LCA: application to the components of glassed wrap

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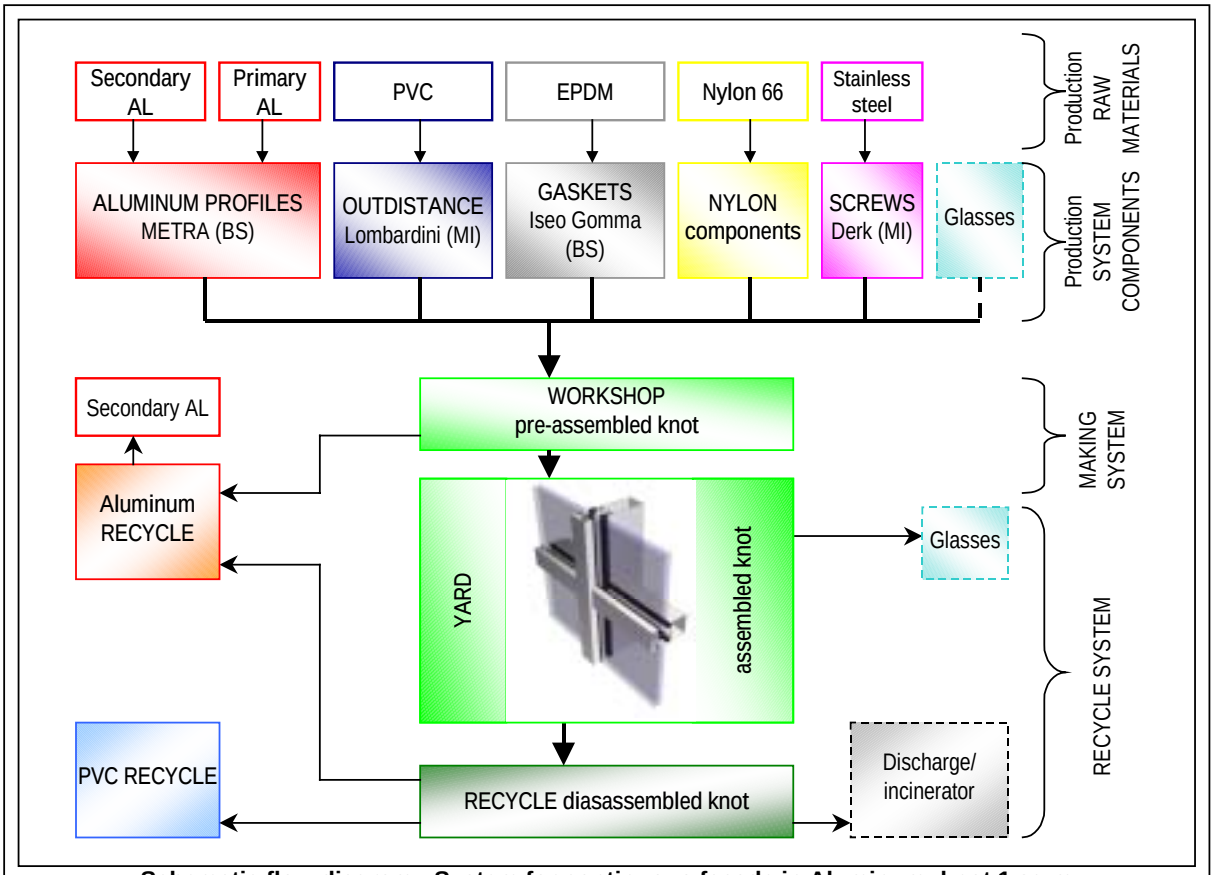
The recent development of investigation tools about the impact of products and services on the environment led to consider complex problems also from an architectural point of view, and to make technological and planning choices in the utmost respect of the environment. This also involves differences in the approach to planning, that entails the respect of environment compatibility requirements, proceeding from the study of the building construction process to the analysis of the building-system during its whole life cycle.

The methodology Life Cycle Assessment (LCA) aknowledged at international level (ISO 14040), represents a tool of analysis for the energy and environmental performances. At the same time it works as a verification of the eco-compatibility of activities and processes throughout the whole life cycle of the products.

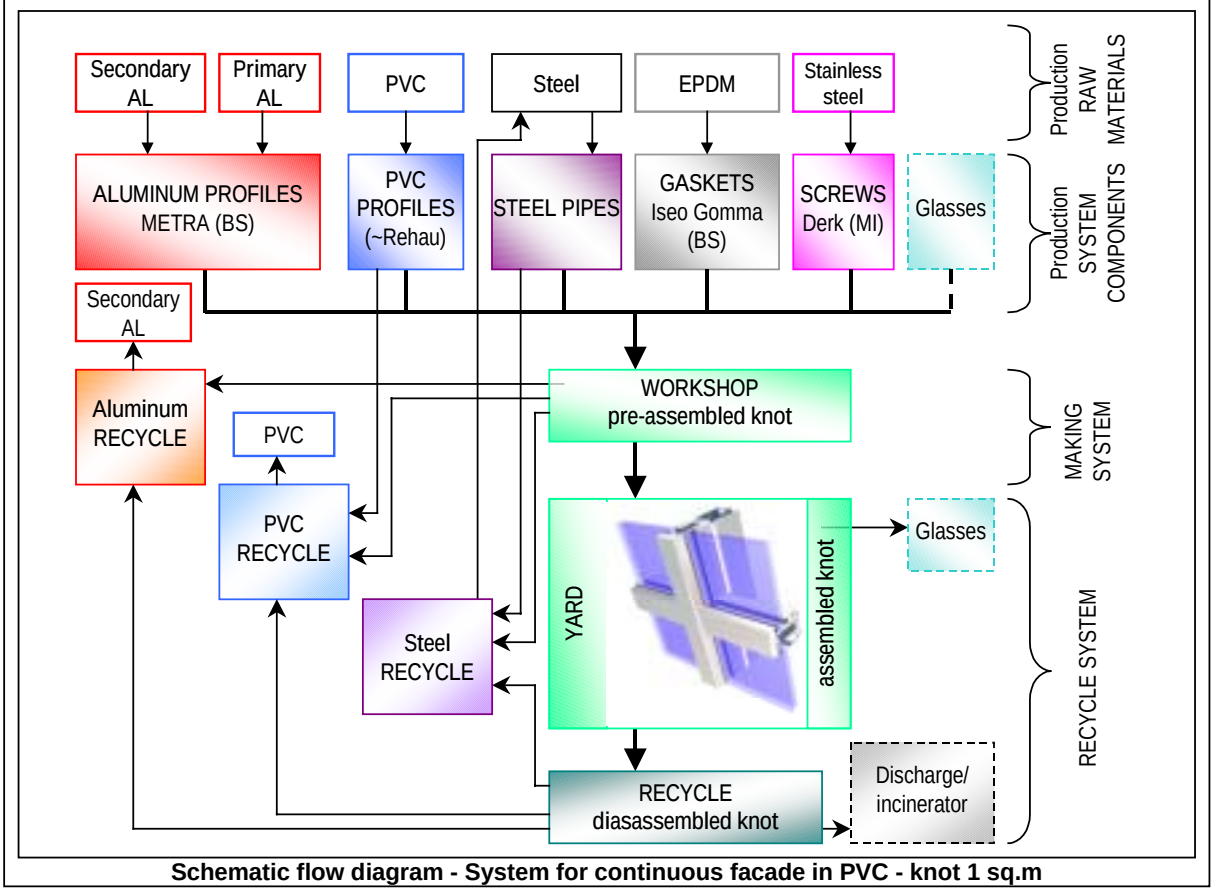
This thesis suggests a complete analysis of LCA based on the Italian reality and supported by a firm – Metra, systems in aluminum, Brescia.
After faceing the theoretical and methodological aspects connected to LCA and the respective system of analysis, evaluation and certification of quality (Ecolabel, Emas, Ecological labels, ISO 140000), the LCA methodology was applied according to the ISO 14040 norms:

- **Goal Definition and Scoping -** This study aims at the determination of a comprehensive profile of two “knots type" of standard system for continuos façade, in aluminum and PVC, based on real productions data, through the analysis of the energy-environmental performances during all their life cycle ("*from cradle to grave*") and including all components, except glass.

  The choice of analysing the processes connected to the life cycle of the two systems arises from the convergence of different interests:
  - Of the UNCSAAL, through the " Plan University " and his " Laboratory for thesis on the metallic windows";
  - Of the "METRA CO" which is interested in the realisation of an analysis of the life cycle in a "system type for continuos façade";
  - of the Human Settlement Sciences Department of the II Faculty of Architecture from Turin, whose aim is the realisation of a data bank concerning the main systems for house building.



Schematic flow diagram - System for continuous facade in Aluminum- knot 1 sq.m



Schematic flow diagram - System for continuous facade in PVC - knot 1 sq.m

Fig. 1 - Schematic flow diagrams - Systems for continuous façade

- **Life Cycle Inventory –** In this phase the layout of the "eco-profiles" of the two systems has been arranged, identifying and quantifying the consumption of resources, energy and the releases in the environment resulting from the different processes of production/treatment of the components and of the systems, referring the results to a functional unity - 1 kgs for the components and 1 sq.m. for the systems -.

  The productive processes of the different components have been analysed starting from the extraction of the raw materials, to get, after the production and the assemblage of the system, to the final disassembling and recycling of the materials (aluminum, steel and PVC) in their productive processes.

  The collected datas have been obtained mainly thanks to a thorough investigation carried out in the firms involved, and partly from the data-base of the *Boustead Model*, used for the realisation of the *Inventory*.

- **Life Cycle Impact Assessment -** The results obtained by gathering and elaborating the Inventory data have been **classified** and **standardized** according to the main environmental effects:
  - global warming
  - acidification
  - photosmog formation
  - nutrient enrichment
  - stratospheric ozone depletion

  Subsequently, the normalisation through Eco-Indicator ‘99, has taken place. This is a tool that synthetizes, according to a unique score, the data concerning consuption and issues.

  Finally, all the results have been produced in cards through an information system of the Inventory and Evaluation data - Met Matrix (*Material, Energy, Toxicity*) - that allows the interpretation according to the requested degree of deeper enquiry.

Author: Anna Bogliolo - II Faculty of Architecture - Polytechnic of Turin	**Data font:** Metra - Vezzani - Boustead model	**Reference period:** anno 2000

CARD 7	Product: RECYCLE ALUMINUM SYSTEM	ENVIRONMENTAL AND ENERGY BALANCE [MET-MATRIX] — LIFE CYCLE PROCESSES									
		AL system	Recycle treatment aluminum system (unitary values)					Recycle AL	Recycle PVC	Recycle system	TOTALS
Life Cycle Assessment' structure		6553 Assemblage AL system	6554 Disassembly AL system	6541 Transport AL system post-use	6542 Pre-treatment	6543 Materials separation and	TOTALE Recycle treatment AL system	6516 AL scrap transport	6600 PVC: collection and recovery	TOTAL Recycle AL system	AL system
Functional unity	**[sq.m]**	1 sq.m	1 sq.m	1 sq.m	1 sq.m	1 sq.m	1 sq.m	4,776 kg input	0,184 kg input	1 sq.m	1 sq.m
Inventory	**Gross Energy [MJ]**	Fuel prod'n & delivery energy	507,790	0,477	1,861	8,649	1,686	12,672	-475,824	-1,340	-464,491	43,298
		Energy content of delivered fuel	505,098	0,228	3,043	9,811	0,806	13,889	-387,382	-3,541	-377,034	128,064
		Energy use in transport	22,617	0,004	5,942	1,067	0,015	7,028	-22,362	-0,130	-15,464	7,152
		Feedstock energy	224,752	0,000	2,604	-2,296	0,000	0,309	-137,882	-2,877	-140,451	84,302
		Total energy	1.260,257	0,709	13,450	17,232	2,507	33,898	-1.023,450	-7,889	-997,440	262,817
	Air emissions [g]	Dust	113,318	0,049	0,714	1,424	0,172	2,359	-106,743	-0,342	-104,727	8,591
		CO	66,628	0,013	4,634	0,644	0,047	5,339	-22,910	-0,431	-18,003	48,625
		CO_2	44.793,723	36,226	735,964	1.013,508	128,125	1.913,823	-42.529,805	-267,253	-40.883,235	3.910,487
		SOx	483,360	0,555	3,206	10,140	1,964	15,864	-382,461	-1,203	-367,800	115,559
		NOx	338,598	0,254	6,498	11,089	0,900	18,741	-230,767	-1,375	-213,401	125,197
		N_2O	0,012	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,012
		HC (hydrocarbons)	96,998	0,239	5,465	5,317	0,844	11,864	-35,118	-0,300	-23,554	73,444
		Methane	194,971	0,103	1,025	6,828	0,365	8,321	-127,254	-1,028	-119,961	75,010
		H2S	0,104	0,000	0,001	0,000	0,000	0,000	-0,001	0,000	-0,001	0,103
		HCl	3,574	0,001	0,012	0,014	0,004	0,032	-3,929	-0,013	-3,909	-0,335
		Aromatic-HC	0,101	0,000	0,019	0,004	0,000	0,023	-0,036	-0,001	-0,014	0,086
		NH3	0,021	0,000	0,003	-0,003	0,000	0,000	-0,004	-0,003	-0,007	0,013
		VOC	1,060	0,000	0,004	0,001	0,000	0,006	0,000	0,002	0,007	1,066
	Water emissions [g]	COD	20,530	0,000	0,098	-0,071	0,001	0,029	-0,331	-0,101	-0,402	20,127
		BOD	2,380	0,000	0,013	0,002	0,001	0,016	-0,286	-0,007	-0,277	2,102
		H+	0,310	0,000	0,004	-0,003	0,000	0,002	-0,241	-0,005	-0,244	0,066
		NH4+	0,061	0,000	0,002	0,000	0,000	0,002	-0,002	-0,001	-0,002	0,059
		Suspensed solids	813,863	0,001	0,991	-0,105	0,004	0,891	-978,699	-0,334	-978,142	-164,279
		NO_{3-}	0,493	0,000	0,000	0,000	0,000	0,000	-0,003	0,000	-0,003	0,490
		Other nitrogen	0,301	0,000	0,000	0,000	0,000	0,000	-0,002	0,000	-0,002	0,300
		CN-	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
		Phosphate as P2O5	0,050	0,000	0,001	-0,001	0,000	0,000	0,000	-0,001	-0,001	0,048
		VCM	0,005	0,000	0,002	-0,002	0,000	0,000	0,000	-0,003	-0,003	0,002
	Solid waste [g]	Special assimilable to the urban	2.911,829	0,000	0,615	-128,219	639,680	512,075	-0,008	-0,354	511,713	3.423,541
		Special not dangerous	24.800,943	0,585	15,276	7,490	2,068	25,419	-30.212,421	-6,880	-30.193,882	-5.392,939
		Special dangerous	706,727	0,149	4,159	2,230	0,526	7,064	-769,677	-1,470	-764,083	-57,356
Classification and Standardisation	**Environmental effects**	Global warming [GWP100] (kg CO_2)	50,122	0,040	0,788	1,201	0,140	2,168	-45,862	-0,295	-43,989	6,133
		Acidification [AP] (g SO_2)	846,567	3,791	10,178	22,010	2,931	38,910	-633,368	-2,696	-597,153	249,414
		Photosmog formation [PHS] (g C_2H_4)	101,401	0,262	5,671	5,393	0,848	12,173	-36,936	-0,326	-25,089	76,312
		Nutrient enrichment [EP] (g NO_3)	703,405	0,527	13,473	22,938	1,864	38,801	-477,722	-2,870	-441,791	261,614
		Stratospheric ozone depletion [ODP] (g CFC_{11})	0,006	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,006
Normalization and "Weighing"		**Eco indicator '99**	4.892	3	94	7	11	114	-3.611	-36	-3.533	1.360

Fig. 2 - Met-Matrix - System for continuos façade in aluminum

- **Life Cycle Interpretation -** On the basis of these results, it is possible to make a comparison between the energy and the environmental incidence of the two systems in question, both on the basis of the single components that constitutes them and on the system themselves.

  The comparison between the two “knots type” has demonstrated that, as far as the mere production is concerned, it exists a real disparity of the energetic loads in favour of the system in PVC, mainly due to the production of the raw materials and particularly to the important load brought about by the primary aluminum (considered in a percentage of 50% for the production of profiles).
  However considering the phases of treatment and recycling, this difference shifts in favour of the aluminum system, thanks to the remarkable potentialities deriving from the recycling of aluminum itself.

Finally, it is important to underline that this thesis, which results from the elaboration of data and hypothesis concerning the Italian productive reality, represents a first experience in the wider framework of a research aming at the realisation of a data bank including energy and environmental information regarding the building components.

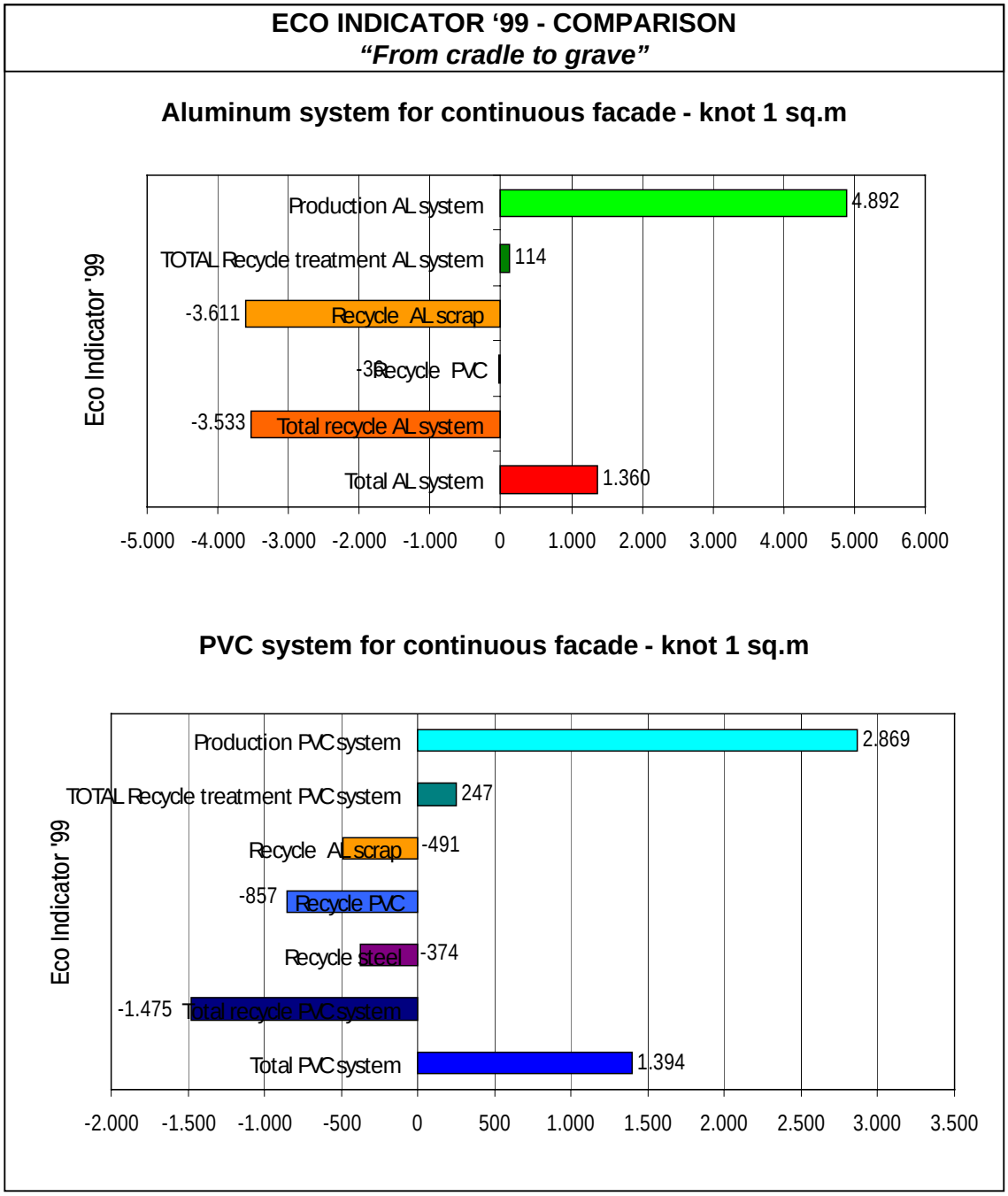


Fig. 3 – Comparison of the Eco Indicator '99 relative to the principal phases of the life cycle of the systems for continuos façade in Aluminum and PVC.

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