# 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

**Adrianus AMHEKA**
Graduate school of Life and Environmental Science, University of Tsukuba,
1-1 Tennodai, Tsukuba 305-8572 Ibaraki, Japan
State Polytechnic of Kupang, Jl. Adisucipto Po.Box.139 Penfui,
Kupang 85011 NTT, Indonesia

**Yoshiro HIGANO**
Graduate school of Life and Environmental Science, University of Tsukuba,
1-1 Tennodai, Tsukuba 305-8572 Ibaraki, Japan

**Takeshi MIZUNOYA**
Graduate school of Life and Environmental Science, University of Tsukuba,
1-1 Tennodai, Tsukuba 305-8572 Ibaraki, Japan

**Helmut YABAR**
Graduate school of Life and Environmental Science, University of Tsukuba,
1-1 Tennodai, Tsukuba 305-8572 Ibaraki, Japan

**Abstract**

Indonesia's target is to reduce GHG emissions to between 26-41% (0.767-1.244) Gton $CO_2$e from base year 2010 to target year 2020. Kupang is one of the cities targeted to achieve this. This research begins by introducing current solid waste management, the development of a Kupang input output (IO) table, introducing pollutant sectors and count amount of $CO_2$e caused by economic activity indicated in the IO table. The results are compared with global warming potential (GWP) for a ten and a hundred year period respectively which show 0.073 Giga Ton (GTon) $CO_2$e or 9.479% and 0.069 GTon $CO_2$e or about 9% emitted by economic activity without being treated properly. As a tool for the Kupang government, we outline a framework for future implementation as the best solution to integrate a number of natural resources and to treat wastes (in the form of $CO_2$, $CH_4$, $N_2O$, NOx, SOx, COD, BOD) before emitted into the environment. This research is the first study that constructs an IO table at a municipal level and counts the amount of $CO_2$e emitted freely to environment in Kupang City for the year 2010.

**Keywords:** GHG Emission, CO2e, IO Table, Kupang City
**JEL classification:**

## 1. Background

The Indonesian government continues to make efforts to reduce GHG emission up to 41% with an aim of around 1.244 Gton CO2e 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 [2]. 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 CO2, NOx, SOx, CH4, N2O during production processes and without proper policy to control it particularly in developing cities [17]. It is necessary to consider how pollutant emission from production activities is determined in proportion to production which is known as assuming linearity [13], [16].

Damanhuri (2008) Study 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 [5]. 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 [4], [5], [6].

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 [4], [5], [17].

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) [16], [4], [5].

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 [7].

## 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*" [10], [15]. 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 [3], [14]. 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 [3], [14] 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 | Individual & other Household services(54), Goods& service |

| include elsewhere | 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 [1], [12]:

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

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 [12]. Total value-added payments are for two sectors [8], [12]:

$$v_1 = l_1 + n_1 \text{ And } v_2 = l_2 + n_2 \tag{4}$$

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

$$X = x_1 + x_2 + x_n + L + N + M \quad \text{or} \tag{5}$$

Summing across the total output row:

$$X = x_1 + x_2 + x_n + C + I + G + E \tag{6}$$

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

$$L + N = C + I + G + (E - M) \tag{7}$$

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 [1], [12]:

$$aij = \frac{z_{ij}}{\sum x_j} \tag{8}$$

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

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) [9], [12]. 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 [18]:

*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:

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

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:

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

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

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

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 [1], [12]:

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

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

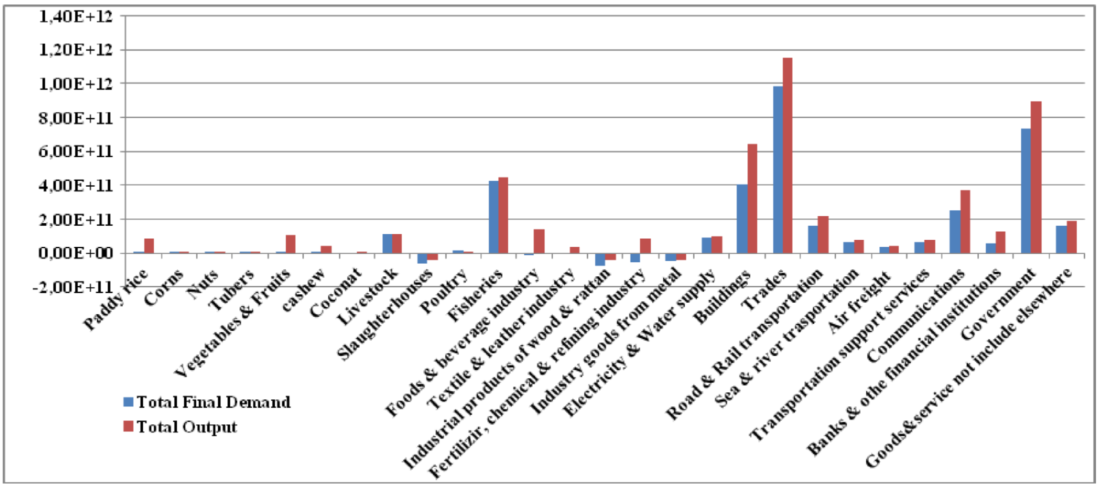

Fig. 1 (Base case) Relationship between final demand and total output for business as usual

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:

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

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

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.*

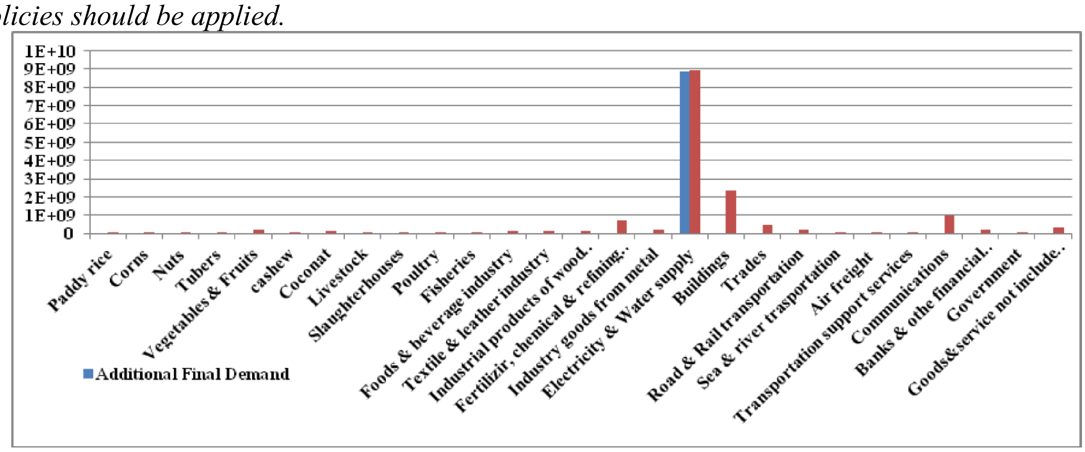

Fig. 2. (Case1) Change in the value of final demand and total output for 10% increase in private consumption expenditure of sector electricity and water supply

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:

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

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

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.*

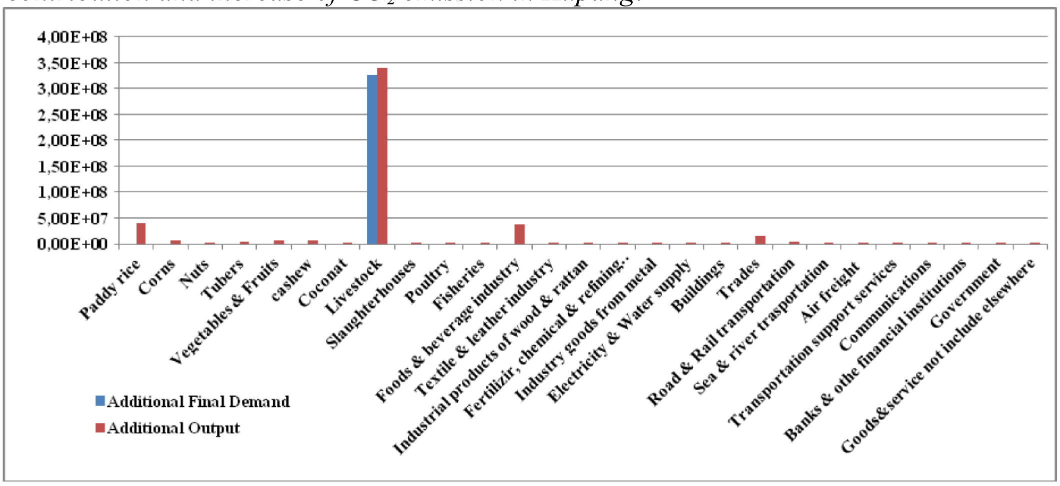


Fig. 3. (Case2) Change in the value of final demand and total output for 10% increase gross domestic fixed capital formation of livestock

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 [12], [14].

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 [11]:

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

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:

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

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

$$T_i = (1 - m_i)e_i Y_i + e_i E_i \quad (24)$$

Where $m_i$ represents the import coefficient defined by equation

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

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:

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

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 $CO_2e$

To ascertain the amount of $CO_2e$ emitted through economic activity in Kupang, we compared the total emission from each sector to the GWP which references the updated decay response for the *Bern carbon cycle model and future $CO_2$ atmospheric concentrations* held constant at current levelsfor a time period of100 years and 10 years. The formula used is:

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

Refer to (27) we obtained the result of GHG $CO_2e$ based on a Kupang IO table 2010 for GWP 100 years is 0.069 GTon or 9% of the target year 2020 as well as 0.073 Gton or around 9.479% for GWP 10 years of the same target year.

These $CO_2e$ amounts need urgent recognition by both the Kupang government and Indonesian government as users on a regional and national level as well as by international organizations. This is also applicable in preparing guidelines for further policy and promotes use of renewable energy system (RETs) or possibility to construct waste treatment plant systems (WTPs) in order to reduce GHG emission in Kupang. These results will give the Kupang government confidence in deciding proper environmental policies and technical measures to cope with both national and regional targets to reduce GHG emission up to 2020. To achieve the target to reduce GHG emission in Kupang promptly, a framework will be required to simplify and smooth the process.

## 8. Framework Possibility Integration Rets And Wtps In Kupang City To Reduce GHG Emission

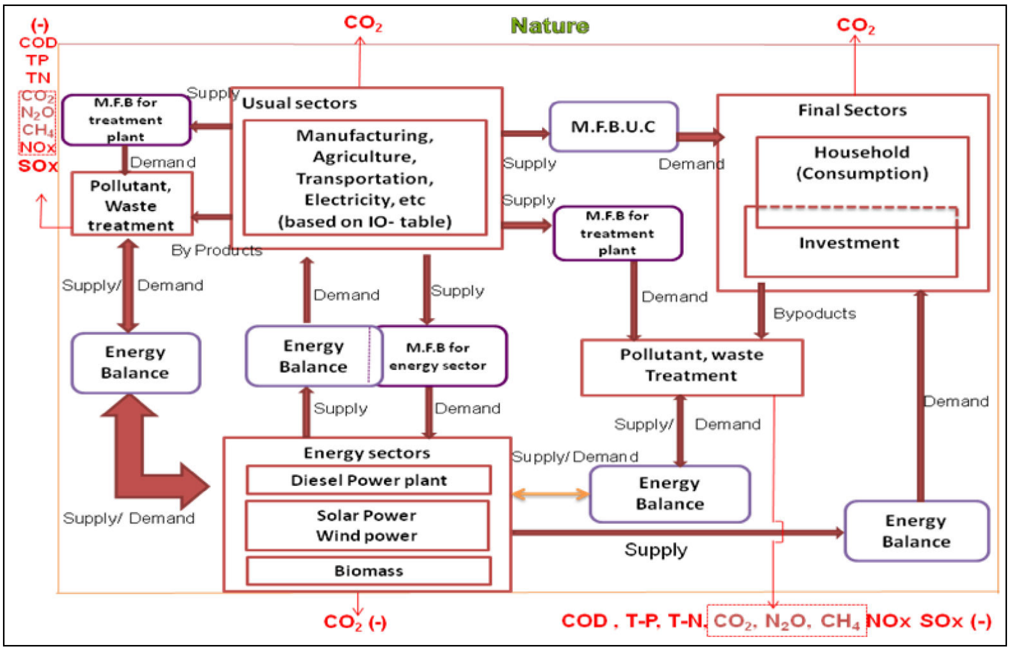


Fig. 4. Framework integrating current and future situation after introducing Renewable Energy Technology system (RETs) and Waste Treatment Process system (WTPs)

The framework is a proposal to government to anticipate the increase of GHG emission in the future. Today in Kupang, electricity is sourced from diesel power plants (DPP) as fossil oriented fuel which emits in the form CO, NOx into the environment directly without proper treatment. Nevertheless, other pollutant sectors (27 sectors) also make large contributions. We divided the industrial sector into two principle sectors, the commodity/ service sector and energy sector. The energy sector produces electricity by DPP and others components produce energy in the form of gasoline, light oil, heavy oil/ kerosene and should be taken into consideration in the market flow balance for the energy sector (M.F.B for energy sector) indicated in the Kupang IO table. The market flow balance of usual commodities (M.F.B.U.C) means the demand for commodities by the usual and energy sectors as intermediate inputs shown in the IO table and by the final demand sector; that is private and public consumption including household and investment (as capital formation) sectors. Energy balance means the demand for electricity by the usual sector, pollution and waste treatment sectors and final sectors should be met by supply of electricity produced by energy sectors and to support it we suggest introducing RETs and WTPs through integrated connection to economic activities in Kupang. Energy substitution described in the framework is possible as far as electricity produced by RETs can be fed into the current electricity power grid.WTPs can become consumers or producers of electricity depending on whether electricity demand is greater or less than electricity produced through the treatment process.

We assumed that when the production level of DPP becomes less, then emission of CO2 can be reduced while the level of economic activities is kept at the same level or more than the level before introduction of RETs and WTPs. Thereby, by introducing this framework and if government accepts it, then CO2 can be further reduced.

## Acknowledgements

Great appreciation goes to Professor Yoshiro Higano my academic advisor for constructive advice, deep and comprehensive analysis of the framework for future implementation. The special thank is also given to Dr. Mizunoya for supervision and guidance during the writing of this paper.

**References**

[1] A. Takayama, Mathematical Economics 2nd ed. New York: Cambridge University Press, 1985.

[2] BAPPENAS, Guideline for developing local action plan for GHG's emission reduction (RAD-GRK), Official document of Ministry of National Development Planning, Republic of Indonesia, 2011.

[3] Batey, Peter W. J. and Melvyn J. Weeks. "The Effects of Household Disaggregation in Extended Input-Output Models",1989.

[4] Damanhuri, E (2010), Solid and hazardous waste management in Indonesia. [online]: coexistence activity report. Available from http://www.kankyo.tohoku.ac.jp/ar2010/2010all.pdf (Accessed 25 May 2011).

[5] Damanhuri, E and Padmi, T (2008) Current Situation of Waste Recycling in Indonesia. [online] ERIA Research Project Report, 3R Policies for Southeast and East Asia. Available from http://www.eria.org/RPR-2008-6-1.pdf (Accessed 27 May 2013).

[6] EPA US. [online] Available at http://www.epa.gov/osw/conserve/materials/hhw.htm (Accessed 25 May 2013).

[7] Faizah, (2008) Household waste management Community-based (case study: Yogyakarta city). Unpublished Master Thesis, Diponegoro University, Semarang, Indonesia.

[8] F. Duchin and G-M. Lange. 1995. "The Choice of Technology and Associated Changes in Prices in the U.S. Economy," Structural Change and Economic Dynamics, 6, 335–357.

[9] G. K. Lee, L. L. Blakesley and WR. Butcher, "Effects of Exogenous Price Changes on a Regional Economy: An Input-Output Analysis," International Regional Science Review, p.20, 1977.

[10] Indonesian independence ceremony guidebook, Regional secretary of Kupang city, 2011.

[11] K. Nansai, Y. Moriguchi and S. Tohno, Embodied Energy Emission Intensity Data for Japan using Input-Output Tables (3EID); Tsukuba, Japan: NIES, 2002, pp.4-41.

[12] R. E. Miller and P. D. Blair, Input Output Analysis: Foundations and Extensions, 2nd ed. The Edinburgh Building, Cambridge CB2 8RU, UK: Cambridge University Press, 2009, pp. 10-51.

[13] S. Ulger, "An integrated dynamic simulation modeling approach for water quality improvement policy", Ph.D. dissertation, Dept. Agri. Eng., p.56, Tsukuba University, Japan, 2003.

[14] T. Mizunoya, Simulation of Environmental Policy, unpublished paper, University of Tsukuba Japan, 2013.

[15] T. Shibata, and H. Kosaka "The internal and external effect of demand on the Japanese economy with a special focus on its transportation system using an international and interregional input-output system", The Journal of Econometric Study of Northeast Asia (JESNA), vol. 8 no.1, p. 2, March 2012.

[16] Waite, R. (1995) Household waste recycling, Earthscan, London.

[17] Y. Higano, Construction of sustainable society and meaning of the three balances in the comprehensive evaluation of environmental policy, Unpublished paper, University of Tsukuba Japan, 2012, p.1-11.

[18] Z. Rose, Ronald E. Miller and Karen R. Polenske (eds.), Frontiers of Input-Output Analysis. New York: Oxford University Press,pp. 119–133.

[19]Working Group I Report UNFCC (1995): Climate Change 1995, The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group I Report, page 22.