

Analysis on Vietnam's NDC Reduction Target and Further Decarbonization using AIM/Enduse

Takaharu Ota^{*1}, Tomoki Hirayama^{*1}, Yuko Motoki^{*1} and Go Hibino^{*2}

*1 Mizuho Research & Technologies, Ltd. (MHRT) *2 National Institute for Environmental Studies (NIES)

Background	Purpose
In Vietnam, the economy has been growing dramatically and GDP growth rate was above 7% in 2018 and 2019, even under the COVID-19 pandemic, still 2.91% in 2020. Also CO2 emission is increasing, CO2 emission per capita has doubled in the last 10 years. Vietnam's urgent issue is to reduce emission with maintaining its economic development. Vietnam's updated NDC indicates that the emission reduction is increased from 9% to 27% by 2030 with international support under the Article 6 th of Paris Agreement.	 Exploring the Potentiality CO2 emission reduction in Vietnam by 2030 Identification of emission pathway and emission peak in Vietnam by 2050 Consideration of Vietnam's strategies for further decarbonization and contribution of supports from developed countries

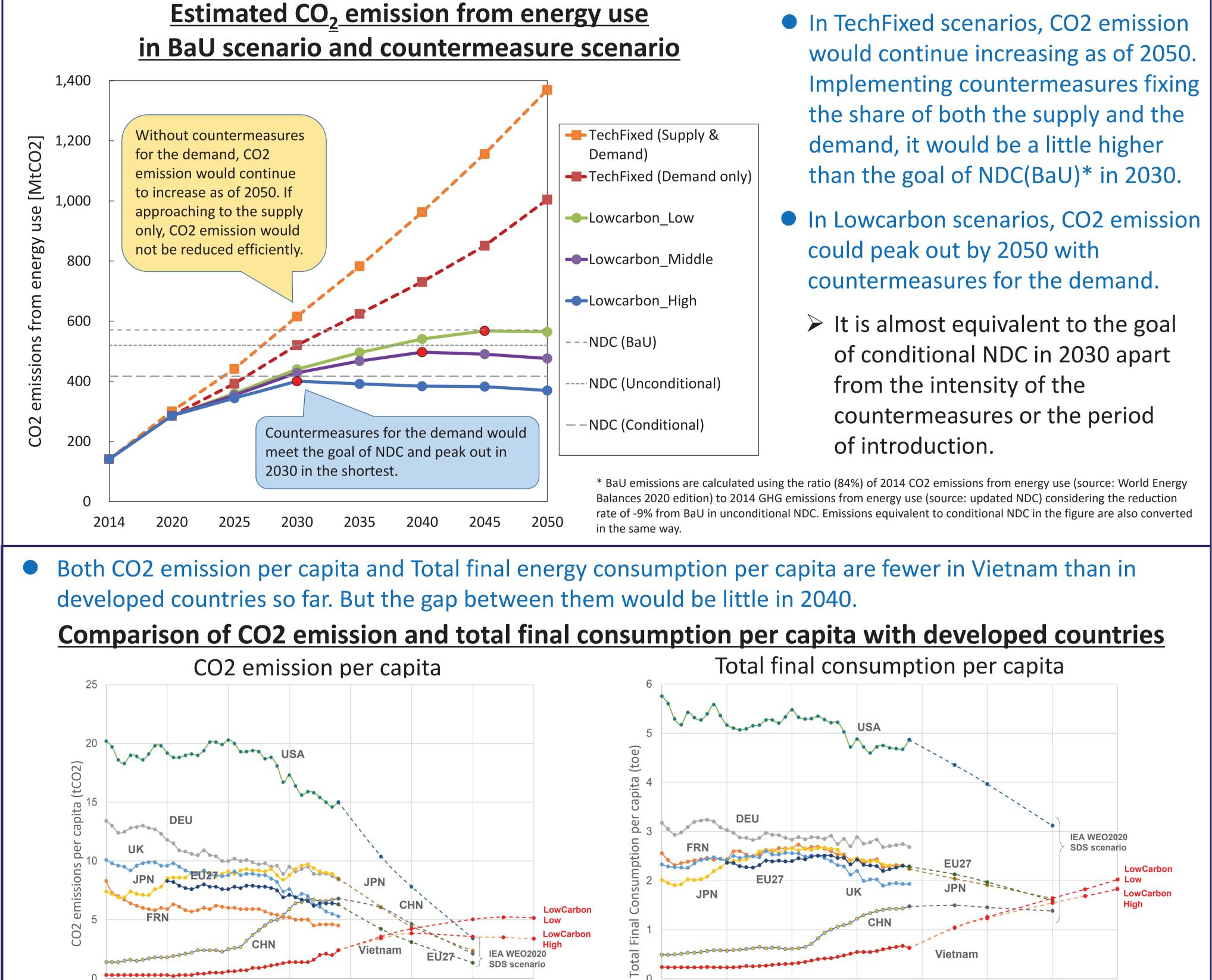
Methodology

<u>ivioaei stri</u>	ucture of Ally	<u>//Enduse</u>	<u>Assump</u>	tion of co	unterr	nea	isures ar		serv	<u>/ICE</u>	<u>e ae</u>	<u>:ma</u>	na
							Intensity of countermeasures *						
Energy	Energy Technology	Energy Service	Countermeasure	Detail	Sector		Device	Tech	Fixed		La	owcarbon	2
- Oil - Coal	- Boiler - Power generation	- Heating - Lighting					Sup	oply & mand	Dema only		Low	Middle	High
- Gas - Solar - (Electricity)	- Blast furnace - Air conditioner - Automobile	- Steel products - Cooling - Transportation	Renewable	Conversion from fossil fuels to renewables	Power			_	Δ			0	Ø
Energy Consumption	Technology	Service Demand	Energy saving	Introduction of high efficiency devices	All			_	_		0	0	Ø
CO2 emission	Selection		Fuel conversion	Conversion from coal and traditional biomass to oil and gas	All			_	_		0	0	Ø
01	echnology Database S	Socio-economic Scenario	Electrification	Introduction of	Building	Heat pu IH cook	mp, ing device	_	_		Δ	0	Ø
 Energy type Energy price Energy constraints 	- Energy consumption - Service supply	- Economic Growth - Industrial Structure	Electrification	electric device	Transport	Electric Hybrid d	vehicle, car	_	_		Δ	0	Ø
- CO ₂ emission factor	- Share	- Employees	ccs	Introduction of CCS	Cement			-	_		\triangle	0	0
	- Lifetime	- Lifestyle	003	Introduction of CCS	Power			-	_		\bigtriangleup	0	Ô
inimize Total Cost (TC) at year t	• Service demand	• <u>Stock dynamics</u>	Hydrogen	Introduction of hydrogen device	Transport	Fuel cel	l vehicle	-	_		-	0	Ø
C = Initial investment cost (\$)	$D(j) \leq \sum_{l} A(j,l) \cdot X(l)$ $D(j) : \text{Service demand quantity of service type } S(l) = \overline{S}(l) \cdot \left(1 - \frac{1}{T(l)}\right) + r(l) - w(l)$	$^{\circ}$ * Δ , O and \odot are intensities of countermeasures. They mean the intensity is low, middle and high respectively.											
$cost (\$/year) \qquad A(j,l): C$ $+ Energy cost (\$/year) \qquad X(l): C$				2030 2050				2014		2030		2050	
	<i>A</i> (<i>j</i> , <i>l</i>) : Output of service <i>j</i> per unit operation of devic <i>X</i> (<i>l</i>) : Operating quantity of device <i>l</i>	$\overline{S}(l)$: Stock of device l in the previous year $T(l)$: Life time of device l	Sector	Unit Service Demand Index Service Demar					Service Demand	I TOOT	ervice emand In	ndex Serv Dem	
+ Payment for energy tax (\$/year) + Payment for emission tax (\$/year)		r(l) : Recruited quantity of device l $w(l)$: Retired quantity of device l	Steel (production) M	Iton 6 100	48 812 64	1,094	Residential	ktoe	12,624	100 1	17,024	135 22,	524
			Cement(production) M	Iton 61 100 1	40 230 164	269	Service	ktoe	2,472	100	7,298	295 23,	118 9
			Other Industry k	toe 15,072 100 44,4	95 295 83,468	554	Transport (passenger)	Bpkm	385	100	960	249 1,9	919 4
									00	100	001		00811

$\begin{array}{c c c c c c c c c c c c c c c c c c c $	s *
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	carbon
Gas - Solar - (Electricity)- Biast furnace - Air conditioner - Coling - TransportationRenewableConversion from renewablesPowerAA- (Electricity)Technology SelectionService DemandService DemandAllO- Energy Database - Energy type - Energy price - Energy price - Energy price - Share - Unitial cost, O& Moost - Service supply - Share - Initial cost, O& Moost - Service supply - Share - Initial cost, O& Moost - Service supply - Share - Unit diversion for - Service supply - Service supply - Service supply - Service supply <b< th=""><th>ddle Hig</th></b<>	ddle Hig
Introduction of high cO2 emissionAllOTechnology SelectionService DemandEnergy Database - Energy type - Energy type - Energy consumption - Energy onstraints - Co2 emission factorSocio-economic Scenario - Population - Economic Growth - Industrial Structure - Emergy onstraints - Co2 emission factorAllO• Introduction of electric deviceAllO• Energy type - Energy consumption - Service supply - Struice supply - Identification• Socio-economic Scenario - Population - Economic Growth - Industrial Structure - Employees - UffettimeO• Mitide Total Cost (TC/ at year t - Unitimexment cost (S) - Co2 emission factor• Socio-economic Scenario - Population - Economic Growth - Industrial Structure - Employees - Uffettime• Socio-economic Scenario - Population - Economic Growth - Industrial Structure - Employees - Uffettime• Operating and maintenance - cost (Sycar) + Pomergif cor energy cost (Sycar) + Pomergif cor energy cost (Sycar)• Socio-economic Scenario - Employees - Uffettime*• Operating and maintenance - Co2 emission for energy cost (Sycar) + Pomergif cor energy cost (Sycar)• Socio-economic Scenario - Employees - Uffettime• Socio-economic Scenario - Energy cost (Sycar)• Operating and maintenance - Co2 emission for energy cost (Sycar) + Pomergif cor energy cost (Sycar)• Socio-economic Scenario - Ener	o o
$\frac{1}{1} = \frac{1}{1} = \frac{1}$	o 🛛 🔊
$\frac{1}{1 \text{ lnergy type}} = \frac{1}{1 \text{ lnitial cost}, 0 \text{ SM todase}} = \frac{1}{1 \text{ lnitial cost}, 0 \text{ Sm todase}} = \frac{1}{1 \text{ lnitial cost}, 0 \text{ sm todase}} = \frac{1}{1 \text{ lnitial cost}, 0 \text{ lnitial cost}, 0 \text{ sm todase}} = \frac{1}{1 \text{ lnitial cost}, 0 \text{ lnitial cost}, 0$	⊃ ©
$\frac{-\operatorname{Energy type}{Energy onstraints}{Energy constraints} - \operatorname{CO}_{2} \operatorname{emission factor} = \operatorname{Energy constraints} - Ener$) ©
$\frac{-\operatorname{Share}}{\operatorname{CO}_{2}\operatorname{emission}\operatorname{factor}} - \frac{\operatorname{Share}}{\operatorname{Lifetime}} - \frac{\operatorname{Introduction}}{\operatorname{Integ}\operatorname{Voltatints}} - \frac{\operatorname{Share}}{\operatorname{Lifetime}} - \frac{\operatorname{Introduct}}{\operatorname{Integ}\operatorname{Voltatints}} - \frac{\operatorname{Share}}{\operatorname{Introduction}} - \frac{\operatorname{Introduct}}{\operatorname{Introduction}} - \frac{\operatorname{Introduct}}{\operatorname{Introduction}} - \frac{\operatorname{Introduct}}{\operatorname{Introduct}} $	o c
$\frac{1}{10000000000000000000000000000000000$) (O
$\frac{\operatorname{inize} \operatorname{Total} \operatorname{Cost} (\operatorname{TC}) \operatorname{at} \operatorname{year} t}{\operatorname{Initial} \operatorname{investment} \operatorname{cost} (\$)} + \operatorname{Operating} \operatorname{and} \operatorname{maintenance} \\ \frac{\operatorname{cost} (\$/\operatorname{year})}{\operatorname{t} + \operatorname{Energy} \operatorname{cost} (\$/\operatorname{year})} + \operatorname{Energy} \operatorname{cost} (\$/\operatorname{year}) \\ + \operatorname{Payment} \operatorname{for} \operatorname{energy} \operatorname{tax} (\ast/\operatorname{year}) \\ + \operatorname{Payment} \operatorname{for} \operatorname$) (O
$Initial investment cost (\$) \\ + Operating and maintenance cost (\$) \\ + Operating and maintenance cost (\$/year) \\ + Energy cost (\$/year) \\ + Payment for energy tax (\$/year) $	⊃ ©
+ Operating and maintenance Image: Cost (s/year) D(j) : Service demand quantity of service j per unit operation of device l S(l) : Stock of device l S(l) : Stock of device l Service Index Servi	
$\frac{1}{S(t): Stock of device l in the previous year}{F(l): Recruited quantity of device l}$	2050
[Steel (production) Mten 6 100 48 812 64 1004 Residential 12624 100 17024 100 100 17024 100 17024 100 17024 100 17024 100 17024 100 17024 100 17024 100 17024 100 100 17024 100 100 100 17024 100	Service Demand
+ Payment for emission tax ($\$$ /year) w(l): Retired quantity of device l Steel (production) Mton 6 100 48 812 64 1,094 Residential ktoe 12,624 100 17,024	5 22,524
Cement(production) Mton 61 100 140 230 164 269 Service ktoe 2,472 100 7,298	5 23,118
Other Industry ktoe 15,072 100 44,495 295 83,468 554 Transport (passenger) Bpkm 385 100 960	9 1,919

- Using AIM/Enduse, we estimate CO2 emissions from energy use in Vietnam up to 2050.
 - \succ AIM/Enduse model selects technologies to meet the service demand with minimizing the total cost.
 - > TechFixed scenarios are set as BaU, which are subdivided to two, "TechFixd (Supply & Demand)" and "TechFixed (Demand) only)".
 - \succ Lowcarbon scenarios are set as countermeasures, which are subdivided to three, "Lowcarbon_Low", "Lowcarbon_Middle" and "Lowcarbon_High" by the intensity of countermeasure and the period of introduction.
 - \succ Refers to Vietnam Population Projection 2014 2049 (GSO, 2016) at population, DRAFT PDP8 (MOIT, 2021) at GDP growth rate, and expectancy data by Vietnamese government at energy source, service demand and energy price etc.

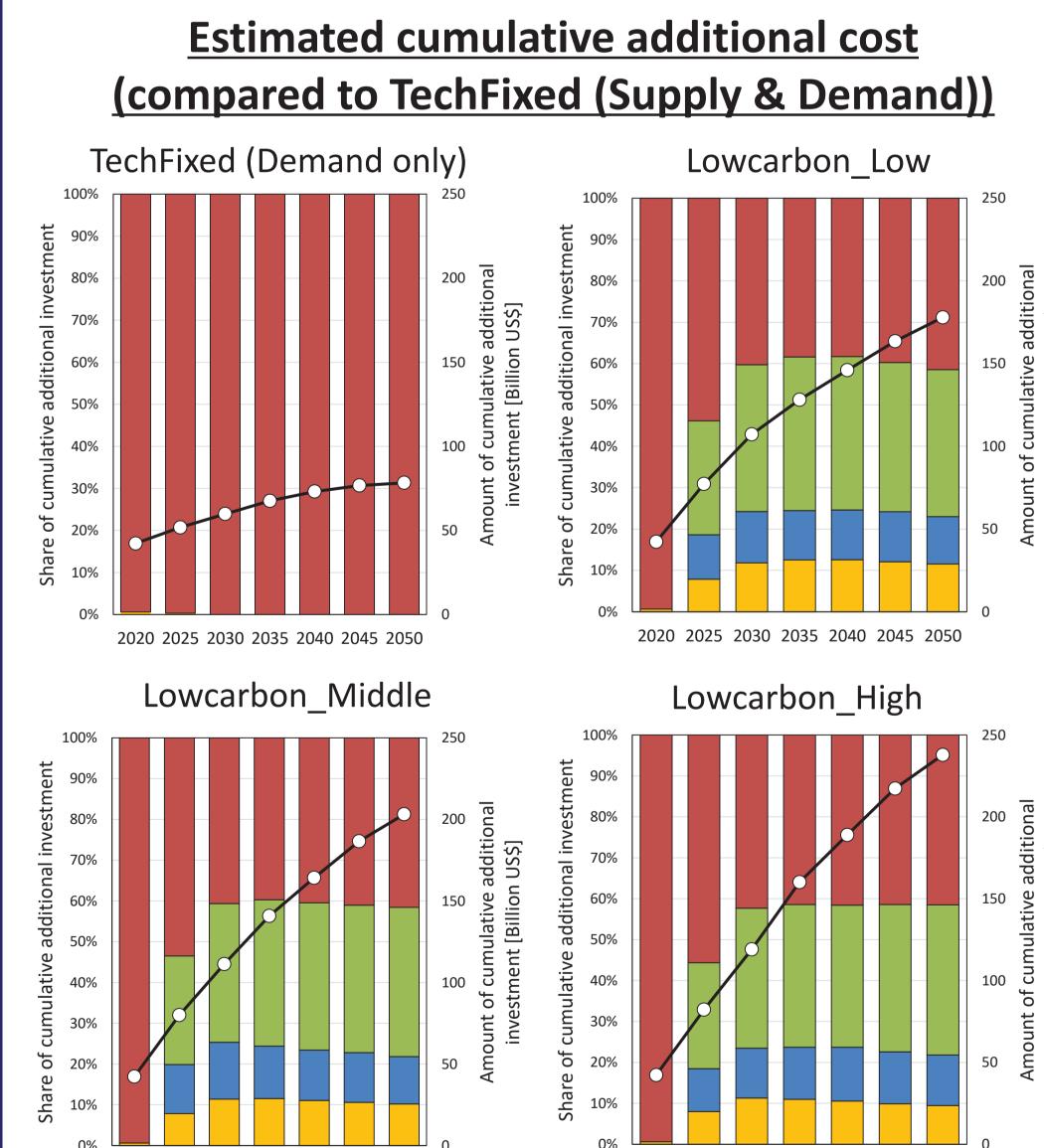
Result



- In TechFixed scenarios, CO2 emission
- Implement the strictest countermeasures, the amount of cumulative additional investment is around 240 billion USD, around 1% of total sum of GDP from 2014 to 2050.
- The amount of cumulative additional investment is required especially in energy sector and transport sector.
 - Developed countries could give technical and financial support in energy sector and transport



sector.



1980 1990 2000 2010 2020 2030 2040 2050 1980 1990 2000 2010 2020 2030 2040 2050	2020 2025 2030 2045 2050 2020 2025 2030 2045 2050
CO2 of CHN, EU27, JPN, USA in 2025, 2030, 2040 from IEA World Energy Outlook 2020 Sustainable Development Scenario CO2 of Vietnam in 2025, 2030, 2040, 2045, 2050 from this analysis (Lowcarbon Low ~ High) CO2 from 1980 to 2018 of all countries and region from IEA CO2 emissions. Population from UN World Population Prospects 2019	Industry Building Transport Energy —Cumulative additional investment
Next Step	
 Explore more efficient scenarios to drive down emissions toward Net-zero after peaking out. Continue to update the technical data and reflect on further analysis of Vietnam, in concert with researchers and 	policy makers.
Conclusion	
 If following Vietnam's current power plan without countermeasures for the demand, CO2 emission would not pea Adopting countermeasures for the demand, with early and broad introduction, CO2 emission could peak out in 20 NDC. 	•

- In Vietnam CO2 emission per capita and total final consumption per capita would be equivalent to or larger than those of developed countries in 2040, which requires Vietnam further climate action to lower its emissions.
- Additional investment to reduce CO2 emissions is needed particularly in energy sector and transport sector in Vietnam, supported by developed countries including Japan.

AIM Acknowledgement : We express our sincere thanks to Mr. Tan, Dr. Lam and Dr. Bao