

# Analyse environnementale de la technologie de traçage pour le recyclage des polymères E. Maris - ARTS et METIERS Laboratoire Conception de Produits et Innovation

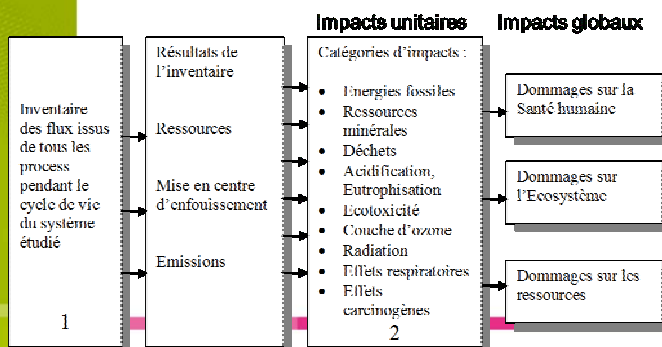
TRIPTIC ( ANR / Ecotech 2009)  
Séminaire de restitution - 4 février 2014

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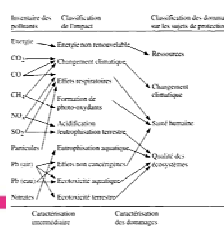


## Principe de l'analyse environnementale de cycle de vie

- Référence (JOLLIET, O. et al, 2005)
- Outil d'ACV : SIMAPRO
- Méthode d'évaluation des impacts : Impact 2002



Catégorie d'impact	Unité
Carcinogènes	kg C2H3Cl eq
Non-carcinogènes	kg C2H3Cl eq
Respiratory inorganics	kg PM2.5 eq
Ionizing radiation	Bq C-14 eq
Ozone layer depletion	kg CFC-11 eq
Respiratory organics	kg C2H4 eq
Aquatic ecotoxicity	kg TEG water
Terrestrial ecotoxicity	kg TEG soil
Terrestrial acid/nutri	kg SO2 eq
Land occupation	m2/yr arable
Aquatic acidification	kg SO2 eq
Aquatic eutrophication	kg PO4 P-lim
Global warming	kg CO2 eq
Non-renewable energy	MJ primary
Mineral extraction	MJ surplus

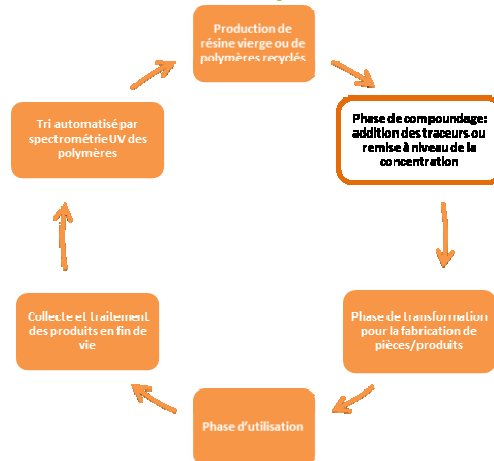


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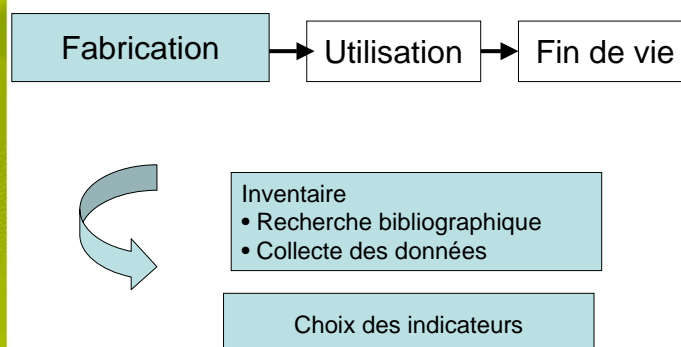
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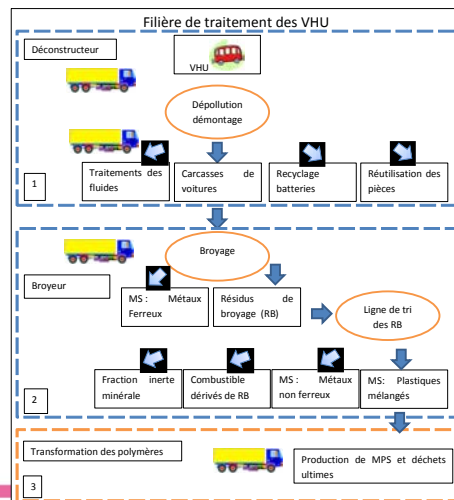
## Recyclage et traçage des matériaux pour le tri : Principe



## Périmètre de calcul



## Modélisation plastiques recyclés issus de la filière VHU



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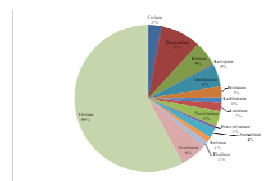
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## Traceurs à base de terres rares : Ressources connues, catégories de minerais, pays (2011 USGS)

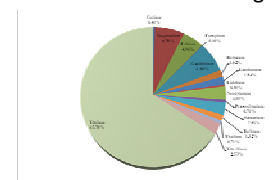
Rare earth	Redinitite		Monazite			
	Mountain Pass, C.A., United States <sup>1</sup>	Bayan Obo, Inner Mongolia, China <sup>2</sup>	North Cape, Western Australia <sup>3</sup>	North Stradbroke Island, Queensland, Australia <sup>2</sup>	Green Cove Springs, FL, United States <sup>4</sup>	Nangang, Guangdong, China <sup>2</sup>
Cerium	40.10	50.00	46.00	45.80	43.70	42.70
Dysprosium	trace	0.1	0.7	0.60	0.9	0.8
Erbium	trace	trace	0.2	0.2	trace	0.3
Europium	0.1	0.2	0.053	0.8	0.16	0.1
Gadolinium	0.2	0.7	1.49	1.80	6.60	2.00
Holmium	trace	trace	0.053	0.1	0.11	0.12
Lanthanum	33.20	25.00	23.90	21.50	17.50	23.00
Neodymium	trace	trace	trace	0.01	trace	0.14
Praseodymium	12.00	18.50	17.40	18.60	17.50	17.00
Samarium	4.34	6.20	5.00	5.30	5.00	4.10
Terbium	0.3	0.8	2.53	2.10	4.90	3.00
Thulium	trace	0.1	0.035	0.3	0.26	0.7
Ytterbium	trace	trace	trace	trace	trace	trace
Yttrium	0.10	trace	0.1	0.1	0.21	2.40
Total	100	100	100	100	100	100

Rare earth	Monazite - Continued		Xenotime		Rare earth laterite	
	Eastern coast, Brazil <sup>5</sup>	Mount Weld, Australia <sup>6</sup>	Lahar, Penak, Malaysia <sup>7</sup>	Southeast Guangdong, China <sup>8</sup>	Xianwu, Jiangxi Province, China <sup>9</sup>	Longnan, Jiangxi Province, China <sup>10</sup>
Cerium	47.00	51.00	3.13	3.00	2.40	0.4
Dysprosium	0.4	0.2	8.30	9.10	trace	6.70
Erbium	0.1	0.2	6.40	5.60	trace	4.90
Europium	0.1	0.4	trace	0.2	0.5	0.10
Gadolinium	1.00	1.00	3.50	5.00	3.00	3.60
Holmium	trace	0.1	2.00	2.60	trace	1.60
Lanthanum	24.00	26.00	1.24	1.20	43.4	1.82
Neodymium	not determined	trace	1.00	1.80	0.1	0.4
Praseodymium	18.50	1.60	1.60	3.50	31.70	3.60
Samarium	4.50	4.00	0.5	0.6	9.00	0.7
Terbium	3.00	1.80	1.10	2.20	3.90	2.80
Thulium	0.1	0.1	0.9	1.20	trace	1.30
Ytterbium	trace	trace	1.10	1.30	trace	0.7
Yttrium	0.02	0.1	6.80	6.80	0.2	2.50
Yttrium	1.40	trace	61.00	56.30	8.00	65.00
Total	100	100	100	100	100	100



xenotime de Guandong



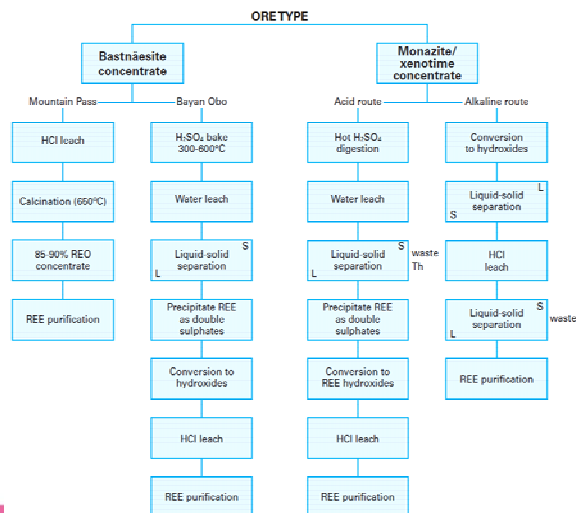
argiles latéritiques de Longnan

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## Procédés d'extraction des terres rares



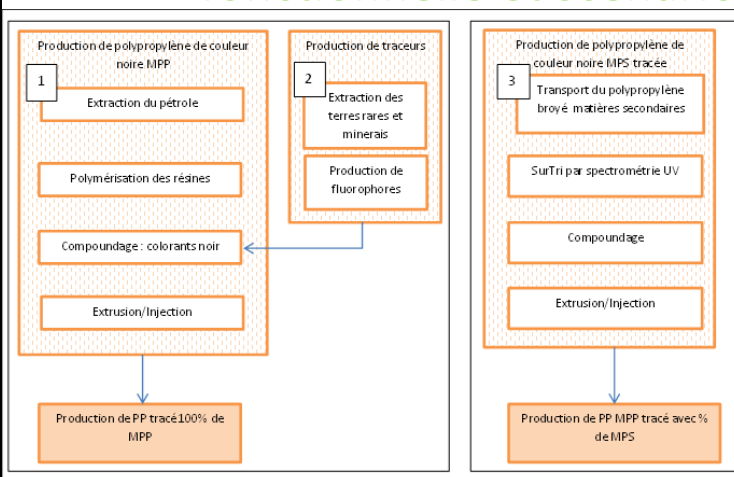
Le recyclage des lampes basse consommation et des DEEE UMICORE, RHODIA?

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## Les limites du système étudié, Unité fonctionnelle et scénarios



UF= Production de 1kg de granulés de polypropylène de couleur sombre additivé de traceurs, pour des applications automobiles comme le pare choc.

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## Données bibliographiques

- Extractive metallurgy of rare earths C. K. Gupta and N. Krishnamurthy
- Life Cycle Assessment of Product Stewardship Options for Mercury-Containing Lamps in New Zealand: Final Report Published by Peter Garrett and Michael Collins, Environmental Resources Management (ERM), for the Ministry for the Environment (2009)
- Kinetics on leaching rare earth from the weathered crust elution-deposited rare earth ores with ammonium sulfate solution, Tian Jun, Yin Jingqun , Chi Ruan , Rao Guohua , Jiang Mintao , Ouyang Kexian
- Rapport de l'UNEP

## Données ECOINVENT

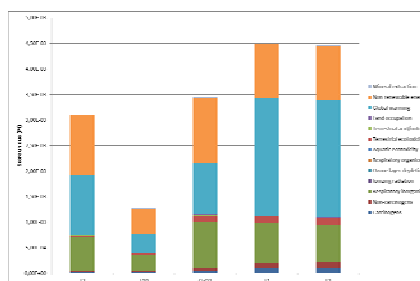
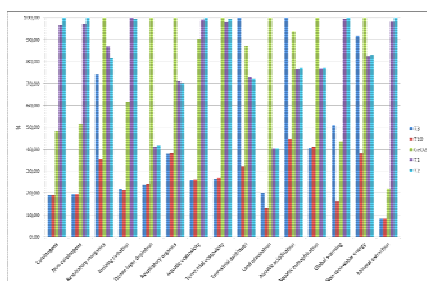
## Données ARTS et METIERS

Environmental benefits provided by the recovery of plastics from shredding of automobiles

Daniel Froelich, Elisabeth Maris, Hugues de Feraudy, Ingo Soppe, Wolfgang Hang, Edited  
by FRAY INTERNATIONAL SYMPOSIUM, 2011

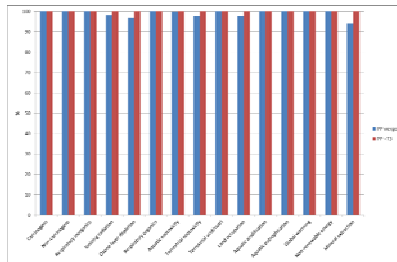
## Caractérisation

### Score unique

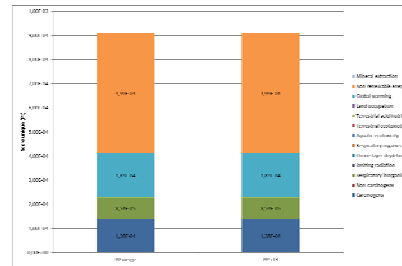


# Comparaison PP vierge versus PP tracé

Caractérisation (%)



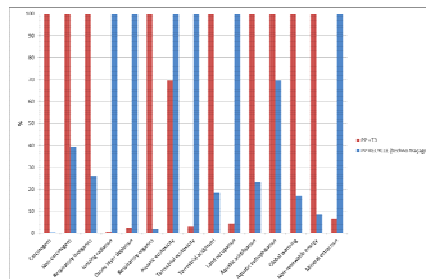
Score unique (Pt) T3 30ppm



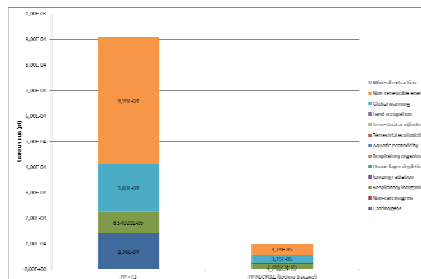
x100 traceur → Impact x1%

# Comparaison PP tracé versus PP recyclé

Caractérisation (%)



Score unique (pt)



MPS=10%MPP

## Conclusion

- Fiabilité des données
- Choix des traceurs
- Choix PP vierge versus recyclé



### TRIPTIC ( ANR / Ecotech 2009)

*Traceurs répartis pour identification des polymères et tri industriel en cadence*  
*Dispersed tracers for polymer materials identification & industrial sorting in cadence*

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