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Different MBT Plant configurations as case studies of various EU co-financed projects Comparison in terms of performed efficiency and mitigation to climate change

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- **ENVIROPLAN S.A.** is currently active in many international environmental projects at Western Balkans, Eastern partnership countries and MENA region and more specific at :

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✓ Azerbaijan	✓ Palestine

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  - ✓ European Investment Bank (E.I.B.)
  - ✓ European Bank for Reconstruction and Development (E.B.R.D.)
  - ✓ World Bank (W.B.)
  - ✓ Local authorities/Ministries
  - ✓ Waste Management Organizations-Public Utility Companies
  - ✓ Private sector

Climate Change
Integrated Waste Management System

There are two main components in dealing with climate change:

- **Adaptation** which is about dealing with inevitable consequences of climate change and attempting to lower the risks and improve resilience. Climate change Vulnerability and Risk Assessment is the process of managing climate change adaptation issues for a project in order to improve the project's resilience to climate change.

- **Mitigation** which is about dealing with the causes of climate change by reducing GHG emissions.

Climate Change Adaptation
Vulnerability and Risk Assessment

- The process can be divided into the following main tasks (i) … v) **Adaptation**
  - I… …ations for the assessment, u… …w the methodology will be u… …ers involvement).
  - v… …and v… …ble t… …ore c…

Sensitivity table: *(example)*		Climate variables and hazards: Flood	Heat	…	Drought
Themes	On-site assets, …	High	Low	…	Low
	Inputs (water, …)	Medium	High	…	Medium
	Outputs (produts, …)	High	Medium	…	Low
	Transport links	Medium	Low	…	Low
	Highest score 4 themes	High	High	…	Medium

Examples of potential climate hazards: *Temperature, precipitation, sea level, wind speeds, humidity, solar radiation, flood, heat, drought*

Vul… …two aspects:

1)

Exposure table: *(example)*	Climate variables and hazards: Flood	Heat	…	Drought
Current climate	Medium	Low	…	Low
Future climate	High	Low	…	Medium
Highest score, current + future	High	Low	…	Medium

2)

Irrespective of the project type.

Basic requirements of Climate Adaptation Vulnerability and Risk Assessment

Sensitivity x Exposure = Vulnerability

Vulnerability table: *(example)*		Exposure (current + future climate)		
		Low	Medium	High
Sensitivity	Low			
(highest,	Medium		Drought	
4 themes)	High	Heat		Flood

Legend:
Vulnerability level
Low
Medium
High

- Vulnerability analysis combines sensitivity and exposures analysis.
- The most relevant climate variables and hazards are those with a high or medium vulnerability level, which are then taken forward to the risk assessment.

Climate Change Adaptation
Vulnerability and Risk Assessment

✓ **Risk Assessment**: Aim of this task is consider the likelihood and severity of each risk affecting the success of the project.

1) Likelihood of impact (Probability). This part looks at how likely the identified climate hazards are to occur within a given timescale e.g. the lifetime of the project. The table provides a scale for assessing the likelihood of a climate hazard.

Term	Qualitative	Quantitative (*)
Rare	Highly unlikely to occur	5%
Unlikely	Unlikely to occur	20%
Moderate	As likely to occur as not	50%
Likely	Likely to occur	80%
Almost certain	Very likely to occur	95%

2) Magnitude of impact (Severity). This part looks at what would happen if the identified climate hazard did occur, what would be the consequences. This should be assessed on a scale of severity per hazard. The impact analysis provides an expert assessment of the potential impact for each of the essential climate variables and hazards.

Scale for assessing the potential impact of a climate hazard (example): Impacts: / Risk areas:	Insignificant	Minor	Moderate	Major	Catastrophic
Asset damage, engineering, operational				■	
Safety and health		■			
Environment		■			
Social		■			
Financial				■	
Reputation	■				
Overall for the above-listed risk areas				■	

Probability x Severity = Risk

Risk table:		Overall impact of the essential climate variables and hazards (example)				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Rare				Flood	
	Unlikely			Drought		
	Moderate			Heat		
	Likely					
	Almost certain					

Legend:
Risk level
Low
Medium
High
Extreme

- Risk analysis combines likelihood and impact of the essential climate variables and hazards.

Climate Change Adaptation
Vulnerability and Risk Assessment

- **Adaptation**: Aim of this task is to manage and reduce effects of climate change to an acceptable level. Divided in two stages

1) Identification and appraisal of Adaptation options.

- Identification of options responding to the risks (workshops, meeting, evaluation, etc.). Adaptation may involve a mix of responses e.g. training, capacity building, monitoring, use of best practices, standards, engineering solutions, technical design, risk management etc.
- The appraisal of adaptation options should give due regard to the specific circumstances and availability of data through expert judgment or detailed cost-benefit analysis.

2) Integration of adaptation options.

Climate Change Mitigation
GHG emissions calculations Methodology

As part of the option analysis, the quantification of each examined scenario for Integrated Waste Management System was performed according to The Carbon Footprint Methodology, that provides a series of emissions factors derived from internationally recognized sources, e.g. GHG Protocol and IPCC Guidelines for National GHG Inventories.

The calculation of the GHG emissions included:

- Both direct and indirect GHG emissions from the different components of the waste management system
- GHG emissions, Avoided GHG emissions and Net GHG emissions of an incremental approach (with-without project scenario)

Scope of GHG emissions produced by different waste management activities

Activity	Net direct GHG emissions (scope 1)	Indirect GHG emissions (scope 2)	Avoided GHG emissions
Material Recovery Facility (MRF)	CO_2 from fuels consumed in waste collection and transportation to and from the facility	CO_2 from grid electricity consumption	CO_2 avoided through material recovery from waste and recycling
	CO_2 from fuels consumed in waste treatment facility		
MBT	CO_2 from fuels consumed in waste collection and transportation to and from the facility	CO_2 from grid electricity consumption	CO_2 avoided through material recovery from waste and recycling
	CH_4 and N_2O in anaerobic processes during biological treatment		CO_2 avoided through energy recovery from incineration of RDF/SRF produced from mixed waste
	CO_2 from fuels consumed in waste treatment facility (i.e. by vehicles)		CO_2 avoided through energy recovery from combustion of biogas produced in anaerobic digestion
Landfill	CO_2 from fuels consumption in waste collection and transportation to and from the facility	CO_2 from grid electricity consumption	CO_2 avoided through energy recovery from landfill gas
	CH_4 from landfill		
	CO_2 from fuels consumed on the landfill site (i.e. by vehicles)		

Source: Jaspers, Staff working papers, Calculation of GHG Emissions in Waste and Waste-to-Energy Projects, 2013

Methodology

To quantify the European Investment Bank (EIB) carbon footprint for investment projects and the associated relative emissions compared to the baseline the following series of activities must be followed:

Define project Boundary

↓

Emission scope

↓

Quantify absolute proj

↓

Identify & quantify baseline emissions
(Be)

↓

Calculate relative emissions
Re=Ab-Be

What to be included in the calculation of absolute, baseline, and relative emissions?

Definition of scope of GHG emissions.

Methodology

To quantify the European Investment Bank (EIB) carbon footprint for investment projects and the associated relative emissions compared to the baseline the following series of activities must be followed:

Define project Boundary

↓

Emission scopes to include

↓

Quantify absolute project emissions (Ab)

↓

Identify & quantify baseline emissions
(Be)

↓

Calculate relative emissions
Re=Ab-Be

Methodology

To quantify the European Investment Bank (EIB) carbon footprint for investment projects and the associated relative emissions compared to the baseline the following series of activities must be followed:

Define project Boundary

↓

Emission scopes to include

↓

Quantify absolute project emi

↓

Identify & quantify baseline e
(Be)

↓

Calculate relative emiss
Re=Ab-Be

Scope 1: Direct GHG emissions. Occur physically from sources operated by the project within the project boundary.

Scope 2: Indirect GHG emissions. From electricity generation that is consumed by the project.

Basic Assumptions

For the GHG emissions calculation, the following specific assumptions were used:

- *Carbon contents of MSW*
- *GHG emissions from waste collection and transportation*
- *GHG emissions from waste treatment*
- *Avoided GHG emissions through recycling of recovered materials*
- *Avoided GHG emissions through recovery of energy from waste*

Case Study 1

EU funded project:

"Preparation of necessary documents for establishing of an Integrated and Financially Self-sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions"

Project Background

EU funded project:

“Preparation of necessary documents for establishing of an Integrated and Financially Self-sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions”,

Financing	EU
Contracting Authority	Central Financing and Contracting Department (CFCD) within the Ministry of Finance
Target groups-Beneficiaries	-MoEPP -Intermunicipal Waste Management Board of the Pelagonija, Southwest, Vardar and Skopje regions -43 municipalities in the 4 regions
Project duration	24 months (12/2015-12/2017)

Project Components

Component nº 1:
Regional Waste Management Plan (RWMPs) for each region;

Component nº 2:
Strategic Environmental Assessment (SEA) Report for each region;

Component nº 3:
Feasibility Study (FS) for each region;

Component nº 4:
Cost-Benefit Analysis (CBAs) for each region

Component nº 5:
Environmental Impact Assessment (EIA) Study on the basis of the Feasibility study for each region

Component nº 6:
Detailed Design and Cost estimation for closure, rehabilitation and after care of municipal non-compliant landfills and dumpsites and for construction of selected waste treatment and disposal facilities for each region;

Component nº 7:
Need assessments, market analyses with costs estimations and Technical Specifications (TSs) for **supply of equipment for waste collection and transferring of waste** for each region;

Component nº 8:
Tender Dossiers for the works contracts for closure, rehabilitation and after care of municipal **non-compliant landfills and dumpsites** and for construction of selected **waste treatment and disposal facilities** for each region

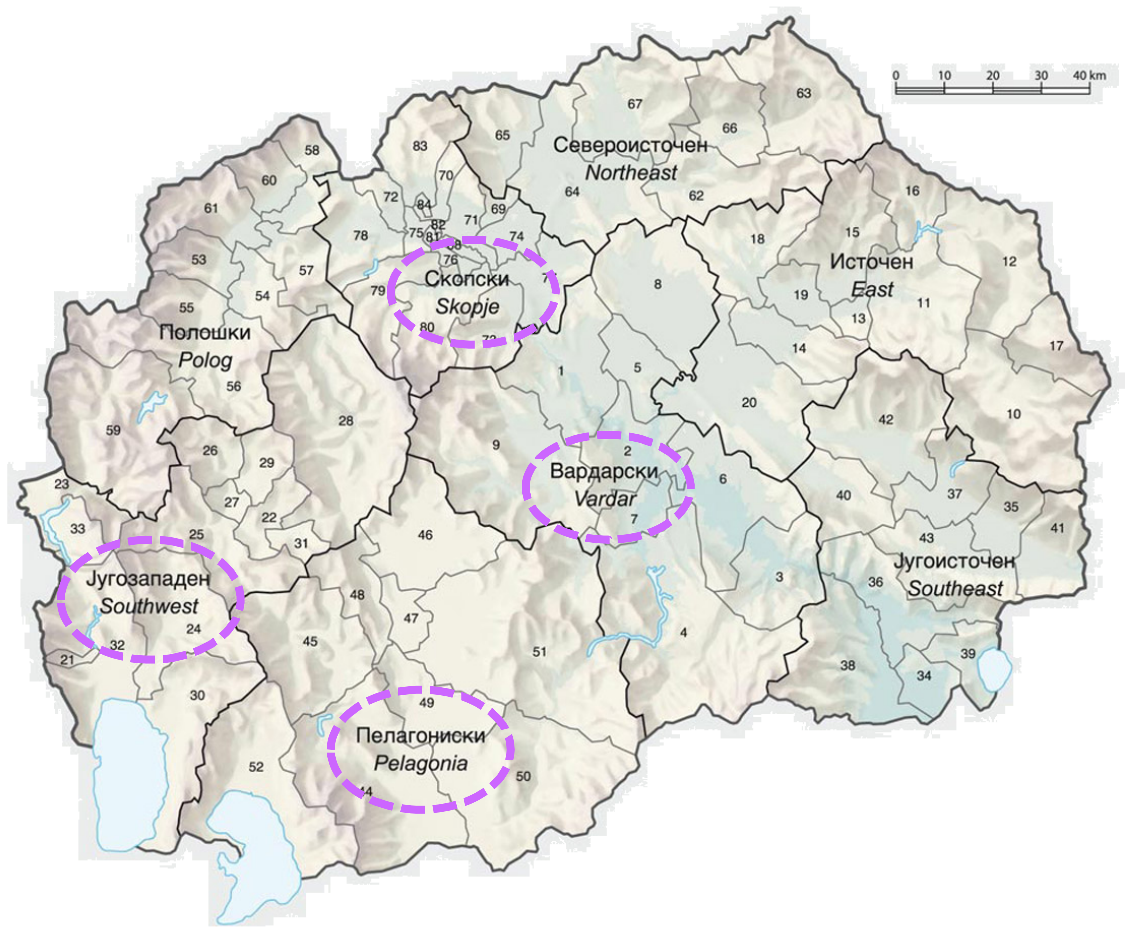
Component nº 9:
Stakeholder Involvement (incl. publicity & visibility)

North Macedonia

consists of 8 regions and 80 municipalities with a population of 2.07 million

has a surface area of 25,713 km^2

borders Albania Kosovo, Serbia, Bulgaria and Greece



North Macedonia, the four regions

VARDAR REGION	PELAGONIJA REGION	SOUTHWEST REGION
135,224 inhabitants or 6.5 % of the total population	231,137 inhabitants or 11.2% of the total population	219,981 inhabitants or 10.6% of the total population
population density 37.9 inhabitants/km^2	population density 49.0 inhabitants/km^2	population density 65.8 inhabitants/km^2
8 municipalities (Sv. Nicole Municipality is included in Regional Planning of East Region)	9 municipalities	9 municipalities
covers 16.2% of the total area	covers 18.9% of the total area	covers 13.4% of the total area

National Legislation/Law on packaging and packaging waste

According article 35 (National aims for treatment of packaging waste), paragraphs (1) b, (1) c & (1) d of Law on management of Packaging and Packaging waste the following should be fulfilled

- ❖ By the end of the year 2020, a minimum of 55% and a maximum of 80% of the weight of packaging waste created on the territory of the Republic of North Macedonia needs to be recycled
- ❖ By the end of the year 2020, the following percentages of materials where from the packaging waste is produced need to be recycled
- ✓ 60% glass
- ✓ 60% paper and cardboard
- ✓ 50% metals
- ✓ 15% wood
- ❖ By the end of the year 2018 22,5% plastic, considering only the recyclable materials in the plastic

National Legislation/Targets of biodegradable municipal waste landfilled (Art. 87 LoWM)

Year	Quantity of BMW landfilled, expressed as a mass percentage of MSW generated in 1995	Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995
Reference year 1995	62%	
2017	47%	25%
2020	31%	50%
2027	22%	65%

Alternative examined scenarios for Vardar, Pelagonija, Southwest regions

	Scenario 1 (1 bin)			**Scenario 2 (2 bins)**	**Scenario 3 (2 bins)**			**Scenario 4 (3 bins)**
	1a (MBT)	***1b (MBT with AD)***	***1c (Incineration)***	***2 (MRF+ Aerobic Composting)***	***3a (MRF+ Aerobic Composting)***	***3b (MRF+ Anaerobic Digestion)***	***3c (MRF + MBS)***	***4 (MBT)***
Waste Collection	One Bin collection system			Two Bin collection system (Organic Waste Bin and Mixed Bin)	Two Bin collection system (Recyclable Waste Bin and Mixed Bin)			Three Bin collection system
Green Points	√	√	√	√	√	√	√	√
Home Compostin g	√	√	√	-	√	√	√	-
Mixed Bin Treatment	Mechanica l Biological Treatment (MBT) with Aerobic Compostin g	Mechanica l Biological Treatment (MBT) with Anaerobic Digestion	Incineration	MRF	MBT with aerobic composting	MBT with anaerobic digestion	MBS (Biostabi lization)	Disposal to Landfill
Recyclable waste bin treatment	-	-	-	-	MRF	MRF	MRF	MRF
Organic waste bin treatment	-	-	-	Aerobic Composting	-	-	-	Aerobic Composting

Multi-Criteria Analysis (MCA)

PROMETHEE MCA method used in order to evaluate the different waste management scenarios. The analysis involves three main phases (a) the setting of criteria, (b) the weighting of criteria, (c) the ranking of alternative schemes

The groups of criteria and individual criteria that was examined are presenting in the

Financial	Technical	Environmental	Social-Institutional
(F1) Investment cost	(T1) Flexibility regarding waste quantity	(E1) Air pollution	(S1) Application of priority of legislation
(F2) Net operational cost	(T2) Flexibility regarding waste quality	(E2) Generation of waste water	(S2) Possibility of creation of new jobs
(F3) Economic sustainability	(T3) Simplicity	(E3) Generation of solid waste residues	(S3) Degree of fulfillment of targets
	(T4) Energetic exploitation	(E4) Toxicity of residues	(S4) Public acceptance
	(T5) Recovery of materials		(S5) Transition to future conditions

Financial Criteria	Weights %
F1	25%
F2	40%
F3	35%

Technical Criteria	Weights %
T1	25%
T2	25%
T3	20%
T4	15%
T5	15%

Environmental Criteria	Weights %
E1	30%
E2	30%
E3	20%
E4	20%

Social-Institutional Criteria	Weights %
S1	20%
S2	10%
S3	30%
S4	25%
S5	15%

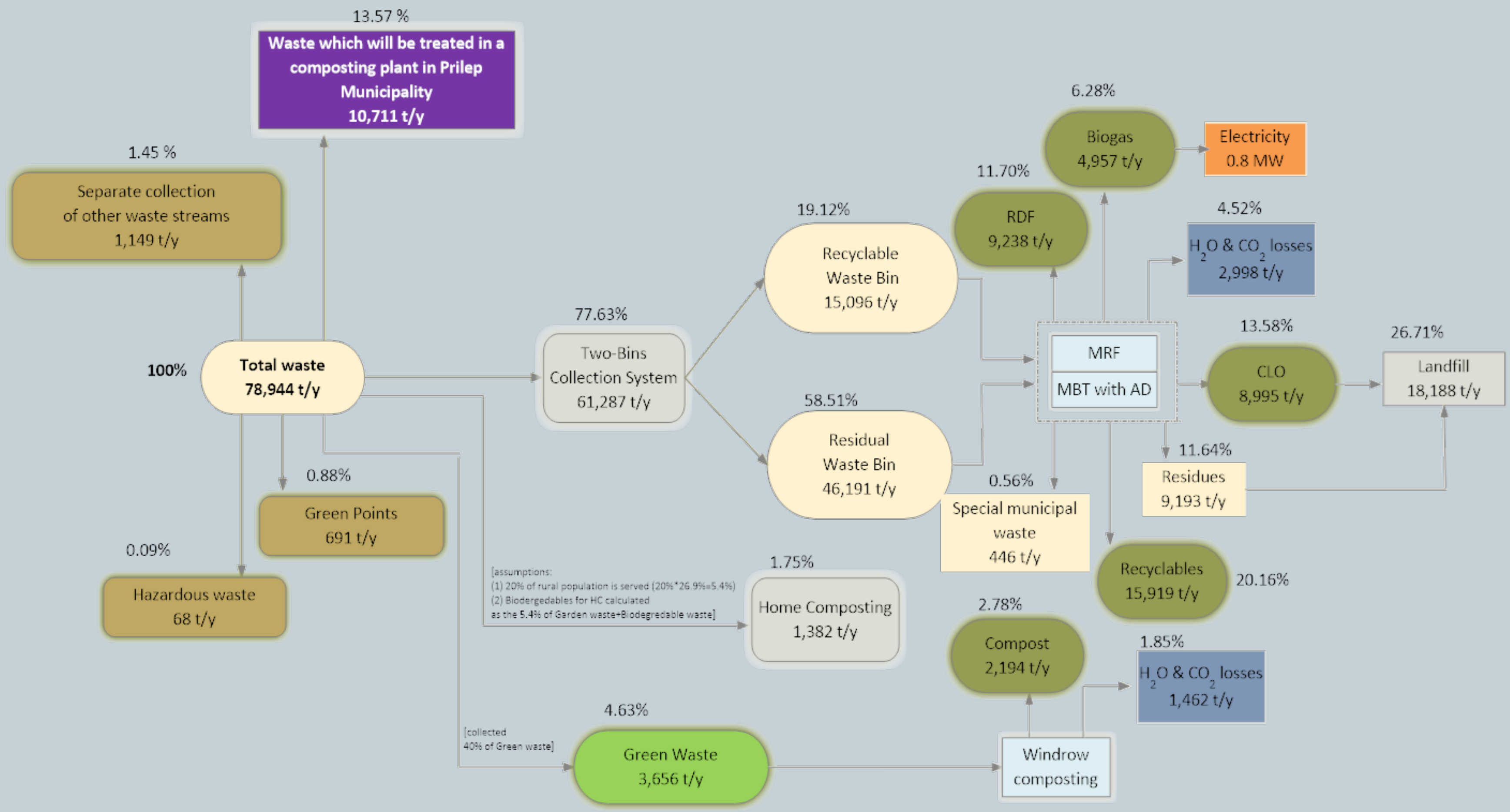
The weights of each sub-criterion have been determined

Selected Waste Management Scenarios in each Region

Regions	Pelagonija	Vardar	Southwest
Waste Collection	Two Bin collection system (Recyclable Waste Bin and Residual Waste Bin)	Two Bin collection system (Recyclable Waste Bin and Residual Waste Bin)	Two Bin collection system (Recyclable Waste Bin and Residual Waste Bin)
Green Points	√ 691 t/y	√ 398 t/y	√ 687 t/y
Home Composting	√ 2,174t/y	√ 1,214t/y	√ 2,002t/y
Residual Waste Bin Treatment	MBT with anaerobic digestion followed by aerobic composting, 54,011t/y	MBS (Biostabilization) 28,503t/y	MBT with anaerobic digestion followed by aerobic composting 41,668t/y
Recyclable waste bin treatment	MRF, 15,096t/y	MRF, 8,556t/y	MRF, 13,874t/y
Green waste treatment	Aerobic Composting, 5,755t/y	Aerobic Composting, 2,301t/y	Aerobic Composting, 3,591t/y
Landfill	√ 21,086 t/y	√ 23,349 t/y	√ 34,167 t/y

Regions	Pelagonija	Vardar	Southwest
Products (t/y)			
Compost	√ 3,453t/y	√ 1,381t/y	√ 2,155
RDF	√ 10,802t/y		√ 8,834t/y
SRF			
Recyclables	√ 15,919t/y	√ 7,470t/y	√ 14,902t/y
Biogas	√ 4,957t/y		√ 3,748t/y

Recommended options for IWMS-Pelagonija Region



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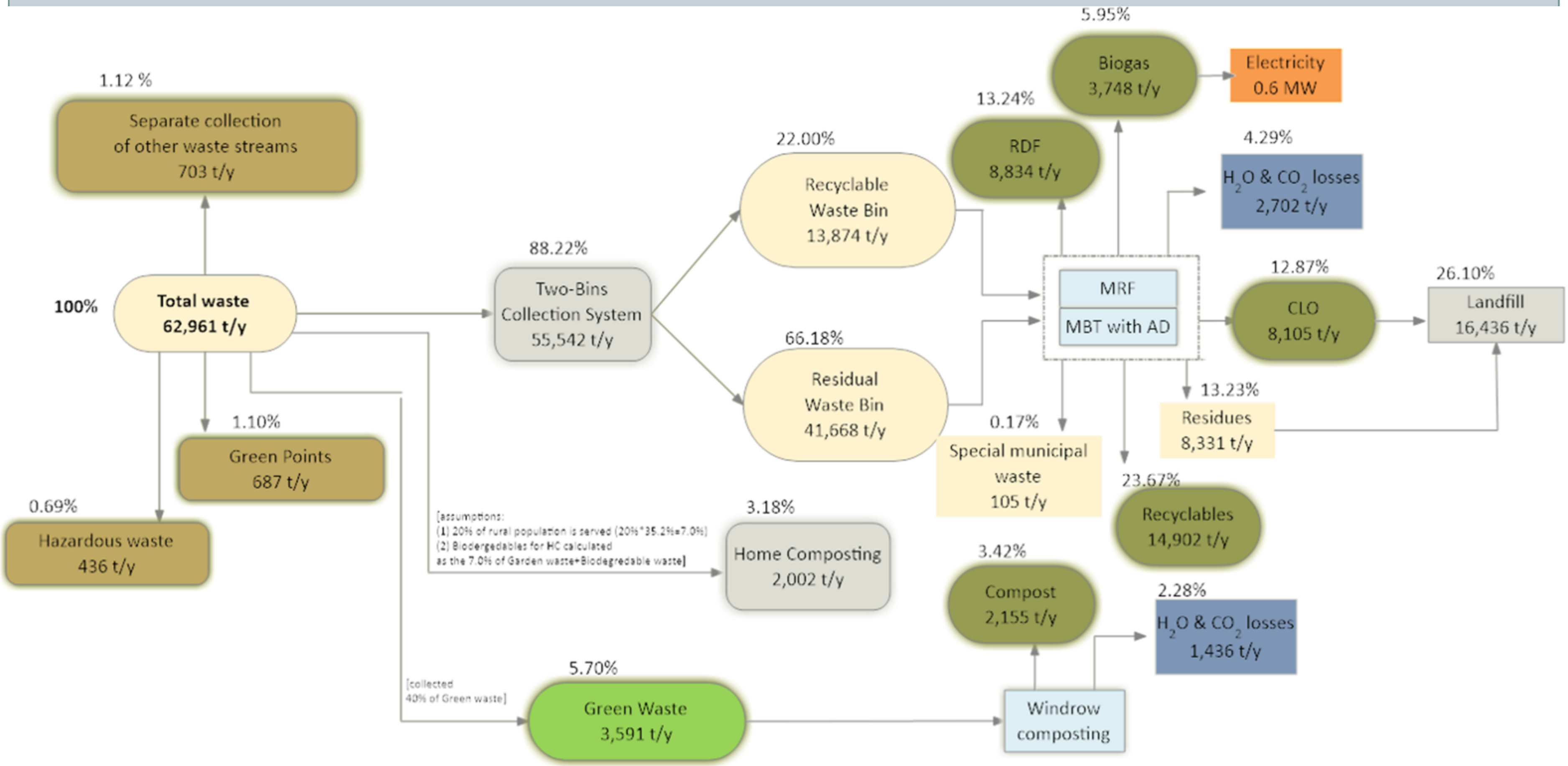
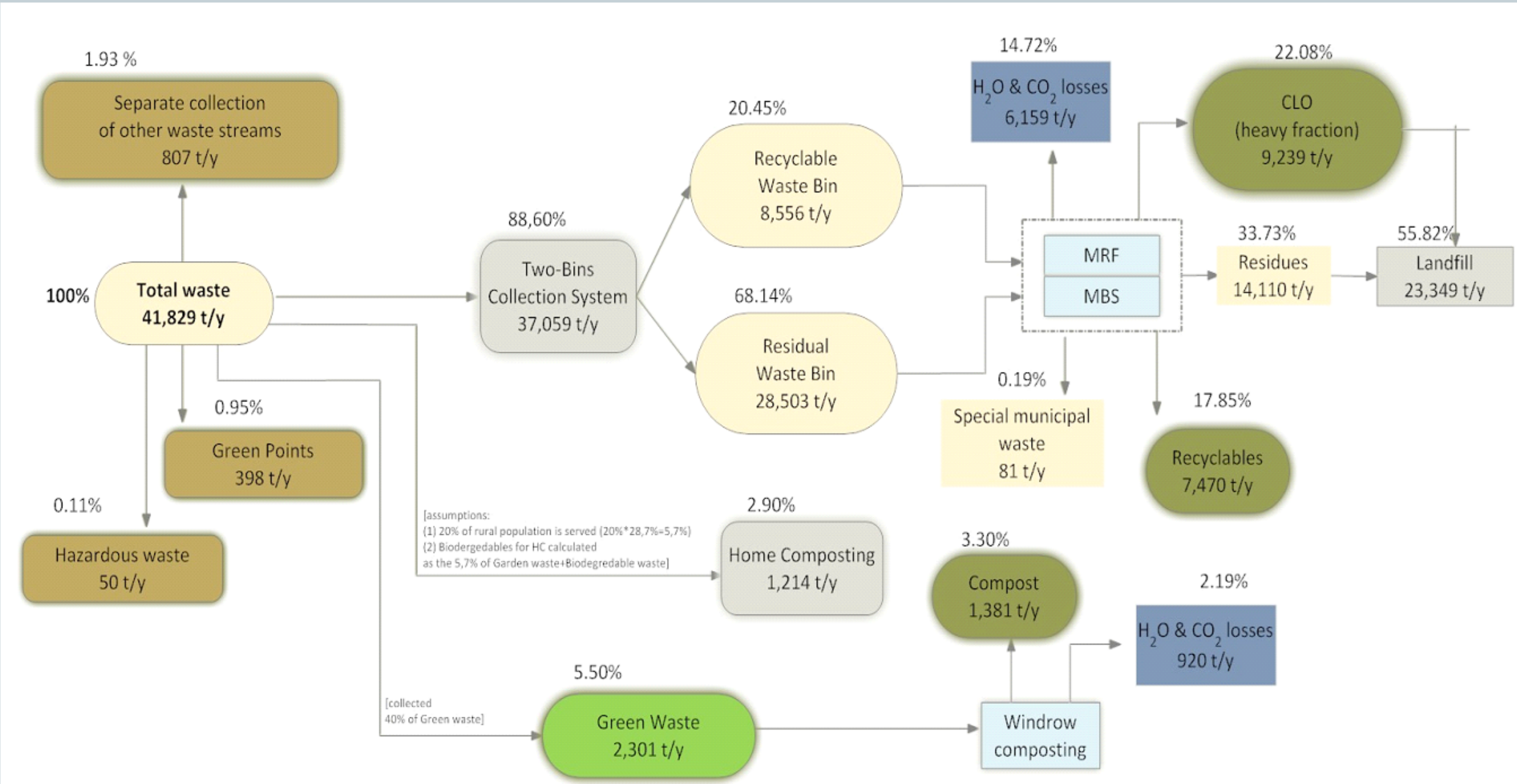
Recommended options for IWMS-Southwest Region



Recommended options for IWMS-Vardar Region



Mixed Waste from Households	
GHG emissions from waste collection and transport (t CO_2(eq))	438
GHG emissions from waste treatment (t CO_2(eq))	
GHG emissions from landfills (t CO_2(eq))	21,779
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	
TOTAL WITHOUT PROJECT SCENARIO GHG EMISSIONS	22,217

GHG emissions, avoided GHG emissions and Net GHG emissions (average 2021-2046), in t CO_2 (eq), for the different components of the waste management system in the baseline (without-project) scenario.

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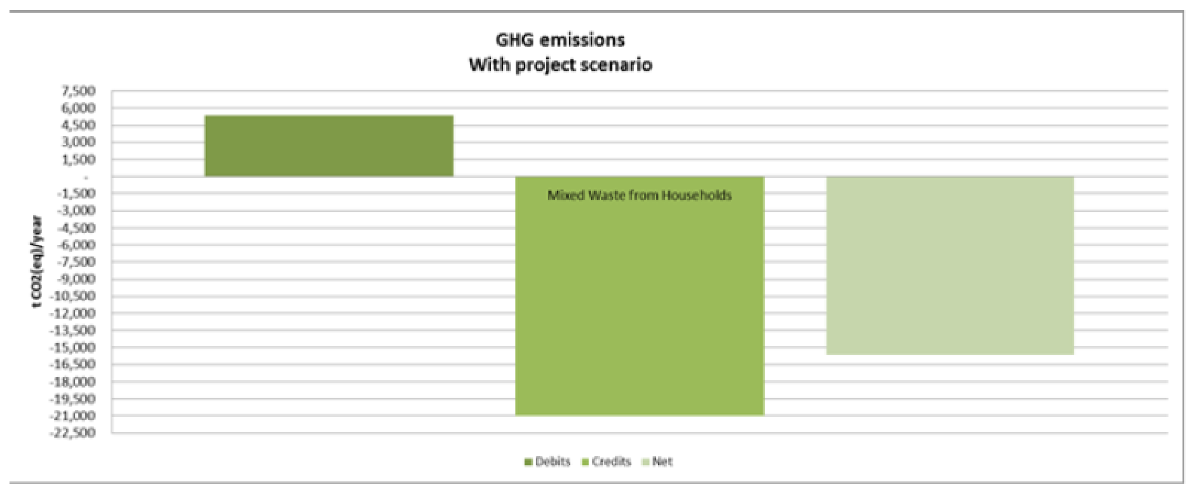
Climate Change Mitigation
Analytical GHG Emission Calculations (Southwest region)
With project scenario

Mixed Waste from Households	
GHG emissions from waste collection and transport (t CO_2(eq))	372
GHG emissions from waste treatment (t CO_2(eq))	3,074
GHG emissions from landfills (t CO_2(eq))	2,114
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-17,652
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	-4,178
TOTAL WITH PROJECT SCENARIO GHG EMISSIONS (t [illegible]	12,797 [illegible]



GHG emissions, avoided GHG emissions and Net GHG emissions (average 2021-2046), in t CO_2 (eq), for the different components of the waste management system in the with-project scenario.

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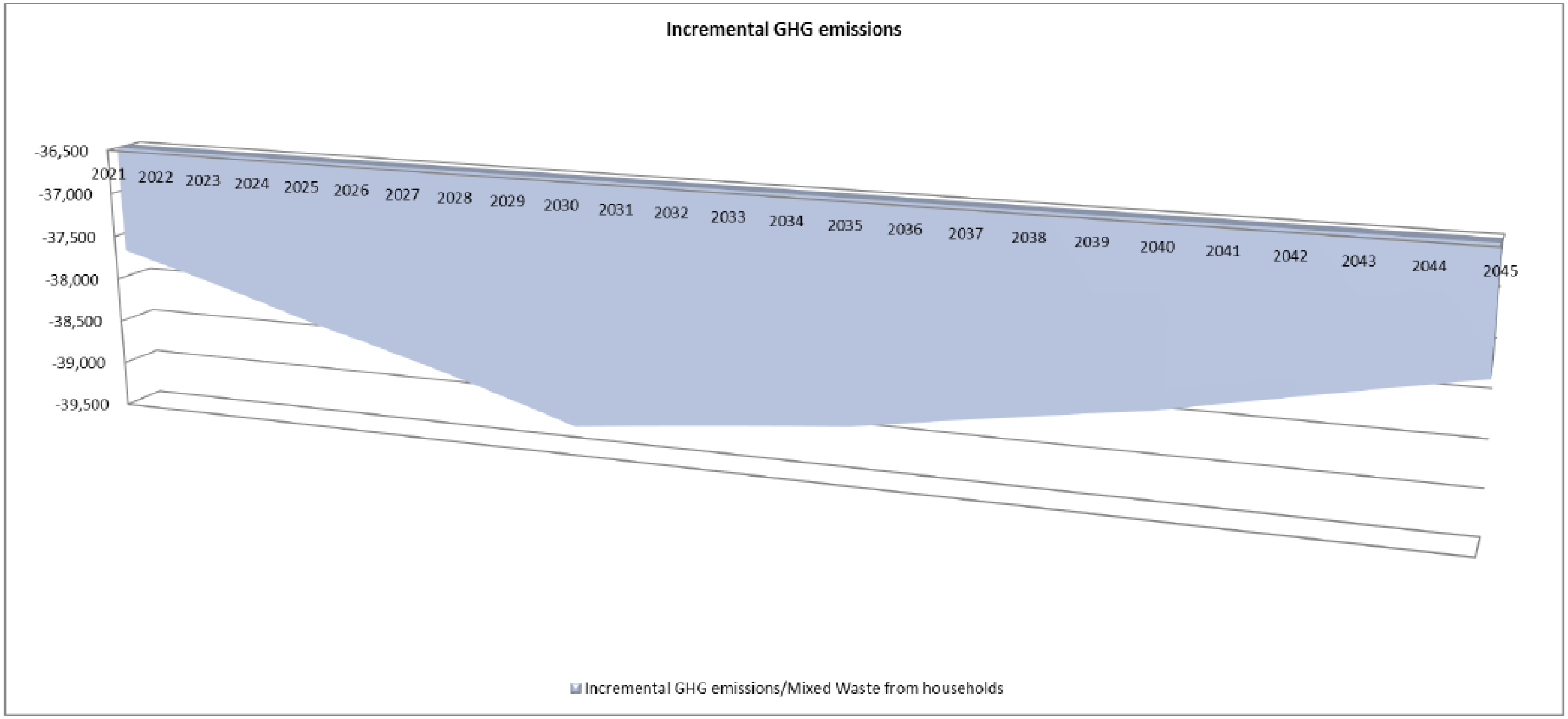
Analytical GHG Emission Calculations (Southwest region) Incremental approach



GHG emissions for each examined scenario-All regions

Regions	Southwest	Pelagonija	Vardar
	Quantification of GHG emissions (With project)		
Total t CO_2(eq) /year (Net)	-16,271	-12,023	-3,609
	Quantification of GHG emissions (Without project)		
Total t CO_2(eq) /year (Net)	22,217	20,352	14,471
	Quantification of GHG emissions (Incremental approach=With-Without project)		
Total t CO_2(eq) /year (Net)	-38,488	-32,375	-18,080

Case Study 2

EU funded project:

"Feasibility study for development of the integrated and sustainable waste management system in Dubrovnik – Neretva County "

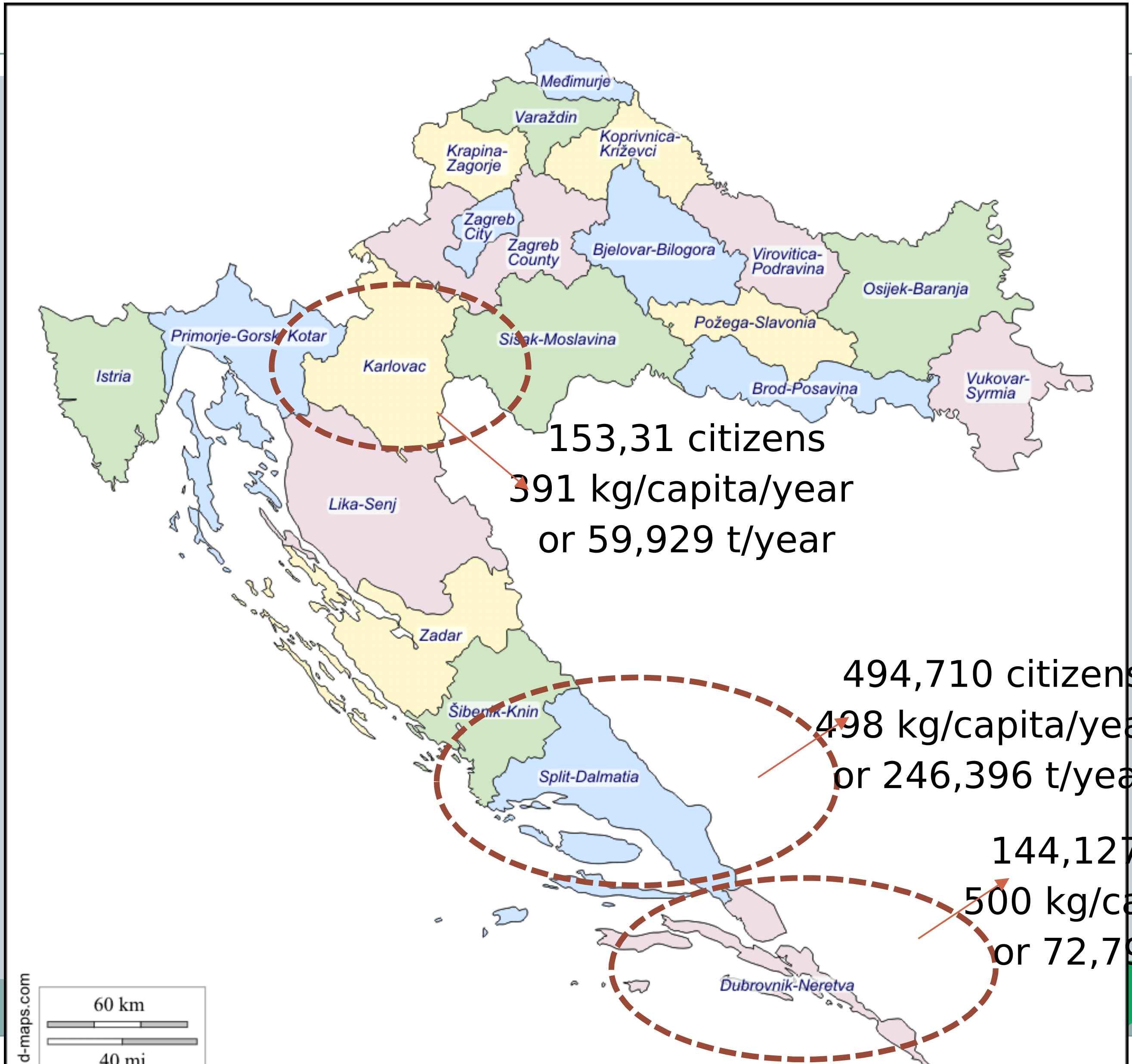
EU funded project:

"Feasibility study for development of the integrated and sustainable waste management system in Split– Dalmatia County "

EU funded project:

"Feasibility study for development of the integrated and sustainable waste management system – Waste Management Center Babina Gora, Karlovac "

Project background



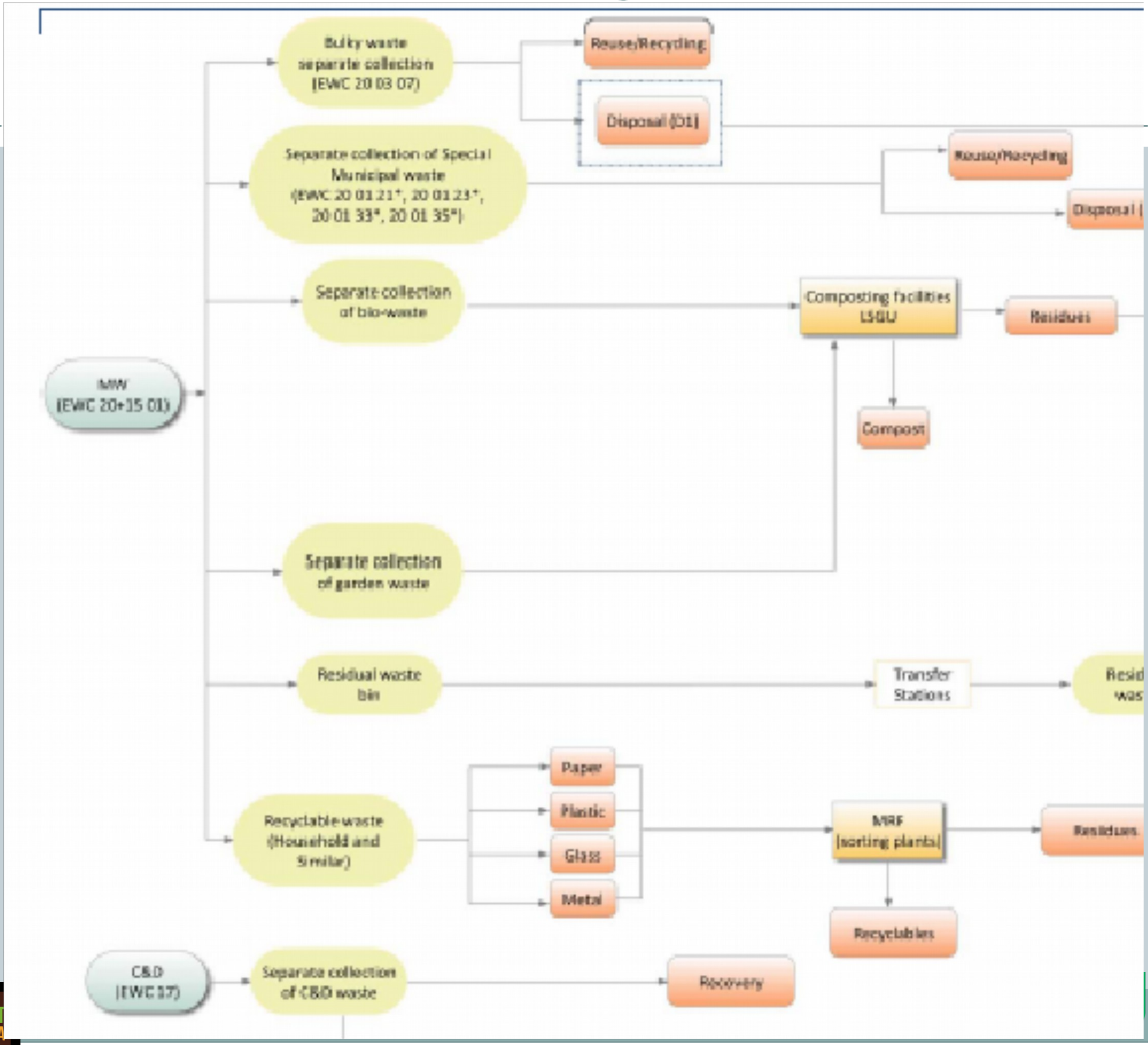
Project background

- Financing: Environmental Protection and Energy Efficiency Fund (EPEEF)
- Contracting authority: County of Dubrovnik-AGO doo
- Contractor: ENVIROPLAN S.A., Brodarski Institute d.o.o., Procurator Vastitatis d.o.o.
- Year of assignment: 2014
- Subject: Feasibility Study, Cost Benefit Analysis, Application Form

Targets to be achieved according NWMP 2017-2022

Goal	To be met by 2022 in comparison to 2015	
waste management	Goal 1.1	Decrease the total quantities of produced municipal waste by 5%
	Goal 1.2	Separatelly collect 60% of mass of produced municipal waste (primarily paper, glass, plastic, metal, bio-waste, bulky waste)
	Goal 1.3	Separatelly collect 40% of mass of produced bio-waste constituent in municipal waste
	Goal 1.4	Landfill less than 25% of mass of produced municipal waste

Waste Management Plan



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Option analysis for Waste Management Centre Technology in DNC

Proposed Scenarios	Description
Scenario 1	Mechanical separation with recovery of Recyclables and RDF and aerobic composting for CLO production
Scenario 2	Mechanical separation with recovery of Recyclables and RDF, wet AD with electricity production and dewatering of digestate
Scenario 3	Biodrying for production of low quality SRF and mechanical separation with recovery of Fe/Al
Scenario 4	Mechanical Separation with recovery of recyclables and RDF, dry fermentation with electricity and heat production and bio-stabilization of digestate (Hybrid MBT)

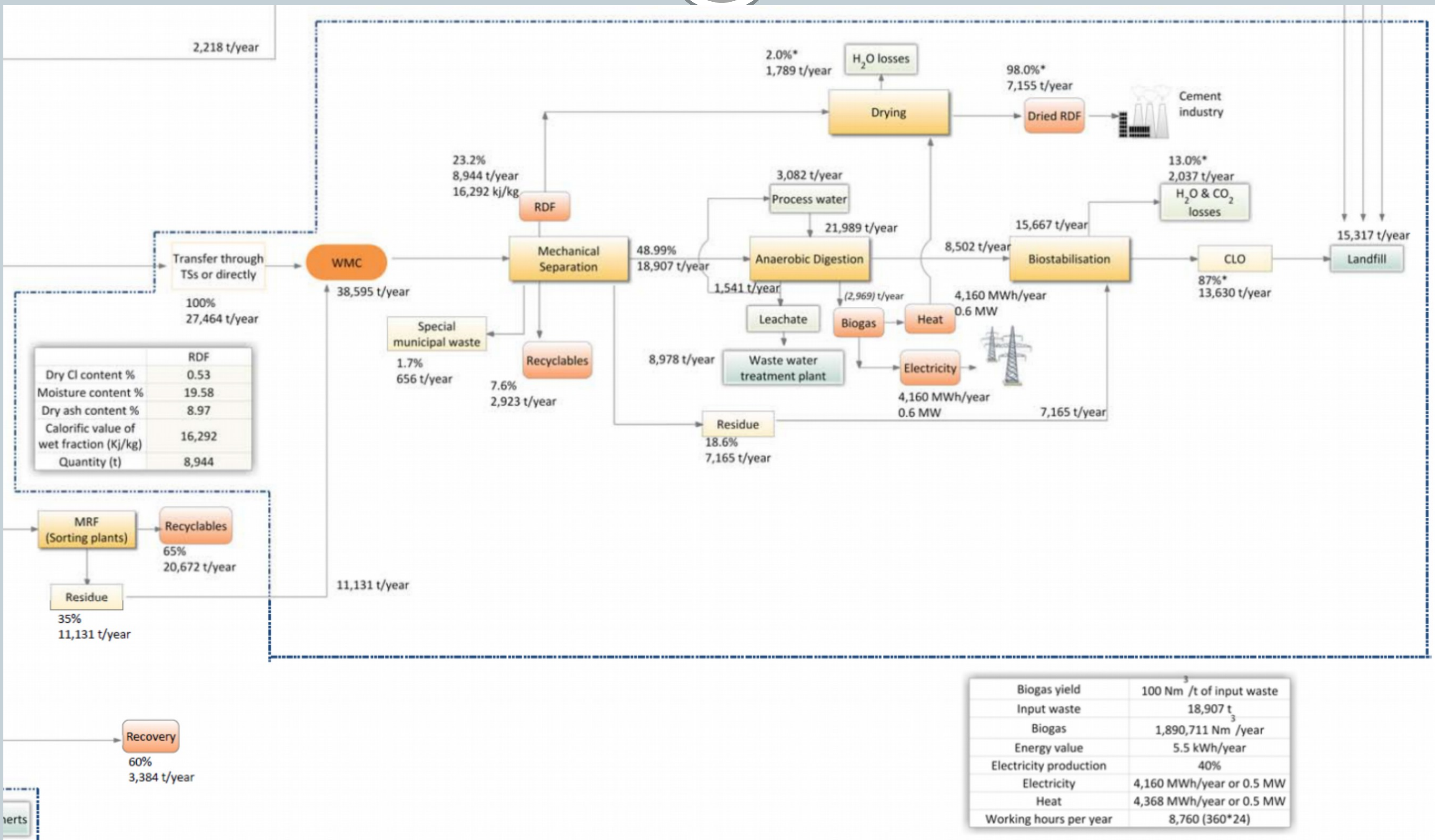
Option analysis for Waste Management Centre Technology in SDC

Proposed Scenarios	Description
Scenario 1	Mechanical separation with recovery of Recyclables and RDF and aerobic composting for CLO production
Scenario 2	Mechanical separation with recovery of Recyclables and RDF, AD with electricity production and further Aerobic Composting for production of CLO
Scenario 3	Mechanical separation with recovery of Recyclables and RDF and biodrying for SRF production
Scenario 4A	Biodrying for production of low quality SRF and mechanical separation with recovery of Fe/Al
Scenario 4B	Biodrying for production of high quality SRF and mechanical separation with recovery of Fe/Al
Scenario 5	Thermal Treatment unit (mass burn incineration) with electricity production

Option analysis for Waste Management Centre Technology in Karlovac County

Proposed Scenarios	Description
Scenario 1	Mechanical separation with recovery of Recyclables and RDF and aerobic composting for CLO production
Scenario 2	Mechanical separation with recovery of Recyclables and RDF, AD with electricity production and further Aerobic Composting for production of CLO
Scenario 3	Mechanical separation with recovery of Recyclables and RDF and biodrying for SRF production
Scenario 4	Biodrying for production of low quality SRF and mechanical separation with recovery of Fe/Al

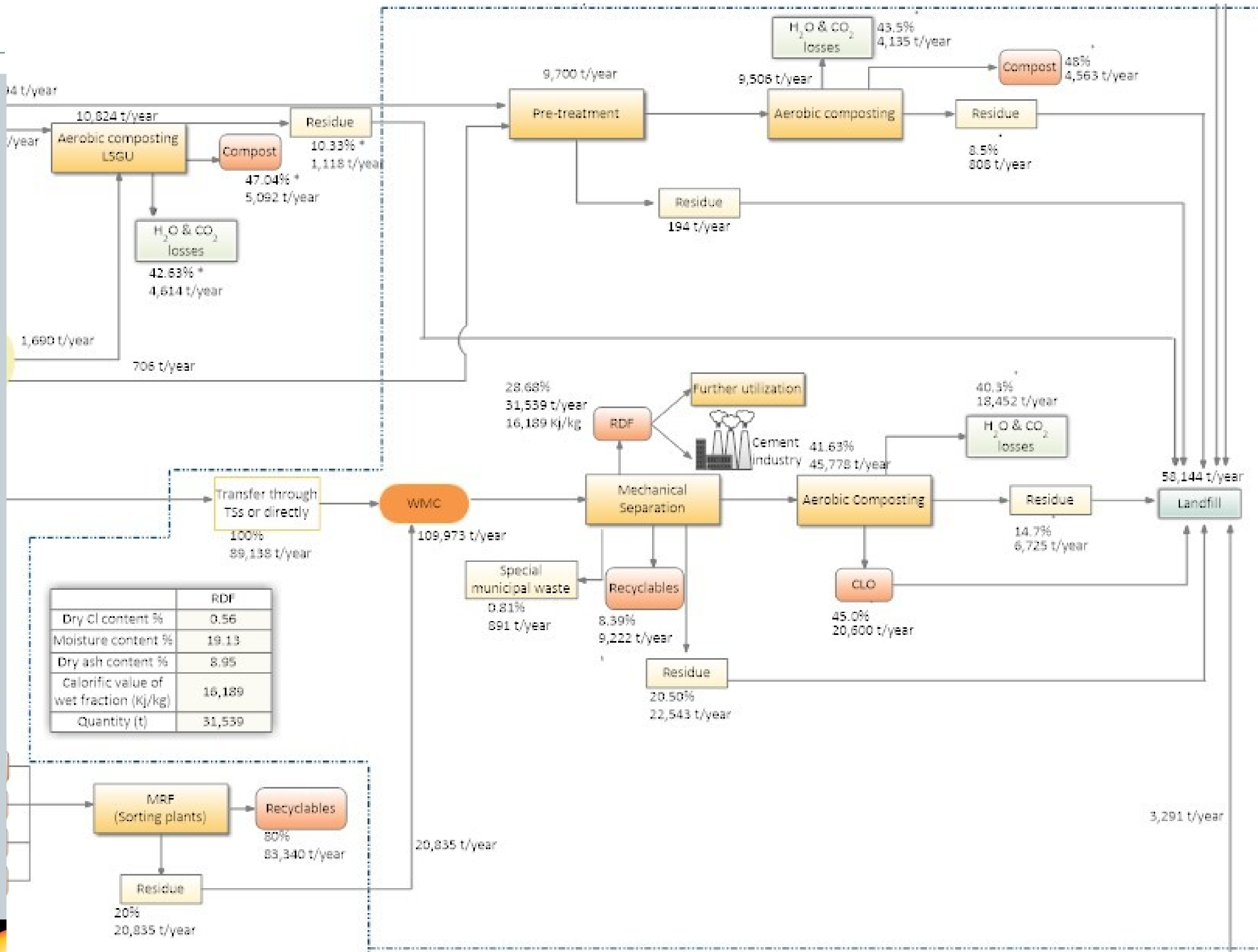
Mass Balance/Residual Waste bin DNC



	RDF
Dry Cl content %	0.53
Moisture content %	19.58
Dry ash content %	8.97
Calorific value of wet fraction (Kj/kg)	16,292
Quantity (t)	8,944

Biogas yield	100 Nm^3/t of input waste
Input waste	18,907 t
Biogas	1,890,711 Nm^3/year
Energy value	5.5 kWh/year
Electricity production	40%
Electricity	4,160 MWh/year or 0.5 MW
Heat	4,368 MWh/year or 0.5 MW
Working hours per year	8,760 (360*24)

Mass Balance/Residual Waste bin SDC



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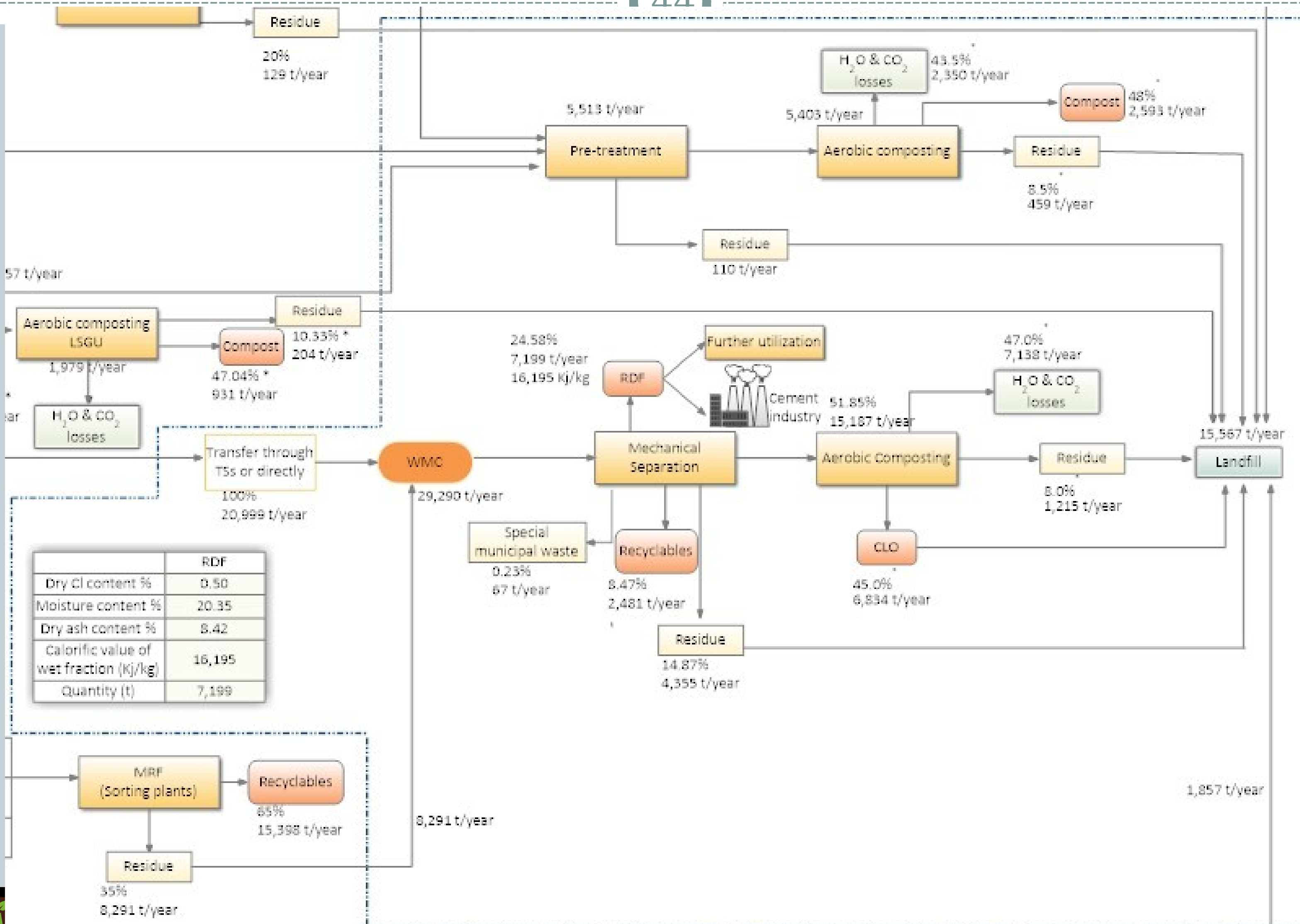
Mass Balance/Residual Waste bin Karlovac County



Groups of criteria used for the option analysis

A. LEGISLATIVE CRITERIA	B. ENVIRONMENTAL CRITERIA	C. TECHNOLOGICAL CRITERIA	D. FINANCIAL CRITERIA
A.1. Compatibility with European and National legislation a	B.1. Air Pollution: dust and odours and contribution to GHG emissions	C.1. Adaptability of the process towards the future volume fluctuation and quality of waste	D.1.Construction cost – Investment cost
A.2. Compatibility with procurement procedures under the rules of the EU	**B.1. Air Pollution: dust and odours and contribution to GHG emissions**	C.2. Proven technology – guarantee of operational excellence	D.2. Net operational cost
	B.3. Noise	C.3. Need of skilled personnel - Employment of local population	**D.3. Economic sustainability**
	B.4. Area requirements for the sitting of facilities	C.4. Existence of a market for the use of the finished product	
	B.5. Mitigation measures in the environment	C.5. Exploitation – Energy efficiency	
		C.6. Management of by-products	

Results Climate Change Mitigation/GHG emissions for each examined scenario – IWMS DNC

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Quantification of GHG emissions in all scenarios (With project)			
Total t CO_2(eq) /year (Net)	-23,274	-24,142	-16,225	-24,432
	Quantification of GHG emissions in all scenarios (Without project)			
Total t CO_2(eq) /year (Net)	12,797	12,797	12,797	12,797
	Quantification of GHG emissions in all scenarios (Incremental approach=With-Without project)			
Total t CO_2(eq) /year (Net)	-36,072	-36,939	-29,023	-37,230

Scenario 4 is the recommended scenario, which includes:

- mechanical separation with recovery of Recyclables and RDF,
- dry fermentation with electricity and heat production and
- biostabilization of digestate.

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Analytical GHG Emission Calculations
Without project scenario

Mixed Waste from Households	
GHG emissions from waste collection and transport (t CO_2(eq))	454
GHG emissions from waste treatment (t CO_2(eq))	19
GHG emissions from landfills (t CO_2(eq))	17,413
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-2,422
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	
Total net GHG emissions (t CO_2(eq))	15,463
Bulky waste from households	
GHG emissions from waste collection and transport (t CO_2(eq))	27
GHG emissions from waste treatment (t CO_2(eq))	250
GHG emissions from landfills (t CO_2(eq))	12
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-2,957
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	
Total net GHG emissions (t CO_2(eq))	-2,666
TOTAL WITHOUT PROJECT SCENARIO GHG EMISSIONS (t CO_2(eq))	12,797

GHG emissions, avoided GHG emissions and Net GHG emissions (average 2020-2044), in t CO_2 (eq), for the different components of the waste management system in the baseline (without-project) scenario.

Analytical GHG Emission Calculations With project scenario

Mixed Waste from Households	
GHG emissions from waste collection and transport (t CO_2(eq))	362
GHG emissions from waste treatment (t CO_2(eq))	1,128
GHG emissions from landfills (t CO_2(eq))	1,745
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-23,519
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	-1,482
Total net GHG emissions (t CO_2(eq))	-21,766
Bulky waste from households	
GHG emissions from waste collection and transport (t CO_2(eq))	27
GHG emissions from waste treatment (t CO_2(eq))	250
GHG emissions from landfills (t CO_2(eq))	12
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-2,957
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	
Total net GHG emissions (t CO_2(eq))	-2,666
TOTAL WITH PROJECT SCENARIO GHG EMISSIONS (t CO_2(eq))	-24,432

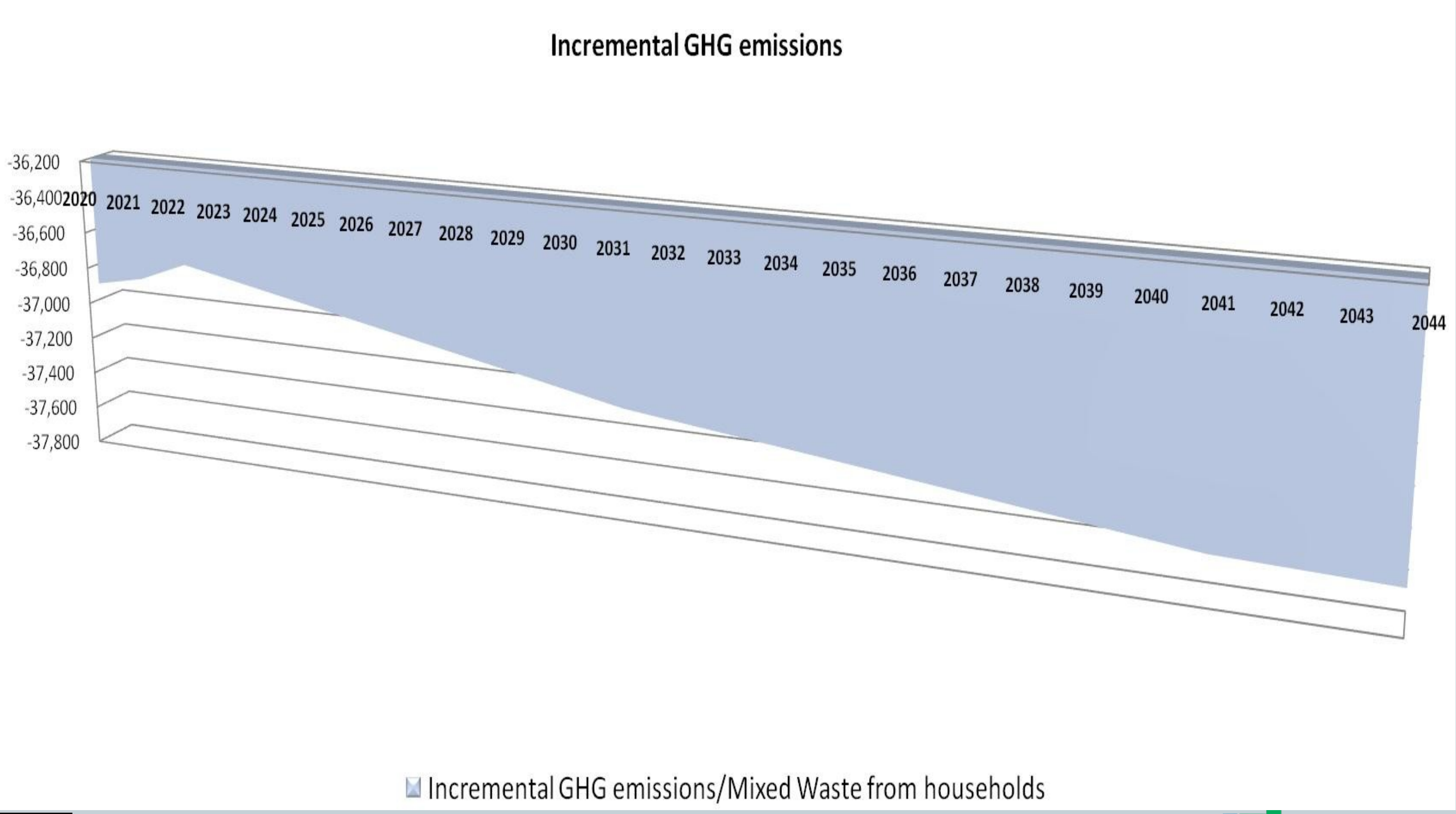
GHG emissions, avoided GHG emissions and Net GHG emissions (average 2020-2044), in t CO_2 (eq), for the different components of the waste management system in the with-project scenario (Sc4).

Analytical GHG Emission Calculations
Incremental Approach

Incremental GHG emissions can be calculated if we subtract the GHG emissions in with project scenario from GHG emissions without project scenario.

TOTAL INCREMENTAL GHG EMISSIONS (t CO_2(eq))	-37,230

Analytical GHG Emission Calculations
Incremental approach



Summarized results

➢ The quantification of GHG emissions for each examined scenario of the project and also for the without project scenario has been implemented taking into consideration the **Carbon Footprint Methodology.** The scenario that ranked as the better solution - Sc4 - had the best performance regarding GHG emissions.

➢ The **percentage of reduction in year 2044 in greenhouse gas (GHG) emissions** with the scenario of the implementation of the project, compared by year 2013 year, has been calculated to **301%**.

With Project Scenario	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2044**
Net GHG emissions, t CO_2-eq	12,039	9,909	-24,222	-24,224	-24,405	-24,527	-24,638	-24,678

Total net GHG emissions from 2013 to 2044, from the present project which have been calculated by Jasper's calculation model.

ADAPT 2CLIMA

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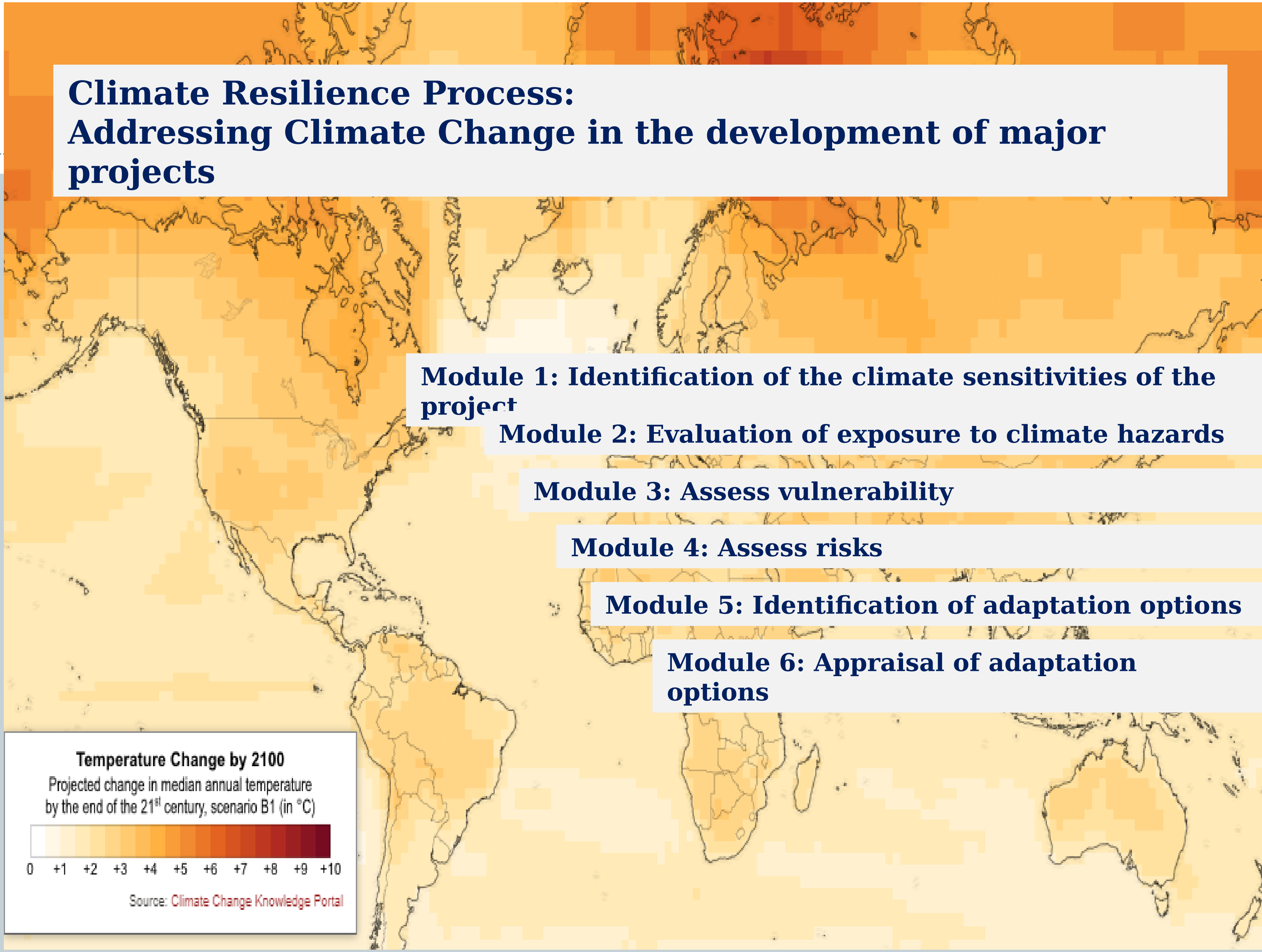
Climate Resilience Process:
Addressing Climate Change in the development of major projects



Module 1: Identification of the climate sensitivities of the project

Module 2: Evaluation of exposure to climate hazards

Module 3: Assess vulnerability

Module 4: Assess risks

Module 5: Identification of adaptation options

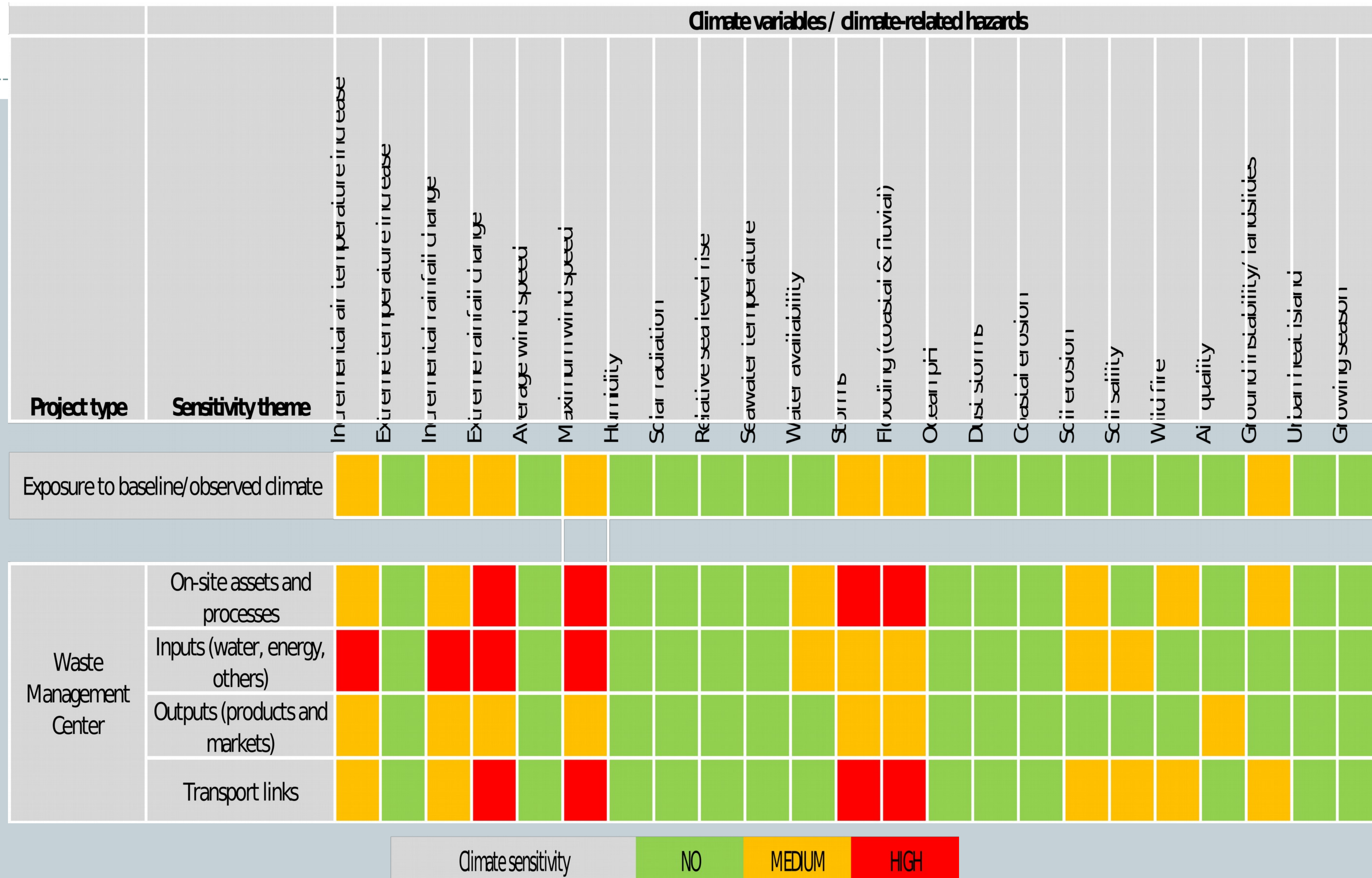
Module 6: Appraisal of adaptation options

Module 1: Identification of the climate sensitivities of the project

Project type	Sensitivity theme	Incremental air temperature increase	Extreme temperature increase	Incremental rainfall change	Extreme rainfall change	Average wind speed	Maximum wind speed	Humidity	Solar radiation	Relative sea level rise	Seawater temperature	Water availability	Storms	Flooding (coastal & fluvial)	Ocean pH	Dust storms	Coastal erosion	Soil erosion	Soil salinity	Wild fire	Air quality	Ground instability/ landslides	Urban heat island	Growing season
		Climate variables / climate-related hazards																						
Waste Management Center	On-site assets and processes	MEDIUM	HIGH	MEDIUM	HIGH	NO	HIGH	MEDIUM	MEDIUM	NO	NO	HIGH	HIGH	HIGH	NO	MEDIUM	NO	MEDIUM	NO	HIGH	NO	HIGH	NO	NO
	Inputs (water, energy, others)	HIGH	HIGH	HIGH	HIGH	NO	HIGH	MEDIUM	MEDIUM	NO	NO	HIGH	MEDIUM	MEDIUM	NO	NO	NO	MEDIUM	MEDIUM	MEDIUM	NO	NO	NO	NO
	Outputs (products and markets)	MEDIUM	HIGH	MEDIUM	MEDIUM	NO	MEDIUM	NO	MEDIUM	NO	NO	NO	MEDIUM	MEDIUM	NO	NO	NO	NO	NO	MEDIUM	MEDIUM	NO	NO	NO
	Transport links	MEDIUM	HIGH	MEDIUM	HIGH	NO	HIGH	MEDIUM	NO	NO	NO	NO	HIGH	HIGH	NO	MEDIUM	NO	MEDIUM	MEDIUM	HIGH	NO	HIGH	NO	NO

Climate sensitivity	NO	MEDIUM	HIGH

Module 2: Assess exposure to baseline/observed climate



Module 2: Assess exposure to future climate

Project type	Sensitivity theme	Incremental air temperature increase	Extreme temperature increase	Incremental rainfall change	Extreme rainfall change	Average wind speed	Maximum wind speed	Humidity	Solar radiation	Relative sea level rise	Seawater temperature	Water availability	Storms	Flooding (coastal & fluvial)	Ocean pH	Dust storms	Coastal erosion	Soil erosion	Soil salinity	Wild fire	Air quality	Ground instability/ landslides	Urban heat island	Growing season
Exposure to future climate		MEDIUM	MEDIUM	MEDIUM	HIGH	NO	MEDIUM	MEDIUM	MEDIUM	NO	NO	MEDIUM	HIGH	HIGH	NO	NO	NO	NO	NO	NO	NO	MEDIUM	NO	NO
Waste Management Center	On-site assets and processes	MEDIUM	HIGH	MEDIUM	HIGH	NO	HIGH	MEDIUM	MEDIUM	NO	NO	MEDIUM	HIGH	HIGH	NO	NO	NO	MEDIUM	NO	MEDIUM	NO	MEDIUM	NO	NO
	Inputs (water, energy, others)	HIGH	HIGH	HIGH	HIGH	NO	HIGH	MEDIUM	MEDIUM	NO	NO	MEDIUM	MEDIUM	MEDIUM	NO	NO	NO	MEDIUM	MEDIUM	NO	NO	NO	NO	NO
	Outputs (products and markets)	MEDIUM	HIGH	MEDIUM	MEDIUM	NO	MEDIUM	NO	MEDIUM	NO	NO	NO	MEDIUM	MEDIUM	NO	NO	NO	NO	NO	NO	MEDIUM	NO	NO	NO
	Transport links	MEDIUM	HIGH	MEDIUM	HIGH	NO	HIGH	NO	NO	NO	NO	NO	HIGH	HIGH	NO	NO	NO	MEDIUM	MEDIUM	MEDIUM	NO	MEDIUM	NO	NO

Climate sensitivity	NO	MEDIUM	HIGH

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Baseline Climate

Vulnerability = Sensitivity x Exposure

Sensitivity	Exposure: No	Medium	High
No	2,5,7,8,9,10,14,15,16,18,20,22,23		
Medium	11,17,19	1,3,21	4,6
High		12,13	

Vulnerability level

(green)	No
(orange)	Medium
(red)	High

Future Climate

Sensitivity	Exposure: No	Medium	High
No	5,9,10,14,15,16,18,20,22,23		
Medium	17,19	1,3,7,8,11,21	
High		2,6	4,12,13

Module 4: Assess Risk

		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Rare				2, 21	
	Unlikely			6, 7, 8, 17	4, 12, 13	
	Moderate			1, 11	3	
	Likely			19		
	Almost certain					

Legend:

Risk level
Low
Medium
High
Extreme

Risk = Likelihood x Impact

Probability			Severity		
Rare	Highly unlikely to occur	0-5%	I	Insignificant	No relevant effect on social welfare, even without remedial actions
Unlikely	Unlikely to occur	5-20%	II	Minor	Minor loss of the social welfare generated by the project, minimally affecting the project long run effects. However, remedial or corrective actions needed
Moderate	As likely to occur as not	20-50%	III	Moderate	Social welfare loss generated by the project, mostly financial damage, even in the medium-long run. Remedial actions may correct the problem
Likely	Likely to occur	50-80%	IV	Critical	High social welfare loss generated by the project: the occurrence of the risk causes a loss of the primary functions of the project. Remedial actions, even large in scope, are not enough to avoid serious damage
Almost certain	Very likely to occur	80-95%	V	Catastrophic	Project failure that may result in serious or even total loss of the project functions. Main project effects in the medium-long term do not materialize

structural and non-structural options

improved monitoring or emergency response programmes, staff training and skills transfer activities, development of strategic or corporate climate risk assessment frameworks, financial solutions

modifications to the design or specification of physical assets and infrastructure, or the adoption of alternative or improved solutions:

Temperature changes Biological process technology options

Rainfall change Flood protection works adaptation

Wild fires Extensive fire fighting networks and emergency plans

Documentation used for the implementation of the project

✓ Guide to Cost-Benefit Analysis of Investment Projects, Economic Appraisal tool for Cohesion Policy 2014-2020, European Commission, Directorate-General for Regional and Urban policy, December 2014.

✓ Jaspers Staff Working Paper on Mechanical-Biological Treatment Plants

✓ Jaspers Staff Working Paper on Public Consultation on Waste Management Projects

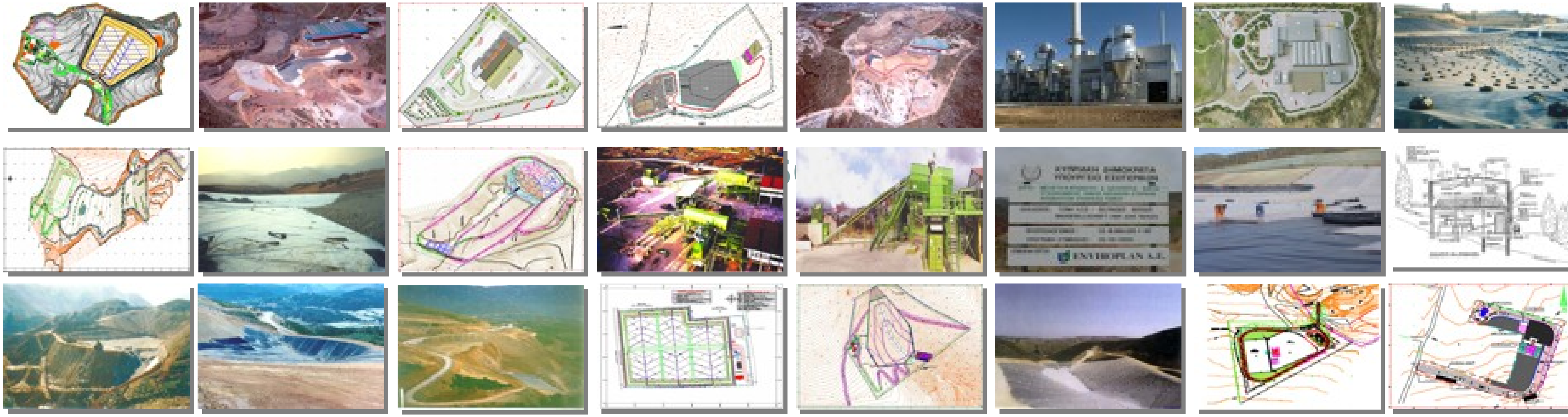
✓ JASPERS Staff Working Papers, Calculation of GHG Emissions in Waste and Waste-to-Energy Projects, Dorothee Teichmann & Christian Schempp, November 2013 (revised version).

✓ EIB Induced GHG Footprint, The carbon footprint of projects financed by the Bank, Methodologies for the Assessment of Project GHG emissions and Emissions Variations, Version 10.1

✓ EC/DGENV/AEA Study 2001 (Waste Management Options and Climate Change, 2001)

What is JASPERS?

- is managed by the European Investment Bank (EIB) and co-sponsored by the European Commission (EC) and the European Bank for Reconstruction and Development (EBRD)
- provides technical expertise for any stage of the project cycle, covering technical, economic and financial questions
- geared to provide advice, ensuring coordination, developing and reviewing project structures, removing bottlenecks, filling gaps and identifying problem in project preparation, to help improve the quality of the major projects to be submitted for grant financing



Thank you for your attention

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