fuel type and diesel oil type, and a model to calculate the CO_2 basic unit was developed. The calculation flow of the CO_2 basic unit of the transportation sector is shown in Fig. 7.

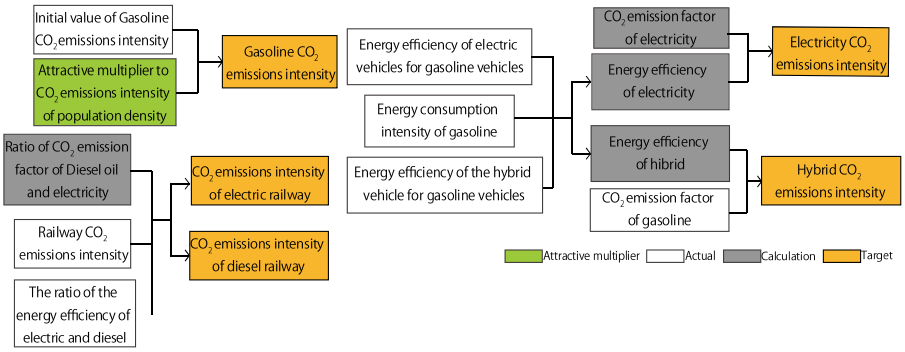

Fig.7 Calculation Flow of CO_2 Emission Intensity of the Transportation Sector

The CO_2 basic unit for gas-powered cars was calculated by the value of the first year of fiscal 1975 being multiplied by a multiplier of the growth rate of population density. CO_2 basic units for electric-powered cars and hybrid cars were calculated by taking into consideration the effect of the energy efficiency ratio of each car and the CO_2 emission factor of electricity based on the calculated CO_2 basic unit of gas-powered cars.

In the case of trains, the existing CO_2 basic unit was divided into CO_2 basic units of electricity and diesel oil using the ratio of the number of electric train cars and diesel train cars and the CO_2 emission factors and the ratio of energy effect of electricity and diesel oil, based on the existing CO_2 basic unit.

4.1 Passenger Sector

The calculation result of the CO_2 basic unit for passenger cars in the passenger sector is shown in Fig. 8.

The values of the CO_2 basic unit are in the order of smallest to largest: hybrid cars (hereafter referred to as "HV cars"), electric-powered cars (hereafter referred to as "EV car") and gas-powered cars. However, as the CO_2 emission factor of electricity has largely increased since around 2000, the CO_2 emission factor of EV cars also has increased, so that it is required to discuss future measures.

The calculation results of CO_2 emissions of the passenger cars in the passenger sector are shown in Fig. 9. As the proportion of EV cars and EH cars is very low, their CO_2 emissions also are very small and gas-powered cars count for the majority of CO_2 emissions. The errors from 2005 to 2009 are on the large side.

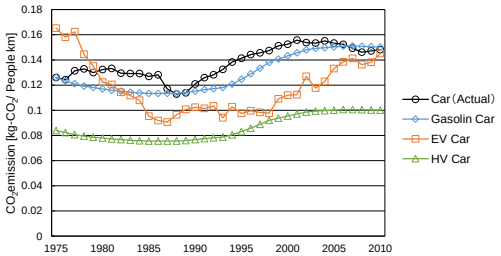

Figure.8
Calculated Result of CO_2 Basic Unit

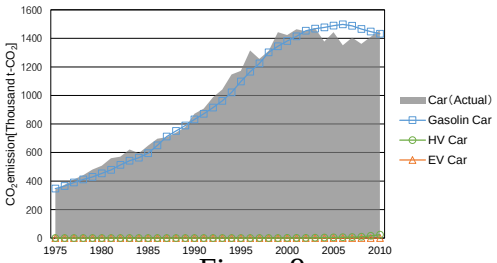

Figure.9
Calculated Result of CO_2 Emission

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4.2 Cargo Sector

The CO_2 basic unit of trains in the cargo sector is shown in Fig. 10.

The CO_2 basic unit of trains has been stable since 1987. The CO_2 basic unit of the electric drive is a little larger than that of diesel drive.

The CO_2 emission of trains in the cargo sector is shown in Fig. 11.

The calculation values of CO_2 emissions in the railroad sector are a little larger than the actual ones.

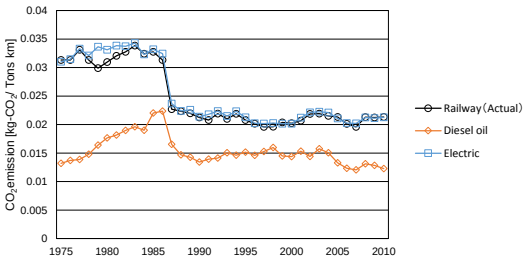

Figure.10
Calculated Result of CO_2 Basic Unit

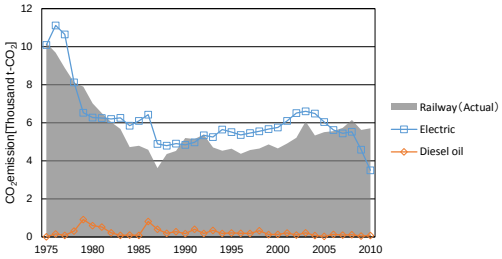

Figure.11
Calculated Result of CO_2 Emission

5. Discussion of the Scenario

The effect of the scenario up to 2050 was discussed using a developed prediction model of the CO_2 basic unit. An outline of the examination items is shown in Table 3.

Table3 Summary of Scenario

Scenario	Summary
BAU Scenario	Remained at status quo (I make a comparison of the new model and the old model)
Renewable Energy Scenario	Production of electricity from renewable energy increase at a constant rate to be about 4.5 times the current in 2030(target of Fukuoka) (renewable energy is pv, wind, geothermal heat, and other) It increase at the same rate after 2030
EV Scenario1	Total percentage of HV and EV to be 54% in 2050 EV is 14%, and HV is 40%
EV Scenario2	Without changing the penetration of next-generation vehicles, EV is 30% , and HV is 24%
Wood Construction Scenario	2015 and later commercial buildings will be wooden, carbon dioxide is to be reduced by Carbon fixed amount.(Useful life is 20 years)(50% of the new construction and, 1% of the existing as of the wooden each year)

The calculation result of the BAU scenario is shown in Fig. 12. Although all nuclear power plants in Japan are shut down as of August 2014, because the Japanese government expresses its policy to continue to operate its nuclear power plants, in the BAU scenario of this research, it is supposed that the nuclear power plants will be operated again and it will keep the nuclear power generation amount at the same level as 2010 in and after 2011. In the consumer sector, CO_2 emissions have been calculated to be larger than the old model since 2005. In the old model, the actual value was used as a CO_2 emission factor, and the actual value of 2010 was fixed as the CO_2 emission factor in and after 2011. Although the new model is used to calculate CO_2 emission factor from the total amount of electric consumption and others, errors occurred because the decrease in energy consumption caused by the worldwide economic slowdown since 2007 could not be reproduced. The energy consumption in the consumer sector is also easily affected by the CO_2 emission factor of electricity because the proportion of electricity is so large in energy consumption. In the transportation sector, the CO_2

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emissions of the old models and new models were very similar. CO_2 emissions by the new model were 8 million tons in 2050, and compared with the old model, they had increased by approximately 8%.

The calculation results from the renewable energy scenario are shown in Fig. 13. In the renewable energy scenario, it was presumed that, based on the targeted value by Fukuoka City to increase the power generation amount by renewable energy by 4.5 times, it was presumed that the power generation by renewable energy would continue to increase at the same rate even after 2030. The electric generation by renewable energy will be 6.54 million GJ in 2030 and 11.63 million GJ in 2050. According to calculation results, CO_2 emissions by the renewable energy scenario greatly decrease more than in the BAU scenario because the proportion of power generation amounts is changed. It is greatly affected by the decrease in the proportion of thermal power generation because the proportion of power generation by renewable energy has increased in the total power generation amount. CO_2 emissions are approximately 4.43 tons in 2030 and it is a decrease of approximately 11% compared to the BAU scenario. CO_2 emissions are approximately 3.88 million tons in 2050 and it is a decrease of approximately 24% compared with the BAU scenario.

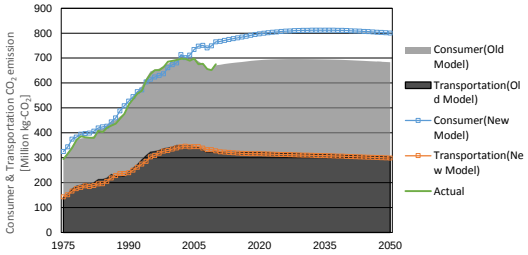

Figure.12 BAU Scenario

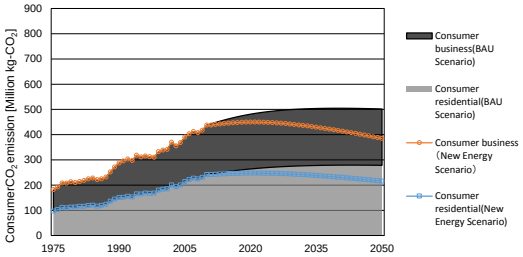

Figure.13 Renewable Energy Scenario

The calculation results of the EV scenarios are shown in Fig. 14. According to EV scenario-1, CO_2 emissions have gradually decreased since 2011 with the increase in EV cars and HV cars. The number is approximately 1.96 million tons in 2050 and it is a decrease of approximately 12% compared to the BAU scenario. CO_2 emissions by EV scenario-2 decreased by approximately 0.1 million tons more than in EV scenario-1. Because EV cars are affected by energy resources composition, it can achieve a larger CO_2 reduction effect when the proportion of nuclear power generation increases or the introduction of new energies progresses.

The calculation result of the wood construction scenario is shown in Fig. 15 and the integrated values of CO_2 emissions since the first year of 2015 are shown in Fig. 16. The Carbon fixed amount is determined by the kind of wood used. In this research, larch is supposed to have been used.

According to the wood construction scenario, CO_2 emissions slightly decreased from the starting year of this scenario in 2015. Due to the decline of the numbers of newly constructed buildings and non-wood buildings, the reduction amount of CO_2 emissions is decreasing year by year. This scenario is structured so that 1% of not only newly constructed buildings, but also existing non-wood buildings would be constructed with wood every year. Therefore, the reduction of CO_2 emissions is largest at the time of the scenario's beginning in 2015. After 2035 when the dismantling of the buildings built in 2015 starts, the CO_2 emissions released at the time of dismantling are larger than the reduced amount caused by new construction. Therefore annual CO_2 emission is larger

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than in the BAU scenario.

The comparison of the integrated values of CO_2 emissions by wood construction scenario and BAU scenario show that the CO_2 reduction amount is only 1%.

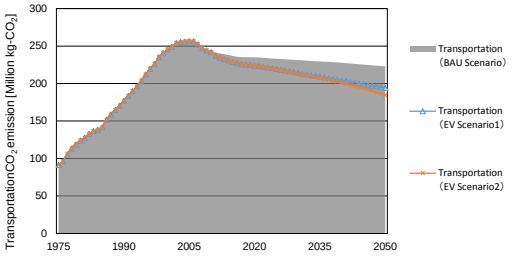

Figure.14 EV Scenario

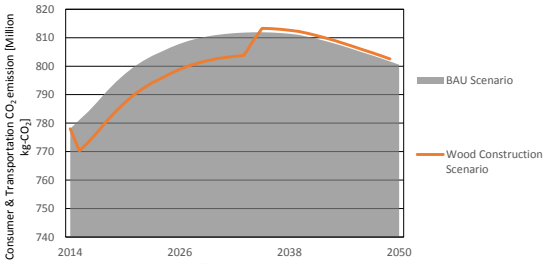

Figure.15 Wood Construction Scenario

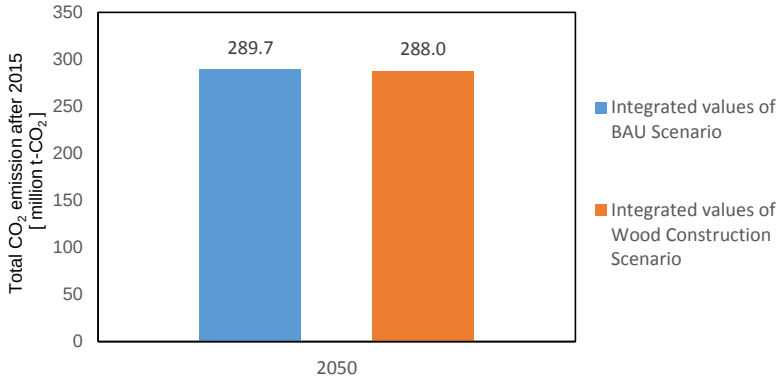

Figure.16 Comparison of the Integrated Values of CO_2

6. Conclusion

In this report, a model was developed for the calculation of the CO_2 basic unit in the consumer and transportation sectors and the effect of the prevalence of renewable energy and EV cars to CO_2 emissions was predicted by the developed model.

As a result, it was confirmed that increases in renewable energy are very effective in the reduction of CO_2 emissions. In the transportation sector, because EV cars are affected to the energy resources composition and EV cars are expected to increase in the future, it is considered to be important to decrease the CO_2 emission factor of electricity and consider alternative energy source in place of electricity. The carbon fixed amount of wood construction is very small, because when a wood building is dismantled, CO_2 is released into atmosphere eventually, so that a large effect cannot be expected. It is necessary to think of ways to fix carbon for a long time such as re-using wood materials after dismantlement.

References

1) Takahiro YAMAMOTO, al. - Development of a Simulator for Long-term Prediction of Urban Environmental Load and CO2 Emission Prediction in Civilian and Industrial Sectors, -The Yellow Sea Rim International exchange Meeting on building environment and energy, pp209-218, 2011

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