

Part 2 Background and Technical Information: Closing the Circularity Gaps for a Manual Waste Sorting Facility that provides feedstock to a pyrolysis unit

1.0 Situation Analysis

Global Petrochemicals, along with other industry players in the plastics value chain, is interested to work with local governments and NGO's to support better management of all waste materials through collection, sorting, and recycling systems, especially in areas where waste management infrastructure is absent and where household waste leakage into the environment is most at risk. Global Petrochemicals are supporting a community collection and sorting project in Bali, Indonesia as a critical demonstration facility that can be subsequently replicated across large areas of southeast Asia to enable a significant contribution to ending plastic waste leakage and promoting circularity. Thus, ideas to ensure its success are welcome by all project partners.

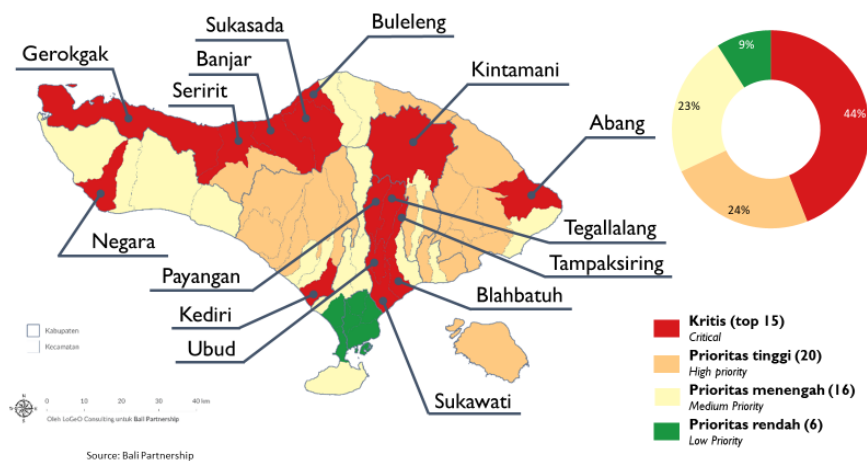
Global petrochemical seeks to source some of the waste feedstock to produce their pyoil from this facility. The success of the pyoil processing unit is dependent upon the ability to source this feedstock at somewhat improved volume, quality, and cost than what has been achieved so far.

2.0 Landscape Analysis

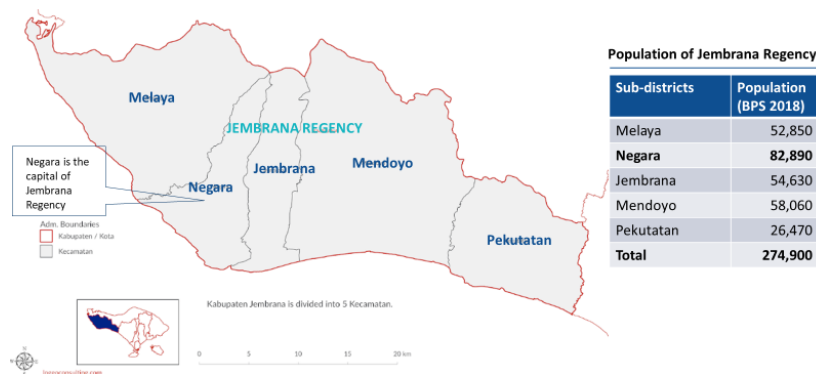
Indonesia is an archipelago in southeast Asia consisting of >17,000 islands. It is a populous relatively low-income country with one of the highest rates of leakage of plastic waste into the ocean associated with gravely inadequate waste management infrastructure. Bali is an island province in Indonesia lying just to the west of the most populous island in Indonesia, Java. Bali is well-known for its premium tourism sector and unique cultural history. It is estimated that 52% of the waste generated on Bali is mismanaged in term of being burned, buried, or illegally dumped and that 33,000 tons of plastic waste waste leak from Bali into the ocean each year.

Jembrana (pop 275k) is a regency in Bali province on the west side of the island. Negara (pop 83k) is the largest sub-district of Jembrana regency and is among the top 15 such sub-districts across Bali judged to have the greatest potential for plastic waste leakage reduction. Thus, the subject waste collection and sortation project, intended to be a model for the region, was sited here.

15 prioritized sub-districts in Bali on basis of potential to reduce plastic waste leakage



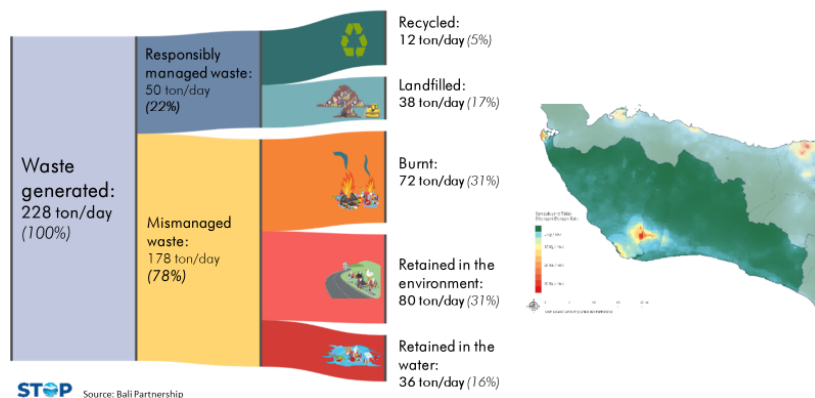
JEMBRANA REGENCY IS BROKEN INTO FIVE SUB-DISTRICTS – MELAYA, NEGARA, JEMBRANA, MENDOYO, AND PEKUTATAN



In addition, Jembrana lies along the main road connecting Bali's capital Denpasar to the nearest large industrial center, Surabaya in East Java. As a result, Negara has some industrial activity and enables better logistics of sorted waste to recycling markets. Across Jembrana, about half of the workforce is associated with tourism, about one quarter are associated with agriculture, and about one quarter are associated with manufacturing.

It is estimated that about 5% of Jembrana's total waste is recycled today and about 78% is mismanaged and 16% is eventually leaked into the ocean (considering only the plastics part of the waste stream, those percentages are 16%, 67%, and 14%). As a result of a lack of alternatives, waste is often dumped into ravines and areas like those shown below, from which they quickly find their way into local waterways.

78% OF JEMBRANA REGENCY'S WASTE IS MISMANAGED WITH 16% LEAKING INTO WATERWAYS



JEMBRANA REGENCY PLASTIC WASTE FLOW



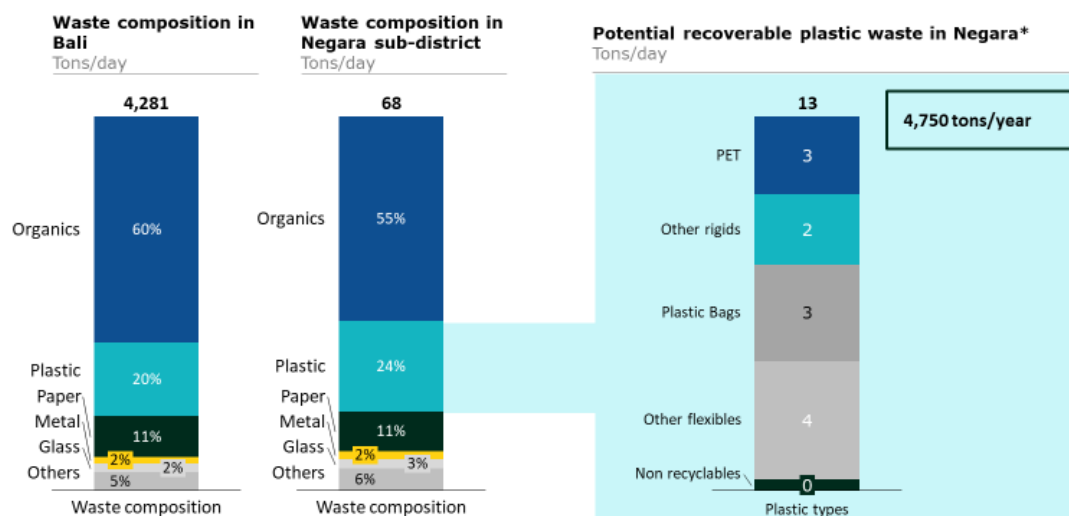
Plastic waste hotspots in negara



STOP Source: Scoping studies 2018

The waste composition in Negara is indicated below. Organic waste is the main component, followed by plastic, then paper, metal, glass, and other. The total plastic waste available in Negara is about 4750 ton/yr. This is composed of polyethylene terephthalate (PET) rigid containers (eg water/soda bottles), other rigid bottles (eg High-Density Polyethylene (HDPE) milk/juice jugs, detergent bottles), plastic bags (eg Low-Density Polyethylene (LDPE) grocery/shopping bags), Other Flexibles (eg, shrink wrap, sandwich bags, food wrappers, food pouches), and then other less recyclable fractions (which may include thermosets, rubber etc).

WASTE COMPOSITION IN NEGARA AND BALI ARE DIFFERENT FROM A TYPICAL INDONESIAN CITY WITH >30% OF POTENTIALLY RECYCLABLE MATERIALS

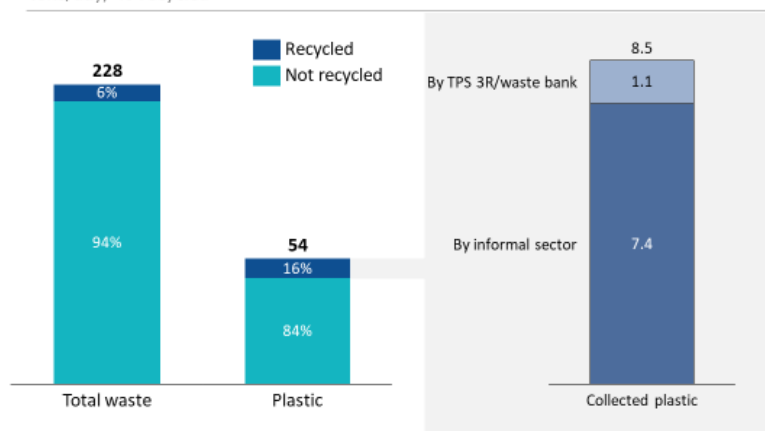


STOP *Based on Muncar waste characterization study, with an assumption that only 80% of total plastics are recoverable, 20% collected but non recoverable because too small format or mixed with organic/residuals

The recycling that occurred in Jembrana prior to this project was accomplished primarily by the “informal sector”. These are sometimes called trash-pickers/waste-pickers who recover the valuable waste they can find and sell it to a network of aggregators. Such collection tends to be inefficient and cherry-pick only the highest value components of the waste stream – metals, PET bottles, HDPE bottles, and leaves the majority uncollected. These informal workers and aggregators were able to find roles in the subject community collection and sorting system with much safer working conditions and greater security of livelihood.

JEMBRANA IS HOME OF A NETWORK OF INFORMAL SECTOR HARVESTING 12.7 TONS PER DAY OF HIGH VALUE RECYCLABLES INCLUDING 8.5 TONS OF PLASTIC PER DAY

Waste recycling rate and breakdown per collection player in Jembrana regency
Tons/day, % recycled



Informal waste collection

- 17 junkshops including middlemen and large aggregators handling a cumulated total of ~17.68 t/day
- 15 waste banks but probably <10 actually active (handling ~ 0.54 t/day)
- 61 school waste banks (handling ~ 0.15 t/day)
- >15 waste pickers at the landfill (scavenging in average 30kg of plastic per week)
- Community composting facility (processing ~3 t/day)
- 1 active TPS 3R handling and sorting ~0.50 t/day (including organics).



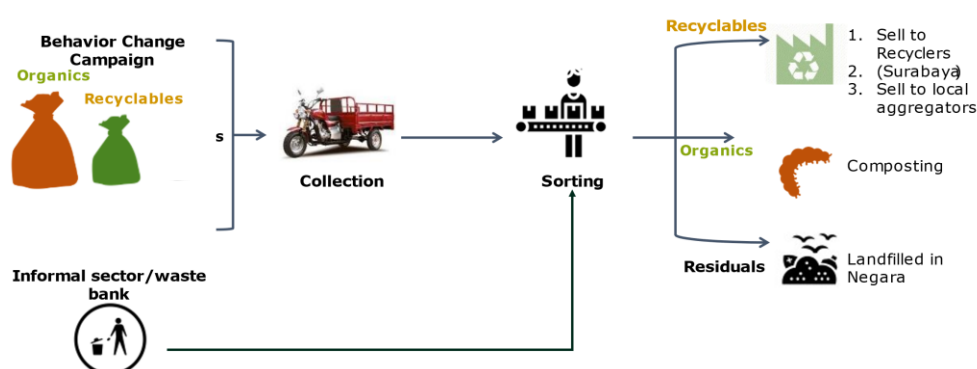
Source: Team analysis based on interviews and field data.

3.0 Jembrana – New Waste Management System Implementation

The system that was implemented in Jembrana requires participating households to segregate their waste into two different kinds of bags designated by color:

- Organic – food waste, garden waste (red bags)
- Inorganic – cardboard/paper, plastics, metal, glass (green bags)

Integrated waste system to eliminate the leakage



4.0 Household Collection

The household waste is collected twice each week in motorized tricycles with large cargo beds. Each of these vehicles can hold about 290kg of waste. The vehicles were selected to be small and manoeuvrable to traverse the narrow lanes necessary to access most households in the area.

Collection operations run 6 days per week with 20 drivers on one day shift. Routes are optimized to cover the area on a three-day cycle such that for each participating household, both organic and inorganic waste is collected twice/week.

Collection operation



Factory general specification of tricycle :

1. Capacity : 650 Kg.
2. Dimensions : 3360 x 1330 x 1350 mm.
3. Back/container Size : 1850 x 1330 x 860 mm.
4. Empty Weight: 360 Kg.
5. Max Power: 10/10.000 KW/rpm.
6. Max Torsion: 13.6/9333 N.m/rpm.



COLLECTION FREQUENCY

Urban Village > 2x/week > Organic and Inorganic

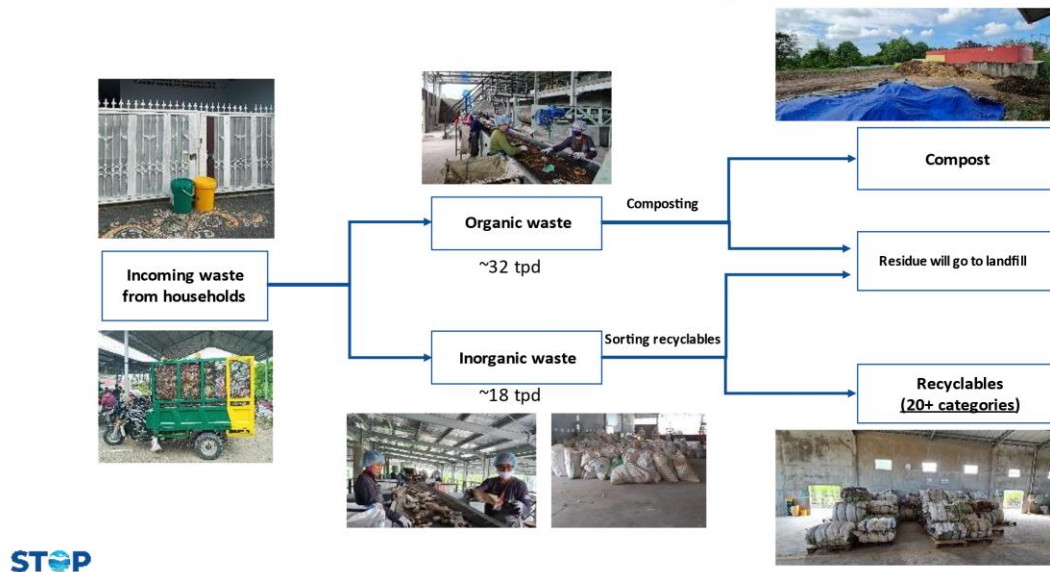
5.0 Waste Sorting Facility

A waste sorting facility was built inside the pre-existing landfill site. The sorting facility operates 6 days/week on one day-shift employing 48 workers. The facility processes both the organic and inorganic waste in different areas.

Community Manual Sorting Facility



Waste Processing Flow at TPST



The organic waste is transported to the sorting facility (~32 ton/day) where it is first weighed and then unloaded at one end of the facility. Then, it is fed onto a moving belt. On the belt workers remove any materials that are not organic food, garden, or otherwise compostable waste. The cleaned organic waste is shredded and then spread onto the composting area and covered for 2-3 months. After that time, the compost is collected, screened, and bagged for sale. Any materials removed from the organic waste line that are recyclable (eg cans, bottles) are brought to the inorganic waste line into the appropriate recycling stream. Contaminants removed from the organic waste stream that are non-recyclable go to the residual stream that is landfilled.

Organic Processing Flow at TPST



MECHANICAL EQUIPMENT AT TPST JEMBRANA

- Composting Area



Grinder



Siever



Front Loader

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The inorganic waste is delivered to the sorting facility (~18 ton/day) where it is first weighed and then unloaded in an open area in the facility. The inorganic waste is loaded onto a moving belt where workers sort the material into categories of cardboard paper, rigid plastics, flexible plastics, aluminum, other metals, and glass. Rigid plastics undergo a secondary manual sortation into PET, polyethylene terephthalate/#1), HDPE (high-density polyethylene/#2, PP (polypropylene/#5), and other. After secondary sortation, the PET, HDPE, PP streams are baled and trucked to either recyclers in Bali and East Java or sometimes to aggregators (“junk shops”) who also buy from other sources and sell on to recyclers.

Inorganic Waste Processing Flow at TPST



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Mechanical equipment

- Inorganic material sorting, handling



Conveyor



Baler



Skid Loader

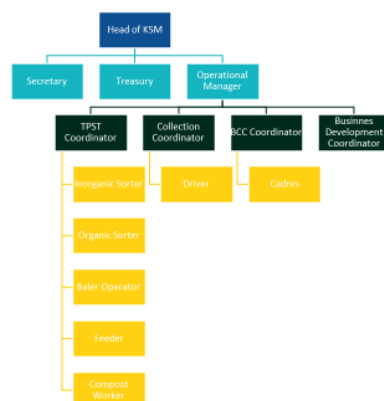
The flexible plastic waste is also baled and currently purchased by junk shops (local waste aggregators) to be recycled into relatively low value applications. The intent of this project is to use this flexible plastic waste stream as a feedstock for a new pyrolysis facility being commissioned in Surabaya, East Java. Improvements in the volume, quality, and/or cost of this flexible plastic waste stream are needed to make project viable in addition to the design of the pyroil purification unit. Contaminants in the flexible plastic waste stream that will prove problematic for pyrolysis are primarily PVC and metals, and secondarily paper/cardboard and PET.



The non-recyclable material removed from the inorganic stream goes to the residuals stream which is landfilled.

The general roles associated with each step of this highly manual collection, sorting, and processing waste management process are outlined below.

ORGANIZATIONAL CHART



6.0 Behavioral, Education, and Engagement Program

The waste collection program requires a significant behavioral and education program among the population to effectively convey the importance of waste management, of household waste segregation, and especially how to segregate waste and comply with the program, and the value of the program to the community, environment, and livelihoods. The program was rolled out village-by-village and involved local regulatory changes, engagement with community leaders, religious leaders (mostly Hindu and Muslim communities), community meetings, school presentations and curriculum development, door-to-door communications by a local women's group, media campaigns (billboards, flyers, banners, social media), and supporting programs like community beach clean-ups and a tricycle parade of the collection vehicles to build awareness and community pride.

Local government and community engagement activities



Engaging with stakeholders to support and understand about the program, also building institutions for the operational supervision of the waste management system (TPST)

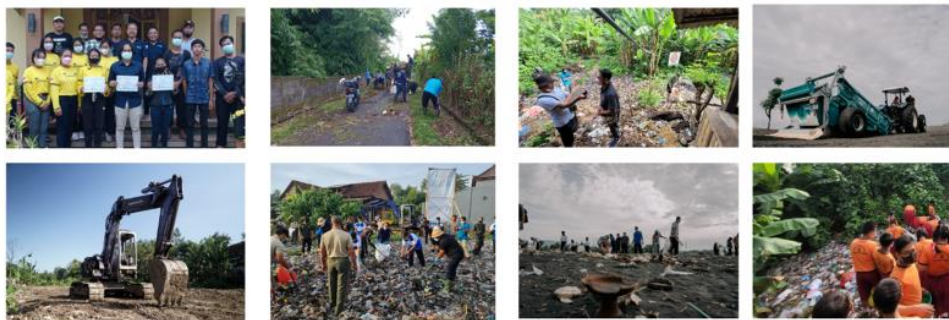


Village socialization, cadre training, door to door socialization for collecting data and educate the household, bin distribution, and monitoring

ACTION PLAN : DIRECT COMMUNICATION

Identify the target audience	Define the key message	Communicate the message	Monitor the impact																
In-person direct communication		In-direct communication																	
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Beach clean-up activities



7.0 Household Participation

Participation in the program by households is voluntary. The cost is 25000 IDR per month (~\$1.70/mo) which is ~1% of local avg income. As a benchmark, on a global basis, waste management services are typically delivered at a cost of about 2% of average local income. Indonesian law does not currently allow compulsory municipal waste pick-up and there have been political obstacles to instituting such requirements (linked to cost). Currently, household participation in the program is less than desired. The volume throughput and operational/capex efficiency of the operation is strongly dependent on the proportion of household participation

Waste Sorting Facility Building Layout

