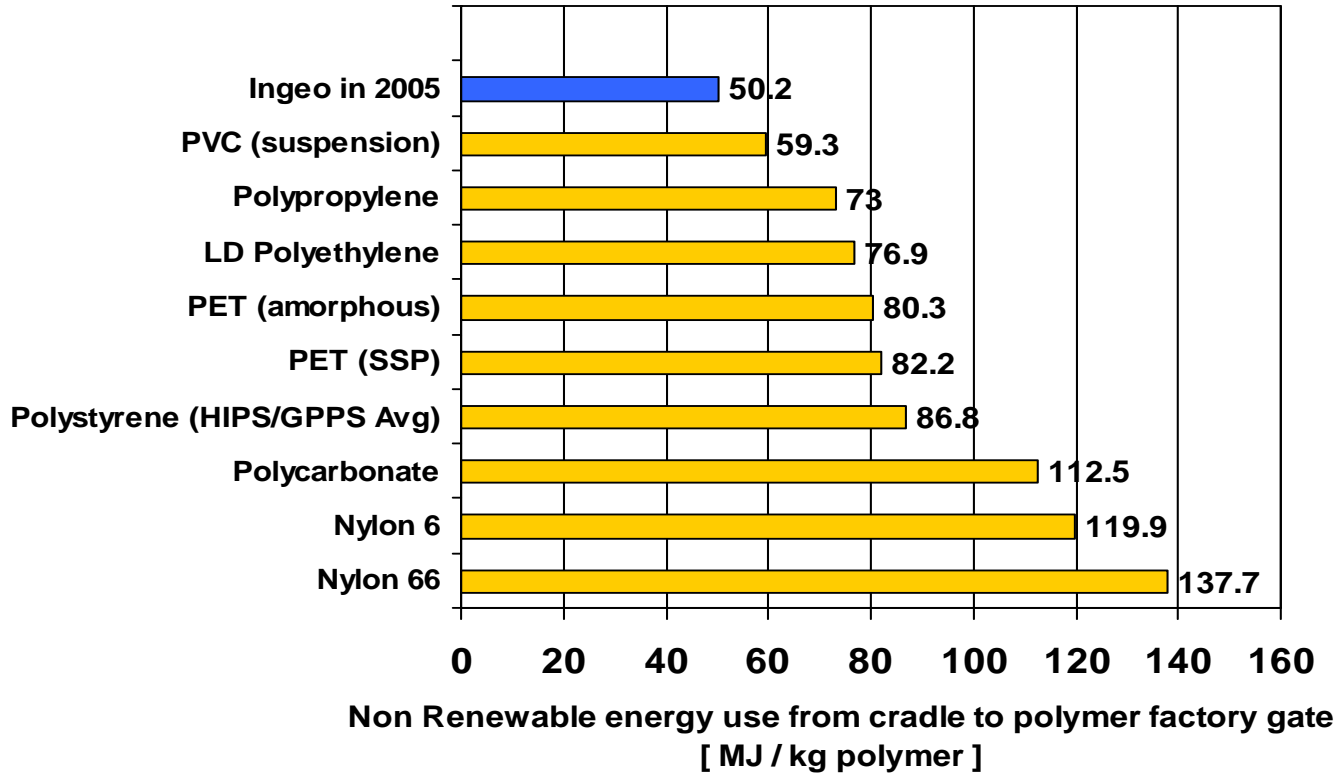
Comparing Environmental Footprint: Greenhouse gas emissions



- Ingeo: Vink E.T.H. et al. The eco-profiles for current and near-future NatureWorks® polylactide (PLA) production. Industrial Biotechnology, Volume 3, Number 1, 2007, Page 58-81.
- Fossil based polymers: *PlasticsEurope*; www.lca.plasticseurope.org
- GWP₁₀₀ factors according to IPCC (CO₂=1, CH₄=23 N₂O=296)



Comparing Environmental Footprint: Non-renewable Energy Requirements



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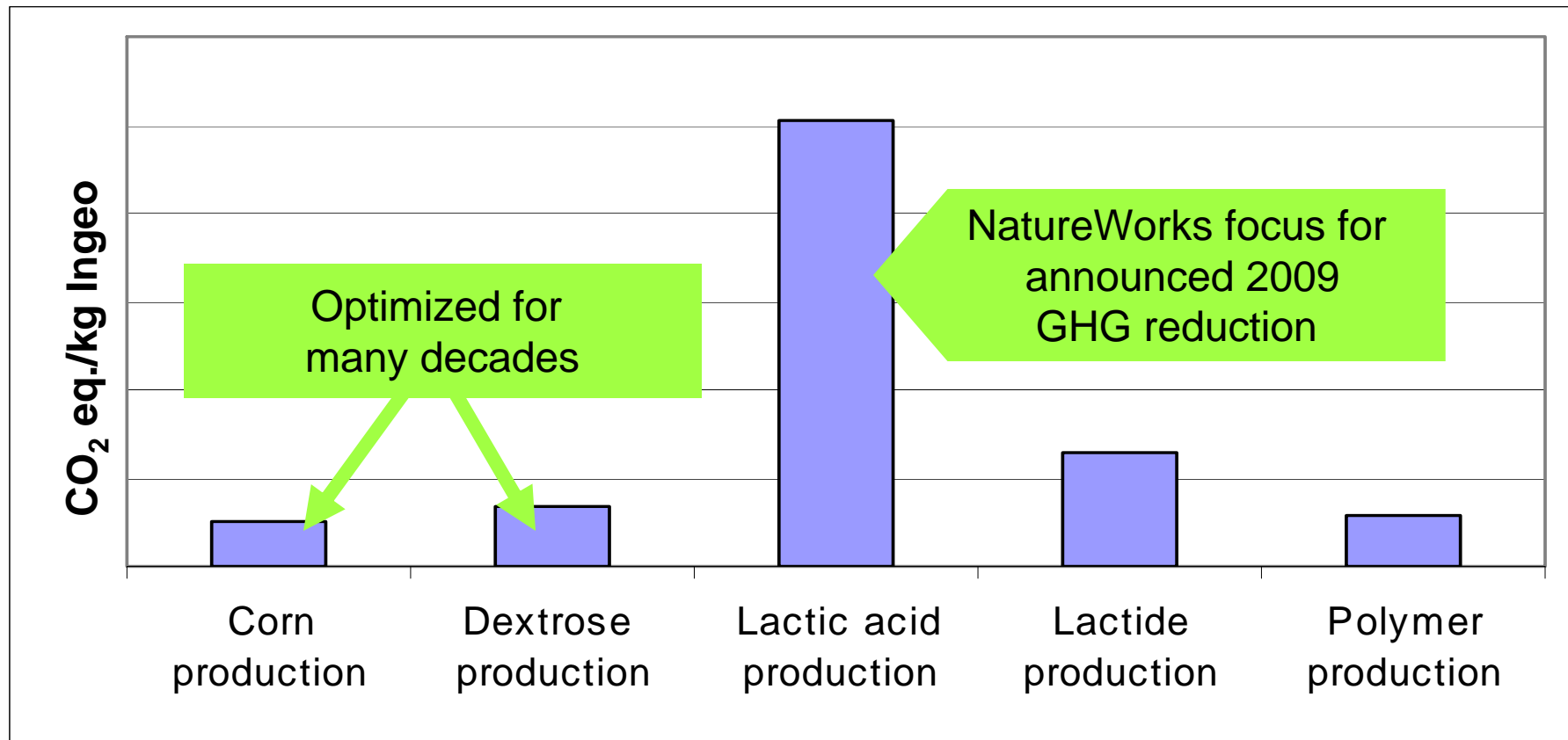


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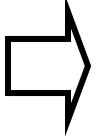

Quantitative outcome of GHG mapping process



This analysis of the 2005 production process indicated that biggest benefit would come from driving GHG reductions in lactic acid production process

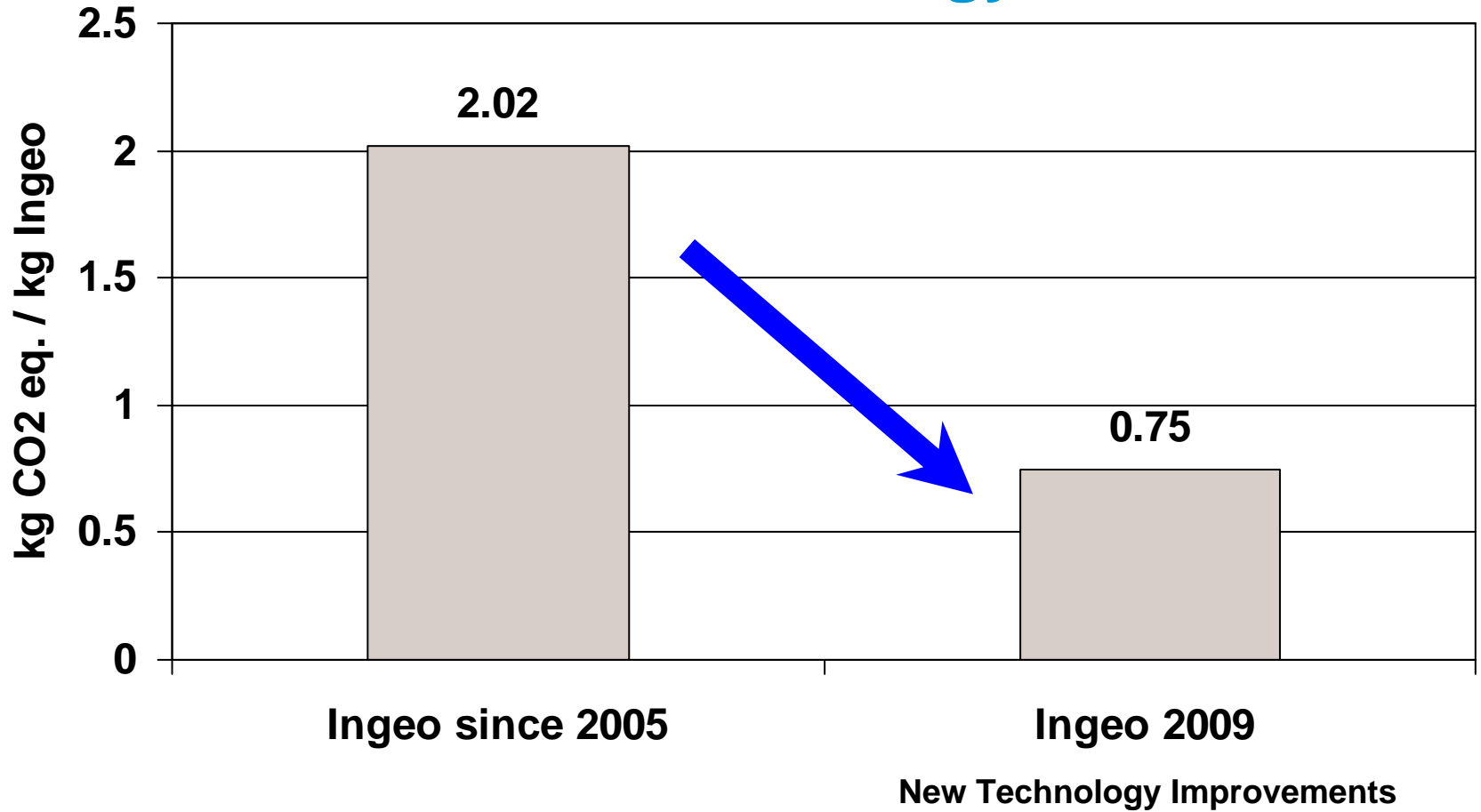


Ingeo™ Eco-Profile Improvements in 2009

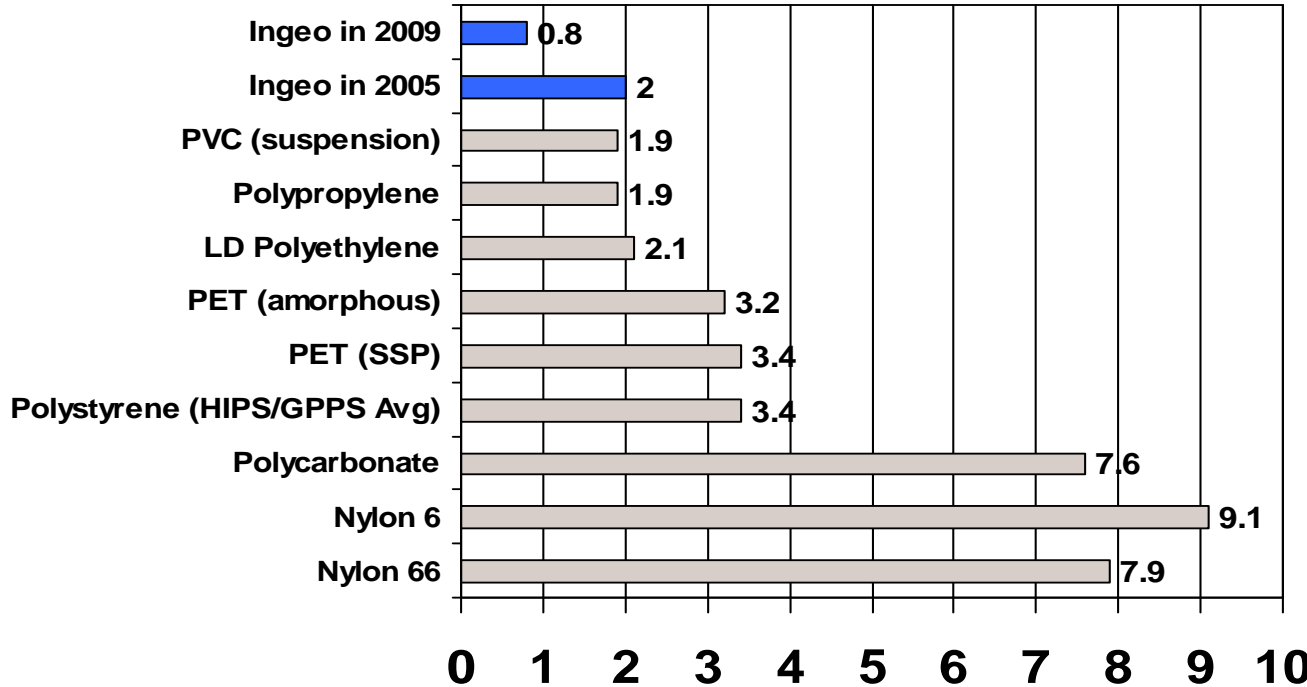
- NatureWorks longstanding Technology Focus 
- Reducing the carbon footprint of the lactic acid supply process
- Results (Online in December 2008)
 - Reduced GHG emission and non-renewable energy usage 
- How..
 - New, proprietary technology for more efficient conversion of dextrose to lactic acid (“NG Technology”)



Results of the utilization of new lactic acid technology on GHG



Comparing environmental footprint: Greenhouse Gas emissions

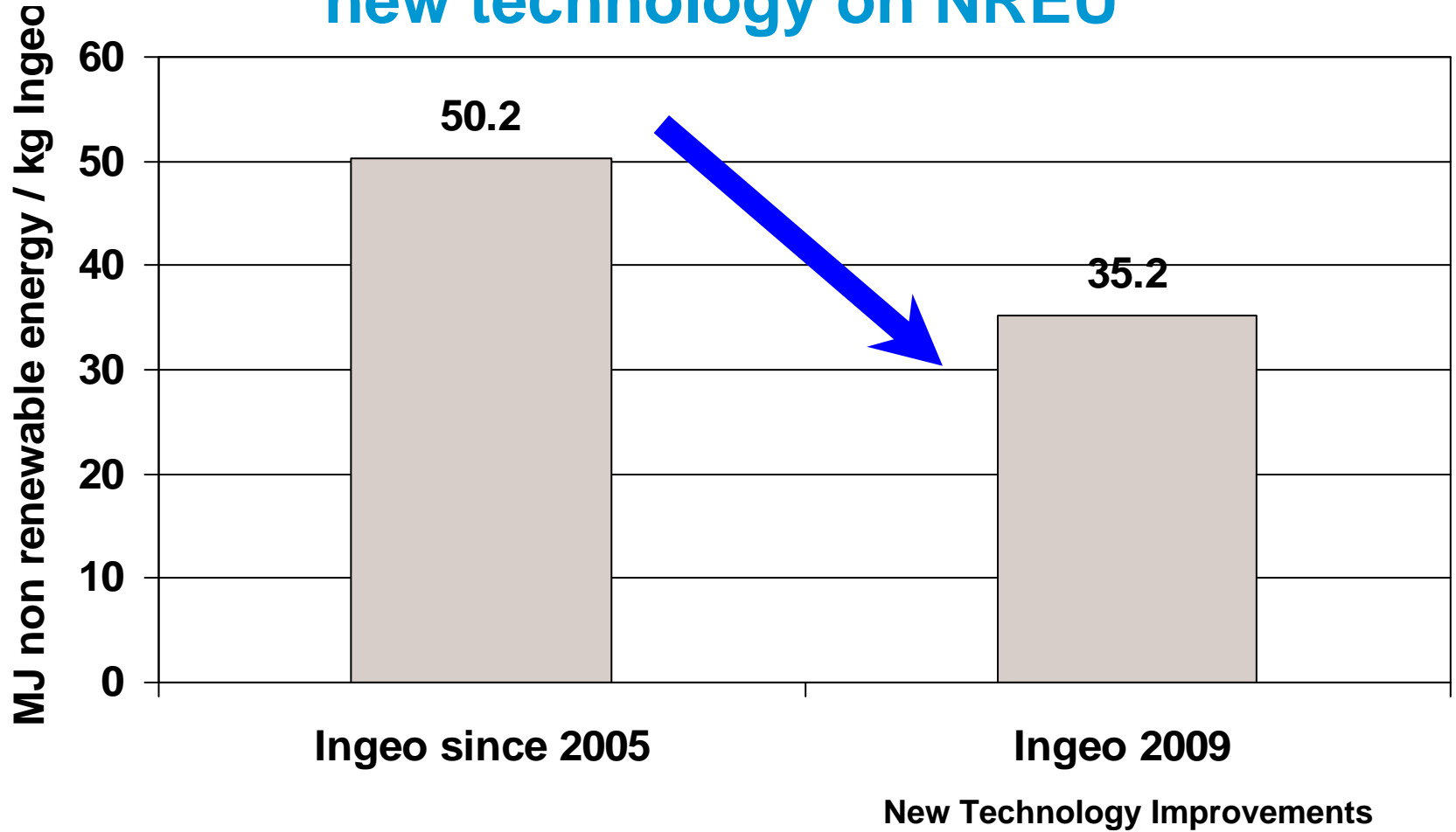


Greenhouse gas emissions from cradle to polymer factory gate
[kg CO₂ eq. / kg polymer]

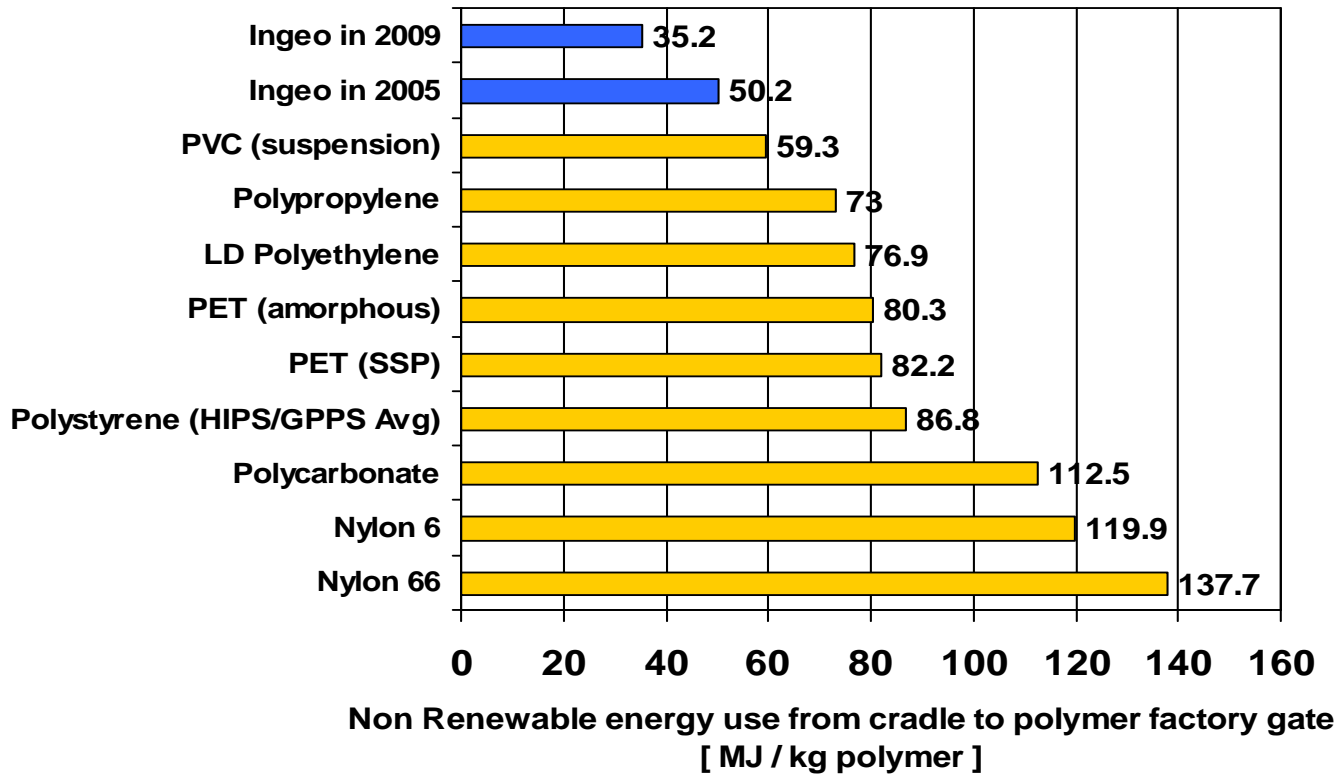
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Results of the utilization of new technology on NREU



Comparing environmental footprint: Non-renewable Energy Requirements



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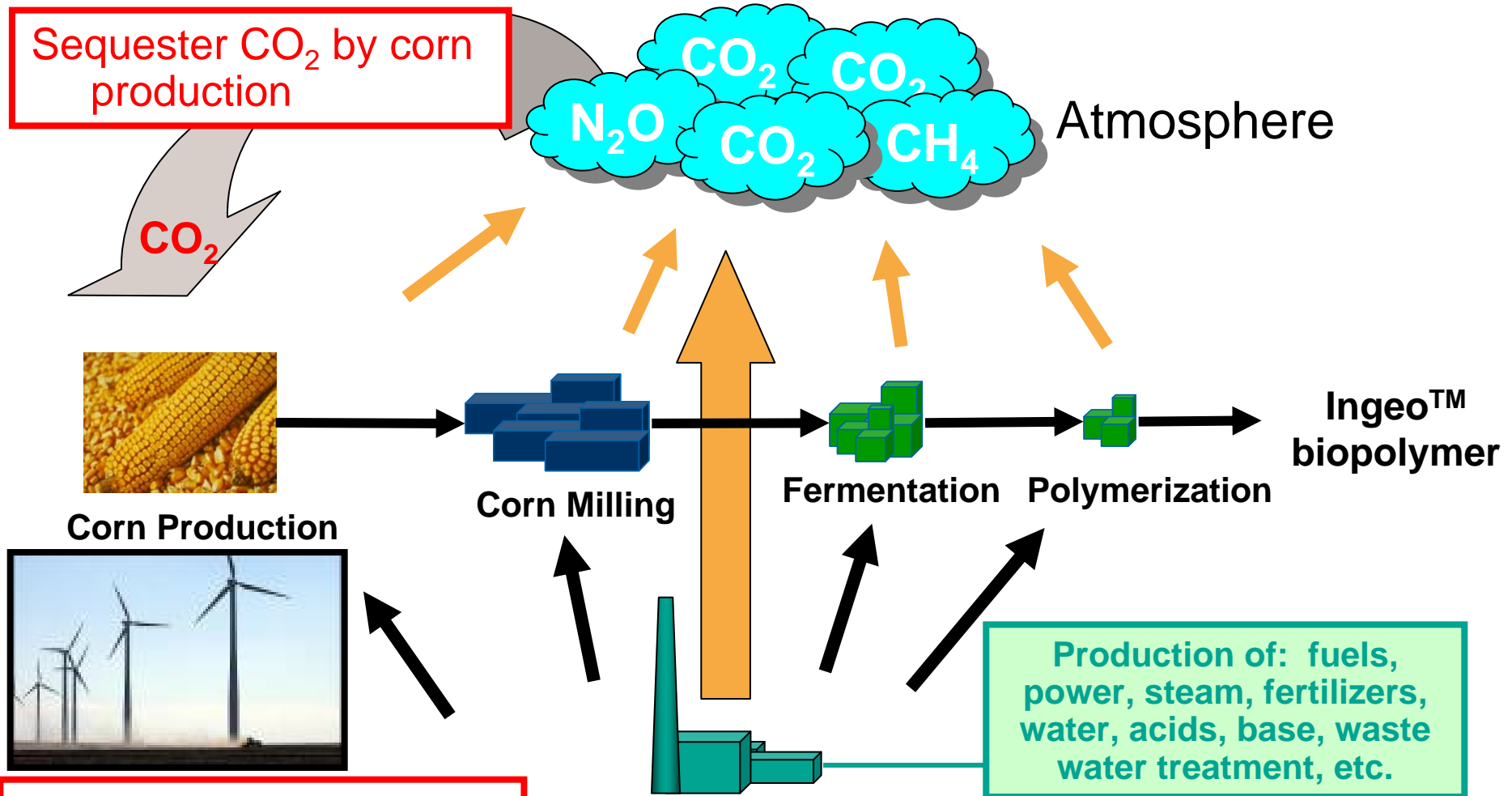


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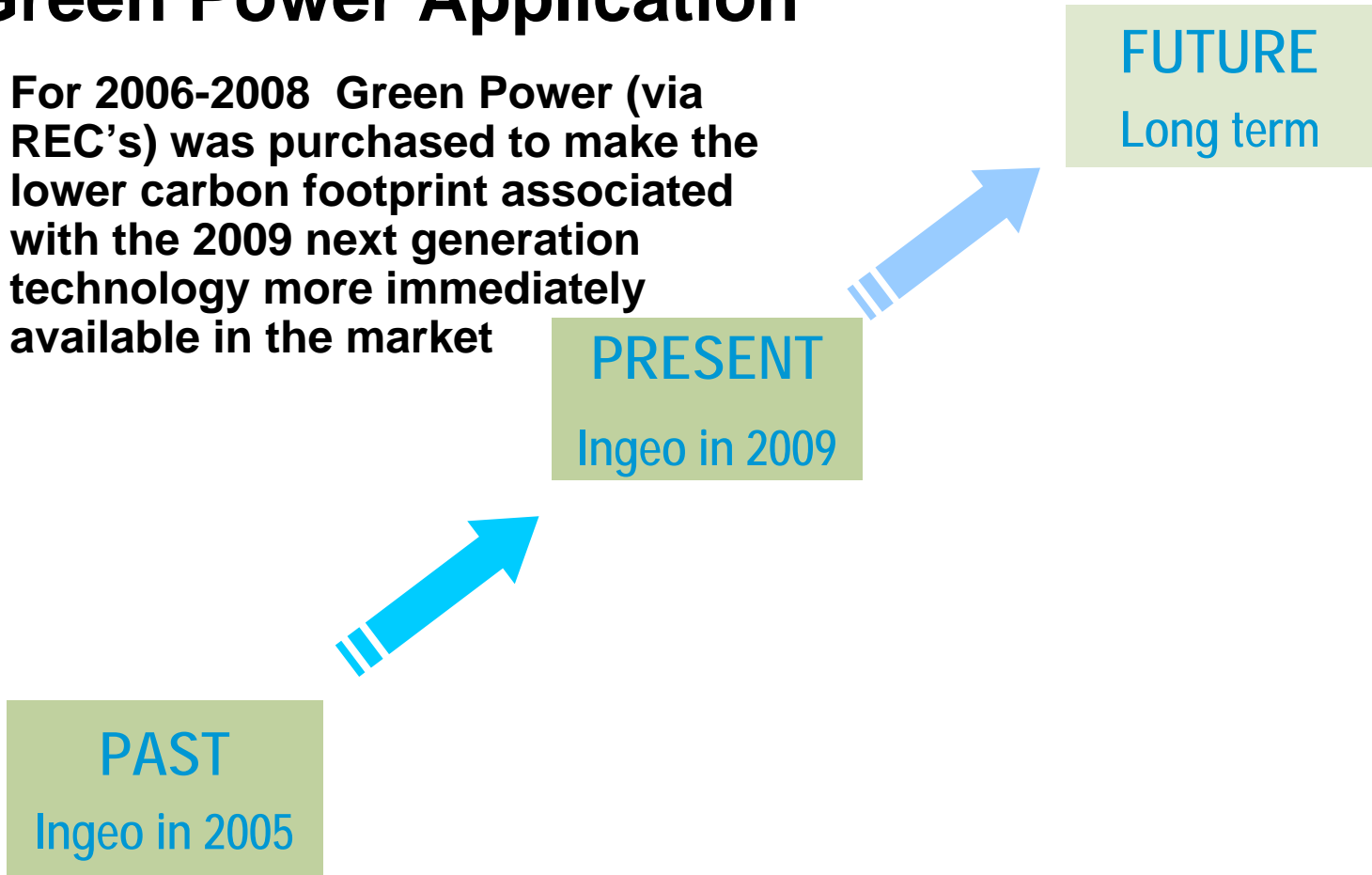


Greenhouse gas (GHG) emissions within the Ingeo™ production system



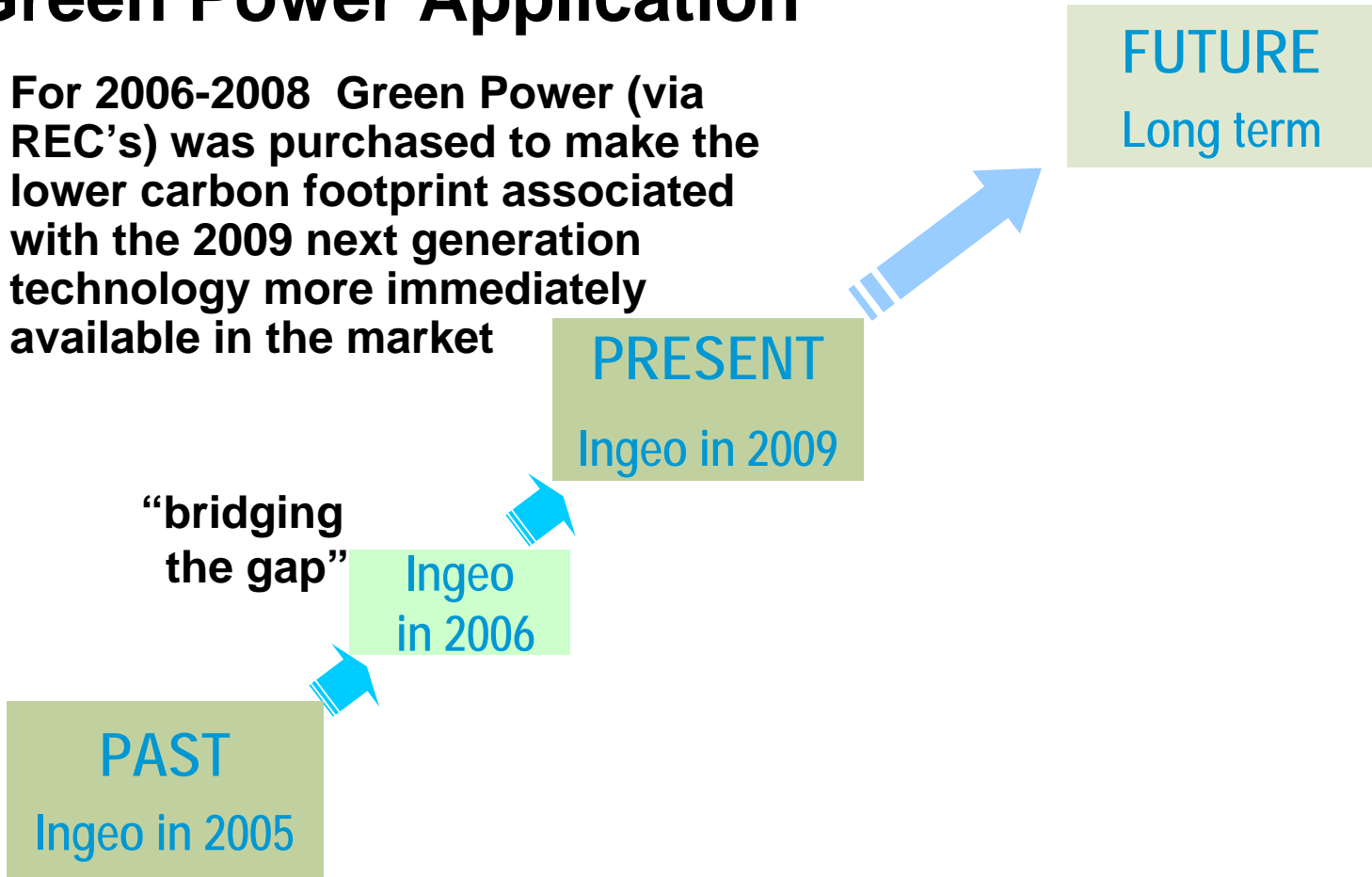
Green Power Application

For 2006-2008 Green Power (via REC's) was purchased to make the lower carbon footprint associated with the 2009 next generation technology more immediately available in the market



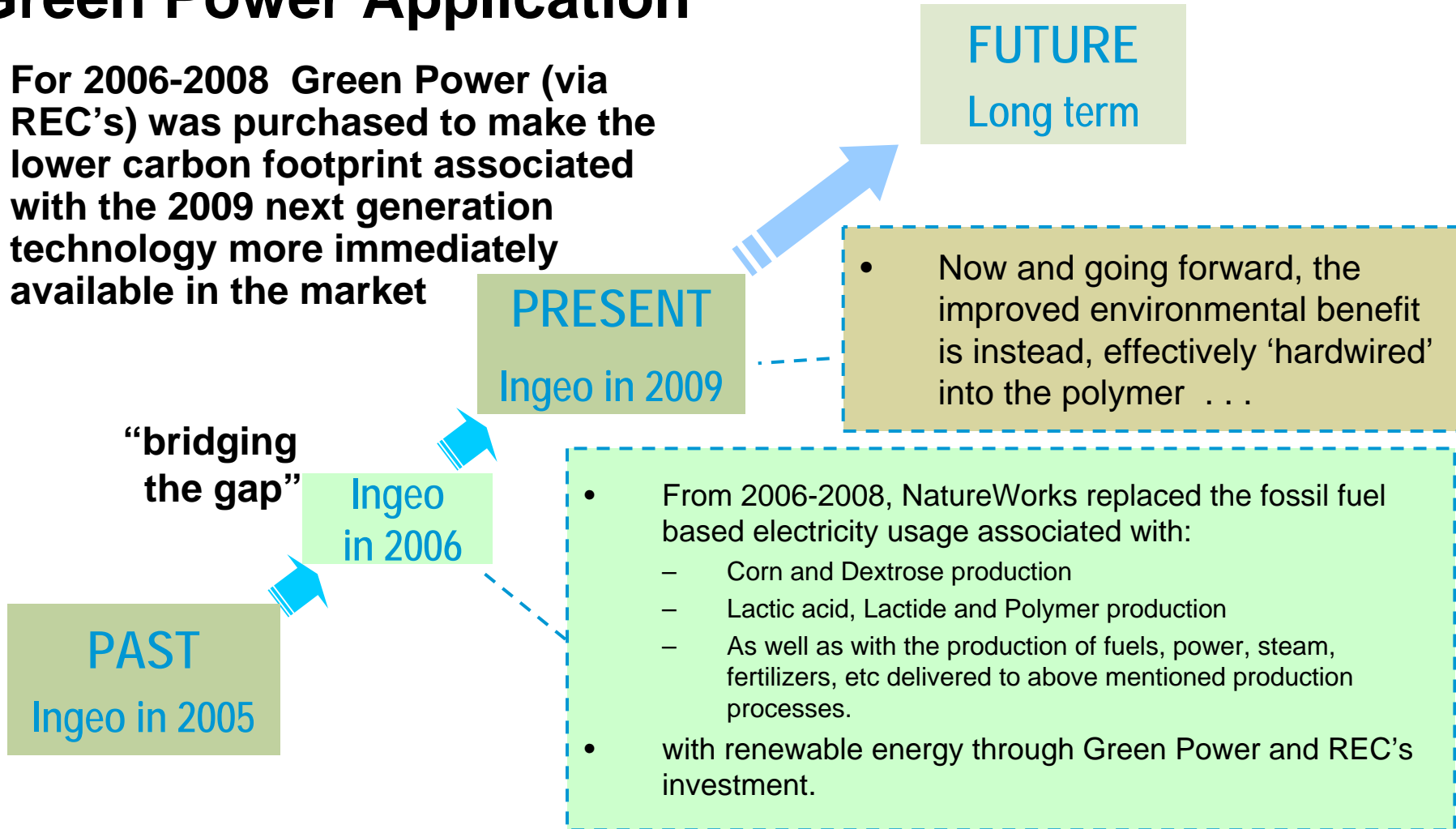
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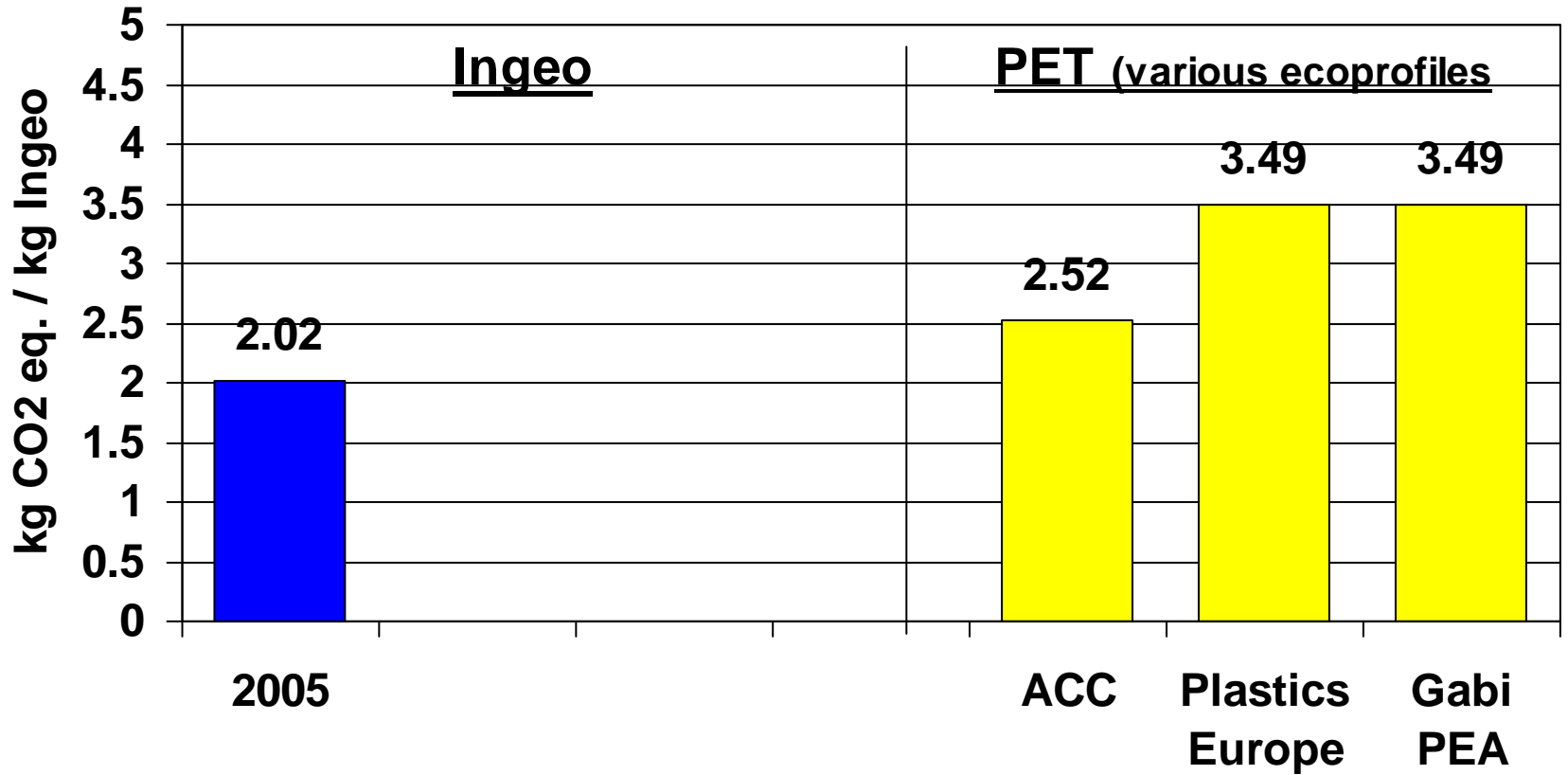


Green Power Application

- **Since 2006, NatureWorks has ‘bridged the gap’ between the 2005 and 2009 eco-profiles via the use of Green Power**
- **Going forward in 2009, the improved GHG benefit is effectively ‘hardwired’ into the polymer . . .**



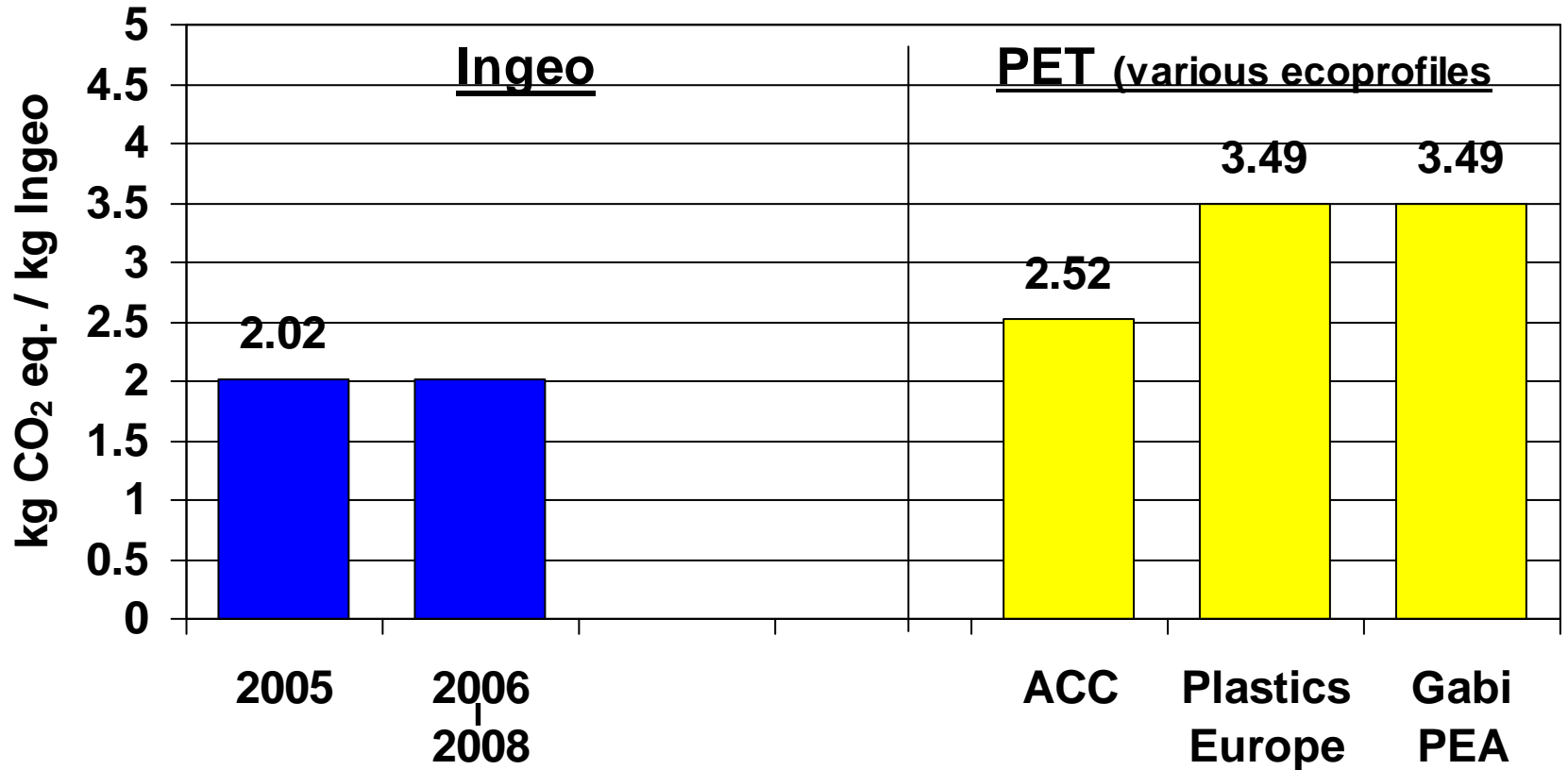
Impact of Green Power Usage on Eco-Profile



Source Data: Ingeo - NatureWorks LLC ;

PET: M. Binder, Technical Director, PE Americas ;

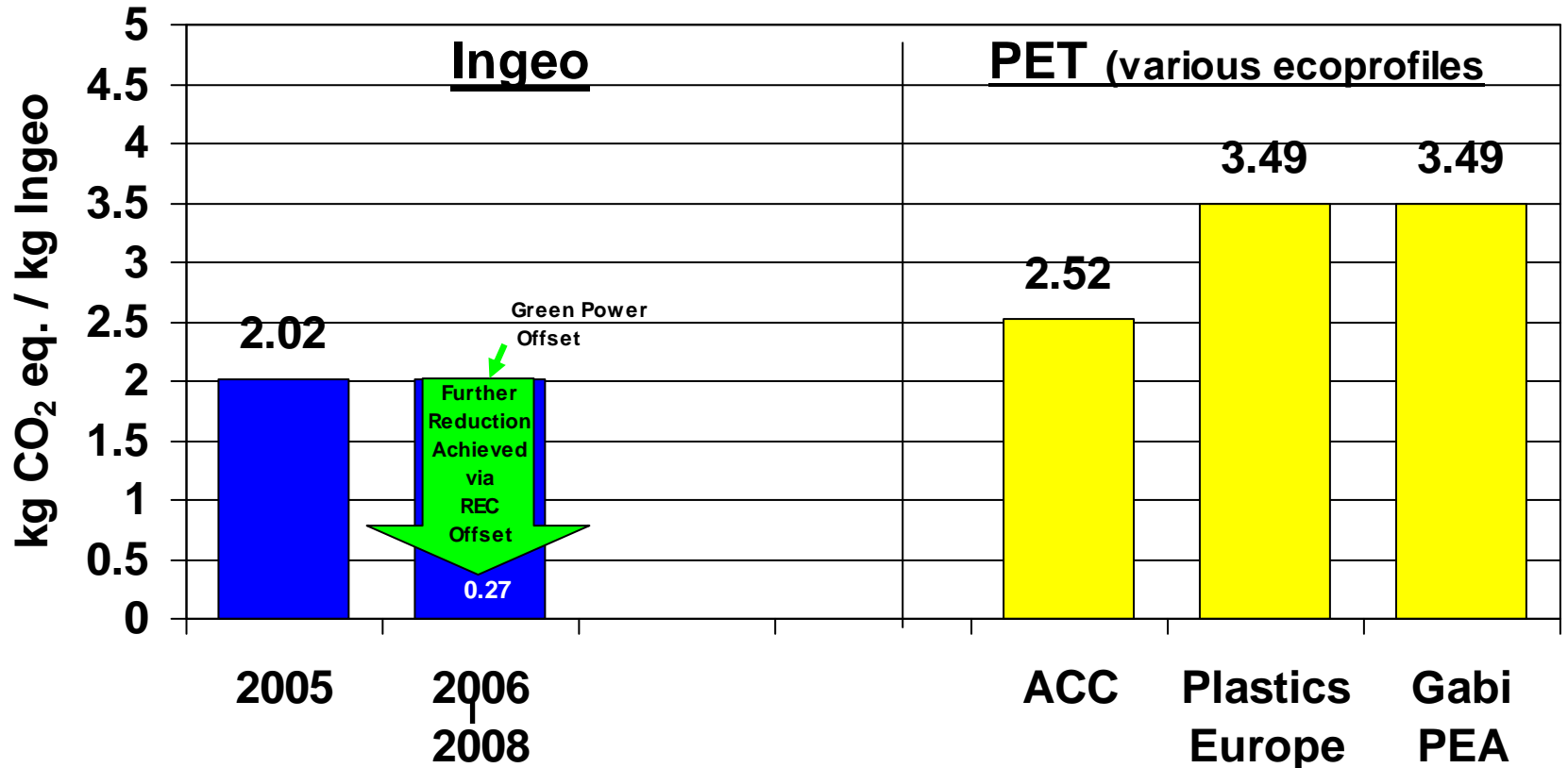
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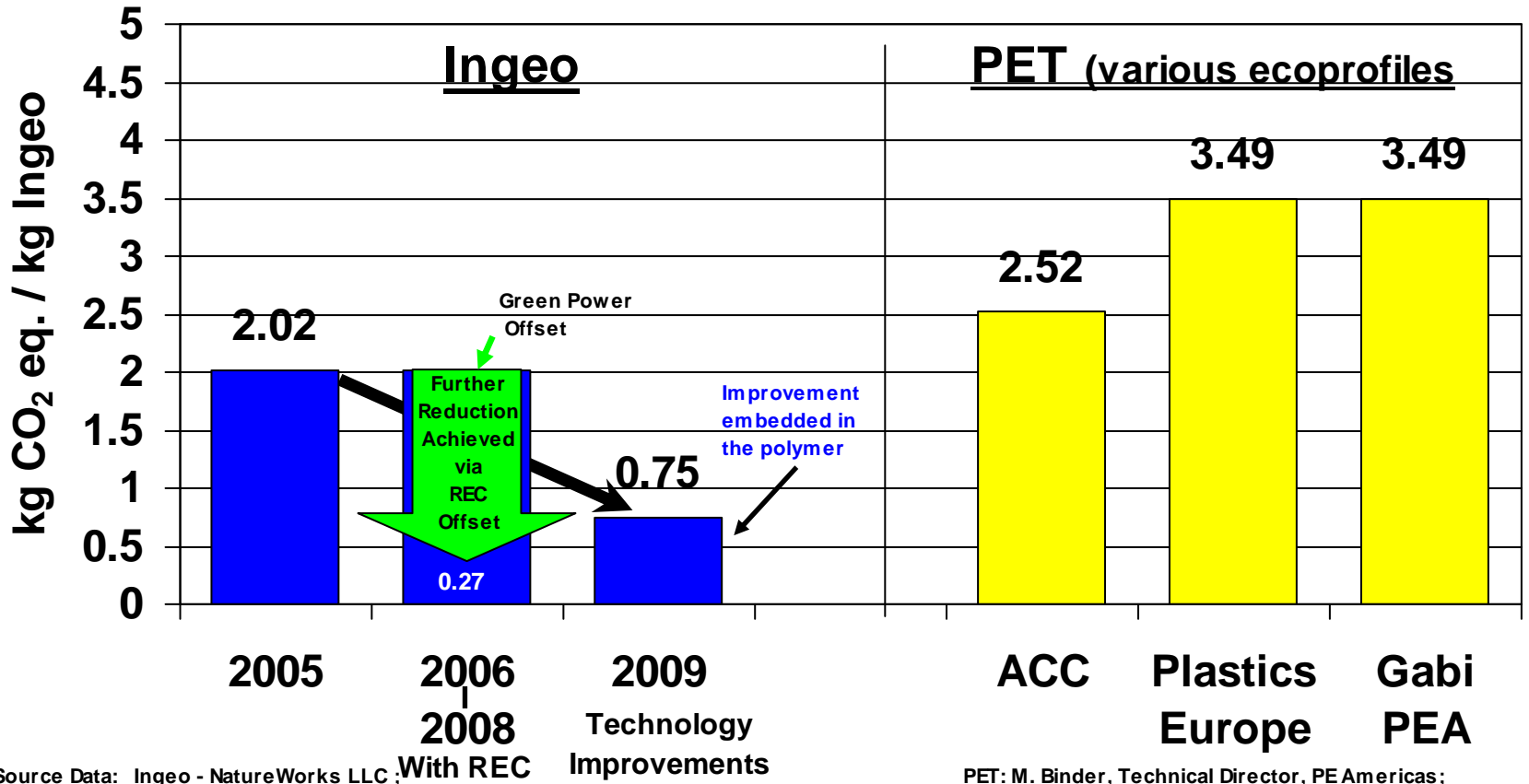
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- **For those customers who value still further reductions in environmental footprint over the 2009 profile, Green Power purchase is an option**

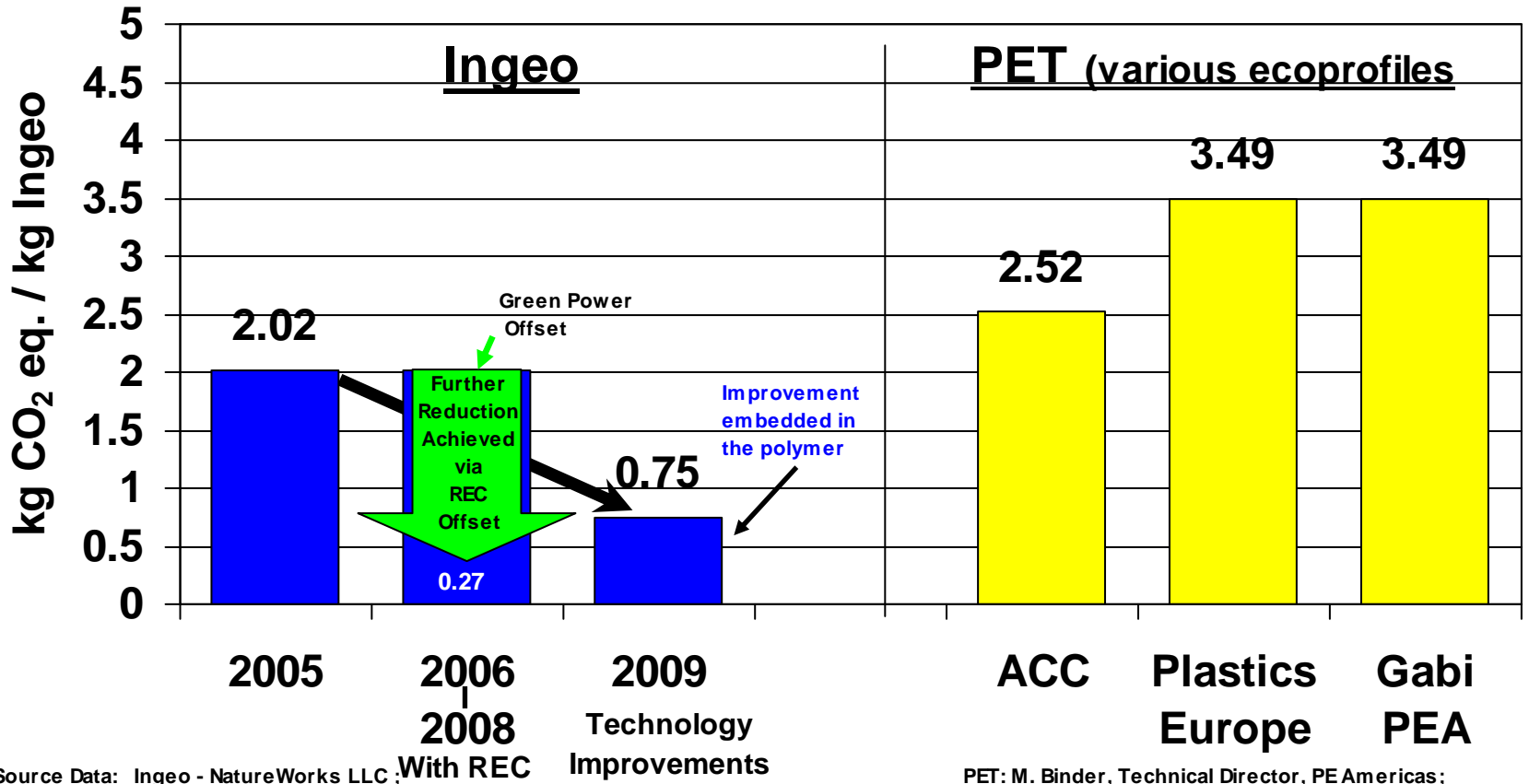


Green Power Options in 2009

- NatureWorks offers a Green Power purchase for those customers who value still further reductions in environmental footprint
 - On request, NatureWorks will purchase Green Power (via the REC mechanism) for the direct electricity use in NatureWorks lactide and polymer plants
- What's this look like in terms of further Ingeo™ GHG Footprint Reduction?



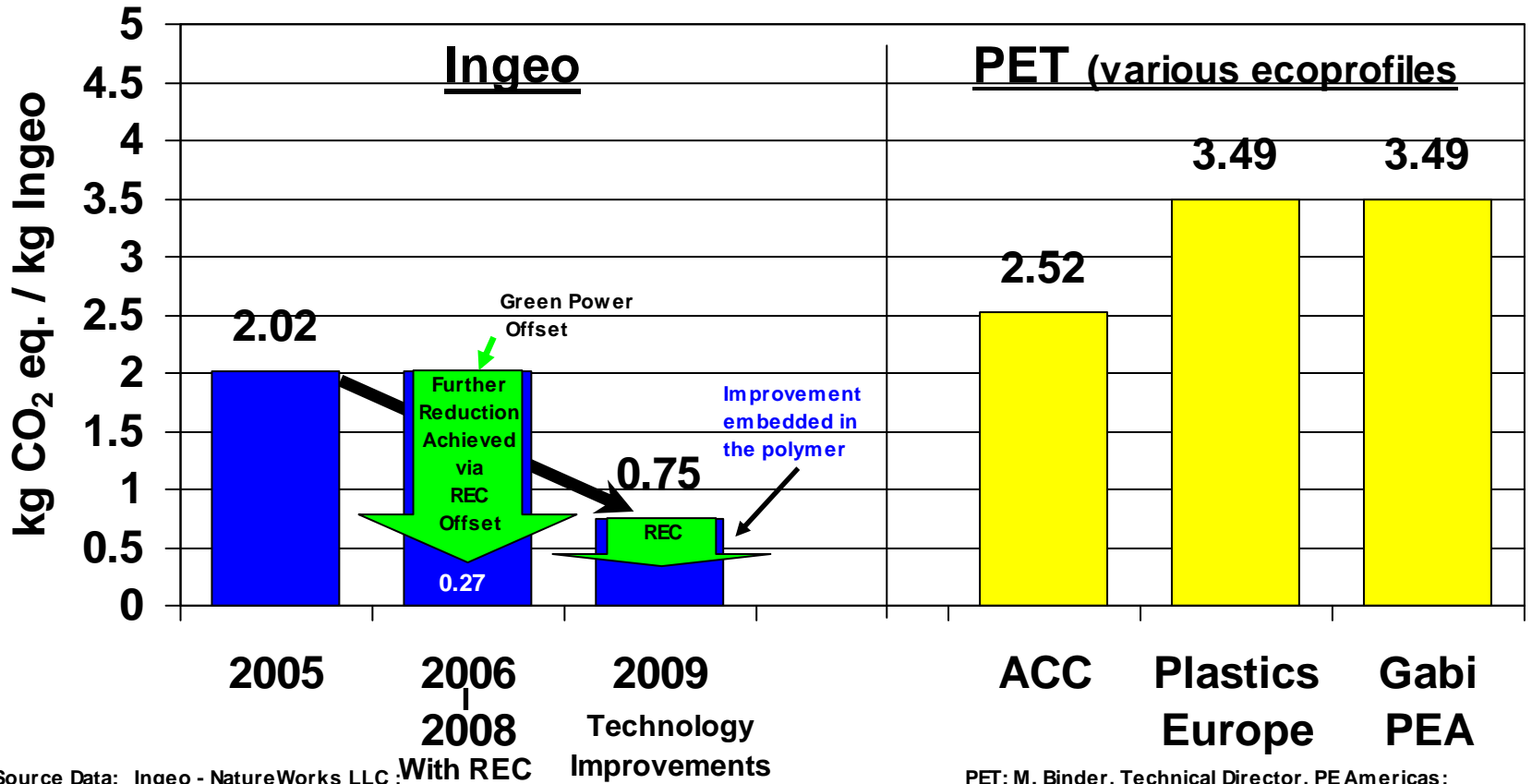
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Green Power Options in 2009

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- What's this look like in terms of further Ingeo™ GHG Footprint Reduction?
- Please contact your Ingeo™ account manager if interested in understanding the costs associated with this green energy option

