Comprehensive Evaluation Approach of Current Situation in Kupang Municipality, NTT Province, Indonesia In order to achieve CO2e target in regional level Based on Kupang IO Table

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Abstract

Indonesia target to reducing GHG emission between 26-41% (0.767-1.244) Gton CO_2e from base year 2010 to target year 2020. Kupang City are having two agenda is meet the energy needs RET system such as PV, Wind and biomass and preserves the environment. Today the only source of electricity power is diesel operated (DPP) it potentially pollute the air, land, water and noise. Other pollutants are wastes from kitchen, agriculture, and livestock. The pollutants in the form of CO_2, CH_4, N_2O, NOx, SOx, COD, TP and TN. Research focused on reducing GHG emission such as CO_2 CH_4 and N_2O. Research started from introducing current waste management, develop Kupang IO table and counting CO_2e at Kupang in 2010 based on IO table as well as introducing pollutant sectors and possibility integrating technology of waste and pollutant treatment to substitute RETs as sectors that reduce GHG emission. As result CO_2e emitted into nature by activities economy without proper treatment in Kupang 2010 are 0.069 Giga Ton or 9% for GWP 100 years and 0.073 Giga ton or around 9.479% for GWP 10 years from self effort of national government target by year 2020 as well as introducing current and future framework which should be implemented ahead as proposal to Kupang government to build sectors that reduce GHG emission

1. Background

The Indonesian government continues to make efforts to reduce GHG emission up to 41% with an aim of around 1.244 Gton CO_2e in 2020 and in order to achieve this they need to involve stake holders from regional to national levels to achieve this target. The program is being organized by the Indonesian government under the Local Action Plan for GHG emission reduction usually called *RAD-GRK.* The program provides directions for local governments to carry out multi-sector GHG emission reduction efforts directly and indirectly through specific efforts considering local characteristics, potential, and authority that must be integrated into a local development plan. Some provinces and cities have been intensively involved in the program; however Kupang City, East Nusa Tenggara (NTT) province has never participated in the RAD-GRK program. This is due to shortage of human resource as well as, lack of data availability and local government support including technical, institutional, financial, environmental and social economic factors.

The environment is necessary for life and work, and economic development of a region is dependent on its socio economic situation including agriculture, livestock, industry, private sector and public sector aside from considering the negative impact of GHG emitted in the form of CO_2, NOx, SOx, CH_4, N_2O during production processes and without proper policy to control it particularly in developing cities. It is necessary to consider how pollutant emission from production activities is determined in proportion to production which is known as *assuming linearity*.

As a consequence of kept an economic increase significantly, very often appear a variety of environmental issues such as uncontrolled of accumulation of rubbish and not manageable especially household wastes in almost big cities in Indonesia. As we know increasing volumes of household waste as a result of industrial development can lead to a negative impact on the environment as found in the larger cities of Jakarta, Bandung, Surabaya, Semarang, Kupang, and other regions in Indonesia, while an increased population will also create a higher stream of household waste generation. The accumulation of industry and population in urban areas in Indonesia such as Kupang city shows that waste generation will increase rapidly, and create serious problems now, and in the future if industrialization is concentrated in a few areas, and population level is not reduced. Waste management including household waste will not be able to be implemented instantly, but needs to be assessed comprehensively. Because of the political and economic conditions in Indonesia, the creation of such a program is necessarily an evolutionary process. Ideally, the Indonesian government should implement many of the steps of the process concurrently to deal with this matter. However, this is rarely possible even under optimum conditions described by *Law No.18 year 2008 regarding waste management* (issued by Indonesian government), as there was no national waste policy up to 2007.

Many large cities in Indonesia are suffering from severe problems caused by disorderly waste management handling. The general method currently practiced in waste management throughout Indonesia is collect-transport-dispose. The municipal methods of transporting household waste from designated collection points to a location for its final dumping, is usually inadequate as most cities have no other alternative if their existing landfill is full or near capacity. If the existing landfills are not adequately prepared and professionally operated, then problems with landfill will always appear. There are not enough collection-transportation vehicles available. The transport vehicles are very often uncovered "old-timers" where the waste has to be deposited manually above the heads of the workers, and these open vehicles sometimes lose part of their load during transit to the dumping area. There is generally too much time lost during transport due to traffic congestion and a transport vehicle can take hours to cover a few kilometres from the city to the landfill meaning that most collection vehicles can do only 2-3 trips a day. Therefore, the Indonesian government should provide more pickup opportunities and endeavour to encourage residents to discard rubbish in the correct place and enable transport to travel to landfill sites more efficiently in both cities and regional districts (Damanhuri, 2010).

Law no. 18 of 2008 is expected to bring major new changes in waste management including household waste, and will serve as an umbrella for solid waste management in Indonesia. Recently, the Indonesian government has undertaken waste management according to several principles, including responsibility, continuity, benefits, equity, consciousness, commonness, safety, security and economic value. These are aimed to improve the health of the community and environmental quality, as well as convert waste into resources i.e. as biomass resource. Indonesia has followed a common rule that waste collection is the responsibility of acity or district (borough council) in their capacity as Waste Collection Authorities (WCAs) (Waite, 1995).

Basically, waste collection systems in Kupang city are lacking because it does not consider gases produced from waste which is emitted to nature directly without any proper treatment, and it will increase the amount of GHG in the future.

2. The assumption of Kupang City‘s ambition for maintaining a sustainable environment in the future

Kupang is the capital city of NTT Province and has an aim to be referred to as a model environmental city and for example nowadays many programs organized by the city government deal with environmental sustainability include programs such as *Kupang Green and Clean*, *District Race Clean* and *Competition of Offices Concerned for the Environment*. This is proof that Kupang city is dedicated to promoting programs to reduce GHG emission in society while promoting prosperity. On one occasion the mayor of Kupang stated "*we need to change our attitude and reconsider conventional ways of living as part of innovative environment solution*". This indicates that in the field of social activities, the city needs to improve eco-conscious urban development through the introduction and promotion of environmental efforts in the community.

As part of environmental promotion, we assume that the city situation needs comprehensive analysis to ascertain in detail the amount of GHG emission emitted to nature by sectors activity in Kupang during 2010. This information will be useful for local government to realise its goal of reducing CO_2 emissions from base year 2010 and act as a core facility dedicated to vitalization of local economies through commitment to carbon reduction projects in Indonesian society and involvement in the RAD-GRK program organized by the national government.

3. Input output table and it usefulness for prediction of CO_2 emission

Input output (IO) analysis was introduced by Dr. Leontief in the late 1930s and has been useful for *inter-industry analysis* and the fundamental purpose of the IO framework to analyse the independence of industries better known as sectors in economics. In order to grasp the economic effects of increasing CO_2 emission from a logical stand point, we need to examine historically the impact of industry infrastructure development in periods of high economic growth by use of an input output model. In general energy IO typically determines the total amount of energy required to deliver a product to final demand, both directly as the energy consumed by an industry's production process and indirectly as the energy embodied in that industry's inputs therefore a more comprehensive examination of a wide variety of factors associated with a spending program, such as impacts on employment, pollution, or capital expenditures should be carefully considered. Further analysis can be done by extending the IO table as necessary. In the case of Kupang, we use a *single region IO model* for city level in order to get a specific input coefficient for the table known as *input coefficient matrix* to figure out the full impact of an exogenous increase in final demand on all industries and describe the coefficient value of intermediate inputs required in the production of one unit of output of the industry. The CO_2 emission of each industry is greatly influenced by the pollutant coefficient of each industry which is done through the *Leontief inverse matrix*. Afterward analysis of environmental problems by extending the IO table can predict how much CO_2 emission has been emitted as a result of social economic activities.

4. Building a Kupang IO table

There is no Kupang IO table; the only available one is the IO table of NTT province for the year 2006. It was a challenge to produce an IO table at a capital city level based on an IO table at province level. We assume that 80% of activities identified in the IO table of NTT province occur in the capital city (Kupang city) and that 90% of technology in each sector or industry are present in Kupang due to its rapid economic development in comparison with other areas in NTT province. This assumption does not apply to other large cities outside NTT province. The following steps were taken to construct the IO table.

First, the Kupang statistic book year 2010 was used as raw data to get the real value of each sector in order to determine how many sectors will comprise the Kupang IO table and at this point we must *consider carefully how many industries* should be included because this will influence the emission coefficient for each sector after adjustment from the Province IO table to City IO table or changing the *competitive import type to a non-competitive import type (domestic type)* by considering the number of workers in these sectors, The land area in use for running the sectors mentioned, technology used, clean water and electricity usage, the use of chemicals as raw materials, sector by ownership type (public or private).

Table 1: Adjustment from NTT Province IO table to Kupang City IO table

No	**Kupang Sectors classification**	**NTT Sectors (Adjust to Kupang Sectors)**
01	Paddy rice	Paddy rice
02	Corns	Corns
03	Nuts	Nuts
04	Tubers	Tubers
05	Vegetables & Fruits	Vegetables & Fruits
06	Other Crops	Other Crops (6), Cashew(7), Tobacco(9), Coffee& Cocoa(10), Vanillin(11), Clove(12), Cotton(13), Other Plantations(14), Other Agriculture& the services(15)
07	Coconut	Coconut(8), Timber Forest products(19), Other Forest(20)
08	Livestock	Livestock(16)
09	Slaughterhouses	Slaughterhouses(17)
10	Poultry	Poultry(18)
11	Fisheries	Fisheries(21)
12	Food & beverage industry	Foods & beverage industry(23), Rice Milling industry(25), Food industry (26), Other Food industry(28), Oils & fats industry(24), Sugar industry(27)
13	Textile & leather industry	Textile & leather industry(30), Cigarette& Tobacco industry(29)
14	Industrial products of wood & rattan	Industrial products of wood & rattan(31), Paper& Printing industry(32)
15	Fertilizer, chemical & refining industry	Fertilizer, chemical & refining industry(33), Cement(&similar) industry(34), Mining& Quarrying(22), other Industry(37)
16	Industry goods from metal	Industry goods from metal(35), Transportation, machinery& other equipment Industry(36)
17	Electricity & Water supply	Electricity & Water supply(38)
18	Buildings	Buildings(39), Real estate& business services(49)
19	Trades	Trades(40), Hotels(41), Restaurants(42)
20	Road & Rail transportation	Road & Rail transportation(43)
21	Sea & river transportation	Sea & river transportation(44)

22	Air freight	Air freight(45)
23	Transportation support services	Transportation support services(46)
24	Communications	Communications(47), Social services(52), Recreation & Entertainment services(53)
25	Banks & other financial institutions	Banks & the financial institutions(48)
26	Government	Government(50), Other Government services(51)
27	Goods & service not include elsewhere	Individual & other Household services(54), Goods& service not include elsewhere(55)

Within the sector column, there are 27 sectors identified in the city of Kupang based on the 2010 Kupang statistical year book. Whereas the NTT column contained 55 sectors into 27 sectors adjusted according to the number of Kupang sectors. This approach assumes that 90% of activities in NTT sectors were conducted in Kupang City due to its position as the Capital City of NTT province. The value of each sector for the IO tables is shown as Table 1.

Table 2: IO table model of NTT (province) and Kupang (city) on transaction valued at producers' prices

		Buying sectors 1 2 n	Final demand Private.	Public.	Invest.	Exports	Imports	Total Outputs
Selling Sectors	1	z_{11} z_{12} z_{1n}	c_1	i_1	g_1	e_1	$-m_1$	x_1
	2	z_{21} z_{22} z_{2n}	c_2	i_2	g_2	e_2	$-m_2$	x_2
	n	z_{31} z_{32} z_{3n}	c_n	i_n	g_n	e_n	$-m_n$	x_n
Value added		l_1 l_2 l_n	0	0	0	0		L
		n_1 n_2 n_n	0	0	0	0		N
Total inputs		x_1 x_2 x_n	C	I	G	E	-M	X

The component parts of the final demand vector represent private consumption (g_i) and exports (e_i). There are often grouped into domestic final demand:

$$(C + I + G) \tag{1}$$

And foreign final demand (exports, E). The final demand vectors for the two sectors:

$$f_1 = c_1 + i_1 + g_1 + e_1 \text{ And} \tag{2}$$

$$f_2 = c_2 + i_2 + g_2 + e_2 \tag{3}$$

Whereas, the components parts of the payments sectors are sectors 1 and 2 for employee compensation (labour service, l_i) and for all other value-added items (n_i) e.g. government services (taxes), capital (interest payments), land (rental payments), entrepreneurship (profit), and so on [8]. Total value-added payments are for two sectors [5], [8]:

$v_1 = l_1 + n_1$ And $v_2 = l_2 + n_2$ (4)

We can estimate the *total value of gross output* by summing down the total output column:

$X = x_1 + x_2 + x_n + L + N + M$ or (5)

Summing across the total output row:

$X = x_1 + x_2 + x_n + C + I + G + E$ (6)

We can also find value of *gross domestic income* and *gross domestic regional product (GDRP)* of Kupang city by using the formula:

$L + N = C + I + G + (E - M)$ (7)

Where $L + N$ is *gross domestic income* and $C + I + G + (E - M)$ is *GDRP*

As for the value of each sector in the Kupang IO table, we need to calculate the input coefficient (a_{ij}) of each sector in the NTT IO table *by making a diagonal matrix* of the table, which is the amount of the diagonal of the matrix, *and represents the value of the total output of each sector.* The formula used divides each element in the intermediate transaction matrix (z_{ij}) by the total of each sector and are shown in the column total ($\sum X_j$). So we can get the input coefficient from each sector (production sectors) which is indicated in table II as follows:

$$aij = \frac{z_{ij}}{\sum x_j} \quad (8)$$

$$\begin{matrix} a_{11} & a_{12} & a_{1n} \\ a_{21} & a_{22} & a_{2n} \\ a_{31} & a_{32} & a_{3n} \end{matrix} \quad (9)$$

Finally we got the input coefficient of 27 sectors from the NTT IO table, and used the same formula to get the value of each sector of the Kupang IO table by dividing each coefficient (a_{ij}) from the NTT IO table with total output or total production of Kupang IO table in order to create an original IO table for Kupang city.

Table III: Supply of product for Kupang IO table (Unit: million Rupiah)

Total intermediate outputs (consumers)	Total exports	Total Final demands	Total imports	Total outputs (products)
29659386.5	0	308774.745	0	5155000.01
3280880.66	1626786.53	2861159.58	0	3189000
897661.507	0	1038843.29	-1610783.4	1144999.99
7231835.73	1189143.46	2493343.39	0	2995000
90972646.2	8053.09744	5333425.96	-2335113.2	8475299.99
33898786.7	459955.722	508785.121	-211648.94	700000
38291391.5	62363.7588	-416472.32	-825324.68	414000

27594374.2	68646193	109638197	0	120200300
17321824.2	0	-59942944	-87835096	68691002.2
35113198.3	2378610.17	11885345.3	0	13375675
21760154.9	166621092	422584479	0	451519000
167545713	5941671.37	-13896294	-260176116	44996789.9
40417052	143979.028	-105796.3	-73241555	30908000.2
37234295	13088389.2	-77780533	-137690351	30569999.5
139891991	17747462.9	-54889665	-182983109	92518969.8
12209569.7	6074155.01	-52038527	-375583122	28825998.4
10459669.3	0	88388007	0	118044746
255748327	0	404836716	0	592126280
176586923	209819455	984629379	-1070317.1	1340501980
66141607.6	28680607.1	158124685	-22857.58	221693740
15866468.5	11803557.4	61958770.2	0	89294260
3352743.31	10115624.8	37459559.4	-1475603	51711110.9
14900086.9	13978477.4	64414343.6	0	101638680
130719736	637977.67	248912990	-3058.2463	419189610
86948540.3	844638.882	58343551.2	-1187.064	174615721
169462782	0	732258207	0	871750800
32860447	15625.5581	158990073	0	181301810
Total: 1666368092	*Total: 559883819*	*Total: 3295898404*	*Total: -1.125E+09*	*Total: 5065547773*

Table IV: Input of specific products & the profit of Kupang IO table (Million Rupiah)

Total intermediate inputs	**Wages & Salaries**	**Business surplus**	**Indirect taxes**	**Gross Value Added (GDRP each sector)**	**Total inputs (products)**
946344	1039782	3100013	22269	4208656	5155000
325067	807065	2014891	12858	2863933	3189000
225429	169157	727548	18689	919571	1145000
376445	585448	1970576	37533	2618555	2995000
771014	1778512	5877764	33267	7704286	8475300
125308	92362	467024	4800	574692	700000
56444	87139	261517	882	357556	414000
35522291	22192334	58769447	1288742	84678009	120200300
45632946	4030201	18506442	456952	23058054	68691000
5752515	2777679	4660202	64184	7623160	13375675
85881773	65547485	281985870	3618958	365637227	451519000
34523307	4278991	5940606	129366	10473483	44996790
11084683	7138127	12390665	83078	19823317	30908000

20870352	2113630	7019189	136568	9699648	30570000
33613911	17654901	35546046	1352506	58905059	92518970
17975901	3683895	5690772	838478	10850099	28826000
50241418	14500063	28522748	978072	67803329	118044747
325468325	103195179	142848914	7672248	266657955	592126280
196809215	233892559	783177555	6492439	114369276	134050198
83587195	30470602	83056338	2214930	138106545	221693740
21101942	20387405	30994366	2153934	68192318	89294260
30002093	6515765	7191354	163905	21709017	51711110
29363851	17561510	44847647	729481	72274829	101638680
247262651	98274763	53439151	3177992	171926959	419189610
43466865	51109486	73485795	1262460	131148855	174615720
282527786	559777864	0	0	589223014	871750800
62853019	59035284	53404431	929154	118448791	181301810

5. Leontief Inverse matrix and analysis of Kupang IO table 2010.

5.1 Leontief Inverse matrix

Once we derived the Kupang IO table, then we calculated the coefficient of each sector by using the same method as for each sector of the NTT IO table.

Normally in an IO table the total supply must be higher than total demand or can be equal actually (demand ≤ supply). For the Kupang IO table the total output products are *5x10*^{15} *Rupiah* bigger than total final demand *3.8x10*^{15} *Rupiah.* This is very important and has proven that *the table has been produced in an accurate manner* compared with the actual situation and the table describes the market equilibrium supply in Kupang City stated by theory of market equilibrium:

Supply market meet demand = Market equilibrium

To count market equilibrium, an approach using a set of fixed technical coefficients, can simply be rewritten as:

$$Ax + f = x \qquad (10)$$

$$\begin{bmatrix} a_{11} & a_{12} & a_{1n} \\ a_{21} & a_{22} & a_{2n} \\ a_{n1} & a_{n2} & a_{nn} \end{bmatrix} \text{ x } \begin{bmatrix} x_1 \\ x_2 \\ x_n \end{bmatrix} + \begin{bmatrix} f_1 \\ f_2 \\ f_n \end{bmatrix} = \begin{bmatrix} x_1 \\ x_2 \\ x_n \end{bmatrix} \qquad (11)$$

Where a represents the input coefficient matrix, x is column vector of total output and f is column vector of final demand.

Now for *Leontief inverse matrix (L)* which focused on the full impact of an exogenous increase in final demand on all industries or sectors and the formula being used before inversed:

$$I - A \qquad (12)$$

Where *I represent an identity matrix* and *A is coefficient matrix* and from this formula, we can estimate a high performance equilibrium model from L and f. Breakdown of the equation into a function matrix is represented by:

$$Ax + f = x \qquad (13)$$

$$[I - A]x = f \qquad (14)$$

$$x = [I - A]^{-1} f \qquad (15)$$

Refer to "(15)", shown *high performance equilibrium model* where we can get the detailed influence of each industry whatever final demand composition is. (See fig. 1 to 3)

Table V: Inverse matrix L' of IO table

Sec.	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**
01	1.111	0.002	0.011	0.003	0.001	0.014	0.009	0.121	0.101	0.203	0.043	0.564	0.009
02	0.001	1.085	0.002	0.000	0.001	0.001	0.000	0.018	0.006	0.002	0.001	0.008	0.000
03	0.000	0.000	1.074	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.000	0.000	0.000
04	0.000	0.000	0.001	1.083	0.000	0.000	0.000	0.015	0.007	0.009	0.001	0.002	0.001
05	0.001	0.000	0.002	0.001	1.081	0.003	0.003	0.022	0.017	0.030	0.009	0.103	0.004
06	0.036	0.002	0.023	0.007	0.000	1.087	0.035	0.023	0.014	0.022	0.032	0.066	0.014
07	0.000	0.000	0.001	0.000	0.000	0.003	1.005	0.000	0.001	0.001	0.000	0.002	0.001
08	0.029	0.009	0.089	0.019	0.006	0.028	0.004	1.043	0.277	0.007	0.002	0.020	0.017
09	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	1.002	0.004	0.002	0.014	0.058
10	0.000	0.001	0.001	0.001	0.001	0.000	0.000	0.002	0.342	1.039	0.001	0.005	0.020
11	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.002	0.003	0.005	1.037	0.020	0.000
12	0.006	0.002	0.012	0.004	0.001	0.023	0.015	0.116	0.117	0.253	0.078	1.018	0.012
13	0.001	0.001	0.001	0.001	0.000	0.006	0.006	0.001	0.002	0.002	0.002	0.002	1.312
14	0.000	0.000	0.001	0.000	0.000	0.002	0.004	0.000	0.000	0.000	0.000	0.001	0.001
15	0.016	0.001	0.007	0.001	0.001	0.008	0.017	0.003	0.003	0.005	0.002	0.010	0.003
16	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001
18	0.006	0.002	0.008	0.002	0.001	0.039	0.068	0.004	0.005	0.006	0.005	0.008	0.006
19	0.017	0.009	0.019	0.022	0.007	0.022	0.021	0.050	0.097	0.090	0.049	0.077	0.058
20	0.006	0.003	0.006	0.006	0.002	0.006	0.007	0.013	0.026	0.024	0.013	0.021	0.015
21	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.006	0.005	0.003	0.005	0.004
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001
23	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.002	0.004	0.004	0.002	0.004	0.003
24	0.001	0.000	0.001	0.001	0.000	0.003	0.008	0.002	0.003	0.003	0.003	0.002	0.014
25	0.006	0.002	0.007	0.002	0.001	0.010	0.011	0.003	0.004	0.004	0.005	0.006	0.011

26	0.002	0.001	0.002	0.001	0.000	0.002	0.003	0.003	0.005	0.005	0.003	0.005	0.004
27	0.001	0.000	0.001	0.001	0.000	0.002	0.003	0.001	0.003	0.002	0.002	0.002	0.002

14	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
0.012	0.033	0.012	0.011	0.015	0.025	0.037	0.055	0.068	0.004	0.044	0.003	0.005	0.054
0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.003	0.000	0.000	0.002
0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000
0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.000	0.009	0.000	0.000	0.005
0.008	0.011	0.016	0.022	0.016	0.015	0.018	0.077	0.019	0.008	0.172	0.008	0.008	0.090
0.028	0.059	0.011	0.008	0.016	0.010	0.010	0.024	0.013	0.003	0.016	0.002	0.004	0.030
0.424	0.012	0.075	0.019	0.074	0.002	0.003	0.001	0.009	0.011	0.007	0.004	0.010	0.002
0.003	0.016	0.004	0.003	0.005	0.004	0.003	0.004	0.004	0.001	0.012	0.001	0.002	0.010
0.004	0.002	0.003	0.002	0.003	0.010	0.003	0.007	0.003	0.002	0.006	0.001	0.002	0.012
0.002	0.003	0.003	0.003	0.003	0.008	0.002	0.003	0.002	0.001	0.017	0.001	0.001	0.011
0.001	0.001	0.001	0.001	0.001	0.004	0.002	0.009	0.003	0.000	0.005	0.000	0.000	0.004
0.021	0.058	0.021	0.019	0.026	0.044	0.066	0.098	0.123	0.007	0.077	0.006	0.009	0.095
0.056	0.007	0.034	0.019	0.021	0.011	0.014	0.001	0.015	0.027	0.012	0.003	0.017	0.005
1.042	0.010	0.026	0.017	0.066	0.002	0.003	0.000	0.009	0.010	0.007	0.005	0.010	0.002
0.023	1.045	0.097	0.080	0.186	0.006	0.028	0.008	0.070	0.031	0.066	0.016	0.041	0.027
0.002	0.003	1.016	0.021	0.016	0.001	0.004	0.000	0.009	0.003	0.002	0.001	0.002	0.000
0.017	0.002	0.019	1.009	0.004	0.002	0.002	0.000	0.003	0.006	0.003	0.001	0.004	0.001
0.053	0.171	0.185	0.266	1.137	0.022	0.042	0.005	0.126	0.163	0.094	0.055	0.143	0.022
0.068	0.043	0.124	0.052	0.113	1.019	0.032	0.035	0.058	0.028	0.125	0.019	0.050	0.066
0.023	0.025	0.050	0.021	0.036	0.018	1.011	0.009	0.016	0.009	0.034	0.006	0.015	0.018
0.005	0.004	0.009	0.004	0.007	0.005	0.002	1.002	0.004	0.002	0.008	0.001	0.003	0.004
0.001	0.001	0.002	0.001	0.002	0.000	0.001	0.000	1.005	0.001	0.002	0.000	0.001	0.001
0.004	0.002	0.008	0.003	0.005	0.002	0.011	0.002	0.058	1.008	0.006	0.001	0.003	0.003
0.027	0.025	0.074	0.112	0.076	0.012	0.029	0.008	0.041	0.045	1.086	0.049	0.041	0.068
0.084	0.053	0.146	0.023	0.043	0.017	0.023	0.003	0.034	0.017	0.018	1.108	0.040	0.008
0.013	0.010	0.025	0.011	0.018	0.005	0.164	0.009	0.269	0.104	0.048	0.096	1.120	0.007
0.010	0.013	0.022	0.041	0.009	0.002	0.097	0.001	0.004	0.007	0.010	0.004	0.004	1.005

5. 2. Analysis of Kupang IO table 2010

For further analysis of the IO table, a simulation was conducted and some scenarios *based on the simulation into the Base case, Case1 and Case2 were created.*

Base case is conducted assuming *business as usual* which keeps the original value of total final demand and total output as well as ratio total (r_X) between output sectors and final demand formulated as:

$$X = [I - A]^{-1} f \qquad (16)$$

$$r_X = \sum X / f \qquad (17)$$

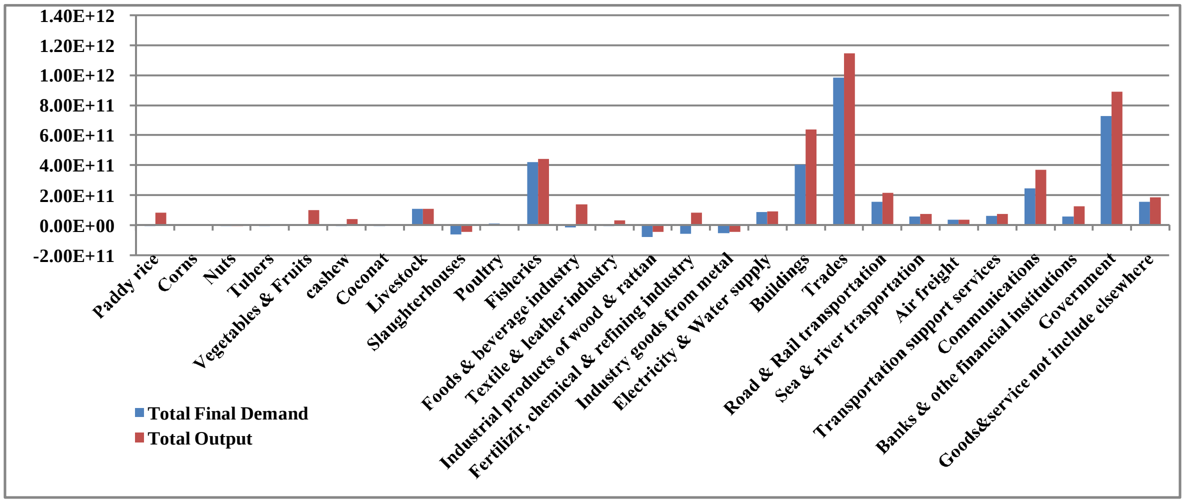

Fig. 1 (Base case) Relationship between final demand and total output for business as usual

For base case, the total output and final demand for sector trades are *$9.8x10^{14}$ and $1.1x10^{15}$ Rupiah respectively* are the highest followed by government, building and fishery sectors. *The ratio total between total output and final demand is 1.47.* This result indicates if we allocate every sector to business as usual; budgeting sectors, exports, imports, household consumption expenditure as well as fixed capital formation do not change significantly and without proper environment policy applied, the possibility of contribution of CO_2 emission in Kupang city is *predicted from trades and government sectors*.

Case1, we supposed that in Kupang city a 10% *increase in private consumption expenditure (household) of sector electricity and water supply*. A new additional output and ratio between total output and final demand are formulated as:

$$\Delta X_1 = [I - A]^{-1} \Delta f_1 \qquad (18)$$

$$r_{X_1} = \sum \Delta X_1 / \Delta f_1 \qquad (19)$$

With a 10% increase in this sector the amount of additional final demand became *8.8x10*^{12} *Rupiah* and additional total output is *8.9x10*^{12} *Rupiah*, whereas the value of other sectors are kept at the same level or unchanged, while *ratio total output sectors and final demand is 1.77*

We chose this sector, because we assumed that an increase in air pollutants and CO_2 emission are bigger sourced by usage of electricity and water supply. When the sector increases, the trade and government sectors also increase based on the base case. So *by anticipating and introducing an increase 10% in this sector we can more easily consider what policies should be applied.*

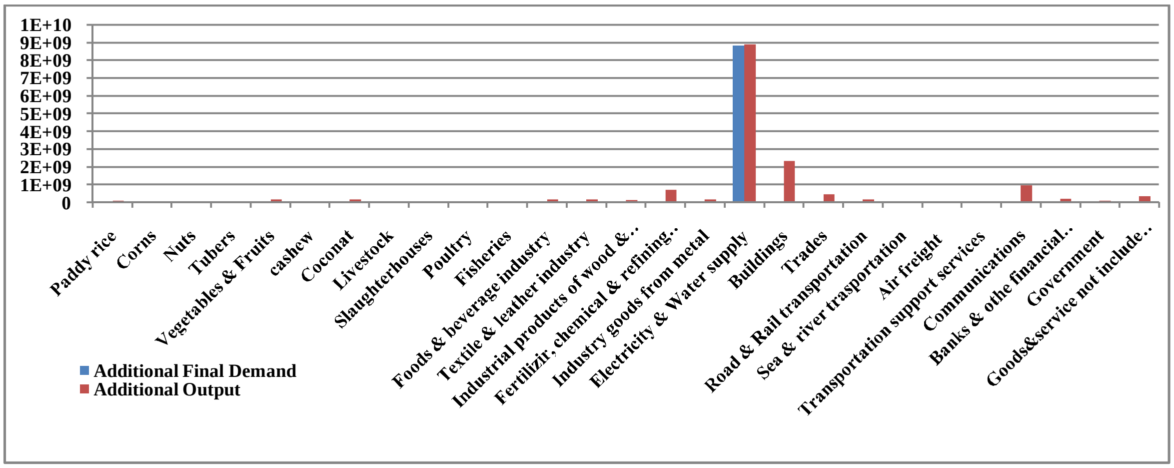

Fig. 2. (Case1) Change in the value of final demand and total output for 10% increase in private consumption expenditure of sector electricity and water supply

Figure 2, shows an increase in10% for electricity and water supply will influence significantly the building and communication sectors as well as lower values for the trades sector and fertilizer, chemical and refining sectors. Thereby, proper policy should be considered for application in the building, trades, fertilizer, chemical and refining sectors. The CO_2e reduction target of the Kupang government can be achieved through an increase of electricity and water supply by 10% therefore *government must implement carbon tax policy, and promote use of new renewable energy in relevant sectors.*

Case2, we suppose a 10% *increase in gross domestic fixed capital formation of livestock sector*. A new additional output is formulated as:

$$\Delta X_2 = [I - A]^{-1} \Delta f_2 \qquad (20)$$

$$r_{X2} = \sum \Delta X_2 / \Delta f_2 \qquad (21)$$

Now the value of additional final demand of this sector becomes *3.3x10*^{11} *Rupiah* therefore additional total output is *3.4x10*^{11} *Rupiah,* while other sectors are kept at the same value or unchanged and the *ratio is 1.45*. We chose the livestock sector because we suppose it is possible to implement the future use of renewable energy from *biomass* which is livestock as raw material in Kupang city. Nowadays, in Kupang pollutants are caused by waste from private and public sectors including livestock, household, agriculture, restaurants, government and waste from other public service sector activities. *These sectors will definitely accelerate the contribution and increase of* CO_2 *emission in Kupang*.

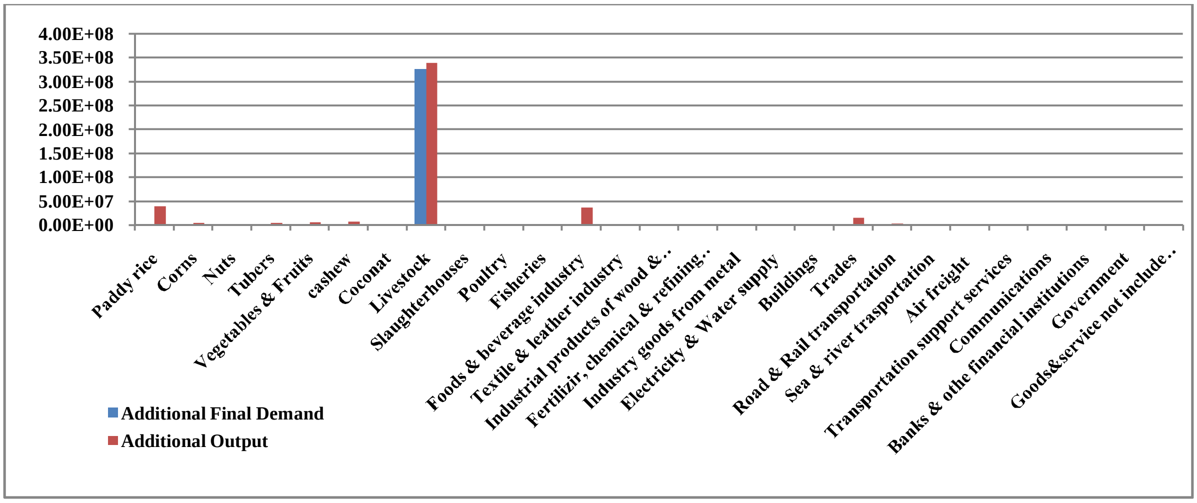

Fig. 3. (Case2) Change in the value of final demand and total output for 10% increase gross domestic fixed capital formation of livestock

Figure 3, clearly shows when there is a 10% increase in livestock sector, other sectors such as foods and beverage, and paddy rice increase rapidly, as well as fisheries and trades sectors; road and rail transportation sectors are also increased. Some agricultural sectors such as corn, tubers, cashews, vegetables and fruits are increased slightly. This relationship among sectors is evident, and we assume livestock sector increases, are caused by the increased productivity of sectors such as agriculture including paddy rice, food and beverage industry, fisheries, trade activities such as restaurants and other activities using transportation services (transport from the field to industries). Therefore, the Kupang government should anticipate increased waste produced by livestock and other sources. However, increased productivity of the livestock sector is still maintained by *introducing a framework of pollutant sector and feasibility to develop integrated new renewable energy as a unit. This matter needs further research*

6. Pollutant Emission structure

Assumed linearity is necessary to predict the pollutant emission amount from production activities which are determined by their proportion to production amount, and the IO table becomes the principal reference. However, in reality, there is a *non-linear* relation between pollutant emission and production amount due to insignificant results if we using analysis by non-linear structure.

The current situation in Kupang, particularly in 2010 suggests the technology used in industries is *expected to be the same as technology used in Japan in 1990.* Therefore, we can estimate using the same formulas used by the *National Institute for Environmental Studies, Japan* to calculate the coefficient emission of CO_2 and air pollutant based on the Japanese IO table for1990.

Calculation of the induced environment burden in each sectors utilized the embodied intensity using equation:

$$e = d\{I - (I - M)A\}^{-1} \qquad (22)$$

Where e represents embodied intensity of each sector, d is direct burden per unit production, I is identity matrix, M is import in each sector, and A is input coefficient matrix.

The final demand for each sector f_i, can be divided into domestic final demand Y_i and export demand E_i shown as:

$$F_i = Y_i + E_i \qquad (23)$$

For equation the induced environmental burden T_i by the final demand for any sector i:

$$T_i = (1 - m_i)e_iY_i + e_iE_i \qquad (24)$$

Where m_i represents the import coefficient defined by equation

$$m_i = \frac{M_1}{\sum_{j=1}^{n} a_{ij}X_j + f_i} \qquad (25)$$

Where a_{ij} represents input coefficient and X_j indicate domestic production of sector j

Refer to "(25)" we *have gained the pollutant emission of each sector* (see table VI).

Table VI: pollutant emission coefficient for each sector

	Industries	**CO2**	**NOx**	**SOx**	**CH4**	**N2O**
		Unit: Kg/100 Million Rupiah				
01	Paddy rice	404.40	5.23	1.31	33.57	0.42
02	Corns	608.57	6.69	2.00	16.79	0.21
03	Nuts	554.38	7.81	1.84	16.79	0.21
04	Tubers	485.65	4.78	1.42	16.79	0.21

05	Vegetables & Fruits	2384.01	23.31	12.01	16.79	0.21
06	Cashew	647.20	7.57	3.63	0.02	0.00
07	Coconut	1997.97	27.39	8.94	0.02	0.01
08	Livestock	517.78	7.51	3.19	123.27	1.12
09	Slaughterhouses	494.50	7.11	2.98	123.27	1.12
10	Poultry	708.27	6.45	5.32	123.27	1.12
11	Fisheries	4583.59	180.24	93.53	0.27	0.08
12	Foods & beverage industry	3449.90	28.50	25.26	0.02	0.00
13	Textile & leather industry	23049.24	200.05	124.41	0.60	0.02
14	Industrial products of wood & rattan	25252.22	205.06	149.00	0.57	0.18
15	Fertilizer, chemical & refining industry	65676.47	424.84	181.39	70.78	0.34
16	Industry goods from metal	51244.33	251.18	150.63	0.66	0.13
17	Electricity & Water supply	13650.87	56.26	44.85	64.79	1.45
18	Buildings	4659.74	40.47	13.77	0.00	0.00
19	Trades	1725.15	15.21	8.34	0.03	0.00
20	Road & Rail transportation	3448.75	49.33	12.43	0.11	0.05
21	Sea & river transportation	11066.33	970.47	637.51	0.11	0.05
22	Air freight	8953.43	131.39	21.64	0.11	0.05
23	Transportation support services	1533.87	22.24	11.75	0.11	0.05
24	Communications	4671.91	33.52	19.81	0.03	0.00
25	Banks & other financial institutions	587.18	4.20	2.35	0.00	0.00
26	Government	4118.20	33.06	18.77	0.08	0.02
27	Goods & services not include elsewhere	2840.61	23.40	12.15	0.07	0.02

Now we are able to identify the air pollutant emission coefficient and GHG emission coefficient accurately based on the Kupang IO table 2010. As for total emission amount each pollutant formulated as follow:

$$E = ZX = \begin{bmatrix} a & b \\ c & d \end{bmatrix} x \begin{bmatrix} p \\ q \end{bmatrix} = \begin{bmatrix} ap + bq \\ cp + dq \end{bmatrix} \qquad (26)$$

Where E represents column vector of pollutant emission amount as well as Z and X are represents pollutant emission coefficient matrix and column vector of amount of production (see table VII)

Table VII: Total emission amount of each sector

Chemical Formula	**ton**
CO_2	**266,166,962**
NOx	**3,489,146**
SOx	**1,875,765**

CH_4	399,331
N_2O	5,276

7. Total amount of GHG CO2e

To address the right value of it amount we are need to compare the ability of each GHG to trap heat in the atmosphere relative to another gas better called Global Warming Pontetial (GWP) for time horizon 100 years and 10 years for the base year 2010. The formula is used to count are:

$$GHGCO_2e = CO_2(t)x1 + CH_4(t)x21 + N_2O(t)x310 \qquad (27)$$

Refer to (27) we get results for GWP 100 years and 10 years are 0.069 Giga Ton or 9% from self effort of target year by 2020 by national government as well as 0.073 Giga ton or around 9.479% from self effort of target year 2020.

These amounts of GHG CO_2e are very useful and urgently needed to prepare as guiding tool for further policy, which Kupang government confidently devise proper environmental policies and technical measures to cope with both national and regional targets to reduce GHG emission up to 2020. To overcome these problems and achieve government target both national and regional, a kind of framework is really necessary to simply and smoothly the GHG CO_2e target.

8. Introducing a framework to possible integrating RETs and WTPs in Kupang city

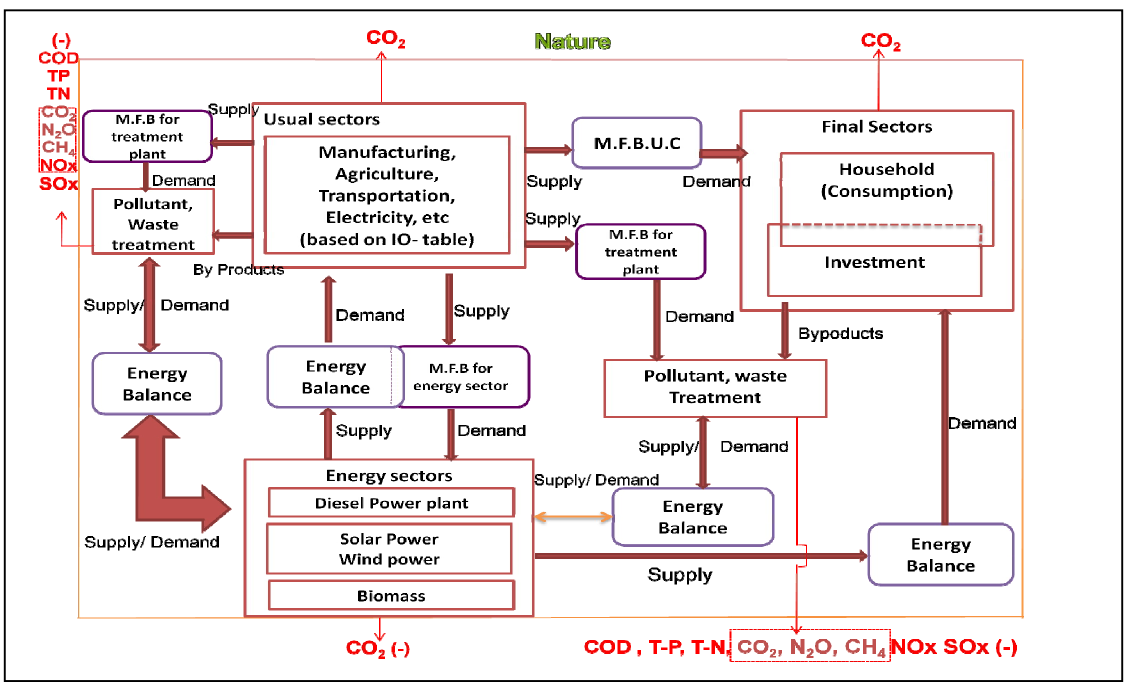

Fig. 4. Framework integrating current and future situation after introducing Renewable Energy Technology system (RETs) and Waste Treatment Process system (WTPs)

Currently, the only electricity in Kupang sourced from the diesel power plants which contributed very much of increasing of CO_2. The framework shown how integrating when introducing RETs and WTPs as a whole in economic activities in Kupang how the pollutant emission, including CO_2 emission has been held in Kupang and how to constraints the CO_2 equivalent (CO_2e). Explanation of the energy substitution is possible as far as electricity produced by RETs can be fed into a current electricity power grid, whereas WTPs depending if demand for electricity is greater or less than electricity produced through the treatment process, thereby the WTPs become consumer or producer of electricity. For the diesel power plant when the production level becomes less, the emission of CO_2 will be less also while the level of economic activities is kept at the same level or more than the level before introduction of RETs. Therefore, by introducing RETs and WTPs with proper advanced technologies are possible to reduce CO_2e.

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