# EVALUATION OF ECONOMIC STRUCTURE DEVELOPMENT OF KUPANG CITY, NTT PROVINCE, INDONESIA TO MEET NATIONAL GHG EMISSION TARGET

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**Abstract**
Indonesian government through RAN/RAD-GRK program set target to reduce GHG emission between 26%~41% by 2020 based on 2005 emissions under BAU. Study begins by simple identify and evaluate current socio-economic structure condition to achieve Indonesia's GHG emission reduction target. We assume optimal GHG reduction rate (n) between 0%~20% then investigate its impacts to related sectors. As result, found 0.015Gt is estimated amount of GHG emission in Kupang before optimized (or about 0. 47% of total GHG emission in Indonesia) and 0.012Gt after optimized. The optimal n is around 15%~17% with Kupang GRP (1,656.86~1,371.51) Trillion IDR. The result indicated that Kupang economic cannot attain n more than 17%~20% without any conflict among stakeholders and current gross regional product (GRP) is not optimal to control GHG emission but has a space for making a higher GRP by keeping the same amount of GRP as before optimized. Relation between n and GRP called the trade-off and it is allowed can be raised up by introducing renewable energy technology for future research. In Indonesia, this study becomes the first study dealt with GHG emission reduction in the city level focused on economic activities.

**Keywords:** Kupang economic, GHG emission, reduction rate
**JEL classification:** O21, O25, O44, R50, R58

## 1. Introduction

Kupang city is located between Australia and Timor Leste and become heart of economic activities in Nusa Tenggara Timur (NTT) province which contribute in supply greenhouse gases (GHG) emissions through its activities. In 2010 the GRP of Kupang 2,296,924 Trillion IDR with population around 336,239 souls and estimate growth 3.6% per year consisted of 82,139 households that spread on a wide area 165.3km2 within 6 districts. In 2007~2010, Kupang economic growth significant namely 8.23% and in 2010 highest compared to the national level that is 6.2% (Kupang in Figure 2011).

Indonesia government has efforts to reduce GHG emission 26% from business as usual (BAU) and 41% if assist from abroad and constitute an integral part of the national and regional planning (Bappenas 2011) through distribution responsible to regional agent called BAPPEDA Kupang in conjunction with NTT province government is efforts by conducted a number of environment programs aims to achieve global GHG emission reduction by 2020 (Amheka and Higano 2015; Amheka 2014). To make sure the GHG emission assessment on national and regional level accurately, it needs by conducting a comprehensive evaluation associated with related sectors.

This study uses Kupang input-output (IO) table that describes interdependence of industries in an economy (Miller and Blair 2009) along with their 28 sectors GHG emission factor including assumptions. The table is constructed by Amheka et al. 2014; 2015; Amheka 2014. The IO analysis was used to assume the energy use of a country for household and industries (Duchin and Lange 1992; Sasai et al. 2012), investment activities affecting to production change regardless of the impact on the environment such as the supply of GHG emission (Meng et al. 2012). Another way is reduced fossil consumption by introduce new energy industries (Uchida et al. 2008) where have positive impact to industrial structure under GHG emission constraints. Thus, this paper we using different model structures parameters in the city scale which giving effect of originality that never been introduced before.

### 1.1. GHG emission in regional Indonesian

Indonesia is the world's third largest emitter of CO2e after the USA in the amount 2.183Gt and projected rise to almost 2.95Gt CO2e by 2020 under a BAU scenario (MoE 2010; Tedjakusuma 2013; Thamrin 2011). Since 2011 Indonesia government has been introducing a program called National/Regional action plan for reducing GHG emissions (RAN/RAD-GRK) conducted preventative measures in reducing national emissions between 26% up to 41% from the BAU by 2020 up to (Amheka and Higano 2015; Amheka et al. 2015a,b). Trends of GHG emission per province in Indonesia have reorganized its data by 2015, reviewing composition of the sector after aggregated and show only about 25% of Indonesia's total emissions for each province where data has been tabulated from various references and has yet to provide comprehensive data on the city level. Therefore, Kupang government as part of regional focal point has committed to reduce GHG emission while keeping economic growth. So, this study will focus on evaluate GHG emission in Kupang city which mainly by industrial sectors as indicated in Kupang IO model by taking into account the amount of GHG emission coefficients every sector calculated by (Amheka et al. 2015). Furthermore, Amheka et al. (2014) reported a study focuses on pollutant counts and emission coefficients emitted by activity economy in Kupang city and became the frontier study in city level in Indonesia.

Objective of the study in the national level is to meet agreement COP-15 Copenhagen to reduce the emissions between 26% and 41% with a range between 0.767Gt CO2e and 1.189 Gt under BAU by 2020 base year 2005 and taking part in support Sustainable Development Goals. In terms of regional level to produce an evaluation framework to succeed RAD-GRK program in Kupang and improve regional competitiveness relating to the joint efforts among ASEAN countries.

## 2. Material and Method

### 2.1. Objective Function

In order to drive the Kupang City's market-oriented economic system, we construct a comprehensive model where the Kupang GRP must be set maximized and the economic status after policies introduction have a significant impact by taking into account the control variables include added value rate and total output production of usual sectors as showed in the formula:

$$MAXGRP = vv\_r * X$$

where, *MAXGRP* is maximize GRP; *vv_r* is added value ratio; $X$ is production vector of usual sectors (en) which representing demand and supply for goods and services in a market condition. The production sectors are depending on the total supply of commodities that must meet total demand which defined as the sum of intermediate demand and final demand. The final demand is composed of household and local government consumption, capital formation, change in stock, and net export. The formula is:

$$X \geq AA * X + CP + CG + INV + ST + EX - IM$$

where, $AA$: IO coefficient matrix of usual sector (ex); $CP$: consumption vector demand by household (en); $CG$: consumption vector of local government (en); $INV$: private and government capital formation vector (en); $ST$: changes in stock vector (en); $EX$: export vector (en); $IM$: import vector (en), both $EX$ and $IM$ confined within an interval.

The consumption vector of household itself is endogenously determined for the income and distribution the consumption. The total payment to labor becomes wages of household is sourced from total business profit. It is assumed that 90% accrues to households as dividend to shareholders and remaining 10% is taxed by the government as direct tax. For household consumption, the formula is used:

$$TCP = \sum CP(i)$$

$$p(i) * CP(i) = \alpha(i) * YD \qquad (i = 1,2,3, \dots, 27),$$

where, $p(i)$: product price of i-th industry (commodity i) (en); $\alpha(i)$: propensity to consumption of i-th commodity (ex) and *YD* is total disposable income of household after reduction of income tax (en).

The general account revenue of Kupang government $(Tg)$ is dependent on the sum of indirect, corporation, and income tax revenue or in the other hand is equated with expenditure by the government which is composed of government consumption, government saving, and income subsidy for households:

$$Tg = TCG + SSG + SBD_{incm} + NTX,$$
$$NTX \leq |NTX|,$$

where, $TCG$: total government consumption (en); $SSG$: (gross) government saving (en); $NTX$: transfer (if it is positive) to or special grant (if it is negative) by the central government (en); $|NTX|$: data of $NTX$ (ex). The government consumption demand for each sector is determined proportionally to total government consumption, using the formula:

$$CG(i) = cg_{r(i)} \cdot TCG\,(i = 1,2,3, \ldots ,27)$$

where, $CG(i)$: government consumption demand for the product of i-th industry (en); $cg_{r(i)}$: constants which proportionally allocate $TCG$ among $CG(i)$ (ex).

For government saving and investment $(TINVG)$ (en):

$$CG(i) = cg_{r(i)} * TCG \qquad i = 1,2,3,\ldots 27$$
$$TINVG = 0.3 * TINV$$

where, $D_g$: depreciation cost of social infrastructures (en), is given $D_g = 1.2 \cdot D$ (assumed depreciation cost of social infrastructures is 120% of the depreciation cost of industrial sectors; $TINV$: Total investment (en).

### 2.2. The constraint of GHG emission reduction

Expected current industrial structure has a space for making a higher GRP by keeping the same amount of GRP as before optimization. The formula is:

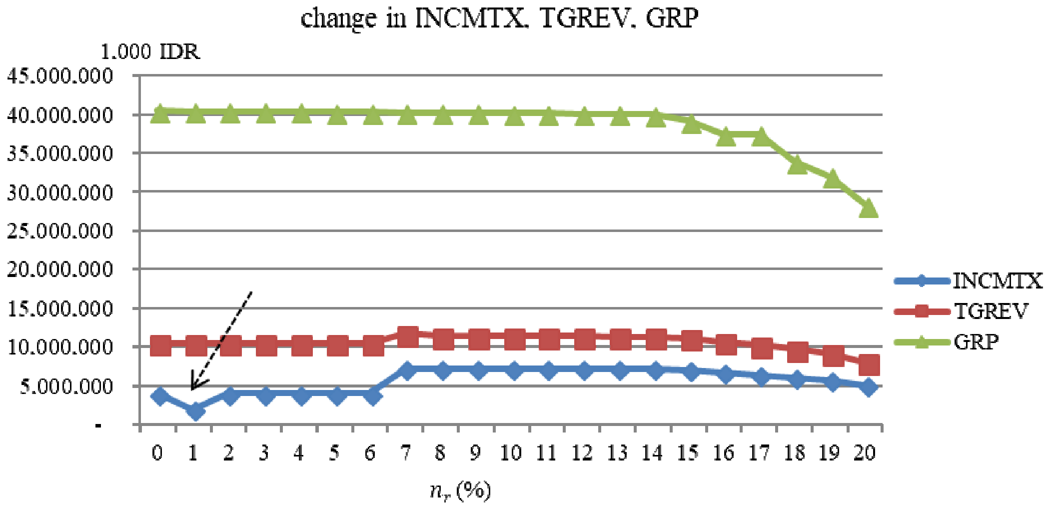
$$ZZ = coef_c * X \leq (1 - \frac{n_r}{100}) ZZ_{bar}$$

where, *ZZ bar*: total $CO_2$ emission in Kupang in 2010 (ex) (Amheka, 2014); $n_r$: GHG reduction rate (ex); $coef_c$ is GHG emission coefficient. It is assumed that each sector cannot change it production more than or less than 20% of the current amount data; $ZZ$: GHG emission after introduction of GHG constraint (en).

## 3. <u>Results and Discussion</u>

After optimisation the government financial sourced from the tax is getting down significantly on the $n_r$ = 1%, then stabile on nr = 2%~6% as indicated in Figure 1, but the tax itself does not much effect as also mentioned in the previous study reported by Mizonoya and Higano (1997), the total government revenue (GRP) which stabile on 10.47 Million IDR upward.

**Figure 1: change in income tax, total government revenue and GRP**



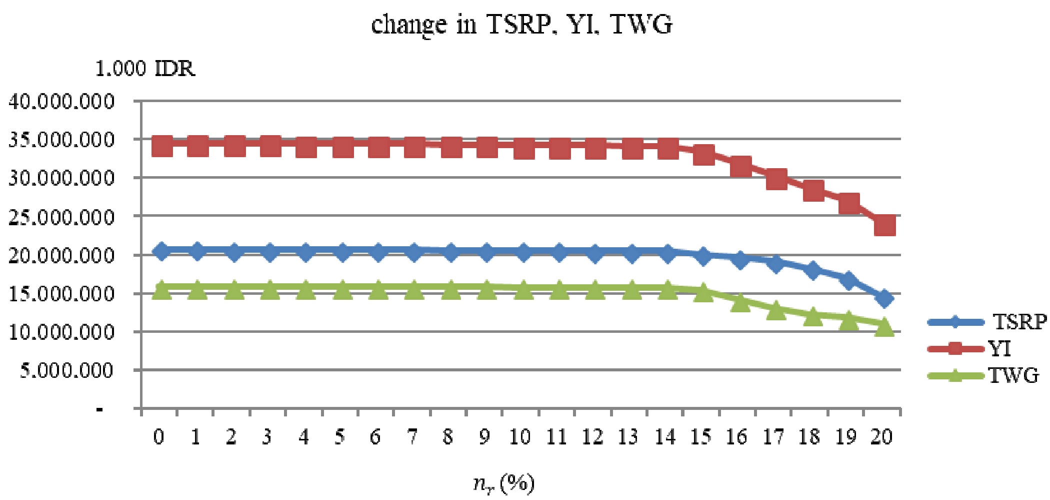

note: 1 USD = 12,500 IDR

It is expected no influence for Kupang GRP at the reduction rate level. Further, the revenue from tax (INCMTX) is raise and stabile on the $n_r$ = 7%~16%, and small effect will influence to total government revenue (TGREV) at the $n_r$ = 7% is rose up to 12.22%. The income tax continues decrease after $n_r$ =20%.

The GRP seems to be stable from $n_r$ = 1%~14%, the drastically decrease on the $n_r$ = 1% due to sensitizing policy applied and 15%~20%, although the $n_r$ = 16% and 17% did not change significantly. Thus, according to the figure explained that the economic cannot support the income of government both from the tax and other resources after $n_r$ = 20% which implies to the Kupang GRP due to economic structure will be influenced perhaps by depreciation from production sector which mainly from productive sectors such as industry, transportation and government including institutional. In this situation an environmental regulation need to be considered in relation to the locations of the GHG emission contributor sectors (Shimamoto, 2016). This optimization is expected livestock and agriculture sectors are also contributed due to using the GHG emission coefficient from NTT economic sectors (55 sectors) were adjusted and adopted from Japan GHG emission coefficient (128 sectors) and in this sense needs to be assessed for further research.

Total surplus (TSRP) of sectors are depends on total output of the related sectors. The Figure 2 is representative described how significant interrelation among economic structure of surplus, household revenue (YI) and their salary (TWG).

**Figure 2: change in surplus, household income and wage/salary**

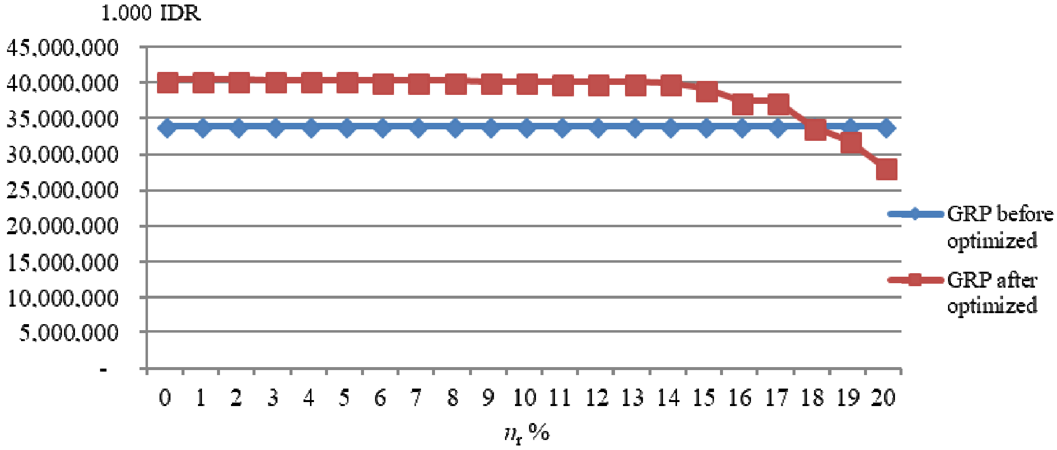



note: 1 USD = 12,500 IDR

There are no significant changes after optimization between $n_r$ = 0%~14%, unless from $n_r$ = 15% and upward. In such situation, can conclude the three variables of the economic as identified in the Figure 2, are directly proportional to each other, hence the reduction rate is a most critical to the impact of economic improvement in Kupang in terms of control environment.

Controlling the GHG emission through reduction rate system as reported in the Table 1 and the Figure 3, covered most effective when the reduction rate between 14% and 17% and convince that the current industrial structure in Kupang is not optimal in terms of GHG emission control.

**Figure 3: change in GRP**




note: 1 USD = 12,500 IDR

After $n_r$ = 20% the economy cannot attain the reduction of GHG without any conflicts among stakeholders. This is because the current government is more focused on improving the sustainability of GDP regardless of the environment, but with the current government's commitment through the rules to reduce emissions is expected to create a green economic growth in the near future

If government willing to obtain nr = 14% then the GRP would be down up to 1.1% before introducing reduction rate system (nr = 0%) follow by controlled GHG decreased up to 0.42% of 2.95Gt (current GHG emission in Indonesia 2005). In this sense, the government for carefully choosing the GHG reduction rate 17% which applicable to consistently keep the economic rather stable or not really a shift away from GRP that expected around 37.43 Million IDR and GHG reduction still controlled properly below 0.42% of total GHG emission in Indonesia.

**Table 1: change in GRP**

| *n* (%) | Total GRP (1000 IDR) | ZZbar (Gton) | ZZ (Gton) |
|---|---|---|---|
| 0 | 40,442,260 | 0.01451977 | 0.01437458 |
| 1 | 40,419,440 -1.1% | 0.01451977 | 0.01437458 |
| 2 | 40,396,610 | 0.01451977 | 0.01422938 |
| 3 | 40,373,790 | 0.01451977 | 0.01408418 |
| 4 | 40,350,970 | 0.01451977 | 0.01393898 |
| 5 | 40,327,840 of current GRP | 0.01451977 | 0.01379378 |
| 6 | 40,292,430 | 0.01451977 | 0.01364859 |
| 7 | 40,257,040 | 0.01451977 | 0.01350345 |
| 8 | 40,221,170 | 0.01451977 | 0.01335827 |
| 9 | 40,185,260 | 0.01451977 of 2.95Gt | 0.01321308 |
| 10 | 40,149,340 | 0.01451977 | 0.01306787 |
| 11 | 40,113,430 | 0.01451977 | 0.01292267 |
| 12 | 40,077,500 | 0.01451977 0.49% | 0.42% 0.0127775 |
| 13 | 40,041,590 | 0.01451977 | 0.0126323 |
| 14 | 39,982,170 | 0.01451977 | 0.01248701 |
| 15 | 39,168,220 98.9% | 0.01451977 | 0.01234189 |
| 16 | 37,430,350 | 0.01451977 | 0.01219661 |
| 17 | 37,430,350 | 0.01451977 | 0.01205151 |
| 18 | 33,884,140 | 0.01451977 | 0.0119063 |
| 19 | 31,985,980 | 0.01451977 | 0.01176102 |
| 20 | 28,285,410 | 0.01451977 | 0.01161582 |

note: 1 US$ = 12,500 IDR

Source: Author calculation

## 4. Conclusion

The implementation of GHG emission reduction rate in Kupang will effective along with keep economic level as high as possible as before introduce the reduction rate but on the other hands the Kupang economic cannot attain reduction more than 20% due to will cause conflict among stakeholders and governments should pay special attention and strategic action through policy interventions that favor significant economic growth in which GHG emissions remain controlled and measurable. This research become the first study in count GHG emission in the level of city through assess comprehensively in terms of economic activity in a region in Indonesia. The model enables implemented in any region including regional level. Expected the trade of between GHG emissions reduction rate and GRP (see Figure 3) will be raised up by introduction renewable energy technology (RET) and at this point a creativity region has space to analyse including its impact to global warming (Batabyal and Beladi, 2016; Shimamoto, 2017). This suggested for further research linked with a framework scenario introducing RET and waste treatment plant (Amheka et al. 2015) to support a challenge of a sustainable development more deeply analysed (Almeida, et al. 2017).

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