Brief introduction on identified technologies with higher priority in each sector

JICA SPI-NAMA/
Low Carbon Technology Assessment Team

28 Aug, 2017

Introduction

1. Seven sectors are considered under the SPI-NAMA/LC-Tech Assessment.
2. Technology catalog is developed and evaluate along with criteria that were determined by series of consultations.
3. Based on expert judgement, approximately 40 LC technologies are prioritized.

NDC implementation toward Low Emission Development

NDC

A national climate change action strategy aiming to GHG emission reduction

Energy /Transport

- 17 options are identified, 10 options from Energy efficiency and industry, 7 options from Power generation, 3 options from transport sector.
- It reflects National Target Program on Energy Efficiency (2006), Law on Economical and Efficient Use of Energy (2010) as well as the Power Development Master Plan No. VII (2011).

Agriculture

- 11 out of 15 options are higher priority.
- It mainly consist of crop production subsector related activities, followed by irrigation, livestock and fisheries subsectors.

LULUCF

- 9 options including protection national/coastal forest, plantation of coastal forest, national forest regeneration are described.
- It reflects the goal that *Viet Nam will reduce its GHG emissions by 8% by 2030 compared to the BAU scenario.*

Waste

- 4 options are identified namely organic fertilizer production, landfill gas recovery, recycling of solid waste and anaerobic treatment of organic solid waste.
- Mitigation measures are identified in the policy document of the waste sector in Viet Nam, i.e. “Decision No.2149/QD-TTg”.

Added!

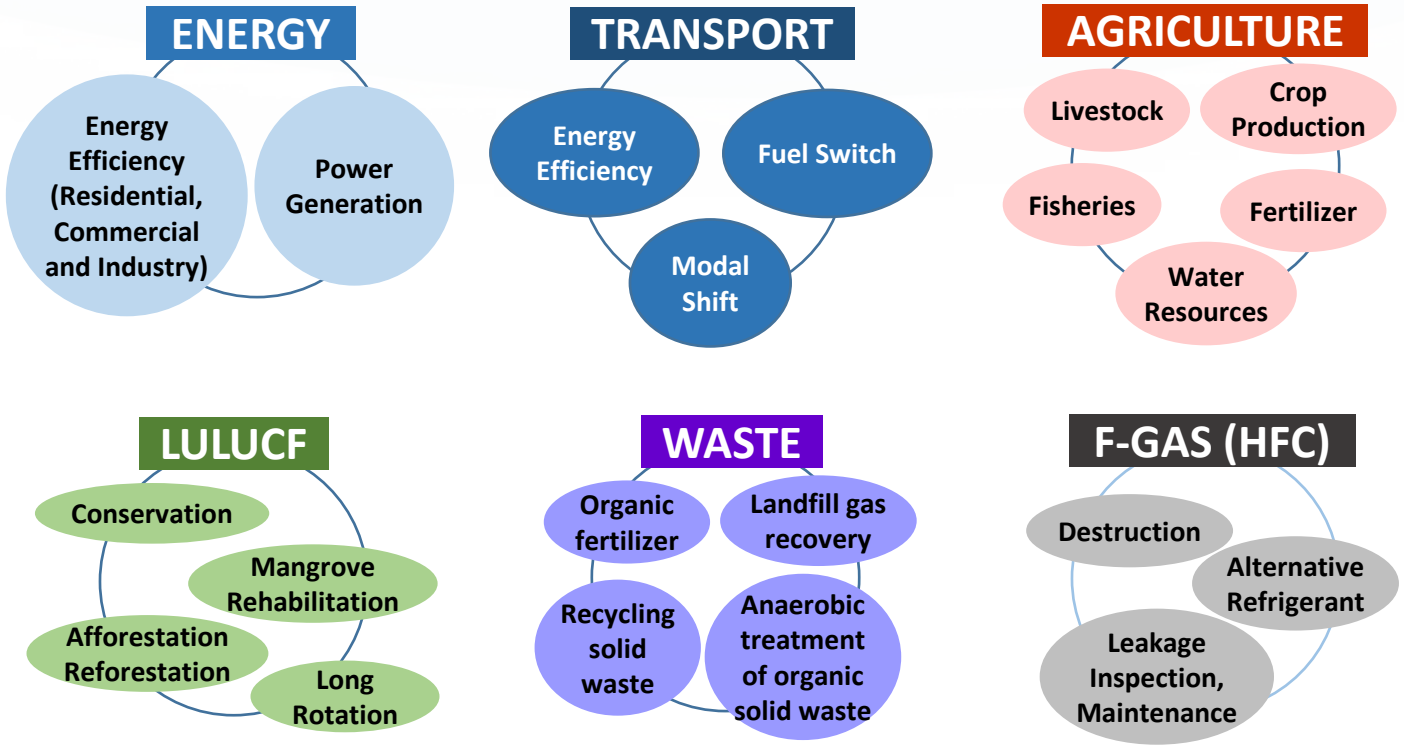
F-gas

- F-gas sector is not included in the INDC, yet it has high potential for GHG emission reduction.
- There is no regulation is developed in Viet Nam.

Implementation →

Low Emission Development

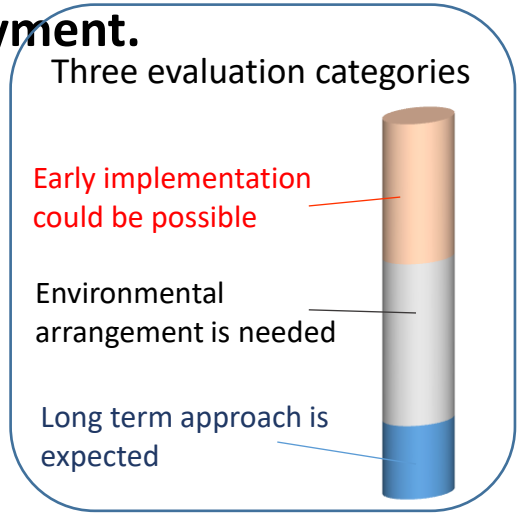
Sub-sector categories in the 7 sectors



- Technologies in Low Carbon Technology Catalogue are classified based by sectors/subsectors
- The F-gas related actions were originally not included in the INDC therefore three sub-sectors are newly identified in this assessment work.
- Additional seven sub-sectors (Road, Railway, Inland water way and Maritime, Aviation, Biofuel, Natural Gases and Electricity) are defined in the transport sector in addition to original options.

Summary of Evaluation

- 143 technologies out of approx. 150 are covered by the evaluation.
- Evaluation was conducted with six common criteria and sector specific criteria.
- Outputs are categorized in three groups, namely:
  - Technologies for early implementation;
  - Technologies for deployment when surrounding condition are consolidated;
  - Technologies which may take a long term for deployment.
- Expert judgement will be applied on overall evaluation in each sector
- Inter sectoral evaluation are not subjected.
- Details are provided in the publication (Oct, 2017)



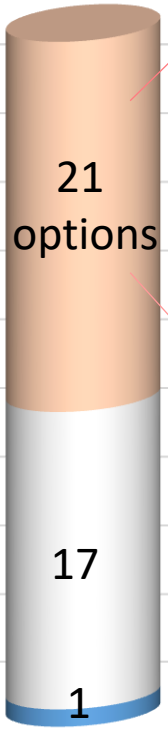
Energy

(Industrial, residential and commercial energy efficiency) and Industrial process

Sub-sector	INDC option	Technology
Residential and commercial	High efficiency air conditioner for household **(E1)**	Inverter air conditioner, Constant-speed air conditioner
	High efficiency residential refrigerators **(E2)**	Inverter compressed type (Insulator/ Insulation type)
	High efficiency residential lighting **(E3)**	LED, CFL (Bulb, F tube)
	Solar water heaters **(E4)**	Hot water tank, Heat collection unit
	High efficiency commercial air conditioning **(E10)**	Building multi air conditioner
	Green building	Building multi air conditioner, LED, Pair glass, High efficiency insulator
Industry	Cement-making technology improvements **(E5)**	Waste heat recovery, Dry kilns with multistage pre-heaters and vertical calcination, Vertical roller mill, Kiln shell heat loss reduction, VFD installation, Combustion optimization
	Brick-making technology improvements **(E6)**	Traditional brick kilns replaced with vertical shaft brick kilns
	Pulp and paper	Efficient debarking, Batch digester modification to have indirect heating, Low pressure drop centre cleaners, Falling film evaporator, etc.
	Steel	Coke dry quenching, WHR-based power generation, Heat recuperation from hot blast stoves, Sintering plant heat recovery etc.
	Refinery	Online furnace cleaning, Optimization of power consumption in utility boiler drives and auxiliaries, Steam savings by trap management etc.
	Beverage	Pasteurizer heat pump system, Cascade cooling system, CO_2 recovery, Heat recovery from bottle washer, Biogas recovery boiler
	Fertilizer	Calcium silicate insulation of high pressure steam pipe line, Isothermal CO conversion reactor, High conversion Rate synthesis reactor

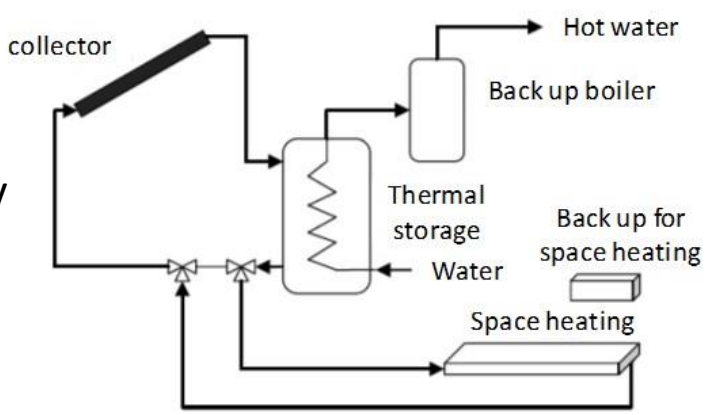
Energy
(Industrial, residential and commercial energy efficiency) and Industrial process

38 technologies are identified



E4 Solar Water Heaters

Solar water heater collects solar thermal energy by a solar energy absorber to warm water or air for hot water supply or air-conditioning.



Mitigation Potential	0.46 tCO_2eq/year/unit (Cumulative 4.84 $MtCO_2eq$ in 2010-2030)
(Initial) Cost	7 million VND/unit

Industry –Refinery (Additional option)

Online cleaning technique applied to the radiating and convicting areas of process furnaces, is able to remove the ashes and deposits accumulated at the tube's surface, achieving an immediate improvement on the furnace performance.

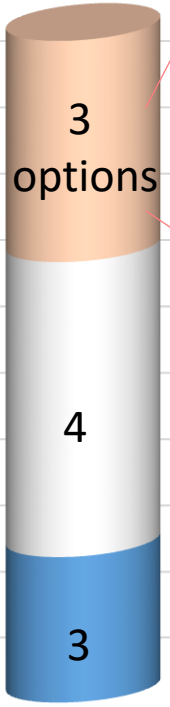
Mitigation Potential	0.02 $MtCO_2$/year
(Initial) Cost	0.13 USD/ton

Energy (Power generation)

Sub-sector	INDC option	Technology
Power generation	Biomass and generation **(E11)**	Direct burning of wood, Agricultural crops, Cogeneration equipment, Combustion boiler
	Small hydropower plants **(E12)**	Reservoirs, Dam, Water transfer channel, Run-of-river type for micro Hydro power plant
	Wind power plants **(E13 &E14)**	On-shore, off-shore
	Biogas power plants **(E15)**	Sewage and agricultural material use
	Coal power plants **(E16)**	Coal power plants
	Solar PV power plants **(E17)**	Roof-top, Ground-mounted
	Natural gas plants	Combined cycle gas turbine
Power transmission and distribution	High efficiency power transmission line	Heat-resistant conductor type, Phase separate with large cross section, Upgrade to smart grid, Low-loss conductor
	High efficiency transformer	Amorphous alloy

Energy (Power generation)

9 technologies are identified



E17 Solar PV Power Plants

The conversion of sunlight directly into electricity using photovoltaic cells. PV systems can be installed on rooftops, integrated into building designs and scaled up to megawatt scale power plants.

Mitigation option	**2020:876-919 $ktCO_2$/year 2030:12,480-13,790 $ktCO_2$/year**
Cost	**2,500 VND/kW**

E11 Biomass Power Plants

Bioenergy is a form of renewable energy derived from biomass to generate electricity and heat. Biomass is any organic matter of recently living plant or animal origin, available in many forms such as agricultural/forestry products, and municipal and other waste.

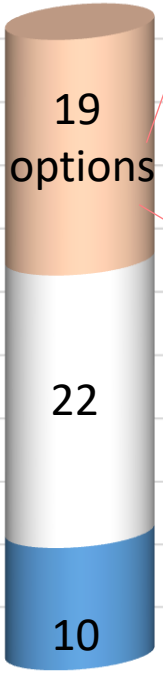
Mitigation option	**For Biomass and Biogas Power Plant, 2020:1,752-1,838 $ktCO_2$/year 2030:7,942-8,775 $ktCO_2$/year**
Cost	**1,220 VND/kW for sugar mill, 1,800 VND/kW for rice husk 2,000VND/kW for biogas, 4,500 VND/kW for domestic waste**

Transport

Category	INDC option	Technology
Modal Shift	Passenger **(E8)**	Urban railway (Metro, LRT, Monorail), Inter-city railway (high speed railway), Bus (BRT), Promotion of public transportation (IC card, automatic ticket gate, bus location system, Park & Ride)
	Freight **(E9)**	Shift from road to railway (Development of access railways to ports, Introduction of new freight car, large size container, Renovation of rail tracks, Development/improvement of railway freight terminal / ICD and set up necessary equipment), Shift from road to water way (Development/improvement of water way freight terminal, development of harbor road, Canal, Port), Multi-modal promotion
Energy efficiency	Road	Improvement of fuel efficiency for vehicle (Eco-driving), Improvement of traffic flow (ITS, Infrastructure), Others (LED light for highway, Promotion of bicycle use)
	Railway	Urban and inter-city railway (Energy Efficient railway vehicle, Energy Efficient appliance and renewable energy for station /depots), inter-city railway (Engine and Locomotive renovation)
	Inland waterway and maritime transport	Port (energy efficient cargo handling machinery, on-shore power supply system, energy efficiency chiller container, renewable energy), Vessel (technical renovation, transformation, waterway vehicles, utilize vessels, improvement of energy efficiency in ship building yard)
	Aviation	Airport (APU to GPU, Renewable energy, Electric vehicle, LED light), Air craft
Fuel switching	Biofuel **(E7)**	Ethanol, Biodiesel (Railway and motor vehicle use)
	Gaseous fuel	CNG, LPG (CNG use in bus, truck and taxi)
	Electricity	Electricity (Electric bus, taxi and bike), Hybrid (Hybrid bus, taxi, and bike)

Transport

51 technologies are identified



E8 Passenger Transport Modal Shift from Private to Public

Various measures to promote passenger modal shift, such as development of urban/inter-city railways (e.g. metro, LRT (Light Rail Transit), tram, monorail, high-speed railway), development/improvement of bus routes/ BRT, and inland waterways.

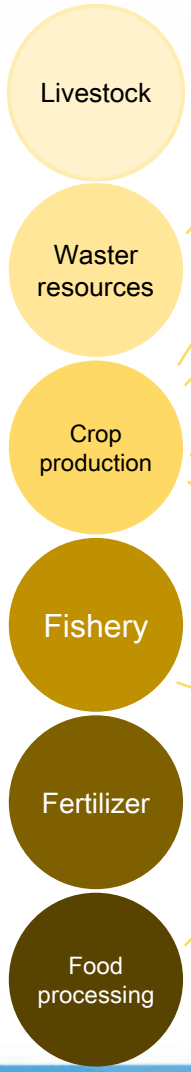
Mitigation Potential	**Examples of urban railways: 38,267 tCO2/year for Hanoi Line 1; 41,579 tCO2/year for Hanoi Line 2; 88,678 tCO2/year for HCMC Line 1**
(Initial) Cost	**Examples of urban railways**: 1,455 million USD (Hanoi Line 1); 1,363 million USD (Hanoi Line 2); 2,183 million USD (HCMC Line 1) (1 USD= 110 JPY)

E9 Freight Mode Shift from Road to Railway

Many measures should be taken such as development/improvement of railway freight terminal/ICD, renovation of rail tracks, and access roads. Also, necessary equipment/facilities should be introduced to handle the cargo from trucks to ships, e.g. introduction of new freight car, large size container, and high-top lifter at rail freight terminals..).

Mitigation Potential	**305 $MtCO_2$/year (Transportation of rubber products; Shift from Truck 810km -> Railway 859km + Truck 35km)** **405 $MtCO_2$/year (Transportation of miscellaneous goods; Shift from truck to railway).**
(Initial) Cost	223 thousand USD (for trailer and 31 feet containers) (1 USD= 110 JPY) 573 thousand USD (for 31 feet containers, tractor head, etc.)

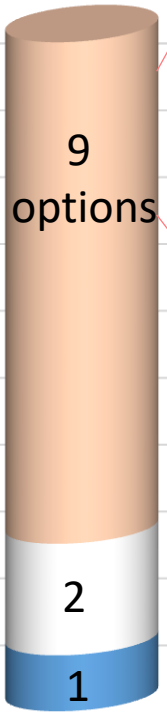
Agriculture



INDC option	Technology
Increase use of biogas **(A1)**	Biogas digester, Biomethanation and power generation
Improvement of livestock diet **(A11)**	Feed-use amino acid (Feed-use Lysine) for pigs and chickens
Alternate wetting and drying (AWD) and, improved rice cultivation **(A3, A9)**	High efficiency pump, Solar pump, Rehabilitation of irrigation canal
Reuse of agricultural residue as organic fertilizer **(A2)**	On-farm composting from agriculture residue
Introduction of Biochar **(A4, A10)**	Biochar manufacturing equipment
Integrated crop management (ICM) **(A5, A6)**	High efficiency pump, Biochar manufacturing equipment
Reuse of upland agricultural residue **(A8)**	On-Farm Composting, Biochar
Improved irrigation for coffee **(A14)**	Drip irrigation, High efficiency pump, Solar pumping system
Improvement of quality and services available for aquaculture, such as inputs and foodstuff **(A12)**	Effluent treatment, Biomethanation
Improvement of technologies in aquaculture and waste treatment in aquaculture **(A13)**	Biomethanation and power generation
Substitution of urea with SA fertilizer **(A7)**	Energy efficient gas-based production unit
Improved technologies in food processing and waste treatment in agriculture, forestry and aquaculture **(A15)**	High efficiency cooling for chilling and freezing facilities in cold chain process

LULUCF

12 technologies are identified



F1, F6 Protection of Natural Forest (1 million ha and 2.2 million ha)

In association of silvicultural methods, this technology includes: 1) Reforestation; 2) forest fire control; 3) insect and pest control; 4) invasive species prevention; 5) forest degradation and deforestation prevention; 6) restoring the degraded forest ecosystems; and 7) development of non-timber forest products.

Mitigation Potential	■ **70.6 $MtCO_2$eq/year, (Cumulative aggregation: 1,413 $MtCO_2$eq in 20 years)**
(Initial) Cost	■ Protection of natural forest (1 million ha): 0.66 USD/$MtCO_2$ ■ Protection of natural forest (2.2 million ha): 0.70 USD/$MtCO_2$

F2, F3, F7 Protection of Coastal Forest (100,000 ha)/Plantation of Coastal Forest (10,000 ha and 30,000 ha)

This technology is a combination of the following techniques: 1) conservation of existing forests; 2) enrichment planting; 3) reforestation; and 4) silvo-fishery practices.

Mitigation Potential,	12.5 $MtCO_2$eq/year (Cumulative aggregation 250 $MtCO_2$eq in 20 years)
(Initial) Cost	Protection of coastal forest (100,000 ha): 0.95 USD/$MtCO_2$ Plantation of coastal forest (100,000 ha): 5.72 USD/$MtCO_2$ Plantation of coastal forest (30,000 ha): 5.88 USD/$MtCO_2$

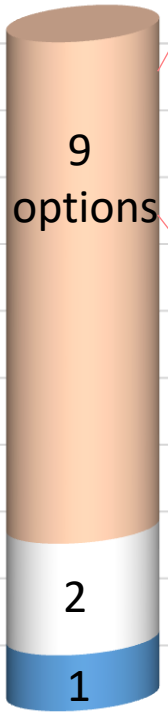
LULUCF

Sub-sector	INDC option / Technology
Conservation	Protection of natural forest **(F1, F6)** Reforestation, Forest fire control, Insect & pest control, Invasive species prevention, Forest degradation & deforestation prevention, Restoring the degraded forest ecosystems Development of non-timber products
Afforestation & Reforestation	Natural forest regeneration **(F4, 8, 9)** Planting technique, Plant selecting, Proper site and suitability assessment for tree species selection, seedling production and quality
Rehabilitation of Mangrove	Protection of coastal forest **(F2, 3)** Plantation of coastal forest **(F7)** Conservation of existing forests, Enrichment planting, Reforestation, Silvo-fishery practices
Long Rotation	Plantation of large timber production forest **(F5)** Business models for the restoration of long-rotation Acacia plantation

Sub-sector	Option / Technology
Scattered Tree Planting	Planting tree seedlings on unplanted lands by individuals and/or organizations
REDD+	Conservation and sustainable management of forests
	Protection and reforestation of forests deteriorated by slash and burn agriculture, and utilization of wood supplied by sustainably managed forests
CO_2 Isolation	Forest Management, Increase in volume of CO_2 fixation per unit area, Expansion of vegetation to arid land and others, Expansion of vegetation by industrial use, Expansion of vegetation by innovative use of biomass

LULUCF

12 technologies are identified



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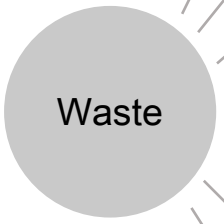
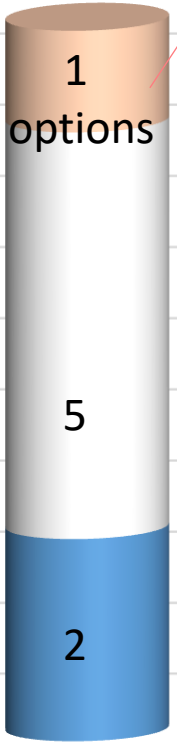
Waste



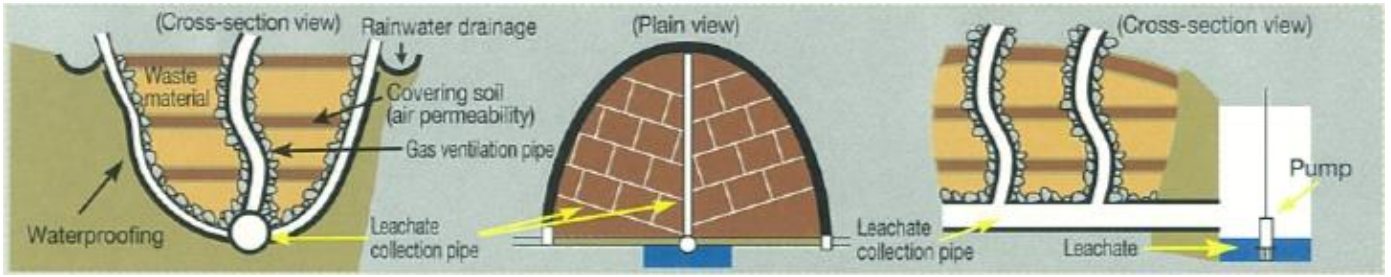
INDC option	Technology
Production of organic fertilizers from organic waste (composting) **(W1)**	Mechanical: Separation / sorting technologies Mixing/sieving, Catalyzing fermentation Operation: Temperature control, Catalyzing fermentation
Landfill gas (LFG) capture/recovery and energy utilization **(W2)**	LFG capture and recovery technology, LFG refining technology, LFG-based power generation, Heat production
Recycling of solid waste **(W3)**	Proper separation of recyclable items from the solid waste at sources of waste generation
Anaerobic Treatment of organic solid waste methane recovery for power and heat generation **(W4)**	Anaerobic fermentation technology, Methane recovery, Heat production
Semi anaerobic landfill operation (Fukuoka method)	Landfill design and operation technology (Japanese unique technology)
Waste to energy	Incineration technology: Storker type furnace, Gasification, Plasma Arc, Methanization
Conversion to low-carbon fuel trucks for waste collection haulage vehicles	Low carbon fuels trucks: Natural gas, LPG, Hybrid, Electric vehicle, Bio Diesel Fuel, Bioethanol
Construction of waste transfer station	Waste transfer facility, Large scale compactors/trailers

Waste

8 technologies are identified



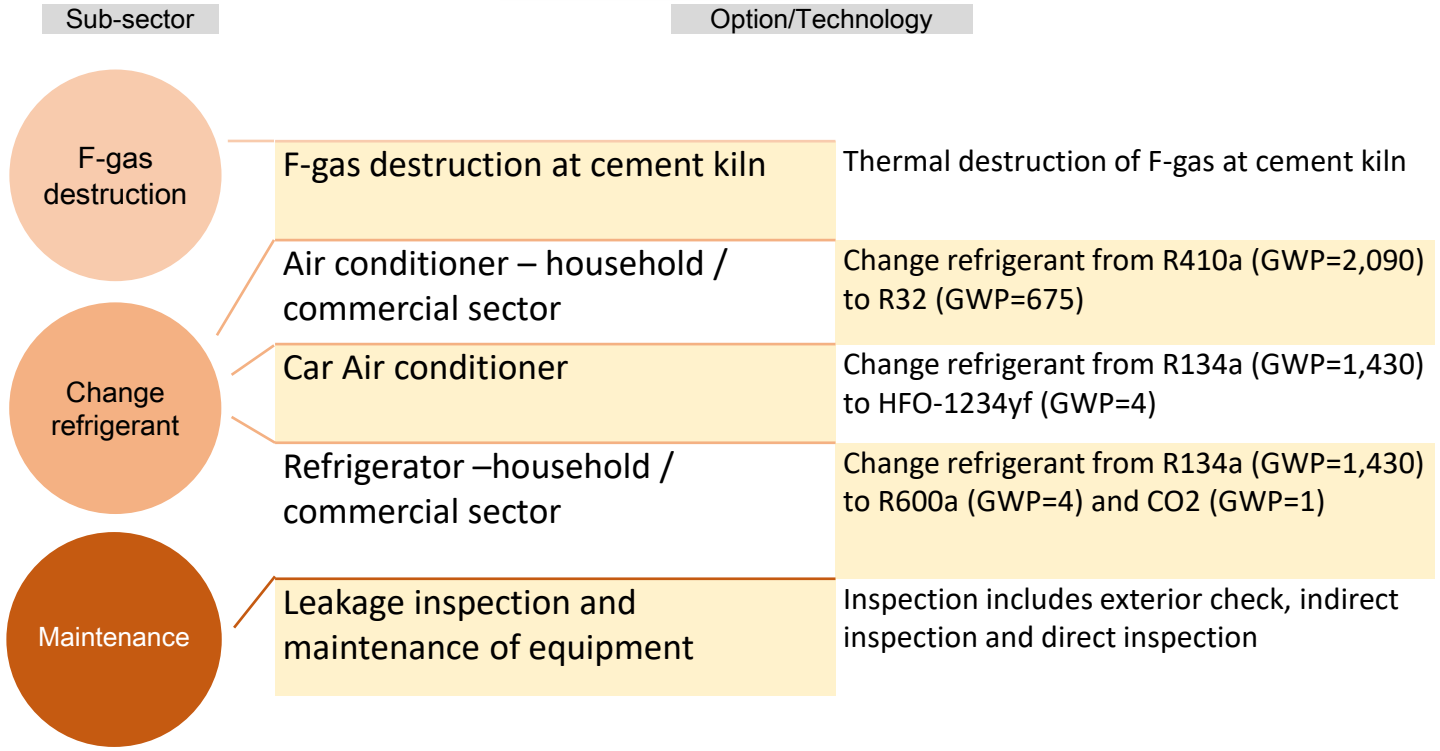
Semi anaerobic landfill operation (Additional option)



Semi-anaerobic landfill operation is to lay the leachate collection pipe, comprising the perforated main and branch pipes and gravel, at the bottom of the landfill to discharge leachate out of the landfill as quickly as possible. This prevents leachate from infiltrating into the ground water and also leads the air into the landfill through the leachate collection pipe by heat convection resulting from difference in temperature between the inner and outside air. In terms of GHGs emission reduction, the air led into the landfill through leachate collection pipe accelerates so-called semi-anaerobic decomposition of organic waste to reduce methane emissions.

Mitigation Potential	**13,500 $MtCO_2$ /year**
(Initial) Cost	US$609,090 (US$ 1=JPY 110) (6 hectare of landfill)

F-gas


Sub-sector
Option/Technology
F-gas destruction
Change refrigerant
Maintenance
F-gas destruction at cement kiln
Thermal destruction of F-gas at cement kiln
Air conditioner – household / commercial sector
Change refrigerant from R410a (GWP=2,090) to R32 (GWP=675)
Car Air conditioner
Change refrigerant from R134a (GWP=1,430) to HFO-1234yf (GWP=4)
Refrigerator –household / commercial sector
Change refrigerant from R134a (GWP=1,430) to R600a (GWP=4) and CO2 (GWP=1)
Leakage inspection and maintenance of equipment
Inspection includes exterior check, indirect inspection and direct inspection

F-gas

6 technologies are identified

F-gas Destruction (Additional option)

There are several destruction methods for F-gas, such as the rotary kiln method, waste combustion method, submerged combustion method, plasma method, catalytic method, overheated steam method, etc. There are three steps in the process of destruction of F-gas by cement kiln: (1) recovery of refrigerant; (2) refilling and transporting F-gas cylinders; and (3) thermal destruction at destruction site, where recovered F-gas is injected into cement kiln and combusted at over 1,000 degrees. Detention time of at least 6 seconds is needed as combustion time in the kiln.

Mitigation Potential	Decomposition of over 99.9% of F-gas.
(Initial) Cost	Low (Attachment cost of pipes and flowmeters for sending F-gas to cement kiln.)

Maintenance (Additional option)

There are three steps for leakage inspection: (1) exterior check: visual inspection, (2) indirect inspection: monitoring of gas pressure, discharge temperature, etc. and (3) direct inspection: using bubbling liquid, electronical gas detection machine, etc. Based on the results of above inspections, required maintenance and repairs to prevent leakage are conducted.

Mitigation Potential	**Data Not Available**
(Initial) Cost	100-2,000 USD/inspection and repairing 5,000–20,000 USD/training seminar for inspection and maintenance of F-gas device

Publication for SPI-NAMA/LC tech assessment

Series of Publications: "Facilitating Effectiveness of Viet Nam's Nationally Determined Contributions" (Vol. 1-3)

0 — Low Carbon Technology Catalogue (base study)

Low Carbon Technologies are listed as an overview, **reflecting LM's sectoral priorities**

1 — **Vol. 1: Summary of Low Carbon Technology Catalogue**

Diagnosis for Low Carbon Technologies applicable to 45 NDC options are summarized . Also some additional mitigation options/technologies are suggested

2 — **Vol. 2: Priority technologies and its evaluation process**

Priority technologies are identified and showcased. Also **Process for stakeholder consultations** for prioritizing procedure are to be recorded

3 — Vol. 3: Assessment output and way forward

Assessment final results are to be described.

The way forward for implementation

Several steps taken by:

- ✓**Removing barriers**
- ✓**Promoting/harnessing coordination with stakeholders**
- ✓**Partially supported by International cooperation**

Low Carbon Society in Viet Nam

Accelerated implementation

Initial implementation

Early actions

Pre-2020	2020	2030	Further

Thank you for your attention