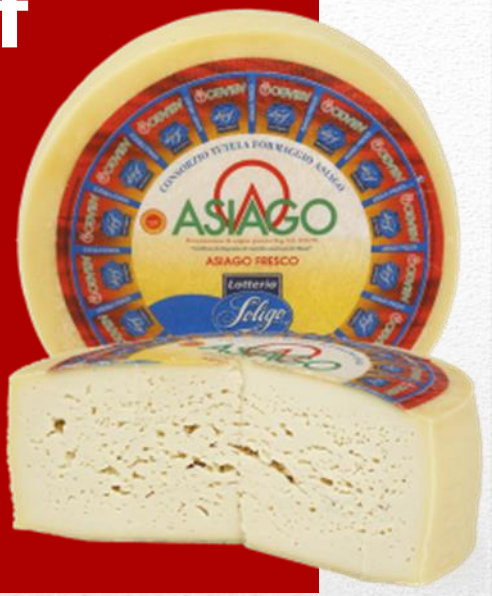
Environmental impact of Italian dairy industry: case of Asiago PDO cheese



A. Dalla Riva, *Ph.D. Student*

J. Burek, D. Kim, G. Thoma, M. Cassandro, M. De Marchi

UNIVERSITY OF ARKANSAS COLLEGE OF ENGINEERING

UNIVERSITÀ DEGLI STUDI DI PADOVA

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10 - Young train session – Dairy innovative research and extension

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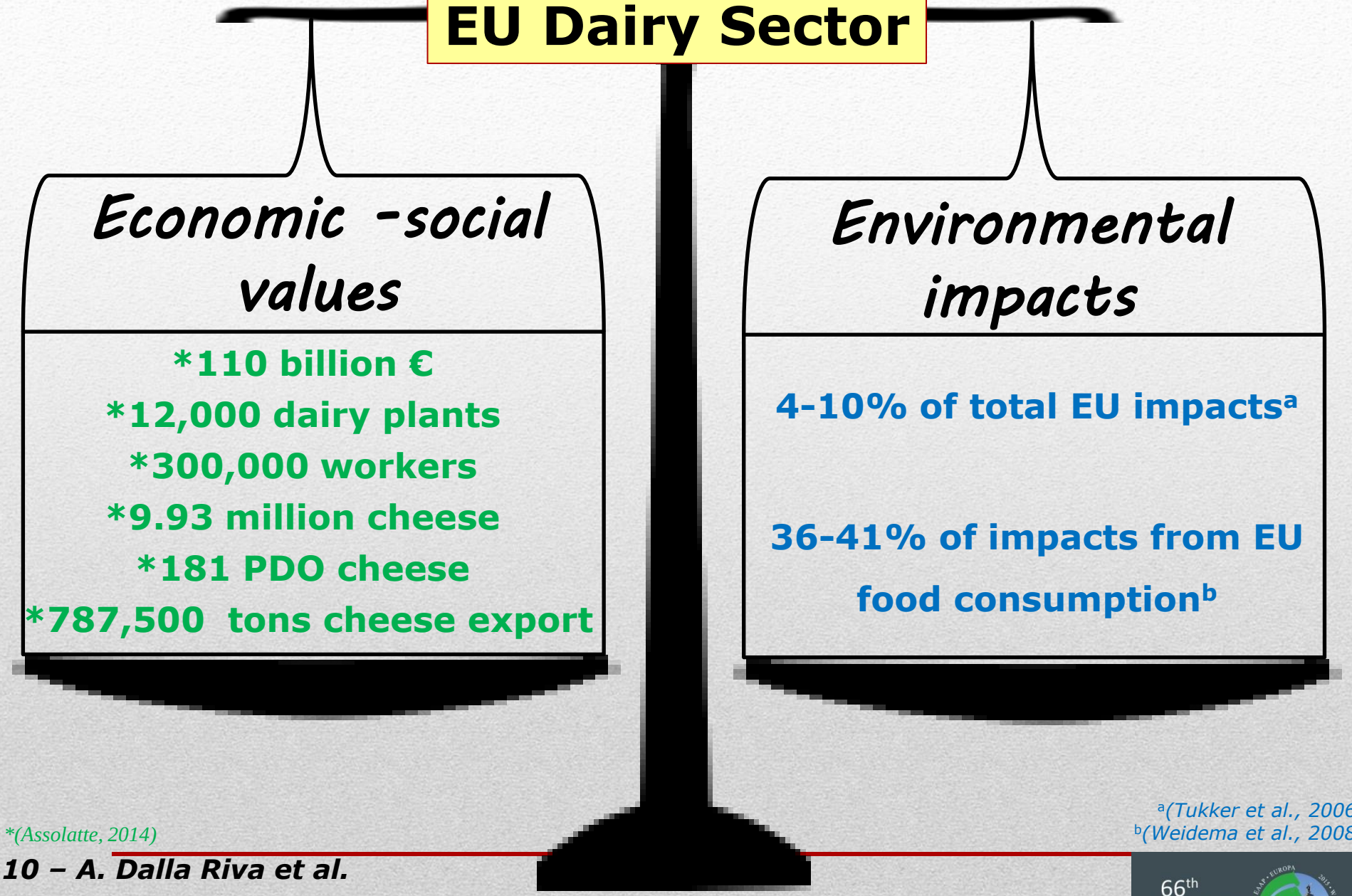
EU Dairy Sector



*(Assolatte, 2014)

[a](Tukker et al., 2006)
[b](Weidema et al., 2008)

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LCA: Life Cycle Assessment

ISO 14040-14044

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Introduction 3

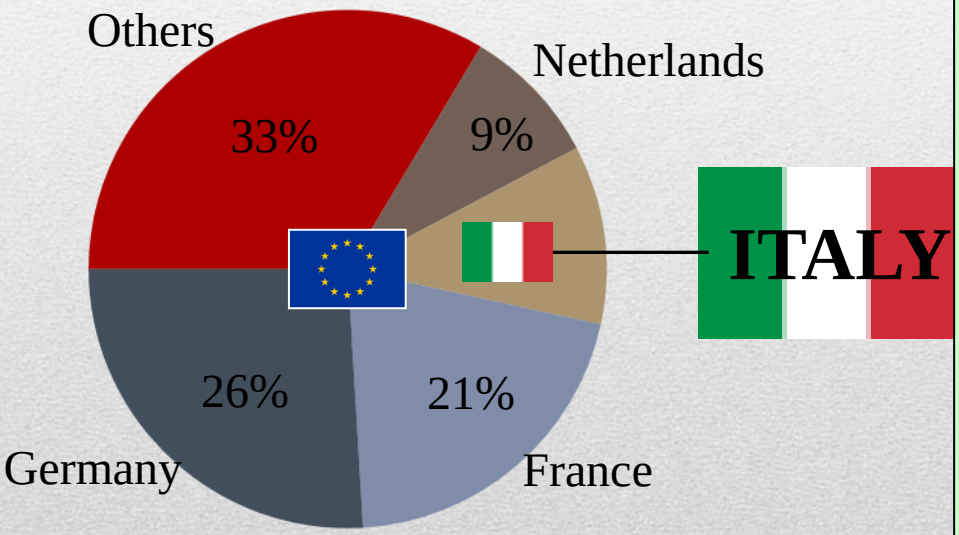
EU-28

2014

Milk: 76,613,000 tons[d]

Cheese: 8,858,720 tons[d]

- 1° World Cheese Producer (57%)[e] -



- 3° EU cheese producer: 11%[d]
  - 4° World Producer: 6%[e] -
- 1 million tons cheese[a]
- 50% PDO cheese[b]
- 48 PDO cheese[c]
- Dairy Industry 11% revenue from Italian food sector[a]

[a](Assolatte, 2015), [b](IDF, 2012), [c](Mipaaf, 2015), [d](Clal, 2014), [e](FAOSTAT, 2013)

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Goal and scope

Scope:

➢ Enviromental impacts of Asiago PDO cheese

- **Asiago 4° IT PDO cheese __21,458 tons**[d]
  - ***Cow's milk***
  - ***North East Italy***

- ➢ *LCA from cradle to dairy plant gate*
- ➢ *34 Dairy farms analyzed*
- ➢ ***1 Dairy plant** (Soligo Dairy Cooperative)*
- ➢ *2013: annual data collection*

- **Focusing on Dairy Plant emissions**
- **Allocation scenario analysis**

[d](Clal, 2014)

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LC Inventory 1

...From farm gate to plant gate

Started coltures
Pelure
Seed Oil
Lysozyme
Casein Plate
Rennet

Land
Water
Natural gas
Diesel
Electricity
Lubricant oil
Cleaning agents
Refrigerant gas
Plastic packaging
Paper packaging
Wood pallets

Raw milk

Waste:
Plastic
Paper
Pallets
Oil
Water

1 Kg
At plant gate


Other cheese


Whey

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Allocation

[a](Kim et al., 2013)
[b](Berlin, 2002)

Milk solids[a]: raw milk

Plant information[a]: other cheese ingredients

Economic revenue[b]: plant material flows and waste

1 Kg

At plant gate

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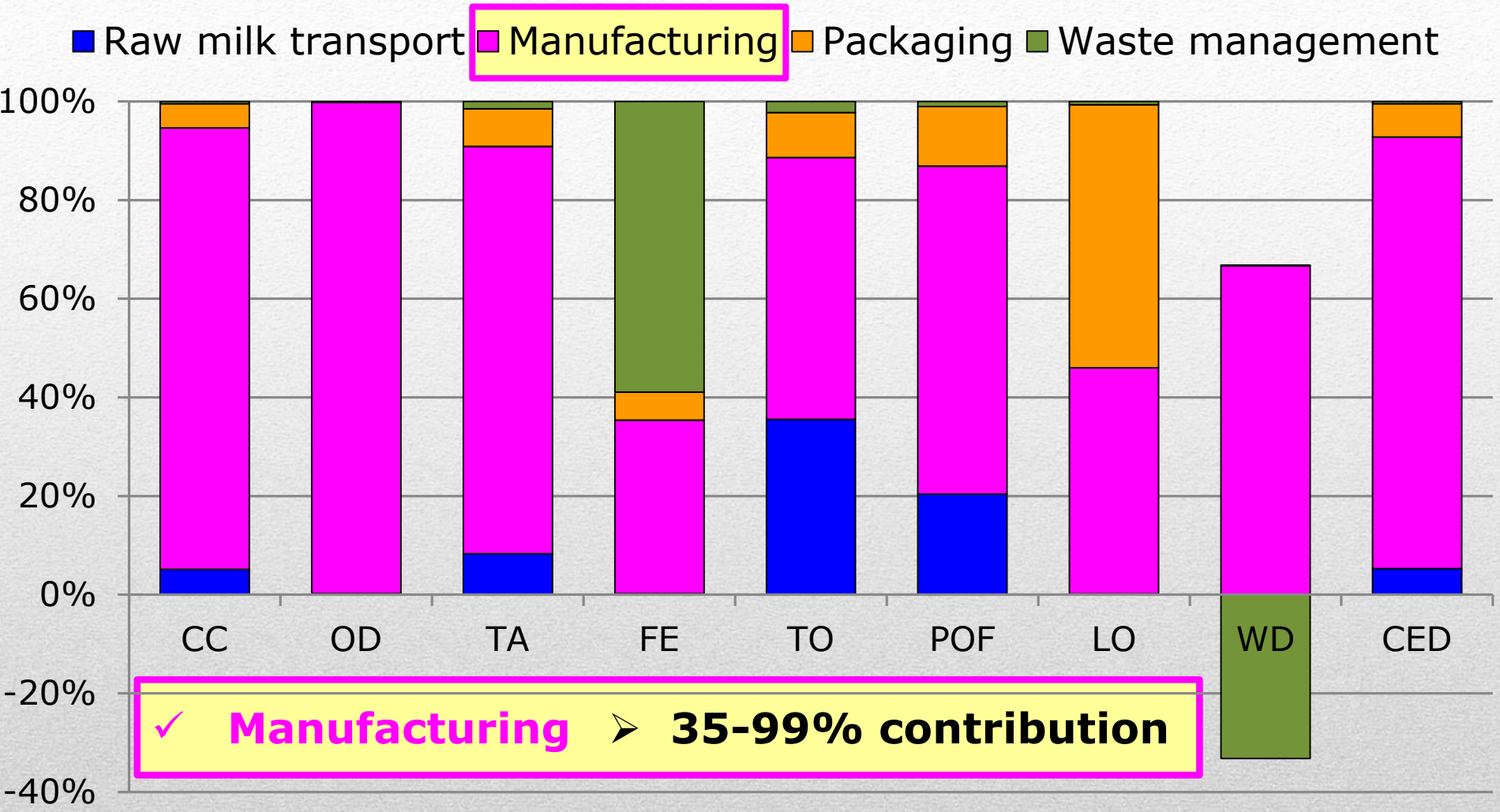
"Farm Gate to Plant Gate"



CC: Climate Change - **OD**: Ozone Depletion - **TA**: Terrestrial Acidification - **FE**: Freshwater Eutrophication **TO**: Toxicity (human-terrestrial-acquatic) - **POF**: Photochemical Oxidant Formation - **LO**: Land Occupation (agricultural-urban) - **WD**: Water Depletion - **CED**: Cumulative Energy Demand (nonrenewable-renewable)

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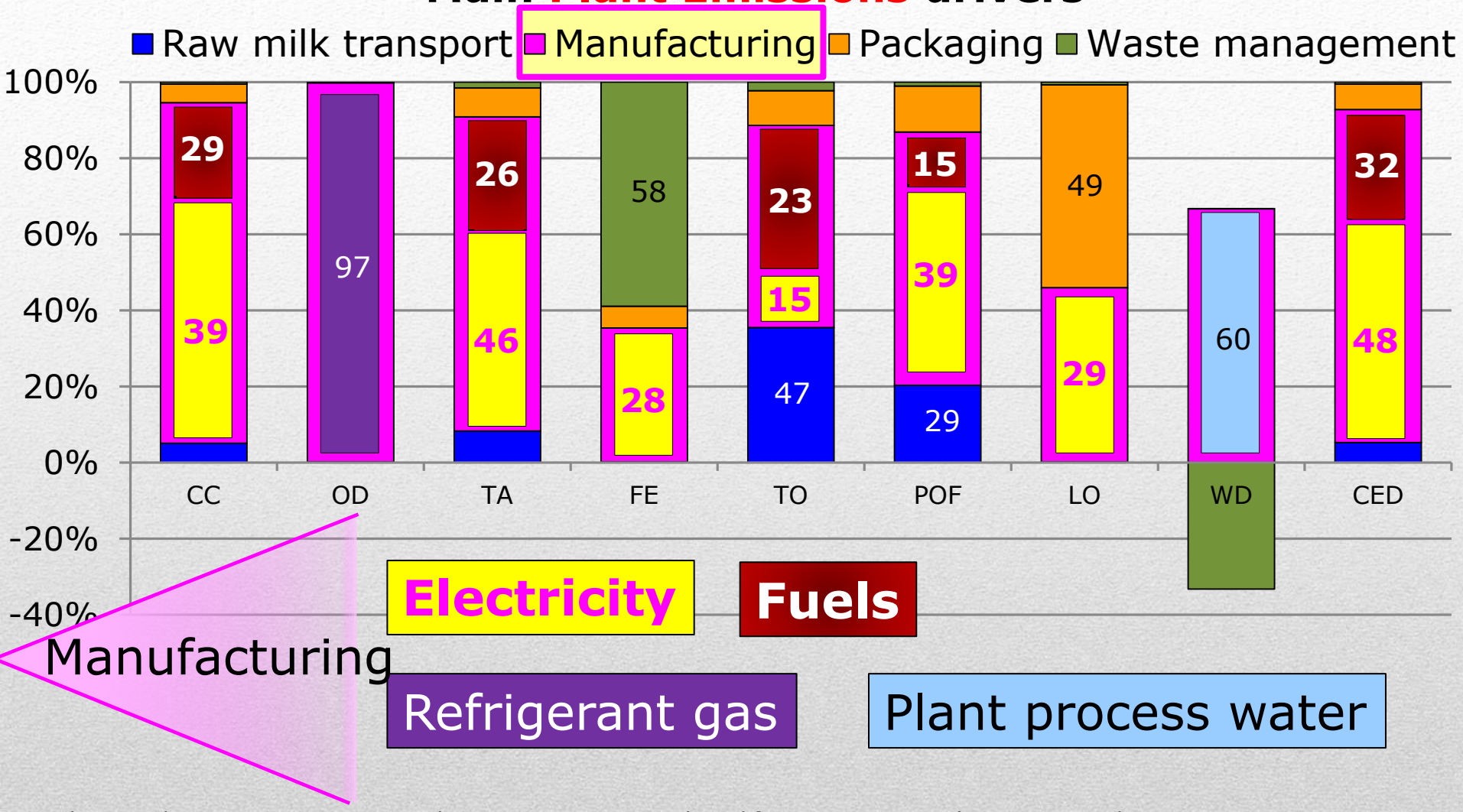
Interpretation 1

Main Plant Emissions drivers



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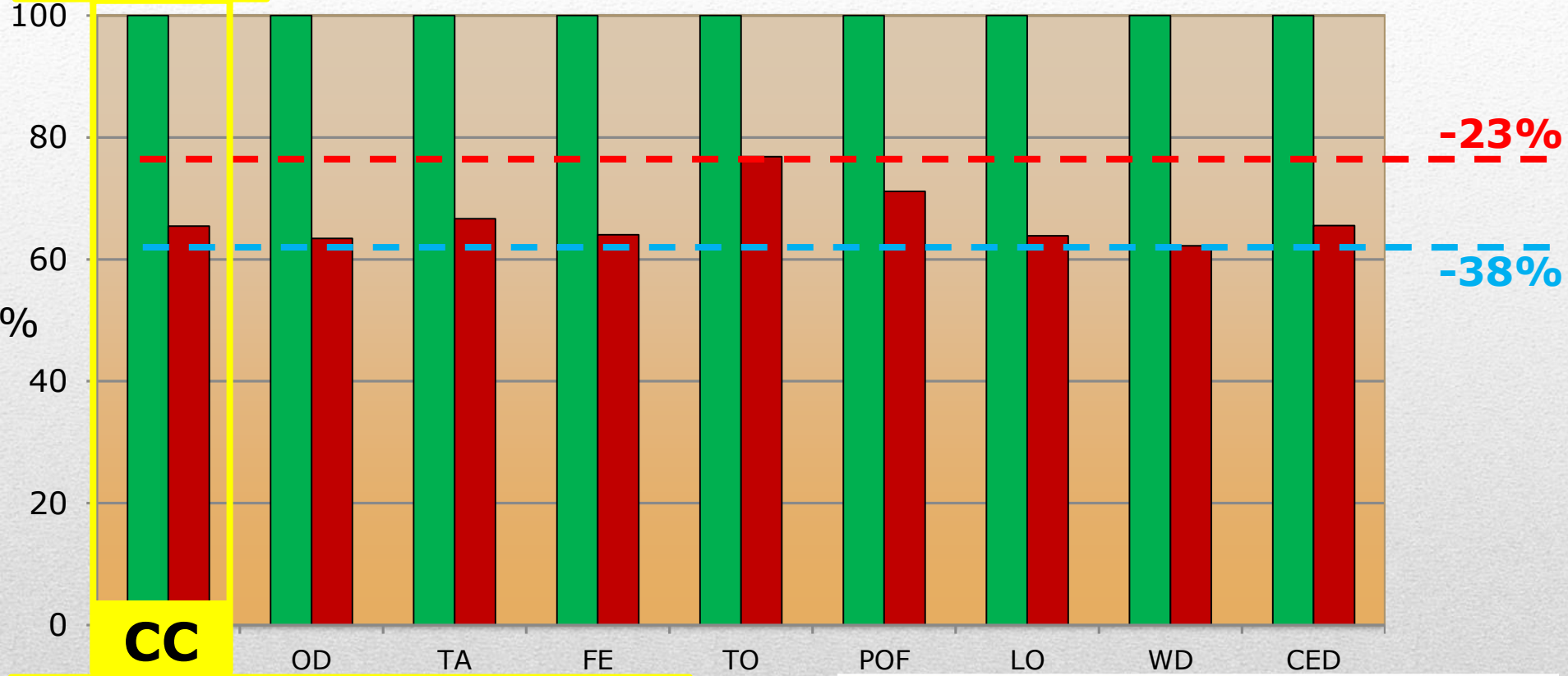
Interpretation 2

Farm gate to plant gate_ Allocation

kg CO_2eq / kg Asiago

Economic vs Milk Solids



E: 1.33 to MS: 0.87

% Emiss	Asiago	Other Cheese	Liquid Whey
Economic	67	31	2
Milk solids	43	16	41

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Conclusion

Methodology


LCA valid tool


Final result comparison


Allocation

Impacts

- ✓ Energy sector improvements
- ✓ Packaging
- ✓ Transport
- ✓ Whey and wastewater management

Future

- ➢ Whole LCA *(from cradle to grave)*
- ➢ LCA on PDO cheese: Added value

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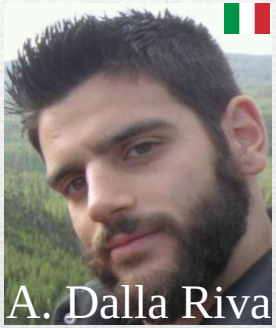
LCA Asiago PDO Cheese

THANK YOU
for your attention!


G. Thoma


M. De Marchi


M. Cassandro


A. Dalla Riva


J. Burek


D. Kim

Thanks to:
Prof. De Marchi, Prof. Cassandro, Prof. Thoma, Post-doc Kim, Researcher Burek, Researcher Putman, Alice Varotto, Giovanni Niero, Giulia Rossi, Giulio Visentin, Enrico Zanetti, Valentina Toffanin, Martina Isaia, Paolo Gottardo, Alba Sturaro.
Local dairy farmers and Soligo Cooperative Dairy Factory.

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APPENDIX

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❖ System boundaries and inventory

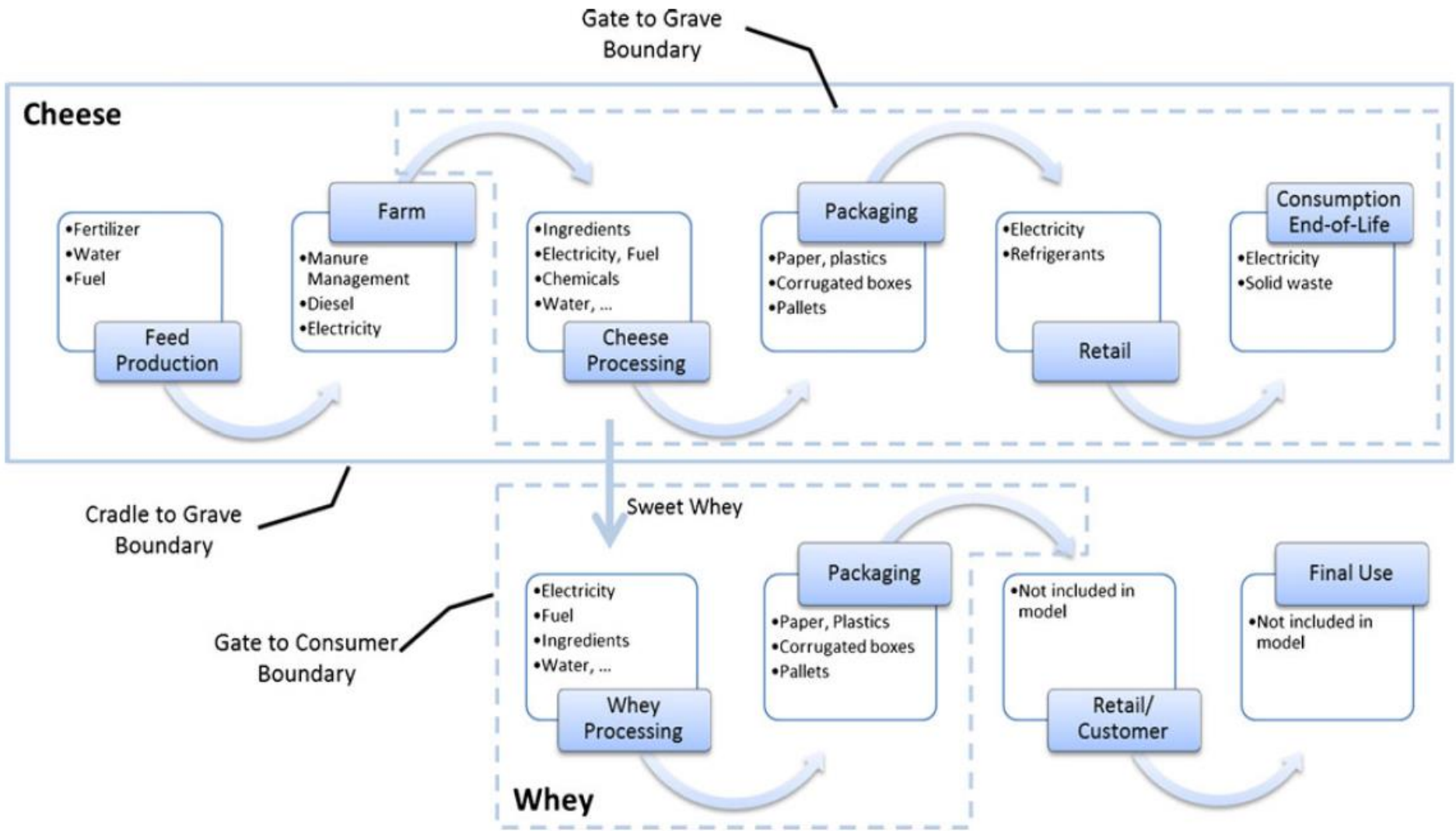

Fig. 1 Flow diagram depicting cheese and whey unit processes/operations, applicable to both cheddar and mozzarella processes. Note that the *curved arrows* represent a transport operation

Kim et al., 2013

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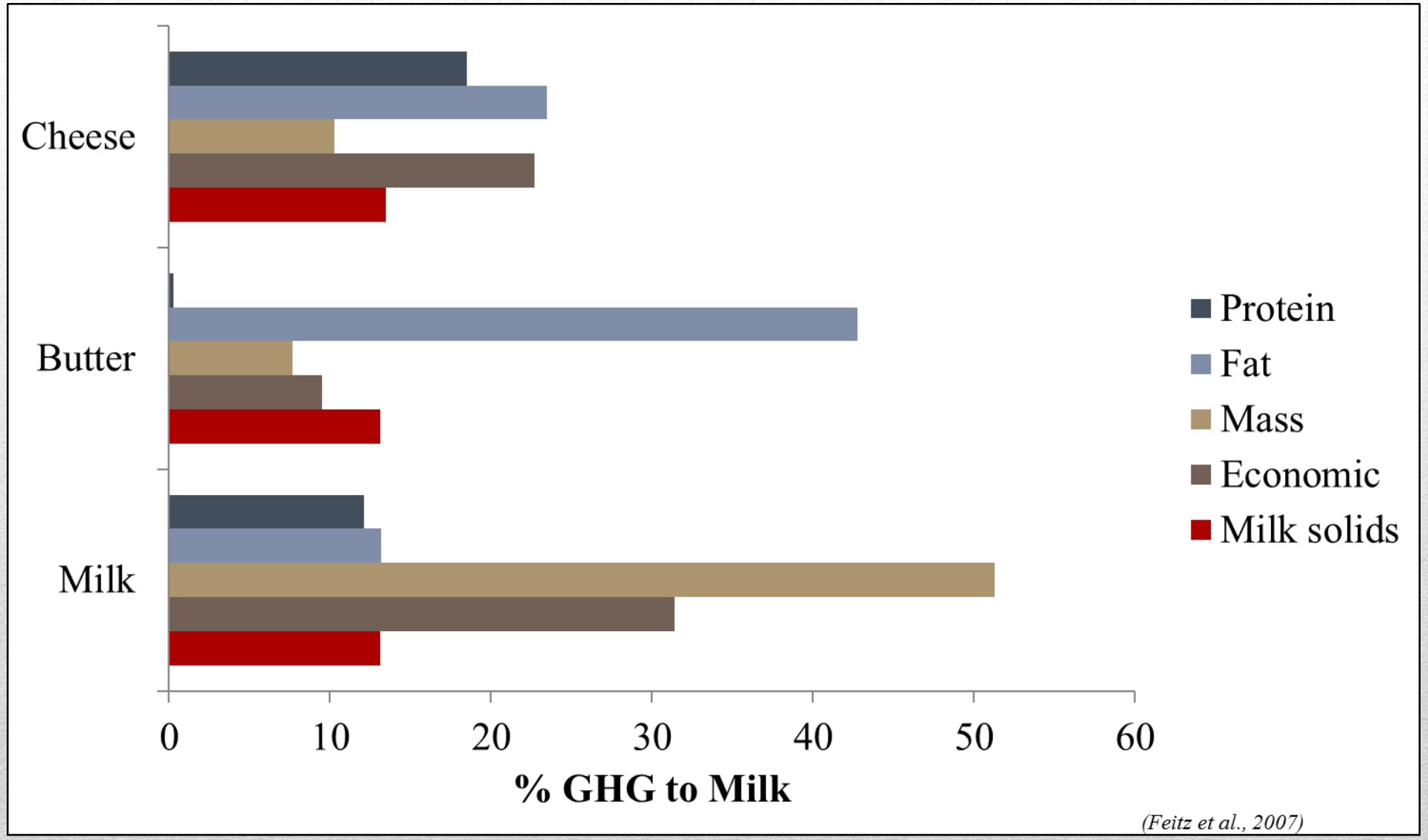
❖ Different allocation methods



(Feitz et al., 2007)

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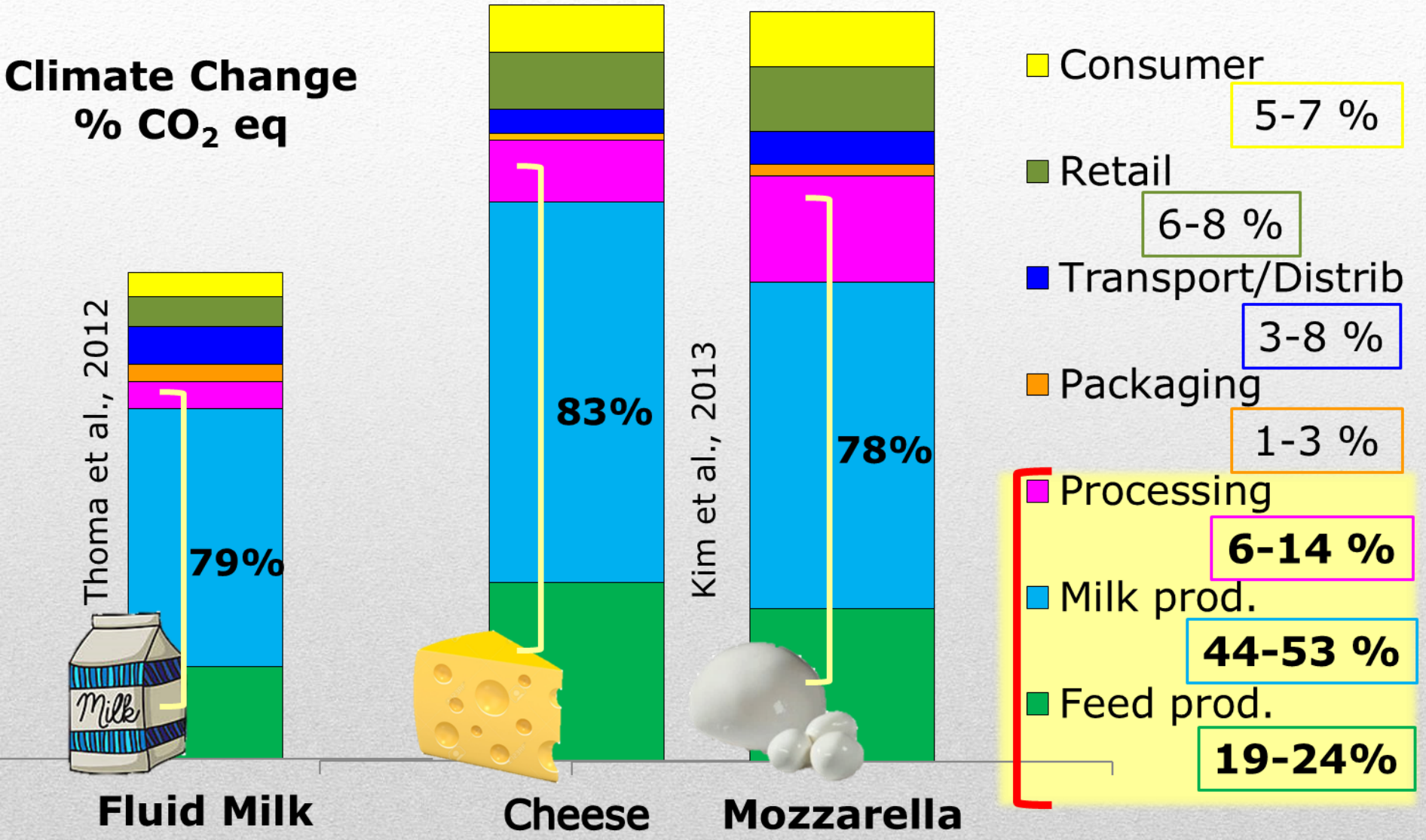
❖ Dairy Products



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LCA Asiago PDO Cheese

Impact categories	Unit	From Cradle to Dairy Plant gate		From Farm gate to Dairy Plant gate	
		EM	MS	EM	MS
CC	kg CO_2 eq	10.14	**9.68**	1.33	**0.87**
OD	kg CFC-11 eq	5.75E-06	**3.80E-06**	5.34E-06	**3.39E-06**
TA	kg SO_2 eq	0.07	**6.75E-02**	4.25E-03	**2.83E-03**
FE	kg P eq	8.13E-04	**8.00E-04**	3.57E-05	**2.28E-05**
TO	kg 1,4-DB eq	0.54	**0.53**	0.08	**0.06**
POF	kg NMVOC	2.12E-02	**2.05E-02**	2.69E-03	**1.91E-03**
LO	m^2a	8.09	**8.07**	0.07	**0.05**
WD	m^3	2.35E+00	**2.34**	0.02	**0.01**
CED	MJ	70.23	**63.34**	20.00	**13.11**

EM= Economic Alloc, MS= Milk Solids Alloc, CC: Climate Change, OD: Ozone Depletion, TA: Terrestrial Acidification, FE: Freshwater Eutrophication, TO: Toxicity (sum of human-terrestrial-freshwater-marine toxicity), POF: Photochemical Oxidant Formation, LO: Land Occupation (sum of agricultural and urban), WD: Water Depletion, CED: Cumulative Energy Demand (sum of nonrenewable fossil-nuclear-biomass and renewable biomass-wind-solar-geothermal-water).

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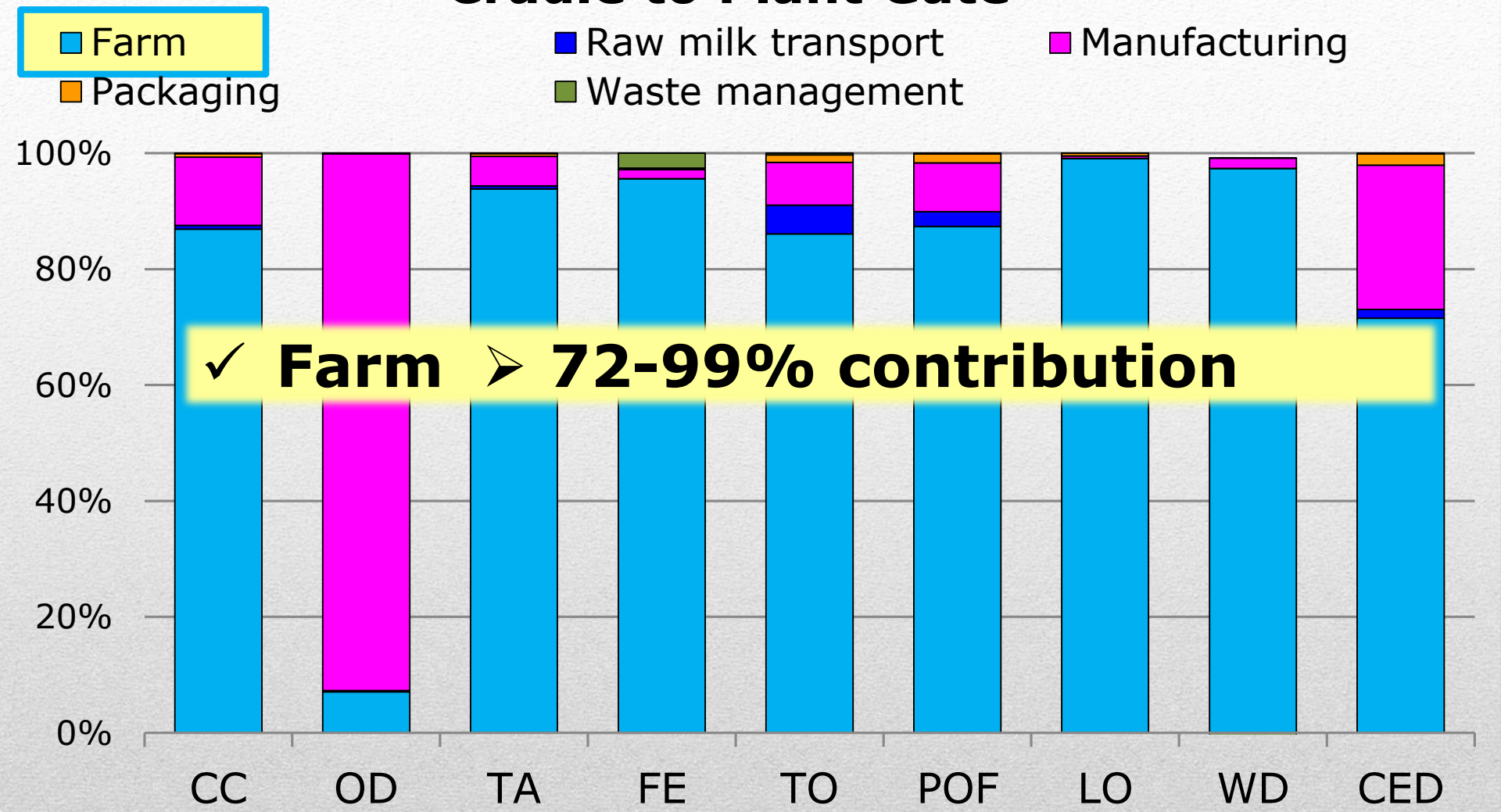
"Cradle to Plant Gate"



✓ **Farm ➢ 72-99% contribution**

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