CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT AND RECOVERY IN LOMBARDY REGION (ITALY)

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RESEARCH PROJECT: ENVIRONMENTAL EVALUATION OF THE C&D WASTE MANAGEMENT SYSTEM IMPLEMENTED IN LOMBARDY REGION

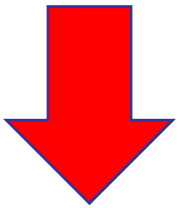
OBJECTIVES:

- Quantifying construction and demolition waste (CDW) amount and flows within the management system of Lombardy Region
- Investigating types, amount and quality of "secondary products" obtained from CDW recovery plants and their actual use (highlighting limiting factors for the market of recycled materials)
- Assessing the environmental performance of the current regional system through the application of the *Life Cycle Assessment (LCA)* methodology
- Identifying benefits and critical aspects of the CDW recycling chain
- Defining possible improving actions based on the state-of-the-art recovery technologies and the LCA results of the current management scenario, to be compared and evaluated from a life cycle perspective

Waste framework directive 2008/98/EC

In order to comply with the objectives of this Directive, and move towards a European recycling society with a high level of resource efficiency, Member States shall take the necessary measures designed to achieve the following targets:

By 2020**, **the preparing for re-use, recycling and other material recovery**, including backfilling operations using waste to substitute other materials, **of non-hazardous construction and demolition waste** excluding naturally occurring material defined in category 17 05 04 in the list of waste **shall be increased to a minimum of 70% by weight



How much CDW is generated?

How much CDW is currently recovered?

LOMBARDY REGION - ITALY

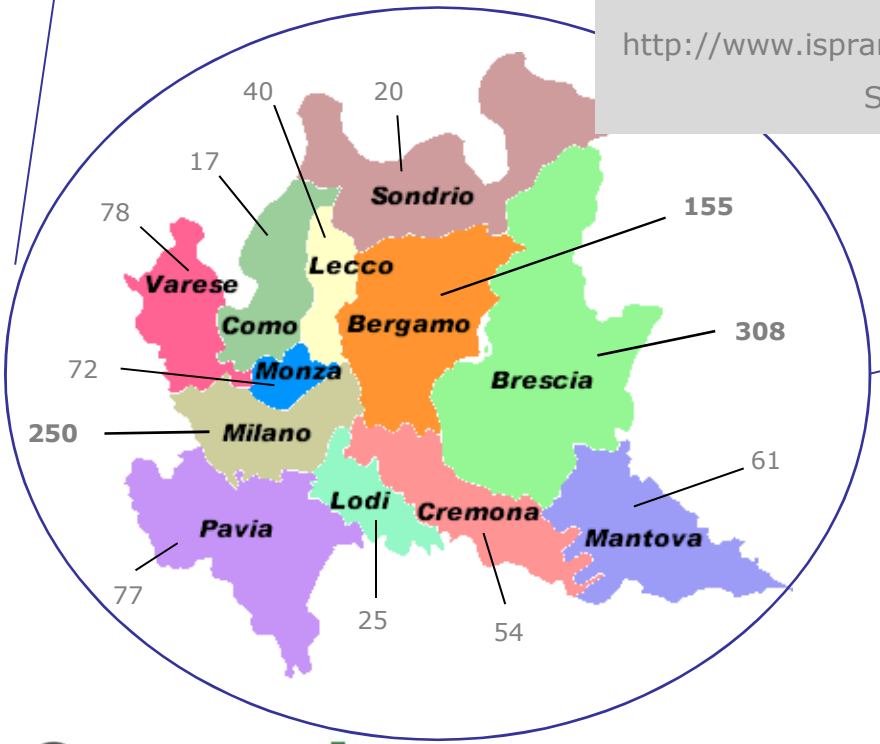
AREA: 23.844 km^2
POPULATION: 10 MILION (1/6 ITALIAN POPULATION)
GROSS DOMESTIC PRODUCT (GDP): 22% ITALY'S GDP
ADMINISTRATIVE DIVISIONS:
12 PROVINCES, 1 METROPOLITAN CITY (MILANO), 1530 COMMUNES

Non hazardous CDW generation in Italy (2013): 47.9 Mt

Non hazardous CDW generation in Lombardy (2013): 10.6 Mt

Source: ISPRA REPORT 2016

http://www.isprambiente.gov.it/files/pubblicazioni/rapporti/RapportoRifiutiSpeciali_Ed.2016n.246_Vers.Integrale.pdf



CDW MANAGEMENT SYSTEM

1157 PLANTS IN OPERATION IN 2016:

- LANDFILLS: 39
- RECYCLING PLANTS + TRANSFER STATION: 1118

SOURCE: CATASTO GEOREFERENZIATO DEI RIFIUTI REGIONE LOMBARDIA
http://www.cgrweb.servizirl.it/cgrweb/ricerca.do

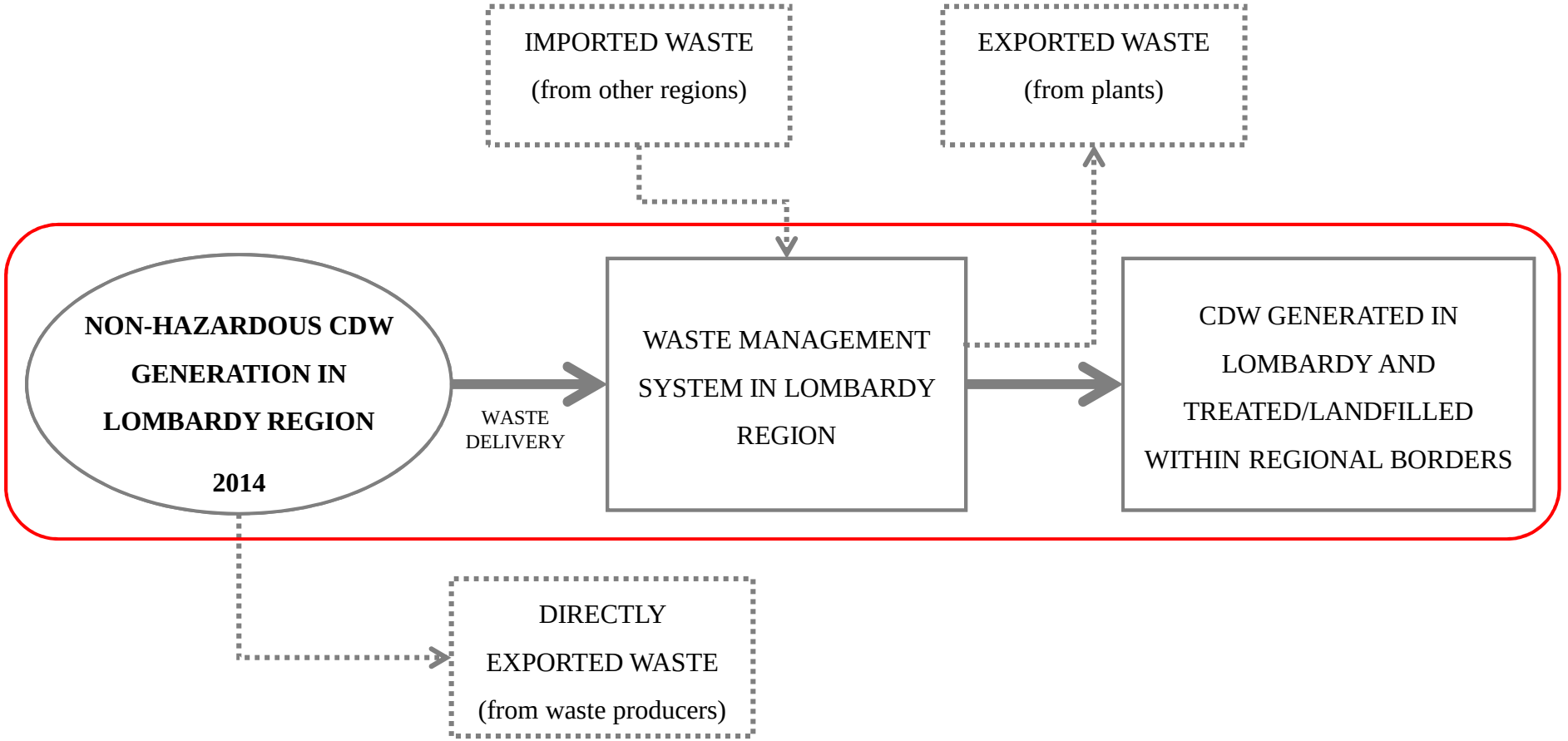
NON-HAZARDOUS CDW INCLUDED IN THE STUDY:

EUROPEAN WASTE CODE 17 XX XX:

- **17 01 concrete, bricks, tiles and ceramics**
  - CONCRETE (17 01 01)
  - BRICKS (17 01 02)
  - TILES AND CERAMICS (17 01 03)
  - CONCRETE, BRICKS, TILES AND CERAMICS IN MIXTURES, NOT CONTAINING DANGEROUS SUBSTANCES (17 01 07)
- **17 02 wood, glass and plastic** (17 02 01, 17 02 02, 17 02 03)
- **17 03 bituminous mixtures, coal tar and tarred products** (17 03 02)
- **17 04 metals (including their alloys)** (17 04 01, 17 04 02, 17 04 03, 17 04 04, 17 04 05, 17 04 06, 17 04 07, 17 04 11)
- **17 08 gypsum-based construction materials** (17 08 02)
- **17 09 other construction and demolition waste**
  - MIXED CONSTRUCTION AND DEMOLITION WASTES, NOT CONTAINING DANGEROUS SUBSTANCES (17 09 04)

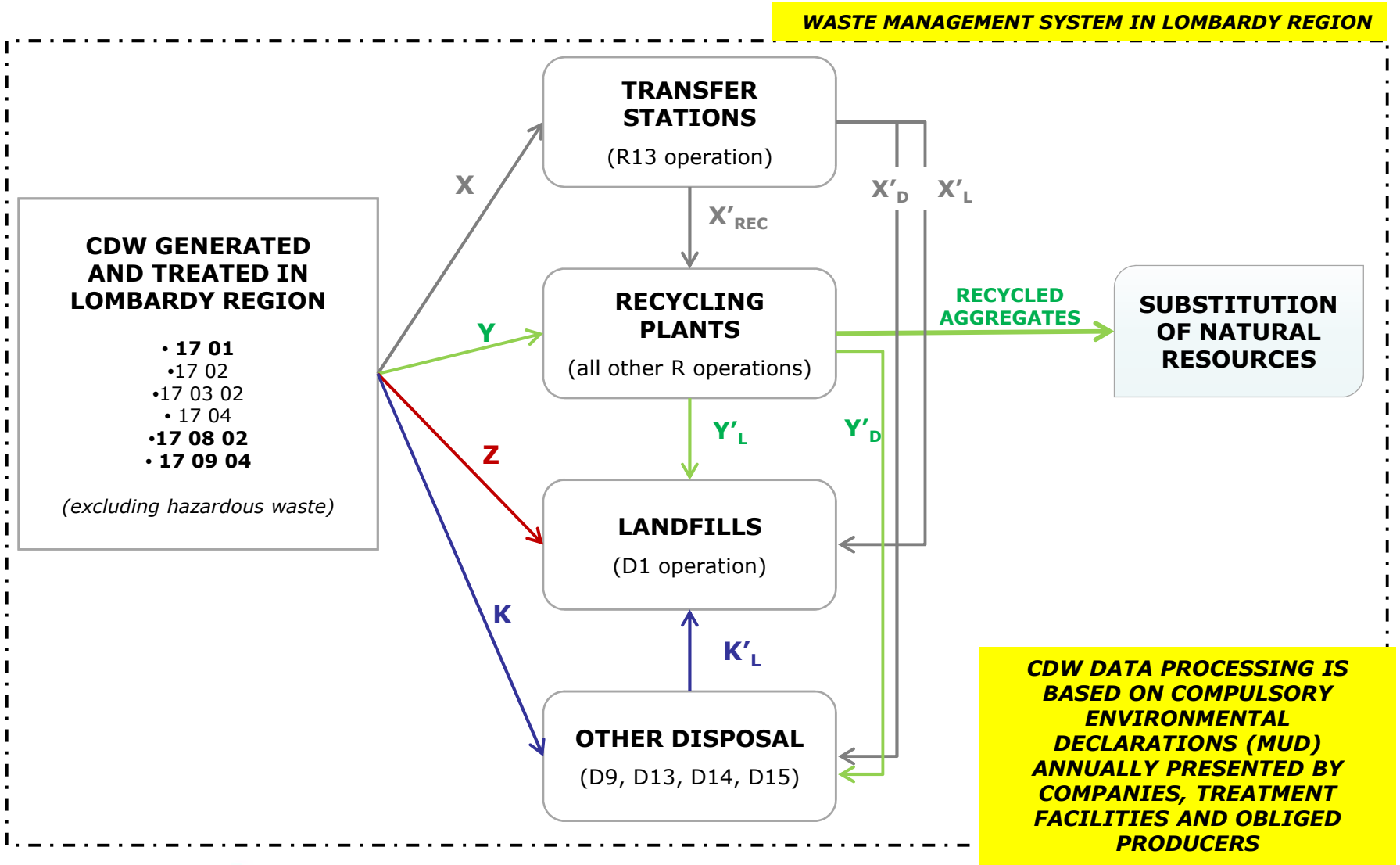
SYSTEM BOUNDARIES OF THE LCA STUDY

- **REFERENCE YEAR: 2014**
- **ANALYSED WASTE TYPE: PREVIOUS SLIDE**
- **SYSTEM BOUNDARIES: REGIONAL WASTE MANAGEMENT SYSTEM (CDW exports/imports are excluded)**

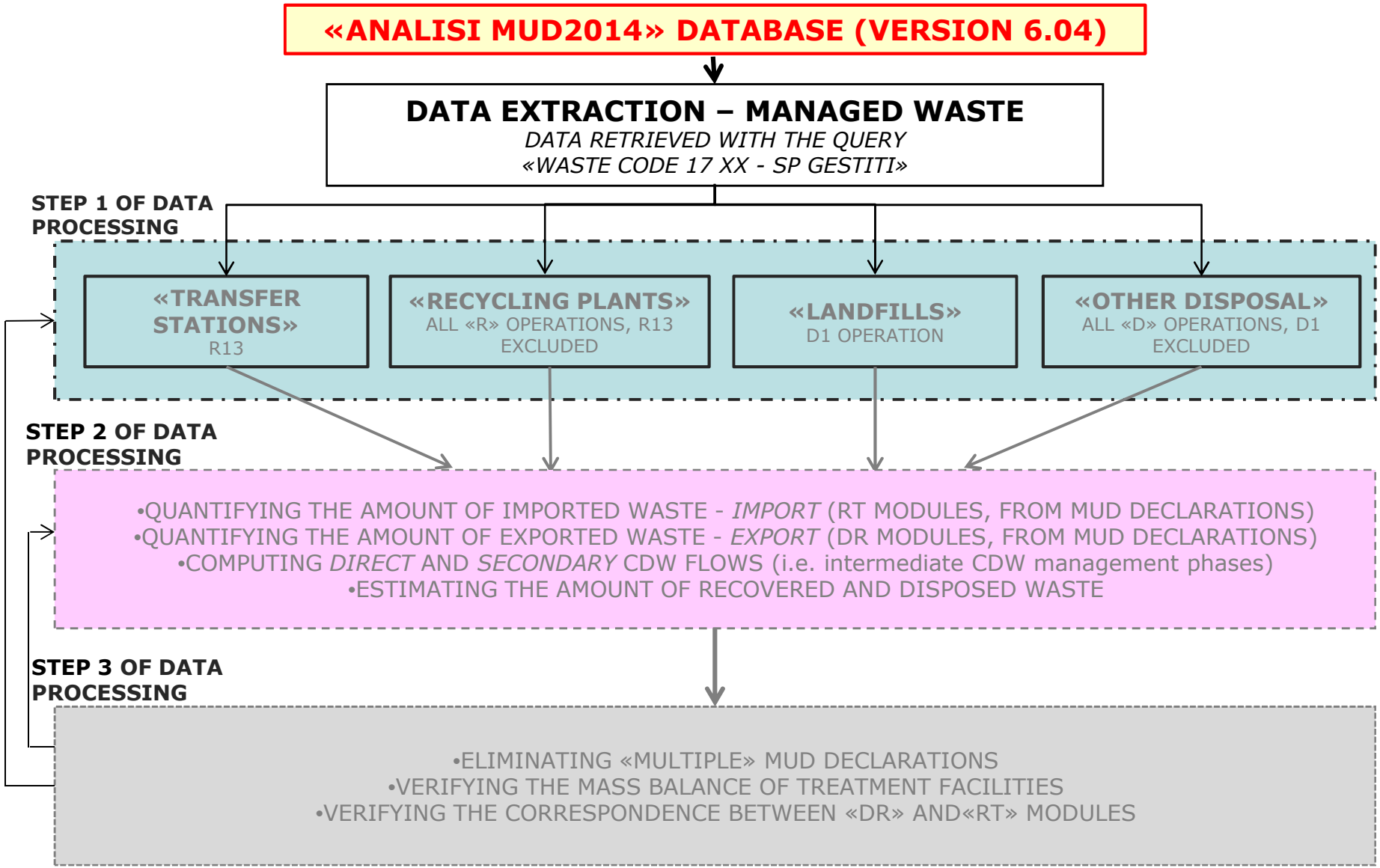


LCA STUDY STEP 1: QUANTIFICATION OF CDW FLOWS

STEP 1. QUANTIFICATION OF DIRECT (X, Y, Z, K) AND SECONDARY (X', Y', K') CDW FLOWS TO EACH TYPE OF TREATMENT FACILITY AND FOR EACH WASTE CODE (DATA DISAGGREGATION)

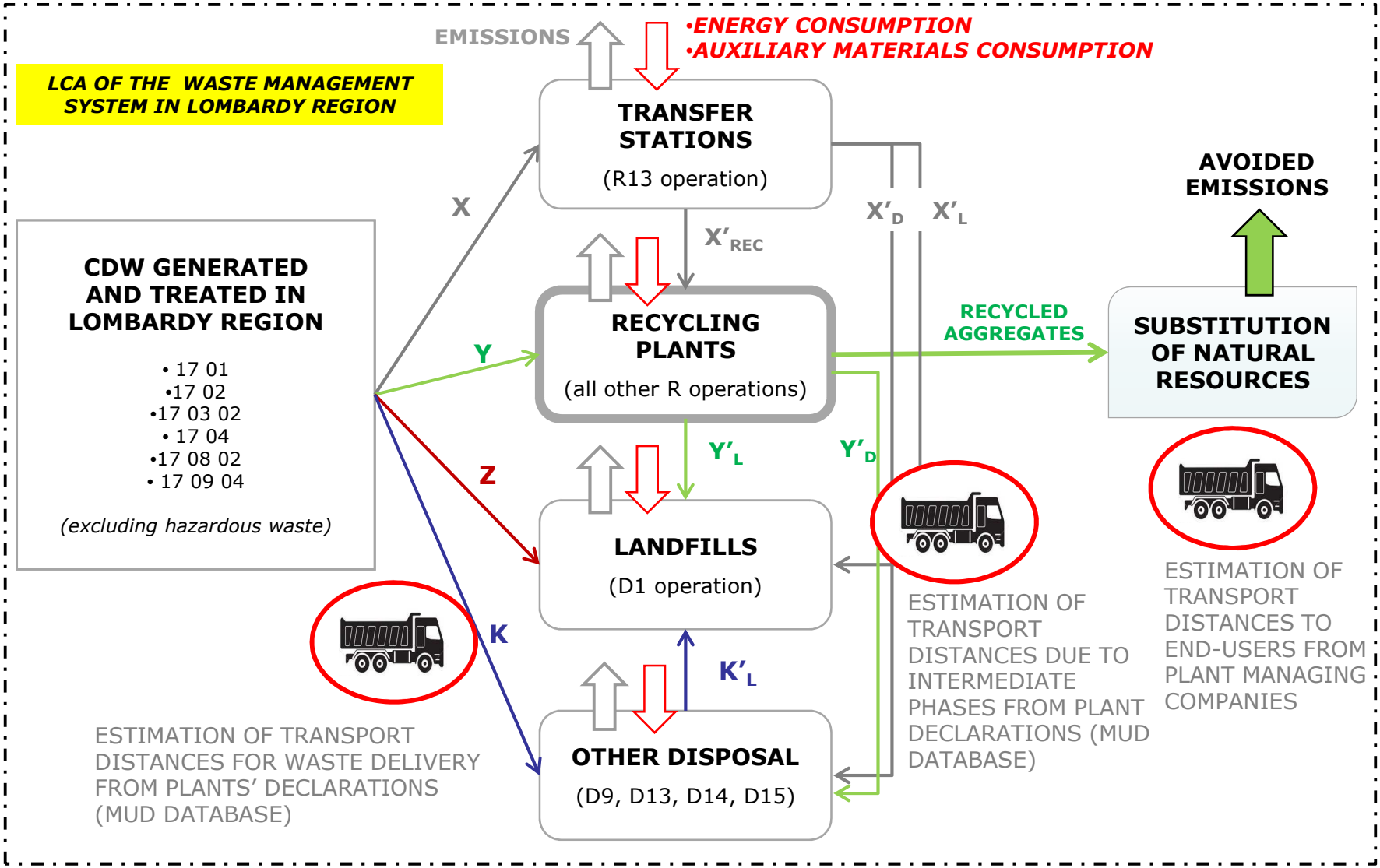


LCA STUDY STEP 1: MUD DATA ELABORATION



LCA STUDY STEP 2: LIFE CYCLE INVENTORY

STEP 2: COLLECTION OF PRIMARY DATA FROM THE LARGEST RECYCLING PLANTS



LCA STUDY STEP 3: CLOSING THE LOOP

STEP 3: MODELLING THE SUBSTITUTION OF VIRGIN RAW MATERIALS

RAW MATERIALS EXTRACTION

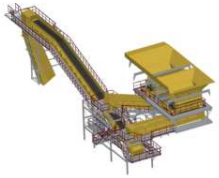
PRODUCTS MANUFACTURING

ON SITE CONSTRUCTION

OPERATION/ MANTAINANCE

DEMOLITION

CDW RECYCLING/ RECOVERY



USE OF RECYCLED PRODUCTS IN THE CONSTRUCTION SECTOR IN SUBSTITUTION OR IN MIX WITH NATURAL RESOURCES

LOST OF VALUABLE RESOURCES

LANDFILL DISPOSAL

CLOSING THE LOOP OF NATURAL MINERAL RESOURCES THROUGH SUSTAINABLE WASTE MANAGEMENT AND EFFICIENT CDW RECYCLING

PRELIMINARY RESULTS OF STEP 1: CDW FLOWS

Import:
code 1701: 47,075 t;
code 170802: 4,419 t;
code 170904: 382,931 t

EXPORTED WASTE (plants)

code 17 01:	**9,189 t**
code 17 08 02:	**4,870 t**
code 17 09 04:	**38,149 t**

CDW GENERATION IN LOMBARDY REGION (2014):

code 17 01: >= 804,625 t
code 17 08 02: >= 31,405 t
code 17 09 04: >= 5,851,639 t

WASTE DELIVERY

REGIONAL WASTE MANAGEMENT SYSTEM

CDW TREATED/LANDFILLED WITHIN REGIONAL BORDERS

code 17 01:	**763,950 t**
code 17 08 02:	**20,988 t**
code 17 09 04:	**5,625,978 t**

DIRECTLY EXPORTED WASTE (producers)

code 17 01:	**>= 31,487 t**
code 17 08 02:	**>= 5,547 t**
code 17 09 04:	**>= 187,512 t**

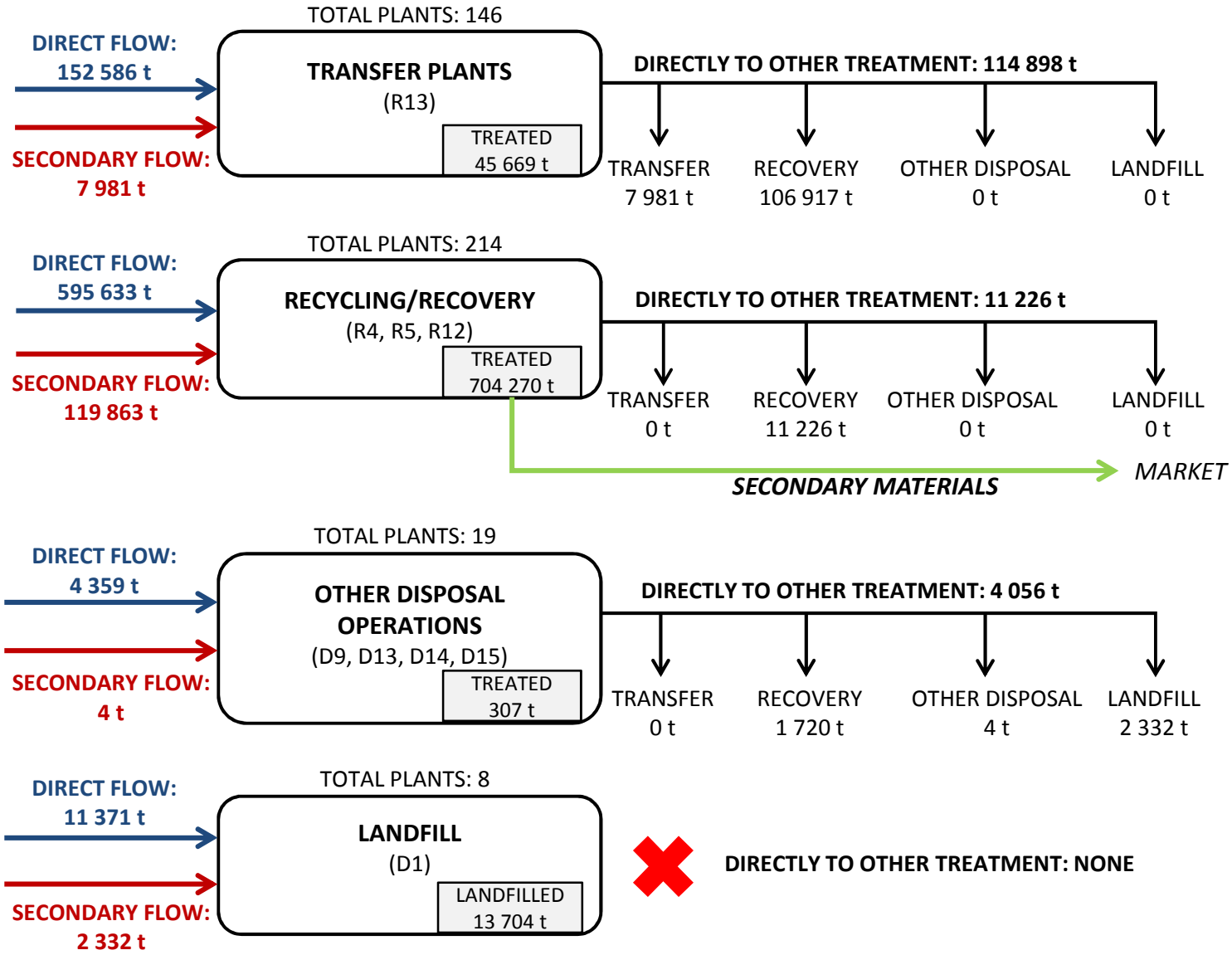
* >= because the contribution of the producers not obliged to fill in the MUD is not included (as not quantifiable)

PRELIMINARY RESULTS OF STEP 1: CDW FLOWS

code 17 01: 763,950 t

Treatment:

- 92.2 % RECYCLING/ RECOVERY
- 6.0% STORED IN TRANSFER STATIONS
- 1.8% LANDFILL
- 0.04% OTHER DISPOSAL OPERATIONS

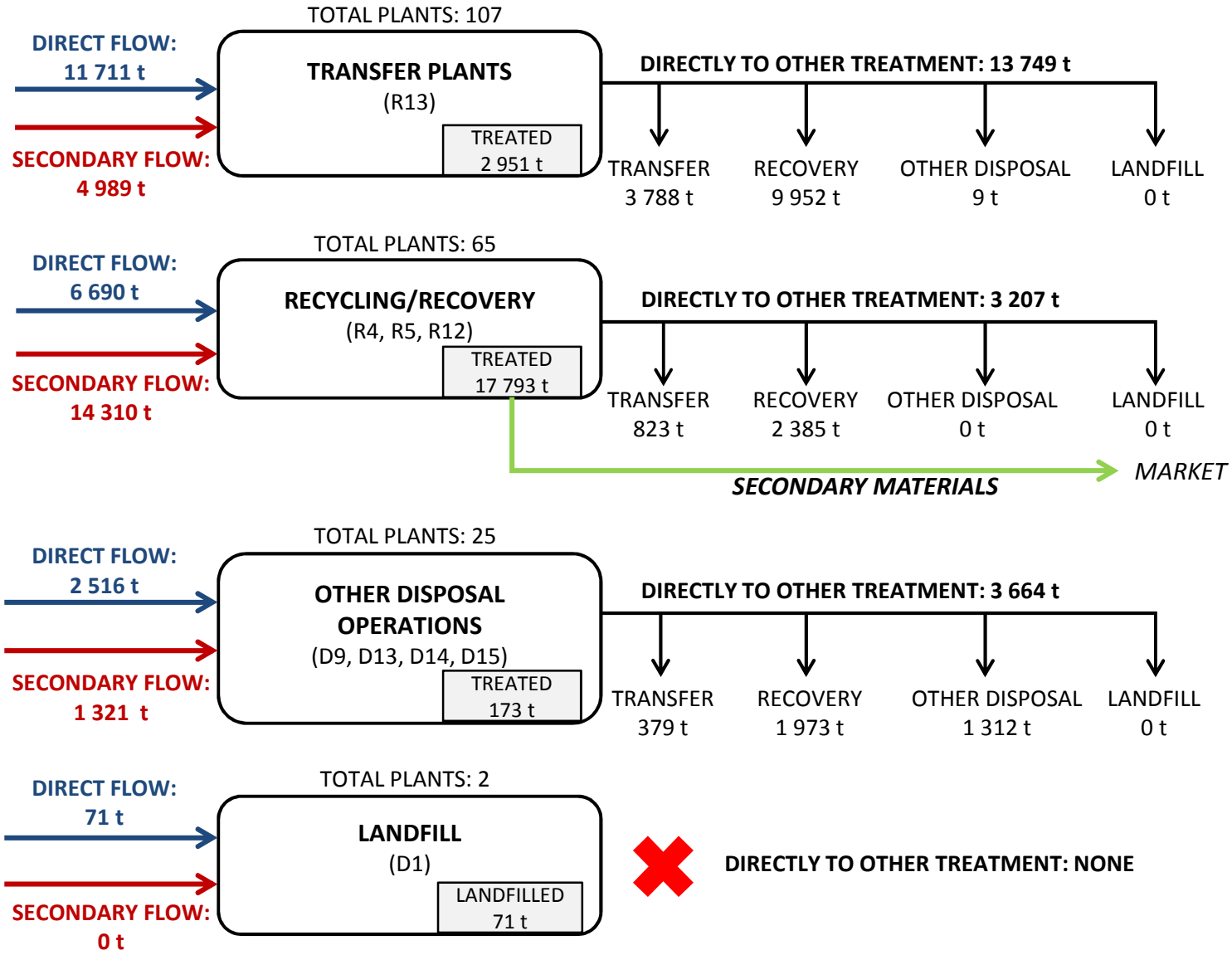


PRELIMINARY RESULTS OF STEP 1: CDW FLOWS

code 17 08 02: 20,988 t

Treatment:

- 84.8 % RECYCLING/ RECOVERY
- 14.1% STORED IN TRANSFER STATIONS
- 0.3% LANDFILL
- 0.8% OTHER DISPOSAL OPERATIONS

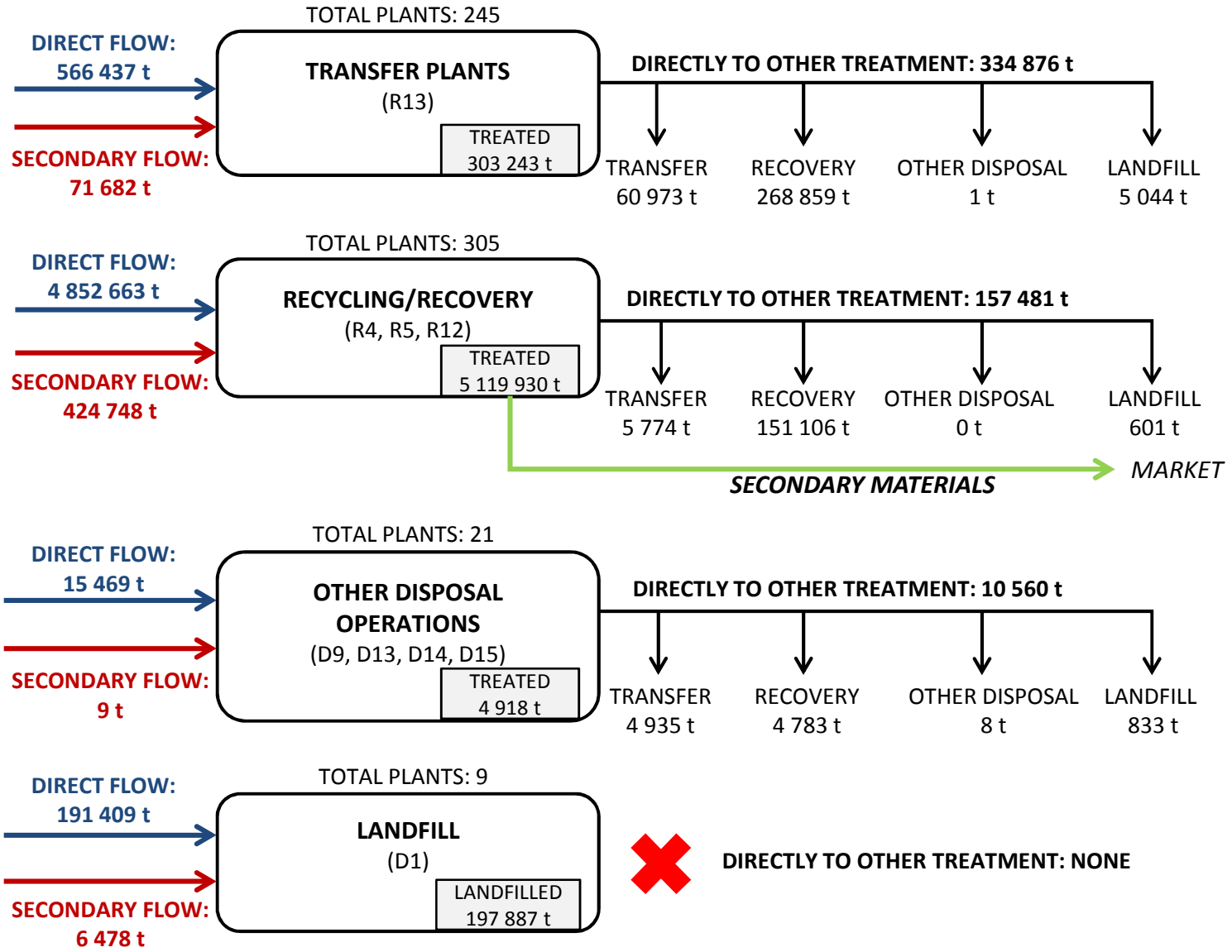


PRELIMINARY RESULTS OF STEP 1: CDW FLOWS

code 17 09 04: 5,625,978 t

Treatment:

- 91.0 % RECYCLING/ RECOVERY
- 5.4% TRANSFER STATIONS
- 3.5% LANDFILL
- 0.1% OTHER DISPOSAL OPERATIONS



PRELIMINARY RESULTS OF STEP 2: INVENTORY

TECHNICAL VISITS TO SELECTED RECYCLING PLANTS:

- 2 FIXED PLANTS (MI) – **TYPE A**
- 4 MOBILE PLANTS (2 MI, 1 BS, 1 BG) – **TYPE B**
- 3 MOBILE PLANTS WITH SORTING OF PACKAGING MATERIALS FROM WORKSITES (1 MI, 1 LC, 1 MB)– **TYPE C**

RECEIVED NON-HAZARDOUS CDW (CODES 1701 + 170302 + 170904): 1.28 Mt

COLLECTED DATA:

- TOTAL RECEIVED AND TREATED NON HAZARDOUS CDW IN 2014
- TYPES AND AMOUNT OF PRODUCED RECYCLED MATERIALS
- QUALITY AND END-USES OF RECYCLED MATERIALS
- AMOUNT OF SEPARATED METALS, PLASTICS, GLASS, …
- RESIDUES TO LANDFILL

→ **OVERALL MASS BALANCE OF DIFFERENT TYPES OF RECYCLING PLANTS**

- ENERGY AND FUEL FOR CDW PROCESSING (crushing, sieving,..)
- FUEL AND OIL FOR WASTE-MOVING MACHINES
- WATER SUPPLY FOR DUST REMOVAL SYSTEMS
- SUPPLY OF MECHANICAL COMPONENTS SUBJECT TO WEAR AND TEAR

→ **CONSUMPTIONS OF ENERGY AND MATERIALS FOR CDW TREATMENT**

NEXT STEP: PROCESSING OF DATA DERIVED FROM QUESTIONNAIRES SENT TO CDW RECYCLING PLANTS TO IMPROVE THE REPRESENTATIVENESS OF PRIMARY DATA

PRELIMINARY RESULTS OF STEP 2: INVENTORY

FIXED RECYCLING PLANTS

USE LARGER AND MORE POWERFUL DEVICES (MAGNETS, CRUSHERS, SCREEN), CONNECTED TO THE ELECTRICITY GRID

ADVANTAGES:

- HIGHER EFFICIENCY FOR METALS REMOVAL
- HIGHER EFFICIENCY FOR REMOVAL OF PLASTICS, PAPERS AND OTHER IMPURITIES
- BETTER PERFORMANCES OF MECHANICAL STEPS
- DIVERSE RECYCLED AGGREGATES, WITH HOMOGENEOUS COMPOSITION AND BETTER TECHNICAL CHARACTERISTICS

DISADVANTAGES:

- NEED OF LARGER AREAS FOR STATIONARY INSTALLATIONS
- ENVIRONMENTAL IMPACTS ASSOCIATED TO WASTE TRANSPORT
- HIGHER CONSTRUCTION AND OPERATING COSTS
- LONG INSTALLATION TIME

MOBILE RECYCLING PLANTS

USE DIESEL MOTORS MOUNTED ON TRACKS AND ADOPT SIMPLER TECHNOLOGIES (SIEVING IS OPTIONAL)

ADVANTAGES:

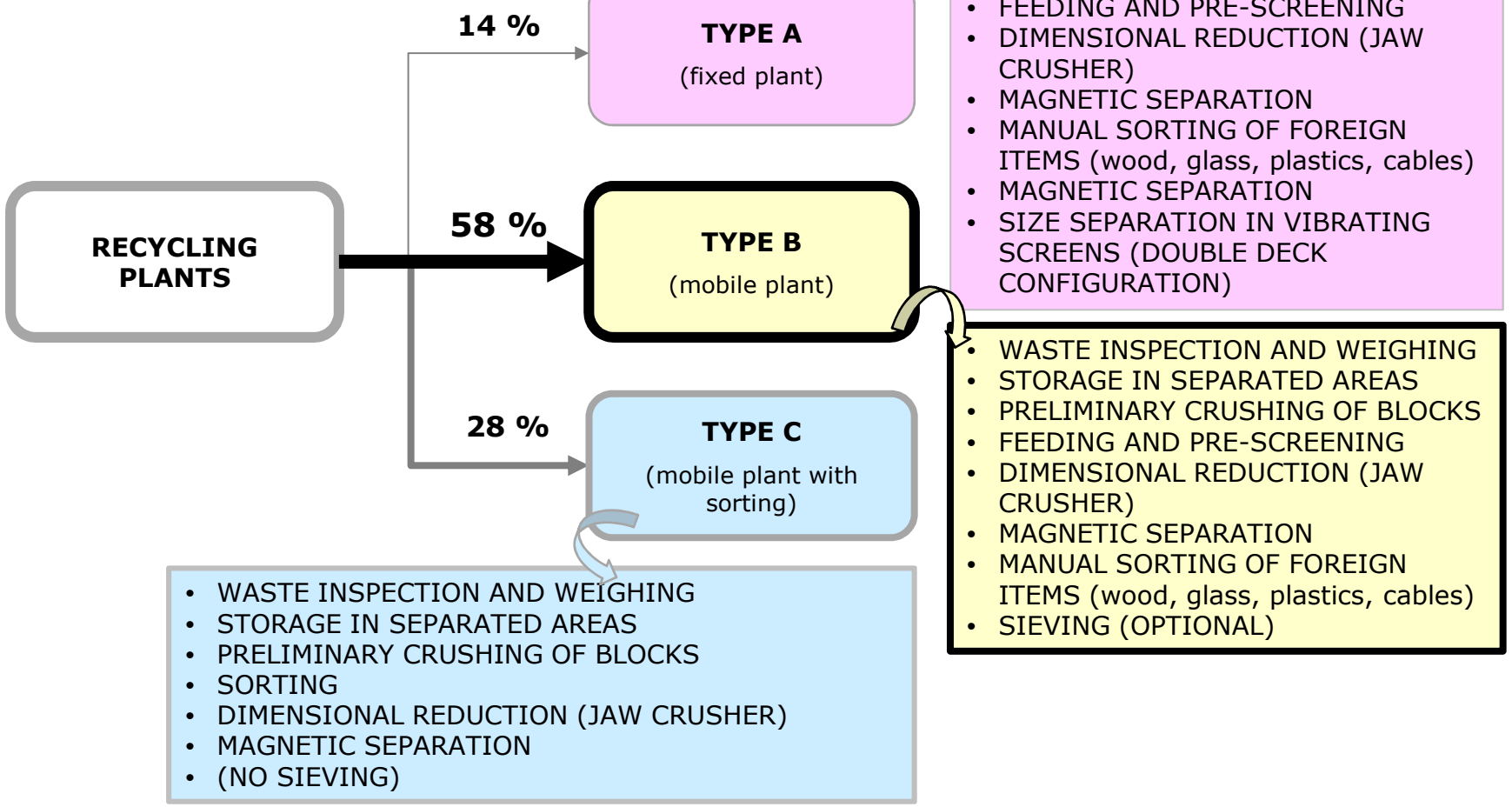
- NEED OF SMALL AREAS
- REDUCED WASTE TRANSPORTATION (when installed at worksites)
- LOW OPERATIONAL COSTS
- REDUCED INSTALLATION TIME

DISADVANTAGES:

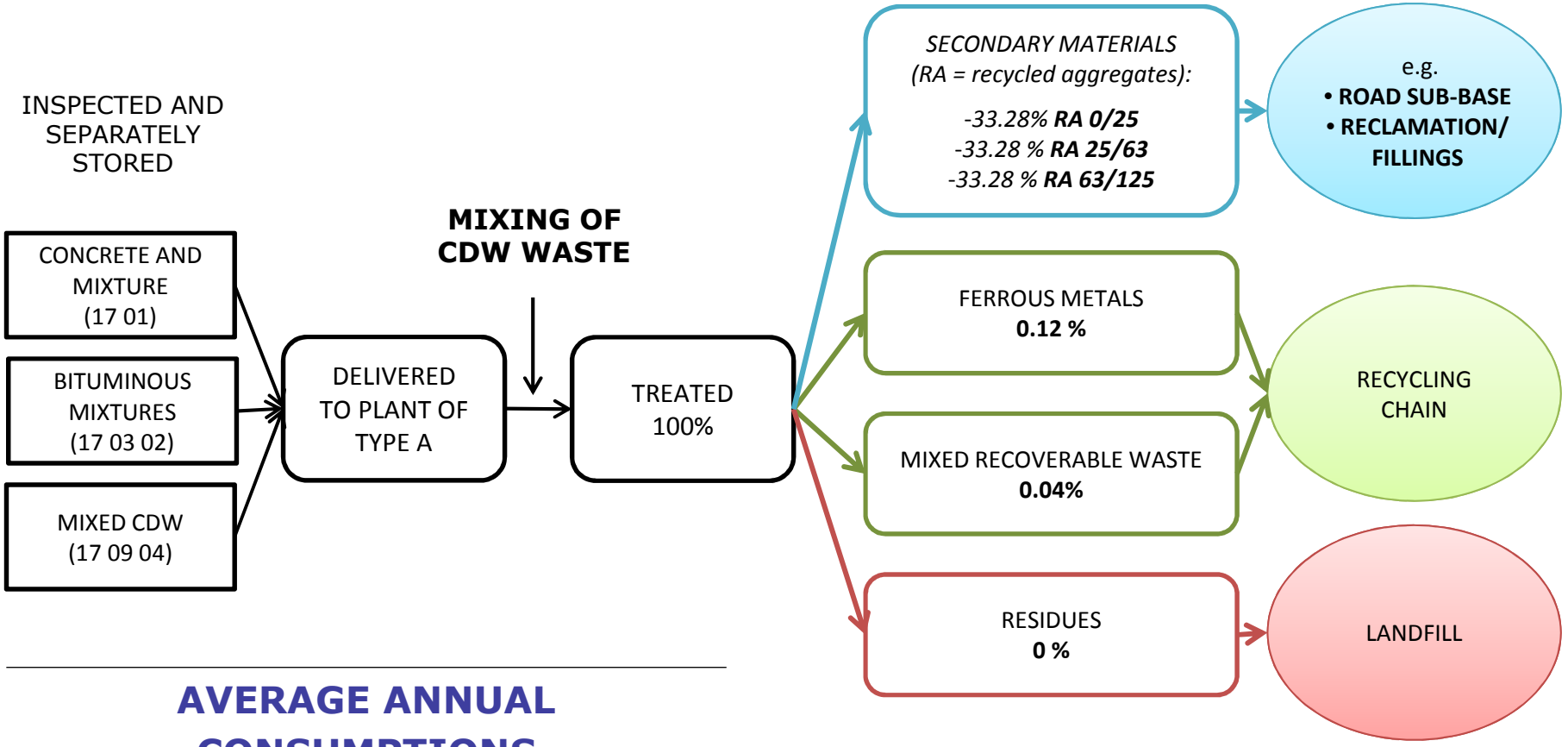
- LOWER TREATMENT PERFORMANCES (METALS SEPARATION, REMOVAL OF IMPURITIES)
- LOWER TREATMENT CAPACITY
- LOW QUALITY AGGREGATES (USUALLY AS ALL-IN AGGREGATE) WITH MORE HETEROGENEOUS COMPOSITION

PRELIMINARY RESULTS OF STEP 2: INVENTORY

% DELIVERY TO THE DIFFERENT TYPES OF RECYCLING PLANTS BASED ON THE RECEIVED AMOUNT OF NON-HAZARDOUS CDW (CODES 1701 + 170302 + 170904) (CONSIDERING ONLY THE VISITED PLANTS)



MASS BALANCE OF TYPE A:



AVERAGE ANNUAL CONSUMPTIONS

ELECTRICITY (kWh/t)	FUEL (l/t)	STEEL (kg/t)
1.13	0.25	0.02

MOBILE TREATMENT PLANT – TYPE A

RECEIVED WASTE

MIXED CDW
(code 170904)

MIXED CDW FROM PRIVATE WORKS
(code 170904)

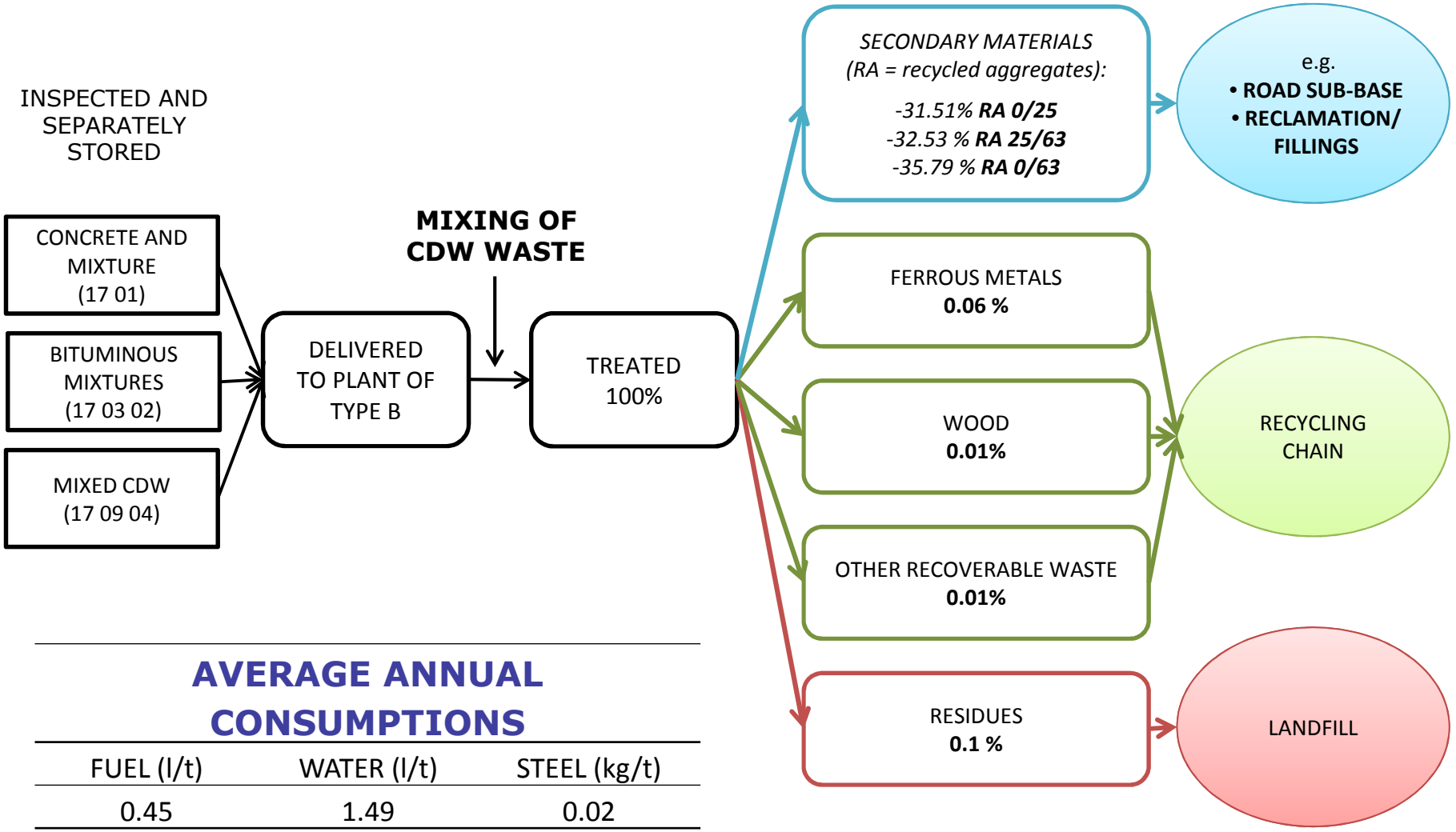
FIXED PLANT

RECYCLED PRODUCTS

COARSE RA (25/63)

COARSE RA (63/125)

MASS BALANCE OF TYPE B:



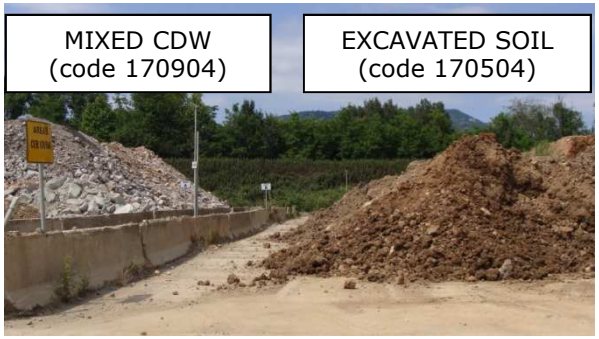
AVERAGE ANNUAL CONSUMPTIONS

FUEL (l/t)	WATER (l/t)	STEEL (kg/t)
0.45	1.49	0.02

MOBILE TREATMENT PLANT – TYPE B

RECEIVED WASTE

MIXED CDW
(code 170904)



EXCAVATED SOIL
(code 170504)

LARGE BLOCKS
(code 170904)

MOBILE PLANT (TYPE B)

ALL-IN RECYCLED AGGREGATES (0/63)

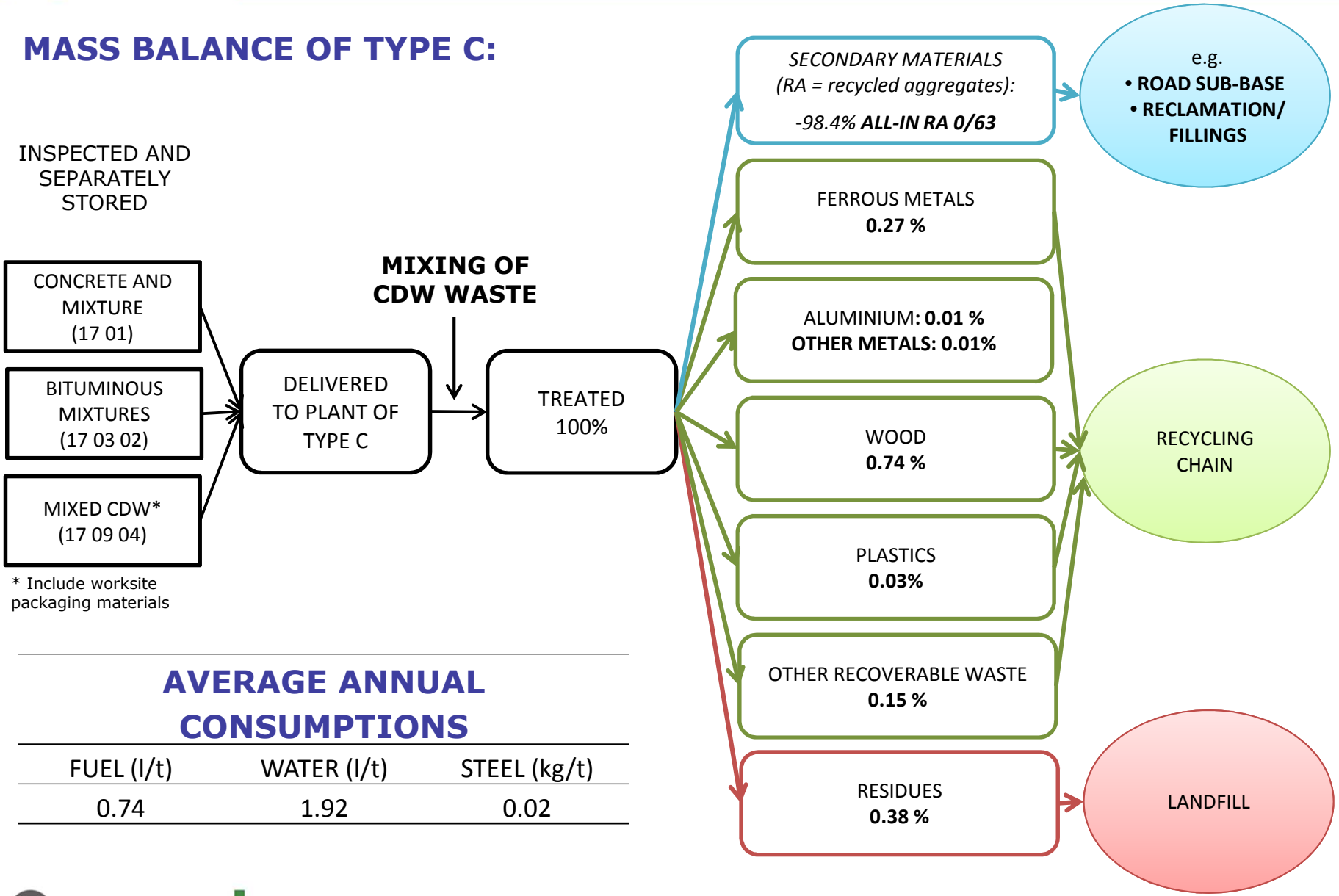
SEPARATED MATERIALS

FERROUS METALS

WOOD

OTHER (MIXED) (WOOD, RUBBER,..)

MASS BALANCE OF TYPE C:



AVERAGE ANNUAL CONSUMPTIONS

FUEL (l/t)	WATER (l/t)	STEEL (kg/t)
0.74	1.92	0.02

MOBILE TREATMENT PLANT – TYPE C

CDW TREATMENT – MOBILE PLANT

MIXED SCRAPS

SEPARATED WASTES:

- WOOD
- PLASTICS
- FERROUS METALS
- OTHER METALS
- CABLES
- TEXTILES
- PAPER & CARDBOARDS

SORTING PLATFORM

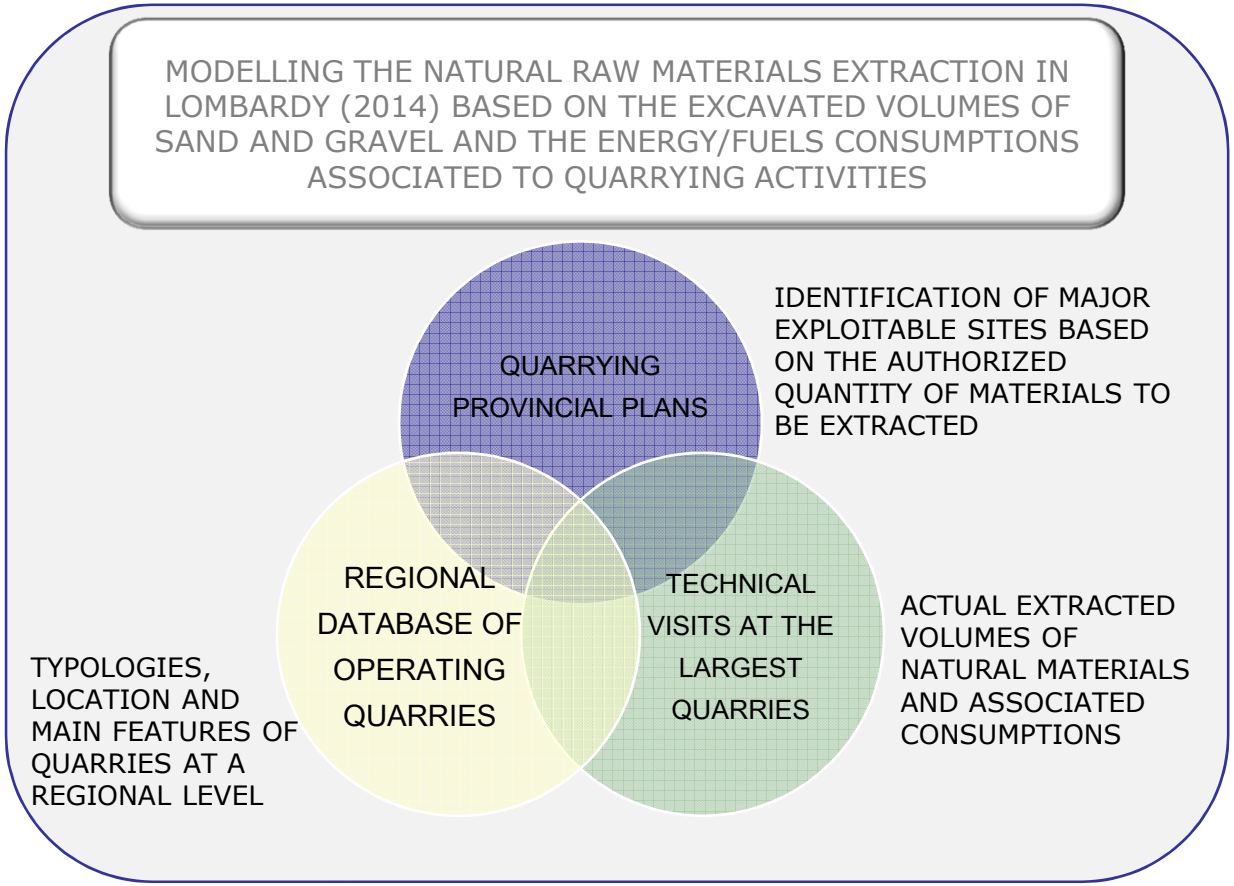
MIXED WASTES FROM WORKSITES
(NOT CONTAINING DEBRIS)

Substitution of natural aggregates

- Modelling the "avoided impacts" associated with the "avoided extraction" of natural resources in Lombardy
- Need of taking into account not only for the quantity of recycled aggregates but also for their quality and their actual market

Substitution of natural aggregates

- Modelling the "avoided impacts" associated with the "avoided extraction" of natural resources in Lombardy



Technical visits
+
Data about quarrying activities from documents yearly prepared by each Province

Substitution of natural aggregates: quality of recycled aggregates

REGULATION EU n° 305/2011	*Harmonised conditions for the marketing of construction products (repealing Council Directive 89/106/EEC)* **CE MARKING**

"The placing on the market of a construction product which is covered by a harmonized standard should be accompanied by a declaration of performance in relation to the essential characteristics of the construction product in accordance with the relevant harmonized technical specifications."

RECYCLED AGGREGATES MUST COMPLY WITH ALL THE REQUIREMENTS FOR THE USE FOR WHICH THE AGGREGATE IS DESTINED

REQUIREMENTS FOR END USES OF AGGREGATES ACCORDING TO EUROPEAN STANDARDS:

EN 12620 Aggregates for concrete

EN 13043 Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas

EN 13139 Aggregates for mortar

VERY LIMITED DEMAND OF RA FOR CONCRETE AND MORTAR PRODUCTION IN ITALY

EN 13242 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction

MOST COMMON UTILIZATION OF RA IN ITALY

EN 13383-1 Armourstone - Part 1: Specification, Part 2: Test Methods

EN 13450 Aggregates for railway ballast

ALL RECYCLED AGGREGATES PRODUCED BY THE ANALYSED PLANTS HAVE THE CE MARKING

Substitution of natural aggregates: quality of recycled aggregates

ITALIAN LEGAL FRAMEWORK FOR THE UTILIZATION OF RECYCLED AGGREGATES IN THE CIVIL SECTOR

CIRCULAR 5205/05

Defines technical and performance criteria that recycled aggregates should satisfy with respect to the intended end-uses, including frequencies of control.
The environmental requirements refer to the limits for eluates set by All.3 of DM 5 February 1998.

❖ RECYCLED AGGREGATES FOR THE CONSTRUCTION OF EMBANKMENT BODY	ALL. C1
❖ RECYCLED AGGREGATES FOR THE CONSTRUCTION OF ROAD SUB-BASE	ALL. C2
❖ RECYCLED AGGREGATES FOR THE CONSTRUCTION OF ROAD BASE	ALL. C3
❖ RECYCLED AGGREGATES TO BE USED FOR ENVIRONMENTAL RECLAMATION AND FILLINGS	ALL. C4
❖ RECYCLED AGGREGATES TO BE USED FOR ANTI-FREEZE, ANTI-CAPILLARY AND DRAINING LAYERS	ALL. C5
❖ RECYCLED AGGREGATES FOR CONCRETE PRODUCTION (Rck<15 Mpa)	EN 12620 EN 8520 -2

ALL RECYCLED AGGREGATES PRODUCED BY THE ANALYSED PLANTS COMPLY WITH THE REQUIREMENTS SET BY THE ITALIAN MINISTERIAL CIRCULAR 5205/2005

Substitution of natural aggregates: market of recycled aggregates

- the regional market for recycled aggregates is highly unstable and strictly connected to large civil works (e.g. EXPO 2015, highways, ..)
- the low cost of natural virgin materials (4-5 €/t), due to the low taxation and lack of restrictions of quarry activities in Lombardy region, is one of the key factors limiting the market of recycled aggregates
- there is still diffidence in potential users towards technical characteristics and performances of recycled aggregates due to their origin
- deficiency of specific tools such as particular specifications of call for tenders («capitolati di appalto») is nowadays a constraining factor for recycled aggregates utilization
- the lack of specific "end of waste" criteria for CDW is one of the reasons for making recycled aggregates less competitive compared to natural aggregates

LCA shall take into account this situation

CONCLUSIONS

ON THE INERT CDW FLOWS AND THE REGIONAL MANAGEMENT SYSTEM

- **The most abundant CDW flow is the mixed one (code 170904) that may be indicative of a scarce source separation at worksites. However, mixed CDW appear to be mainly composed of concrete, soils, tiles and ceramics with a rather low level of impurities such as wood, glass, plastics. Moreover, treatment facilities usually require CDW delivers to sent «clean CDW» in order to produce recycled aggregates of higher quality grade** (waste code is assigned by waste producers who tend to classify wastes as mixed 170904 for precautionary reasons)

- **CDW treatment facilities appear rather widely distributed across the regional territory, which is essential to reduce waste transport distances**

- **The inert CDW are mainly directed to recycling facilities and only a limited amount is landfilled (< 4%)**

CONCLUSIONS

ON THE TREATMENT TECHNOLOGIES AND PRODUCED RECYCLED AGGREGATES

- In the analysed recycling facilities, all the inert fractions of CDW (1701, 170302, 170904) are mixed together before treatment
- Mobile plants are the most widespread technological option in Lombardy region due to economic reasons
- Recycling plants produce aggregates mainly used as sub-base materials in road construction or for environmental reclamation and fillings
- All produced recycled aggregates comply with the requirements set by the Italian Ministerial Circular 5205/2005 for the intended end-uses and have the CE marking
- The regional market for recycled aggregates is highly unstable and strictly connected to large civil works

ACKNOWLEDGEMENT

THE PRESENTED RESEARCH PROJECT WAS FINANCIALLY SUPPORTED BY THE LOMBARDY REGION GOVERNMENT.
SPECIAL THANKS TO ARPA LOMBARDIA FOR TECHNICAL SUPPORT AND TO ALL CDW RECYCLING PLANT OPERATORS FOR PROVIDING US USEFUL DATA AND INFORMATION.

THANK YOU FOR YOUR ATTENTION

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LEAP
Laboratorio Energia e Ambiente Piacenza
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POLITECNICO
MILANO 1863
3rd MatER Meeting
Innovation and Trends in Waste Management
May 22nd - 23rd, 2017
Politecnico di Milano, Campus PIACENZA
May 22nd, 2017
• Introduction
• Session 1: Strategies and perceptions on waste management
Key-note speakers:
- Raffaello Cossu, Università degli Studi di Padova (Italy)
- Paul Davison, Proteus Environmental Communications (UK)
• Session 2: Closing the loop: potentials and critical issues
Key-note speaker:
- Costas Velis, University of Leeds (UK)
• Poster Session
May 23rd, 2017
• Session 3: Processes and technologies for energy recovery
Key-note speaker:
- Franz Neubacher, UVP Environmental Management and Engineering (Austria)
• Poster Session
• Session 4: Processes and technologies for material recovery
Key-note speaker:
- Daniel Boeni, Managing Director WtE plant of KEZO, Hinwil (Switzerland)
MatER Study Center organises its 3rd Meeting on Innovation and Trends in Waste Management. The event arises from the fundamental goal of MatER, that is providing a thorough, objective representation of technologies and policies for material and energy recovery from waste, thereby contributing to move toward sustainable waste management. The Meeting aims at being an update on latest trends in Sustainable Waste Management, dealing with regulatory, strategic and technical-scientific aspects.
The event is organised with the scientific support of DICA (Department of Civil and Environmental Engineering) and Energy Department of Politecnico di Milano.
Call-for-abstract
Call-for-abstract is open from May 30th, 2016 to November 30th, 2016.
Languages accepted are Italian and English.
Submitted abstracts will be evaluated according to their innovation and scientific value and will be selected for presentation as oral communications or posters.
The authors of a number of leading abstracts will be invited to extend the abstract into a full paper that will be peer-reviewed for publication on "Waste Management & Research" or "Ingegneria dell'Ambiente", according to the language of the paper.
For further information, visit the web site www.mater.polimi.it.