

# 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):

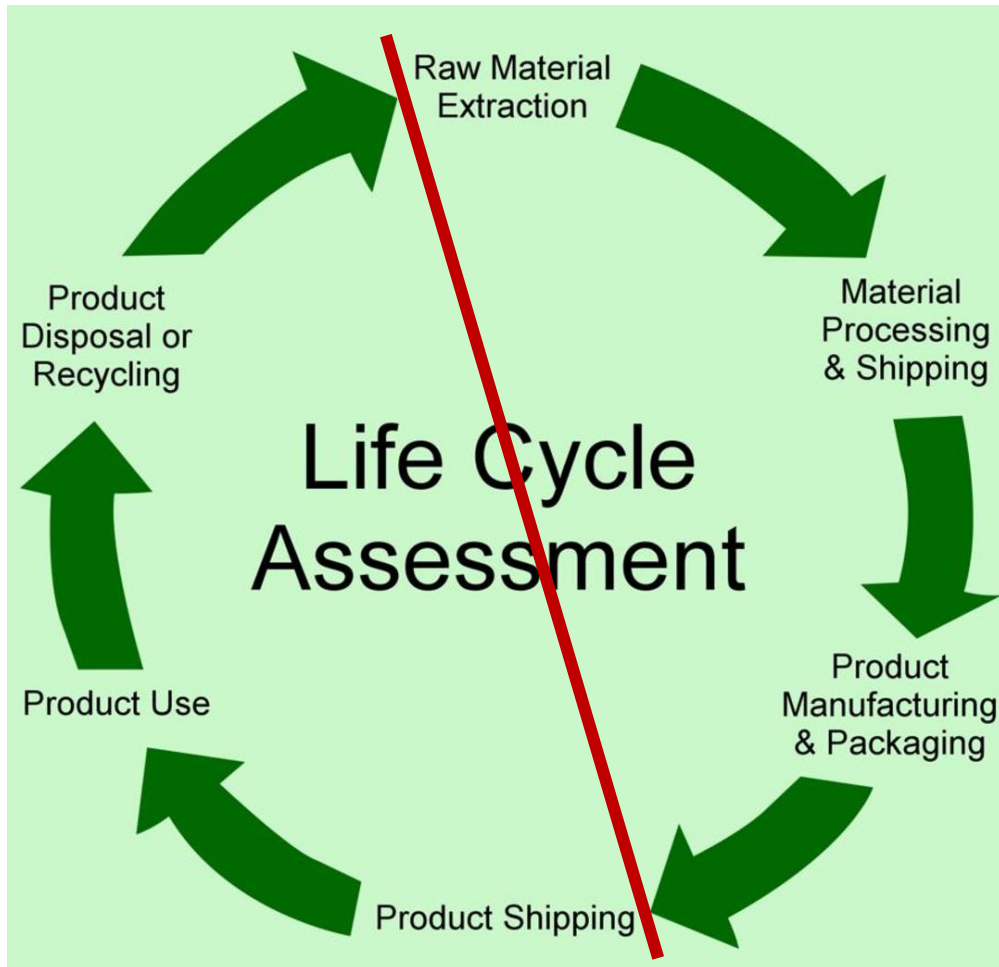
- to evaluate the **new continuous process (Trialkyl)** for TMPi
- to compare the environmental assessment with **existing** TMPi production processes, such as the **tertiary amine process (TEA)**.

### **The persons involved in Action C:**

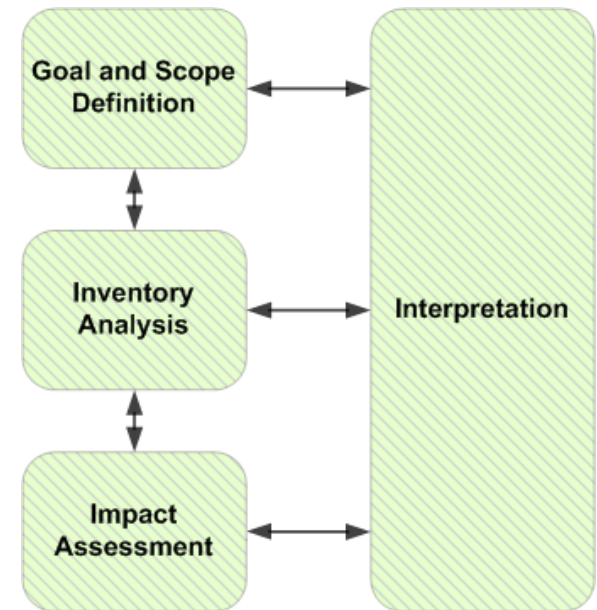
Selim Stahl (Lic), RISE (2016-2018),  
Birgit Brunklaus (PhD), RISE (2018-2019)



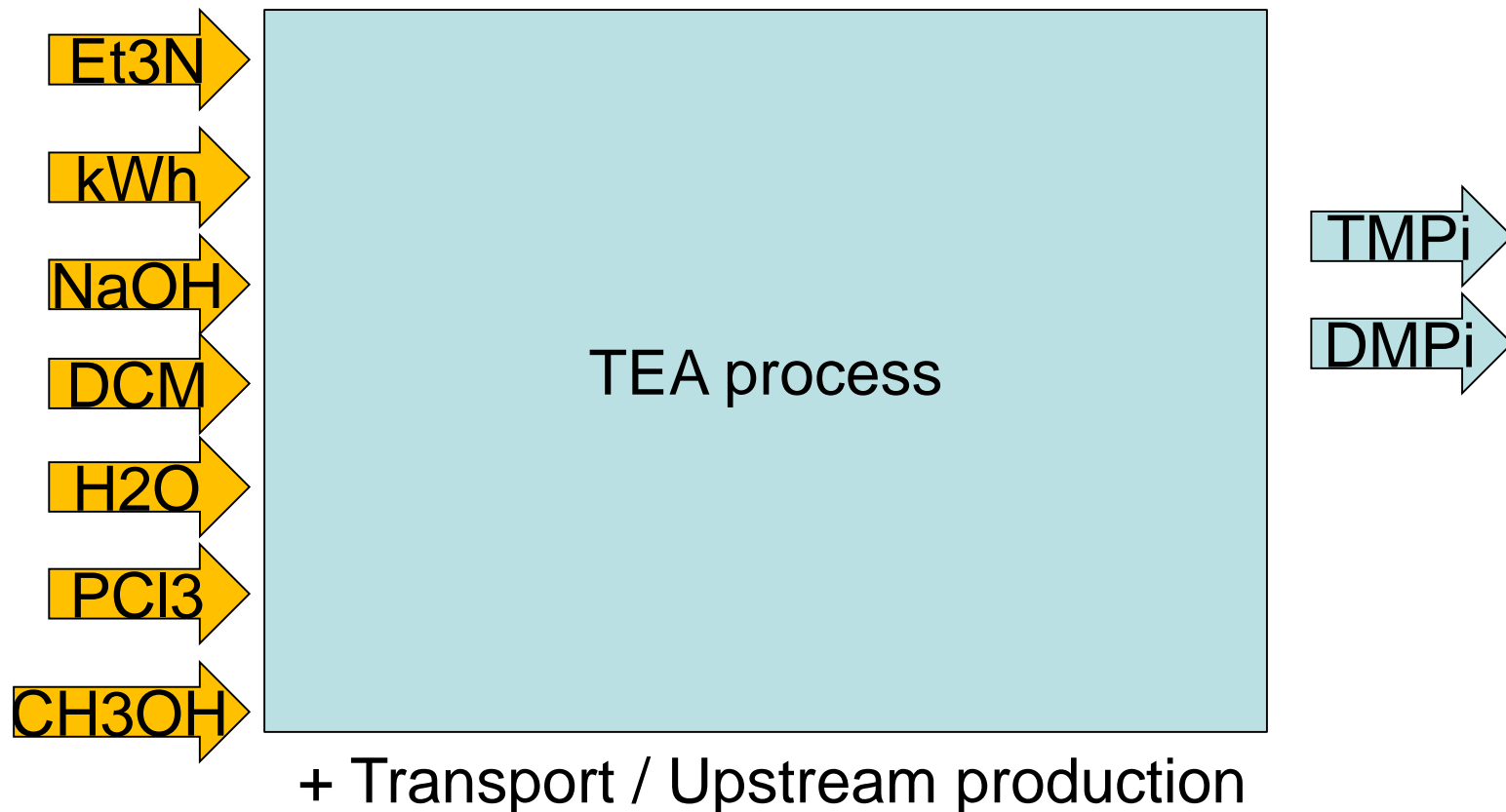
# Cradle-to-Gate LCA



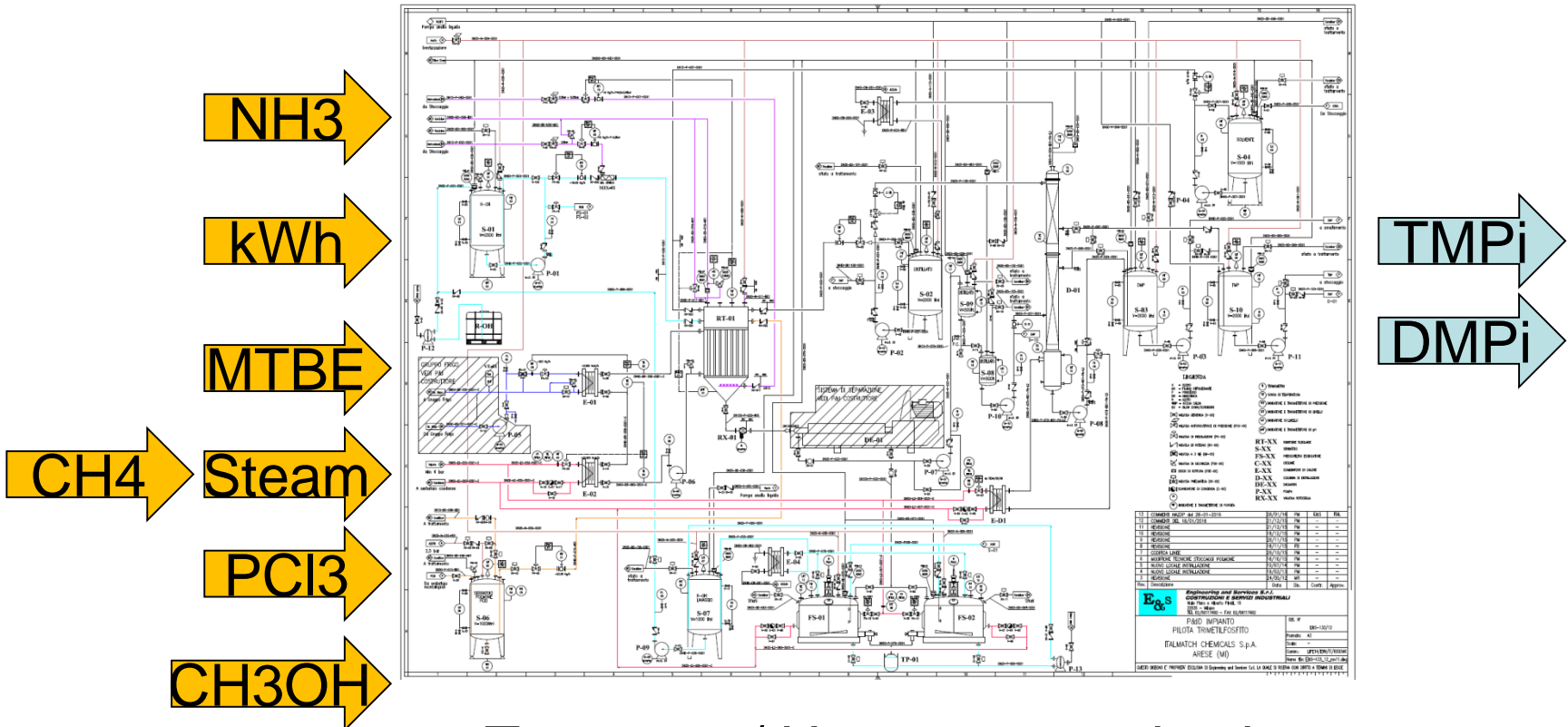
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# TEA process Life Cycle Inventory



# 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

In	4 tube	9 tube	per hour
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

### 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	
<b>Climate</b>	kg CO2 eq	<b>3.14</b>	<b>6.45</b>	4.99	<b>52.9</b>	<b>-94 %</b>	<b>- 87 %</b>
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	<b>156.5</b>	125.8	901.6	-93	<b>- 83 %</b>
Photochemical oxidant	kg NMVOC	0.01	0.022	0.026	0.29	-96	
<b>Water depletion</b>	m3	<b>16.4</b>	27.9	31.8	<b>43.6</b>	<b>-62</b>	

## 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	<b>3.14</b>	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	<b>16.4</b>	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)