



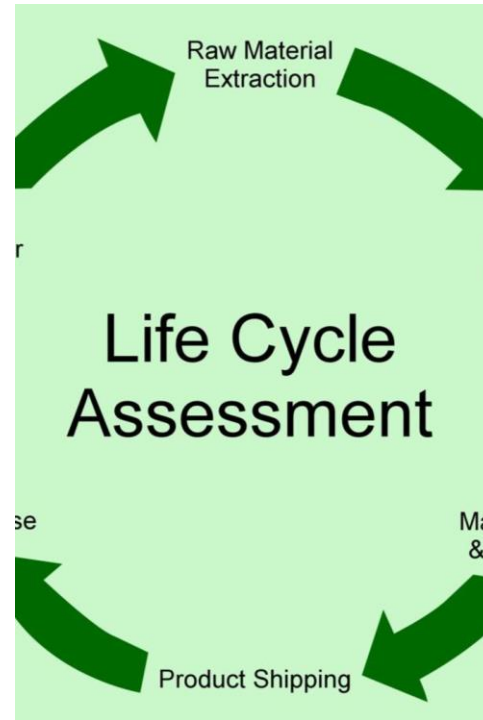
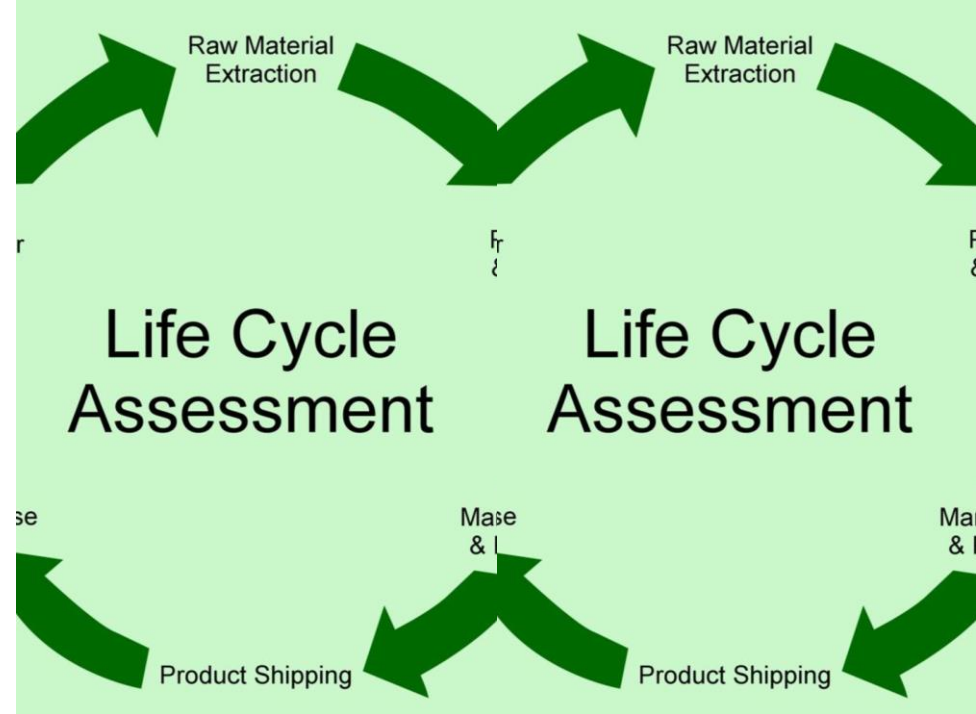
EU LIFE-TRIALKYL - AN INNOVATIVE AND SUSTAINABLE CONTINUOUS PROCESS FOR THE DEVELOPMENT OF HIGH QUALITY TRIMETHYL PHOSPHITE (LIFE14/ENV/IT/000346)

ACTION C - LCA

Birgit Brunklaus, Selim Stahl
Juni 2019

RISE Research Institutes of Sweden

**Built Environment, Sustainable Society
Environmental Systems Analysis**



ACTION C: LCA

LIFE-TRIALKYL - AN INNOVATIVE AND SUSTAINABLE CONTINUOUS PROCESS FOR THE DEVELOPMENT OF HIGH QUALITY TRIMETHYL PHOSPHITE (LIFE14/ENV/IT/000346)

The project description (Action C):

“The consortium will conduct a thorough Life Cycle Assessment (LCA) in order to assess the environmental impact of the project by considering **the entire value chain** from raw materials to products disposal.”

The objective of this Life Cycle Assessment (in the report):

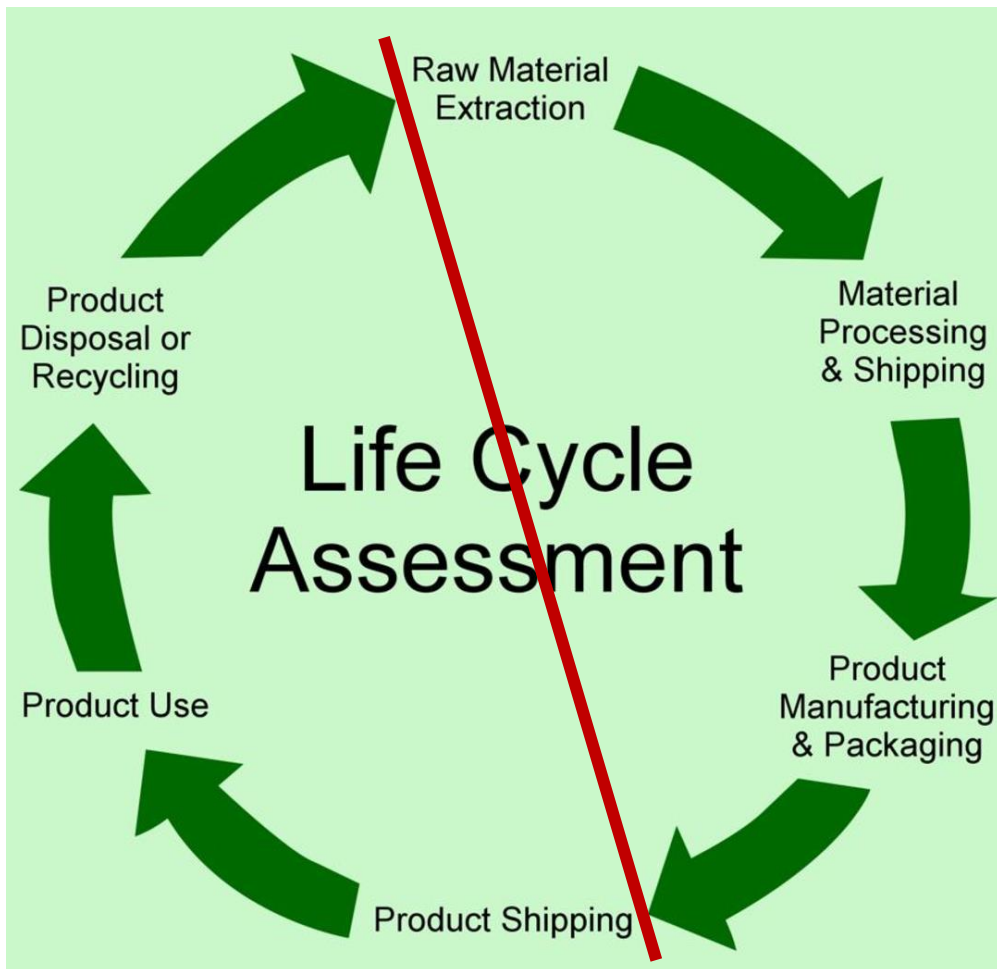
- to evaluate the **new continuous process (Trialkyl)** for TMPi
- to compare the environmental assessment with **existing** TMPi production processes, such as the **tertiary amine process (TEA)**.

The persons involved in Action C:

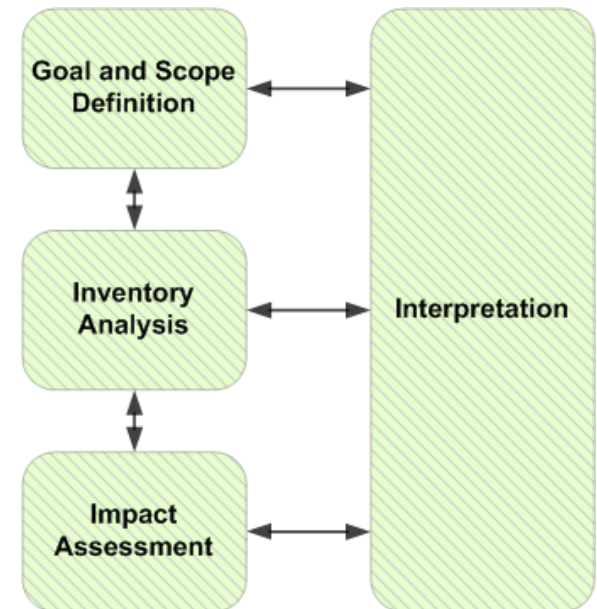
Selim Stahl (Lic), RISE (2016-2018),
Birgit Brunklaus (PhD), RISE (2018-2019)



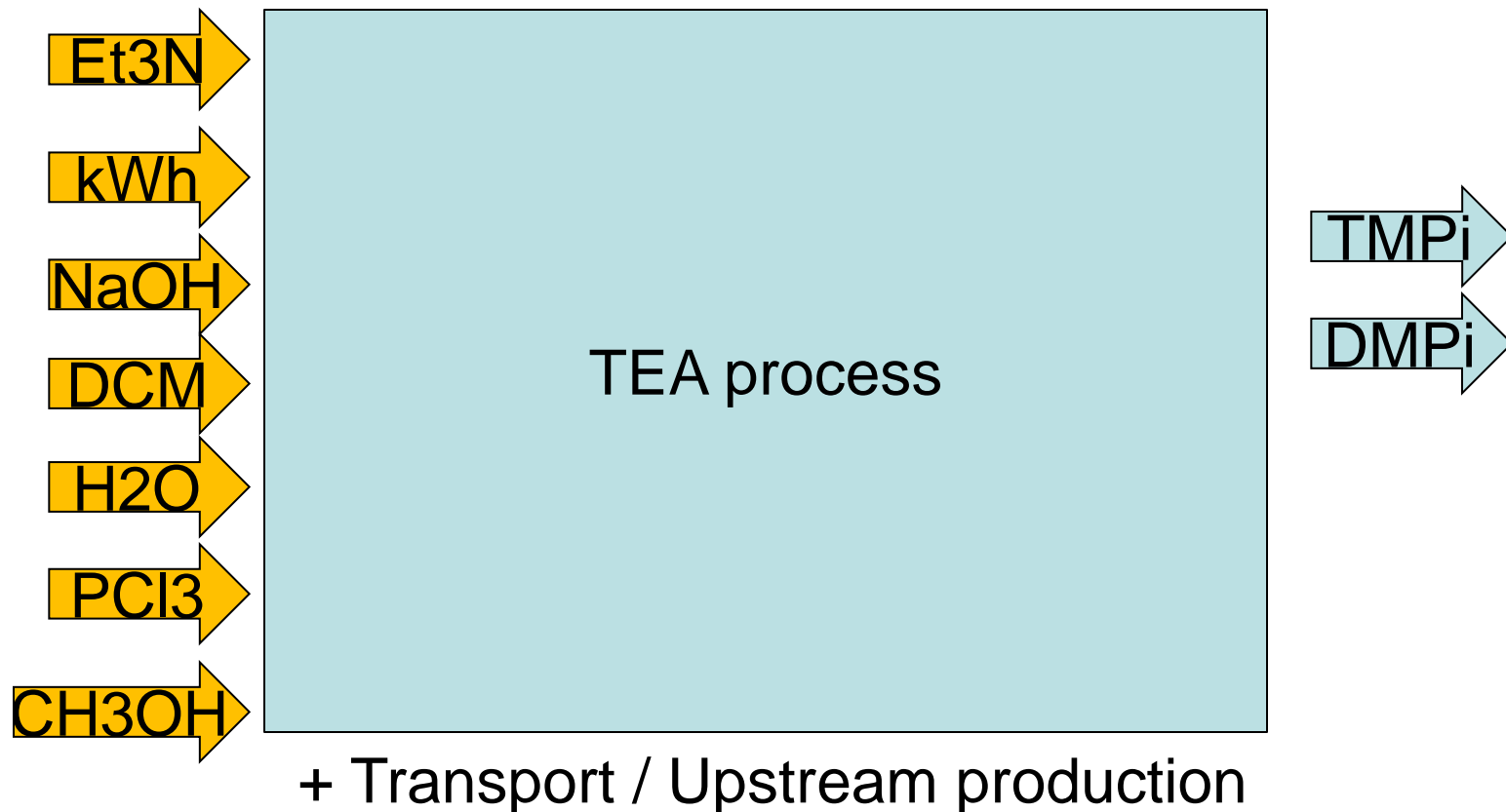
Cradle-to-Gate LCA



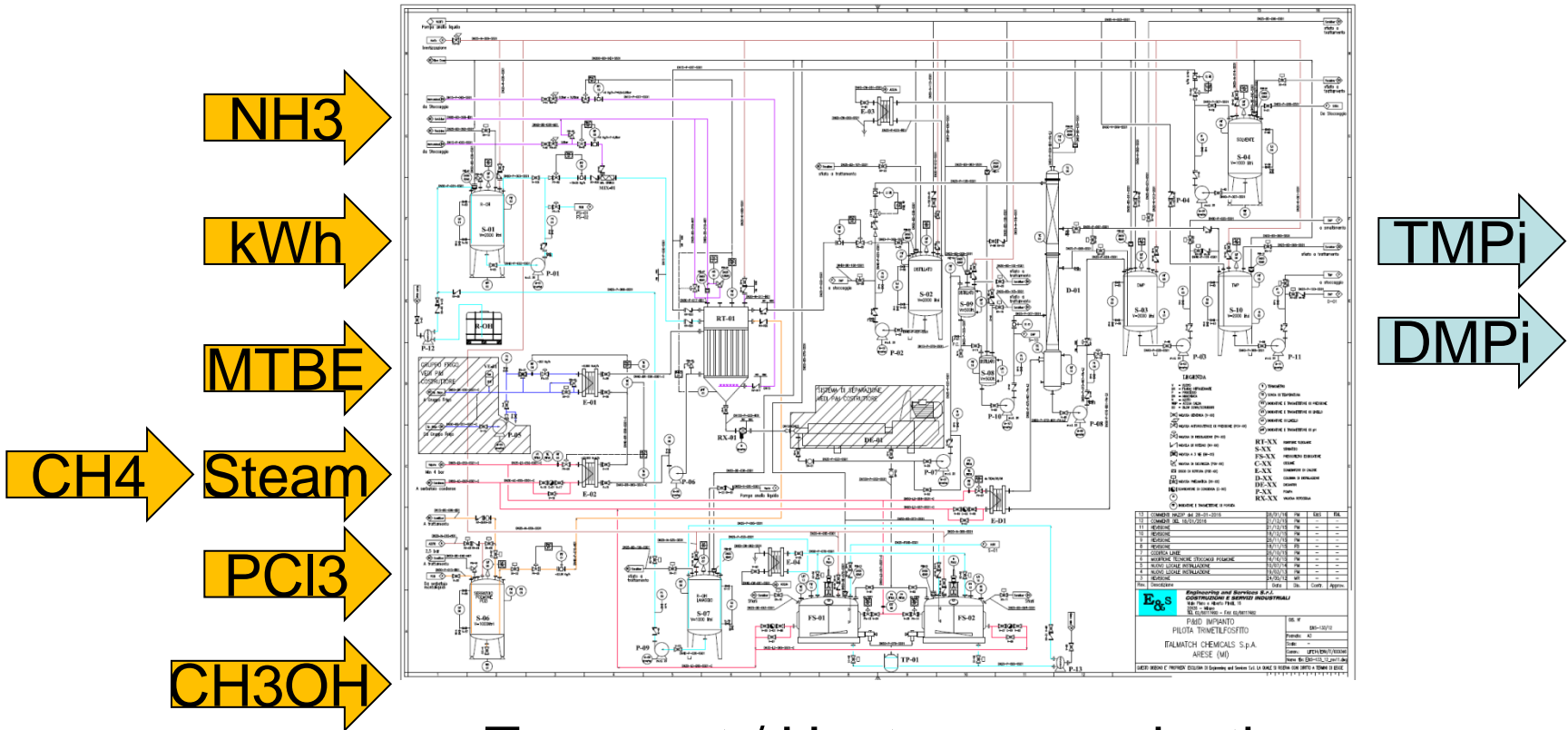
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TEA process Life Cycle Inventory



Trialkyl pilot Life Cycle Inventory



+ Transport / Upstream production



Trialkyl TBP - Pilot Plant vs LAB

1. Energy consumption – Pilot plant (june 2019)

Electricity use	35 kwh/h	
Natural gas	1,15 m3/h	13,3 kwh/h

1. Energy consumption - LAB data (june 2017)

Electricity use	35 kwh/h	
Natural gas	1,55 m3/h	18,3 kwh/h

2. Mass balance

Pilot using TBP

	4 tube	9 tube	per hour
In			
PCI3	10		kg/h
NH3	4		kg/h
BuOH	16,7		kg/h
Out			per hour
TBP	16		kg/h
DBP	3,7		kg/h
NH4Cl	11		kg/h

Reaction
yield 90%

Water (also for
steam) and
wastewater use

Fertilisers produced

Solvents used e.g. MTBE Methyl-tert-butyl-ether

30 m3/h

30 kg/h

In (LAB data)

	1 tube	9 tube	per hour
PCI3	2,7		kg/h
NH3	1		kg/h
BuOH	4,4		kg/h

Out (LAB data)

		per hour
TBP	4,4	kg/h
DBP	0,38	kg/h
NH4Cl	2,8	kg/h

Reaction
yield 90%

The energy- and mass balances LAB and Pilot data:
The results show similar values:

Reaction 1 tube, total 9 tubes, annual production 180 ton.

LAB data (3,05 kwh/kg) and Pilot data (3,018 kwh/kg).

Pilot data provided from Italmatch in June 2019 (Lab data in June 2017)

ACTION C: LCA Results

Impact	Unit (per kg TMPi)	Trialkyl I TMPi (LAB)	Trialkyl TBPI (LAB, PILOT)	Trialkyl TEPi (LAB)	TEA TMPi	LCA TMPi Delta %	LCA TBPI Delta %
Acidification	kg SO2 eq	0.017	0.016	0.031	0.21	-92	
Climate	kg CO2 eq	3.14	6.45	4.99	52.9	-94 %	- 87 %
Eutrophication	kg PO4 eq	0.007	0.012	0.015	0.049	-85	
Ozone depletion	kg CFC 11 eq	7.6E-7	1.27E-6	1.33E-6	3.86E-5	-98	
Energy demand	MJ	64.6	156.5	125.8	901.6	-93	- 83 %
Photochemical oxidant	kg NMVOC	0.01	0.022	0.026	0.29	-96	
Water depletion	m3	16.4	27.9	31.8	43.6	-62	

ACTION C: LCA sensitivity Yield and energy

Impact	Unit (per kg TMPi)	Trialkyl TMPi 90%	Trialkyl TMPi 80%	LCA TMPi Delta	TEA TMPi	TEA TMPi with el&NG	LCA TMPi Delta
Acidification	kg SO2 eq	0.017	0.019		0.21	0.018	
Climate	kg CO2 eq	3.14	3.53	+ 10%	52.9	3.23	> 90%
Eutrophication	kg PO4 eq	0.007	0.008		0.049	0.004	
Ozone depletion	kg CFC 11 eq	7.6E-7	8.56E-7		3.86E-5	2.91E-5	
Energy demand	MJ	64.6	72.68	+10%	901.6	60.44	> 90%
Photochemical oxidant	kg NMVOC	0.01	0.011		0.29	0.014	
Water depletion	m3	16.4	18.4		43.6	6.49	

Conclusions

1. Encouraging results for TMPi, TBPi and TEPi (Lab data)
Reduction of 80-90% (Energy and GWP)
2. The yield and energy important for results (sensitivity analysis)
3. Similar results for TBPi (based on Pilot data)
4. Final conclusion for TMPi (further Pilot data)



THANK YOU!

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Juni 2019

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