Low-Carbon Model Town in [Da Lat, Viet Nam]

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Contents

Summary of Interventions

Overview of interventions – Da Lat

Sector	Intervention	Target (by 2030)	Cost (Million USD)	Cumulative CO_2 Savings ($MTCO_2$)
Transportation	Penetration of low emission fuel– 2W & 4W EV & Biofuel in goods vehicle	40% of total vehicle stock	0.5	0.131
	Modal shift - Establishment of non-motorized vehicle and pedestrian Infrastructure	Shift of 5% vehicular passenger	0.6	0.082
	Aggregation of passenger occupancy in personal vehicles through ride sharing options[1]	-	-	-
Area Energy System	Aggregated heating/cooling supply units[2]	-	-	-
Untapped Energy	Waste to Energy – Power generation through incineration of solid waste.	Utilization of total solid waste generated (~185MT)	75.00	0.181
	Ground source heat pump - heating purpose in commercial and residential buildings	25% of total building stock	0.01	0.00001
Renewable Energy	Rooftop Solar Power Generation in residential and commercial buildings[3]	-	433	0.165
Multi Energy System	Cogen or CHP plants produce electricity along with heating which can be used for heating system	35% of commercial buildings	0.003	0.00003
Energy Management System	Integrated Building Energy Management Systems (BEMS) for monitoring and controlling energy-related building plant and equipment	-	Finance varies with project	20% of energy consumption
Town Structure	Town planning concepts to reduce vehicular (Transit Oriented Development) & increase carbon sequestration (Green Redevelopment) for new area[4]	-	-	-

Overview of interventions – Da Lat

Non-Motorized Transport Infrastructure

Concept	Development of dedicated road routes for use by cycles & pedestrians only
Need	Da Lat provides bicycle routes for tourists. Similar route for citizens will reduce need for 2W
Benefit	• Reduced traffic congestion in roads • Reduced use of fossil fuel based vehicles • Promote walking and cycling i.e. potential to improve citizens' health • Reduce incidence of road accidents

Ride Sharing Options

Concept	Sharing ride with co-passengers travelling in same route
Need	Short trips within Da Lat city can be completed through bike/car sharing
Benefit	• Reduced traffic congestion in roads • Reduced cost of ownership of vehicles • Reduce emission by reducing vehicles on road • Provides new opportunity for local businesses

District Energy System (DES)

Concept	Centralized production of steam/hot water,/chilled water transported through underground pipes to buildings where used for heating/cooling purpose.
Need	Heating requirements of commercial building esp. hotels can be provided through DES
Benefit	• Reduces overall energy loss in power generation • Reduced environmental footprint • Increases space in buildings by eliminating need for boilers & chillers

Waste to Energy

Concept	Generating power through incineration of organic substances present in urban solid waste
Need	Existing incinerators can be retro-fitted to add equipment for generating electricity
Benefit	• Reduce landfill need • Create alternate revenue source • Reduces intensity of air & land pollution • Promotes reuse of discarded material

Photo Source: [1]NMT in Bogota,[2]NMT in Dar-es-Salaam, [3]Ride sharing in HCM, Hanoi

Source: [1]Project Team Analysis,[2]CAI-Asia Center

Overview of interventions – Da Lat

Ground Source Heat Pump (GSHP)

Concept	Utilize ground as heat source/sink to provide heating/ cooling needs with minimal use of fossil fuels
Need	Heating requirements of building esp. residential can be provided through GSHP
Benefit	• Utilization of renewable energy source & lower fossil fuel use • Reduce dependency on grid power • Cost savings for user over lifetime

Co-generation plant (CHP)

Concept	Generating power & heat by using same amount of fuel as conventional power generation unit
Need	Cost in setting up individual units in commercial buildings for heating/ cooling can be avoided
Benefit	• Reduced fuel use & emissions due to higher efficiency of CHP (85%) over thermal (40%) • Can be combined with DES for heating & power generation solution for city

Building Energy Management System (BEMS)

Concept	• Use of electronic system for monitoring, analysing and controlling energy consumption of buildings • Automated to optimize power consumption by switching off applications while not in use
Need	Commercial buildings, especially hotels, can reduce up power consumption by up to 20%
Benefit	• Eliminates wasteful power consumption • Cost savings from reduced power consumption • Contributes to lower emissions

Town Structure

Concept	**Transit Oriented Development**	**Green City Land Use Planning**
	Maximize residential, leisure & business space within walking distance of public transport	Increases green spaces within cities - increasing carbon sequestration
Need	Expansion area can integrate such concepts to ensure sustainable development in future	
Benefit	• Making future developments emission proof • Increased convenience of citizens in transportation and quality of life	

Photo Source: [1]Flowchart of GSHP,[2]Flowchart of CHP

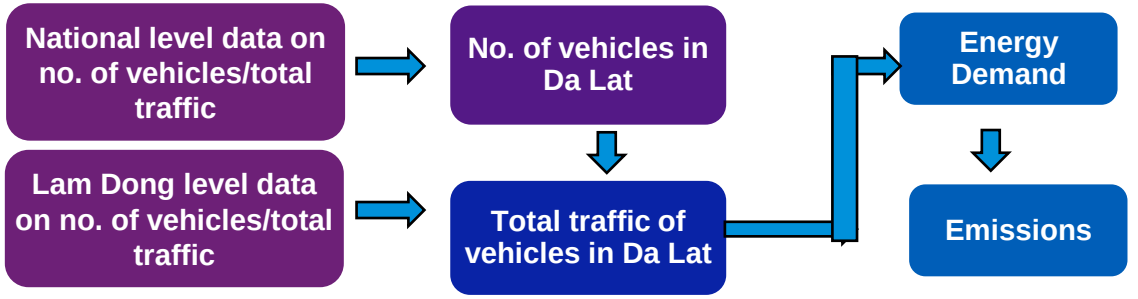
BAU Scenario

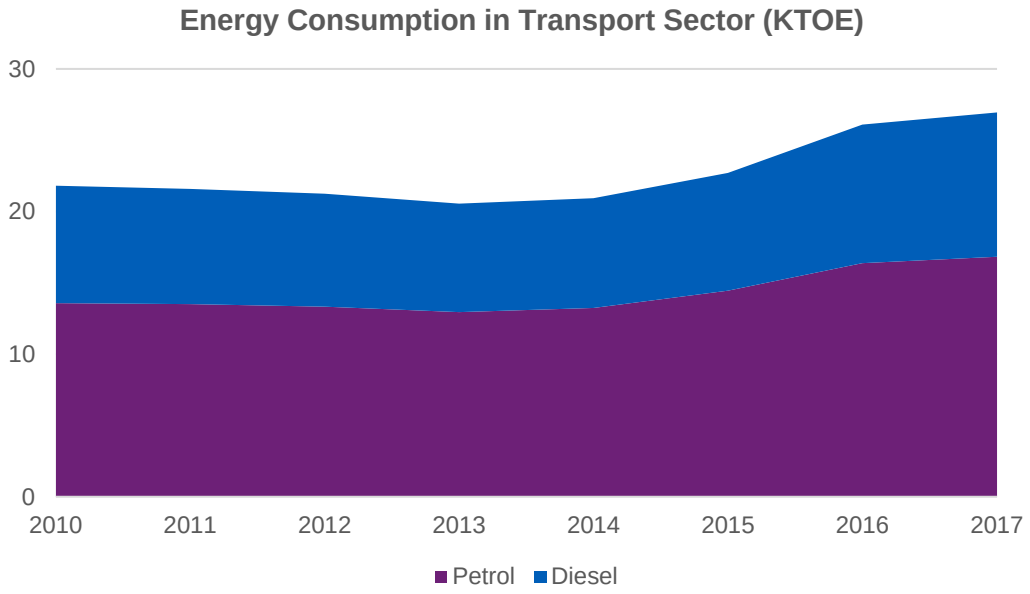
BAU Scenario – Transport Sector

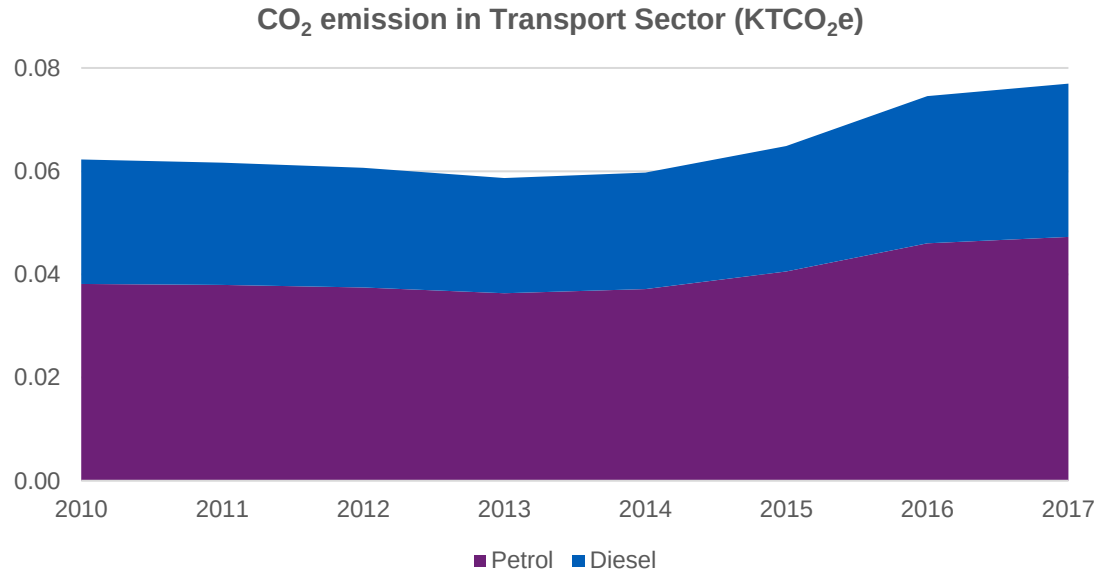
Key Characteristics of Sector

- Roadways major means of transportation
- Category of road transport - 2W, 4W passenger (i.e. cars, buses, taxis) & 4W freight vehicles
- 93% of total vehicle population comprise 2W[1]
- Share of fuel in 4W passenger – 80% petrol, 20% diesel[2]
- 2W – 100% petrol and 4W freight – 100% diesel

Methodology







- ***Overall vehicle population increased by 3% CAGR with 4W passenger vehicles having the highest increase (17% CAGR)***
- ***Emissions also increased by 3% CAGR indicating vehicle efficiency/ has remained constant***

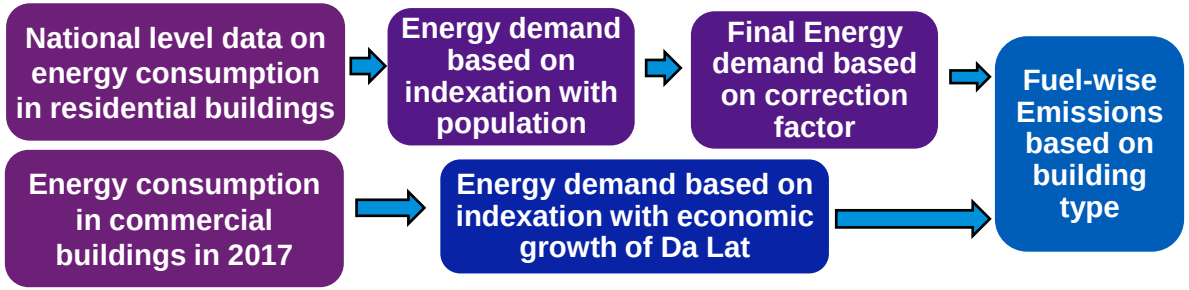
Source: [1]Project Team Analysis,[2]CAI-Asia Center

BAU Scenario – Buildings Sector

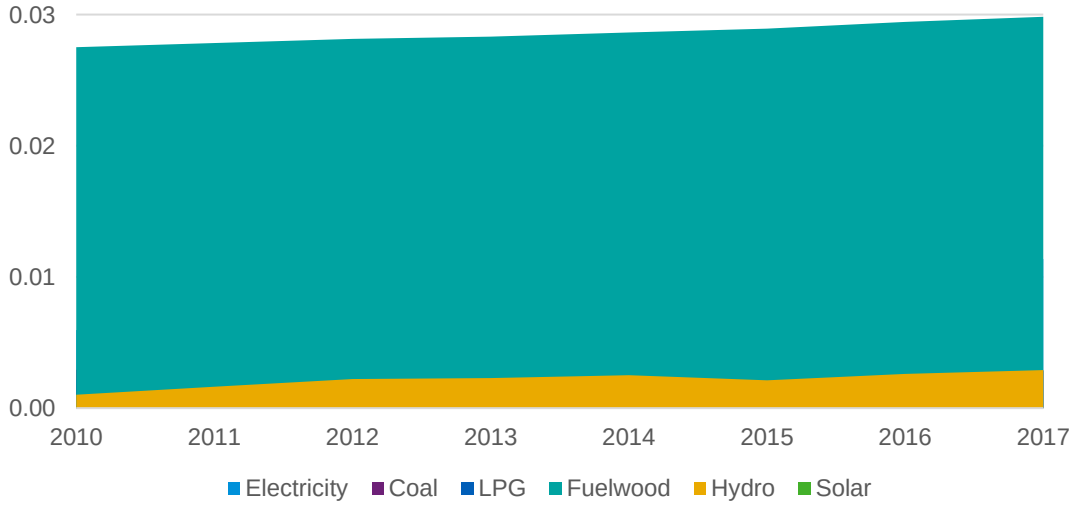
Key Characteristics of Sector

- Fuelwood (61%) is primary fuel in residential buildings followed by electricity (27%). Coal and other fuels comprise 12% of total energy consumption[1]
- In commercial buildings, electricity is only source of energy[2]
- Practice of building energy system limited and rooftop solar power practiced sparingly[2]

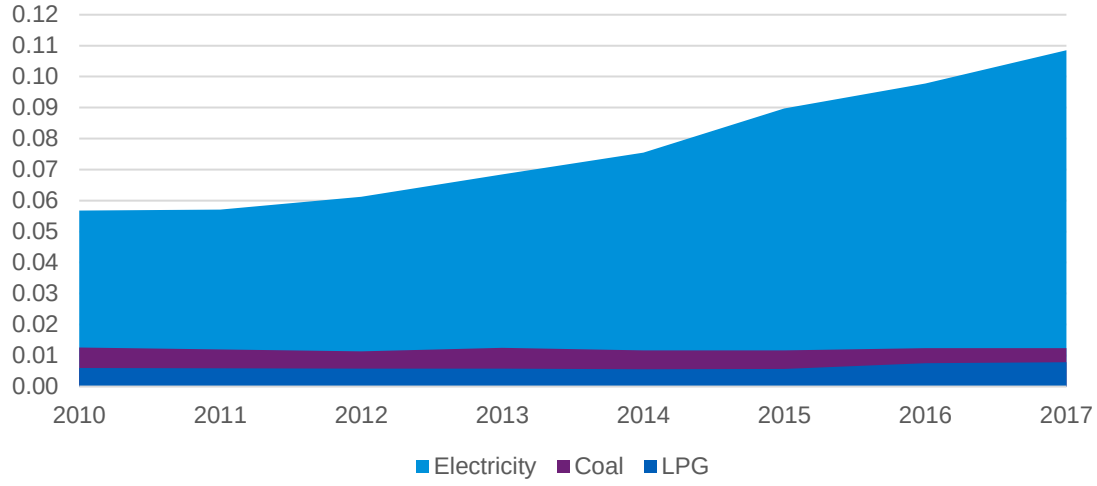
Methodology



Energy Consumption in Buildings Sector (KTOE)



CO_2 emission in Buildings Sector ($KTCO_2e$)



- ***Residential buildings comprise 97% of consumption in buildings sector***
- ***Overall energy demand increased by 3% CAGR with highest growth in commercial buildings sector (15% CAGR)***
- ***Emissions has increased by 8% CAGR primarily due to increased use of fossil fuels (LPG, kerosene) in residential sector***

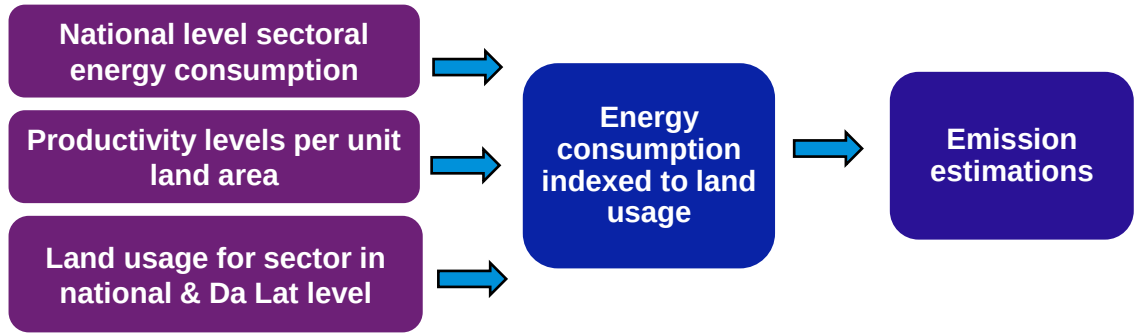
Source: [1]IEA, [2]Stakeholder consultation

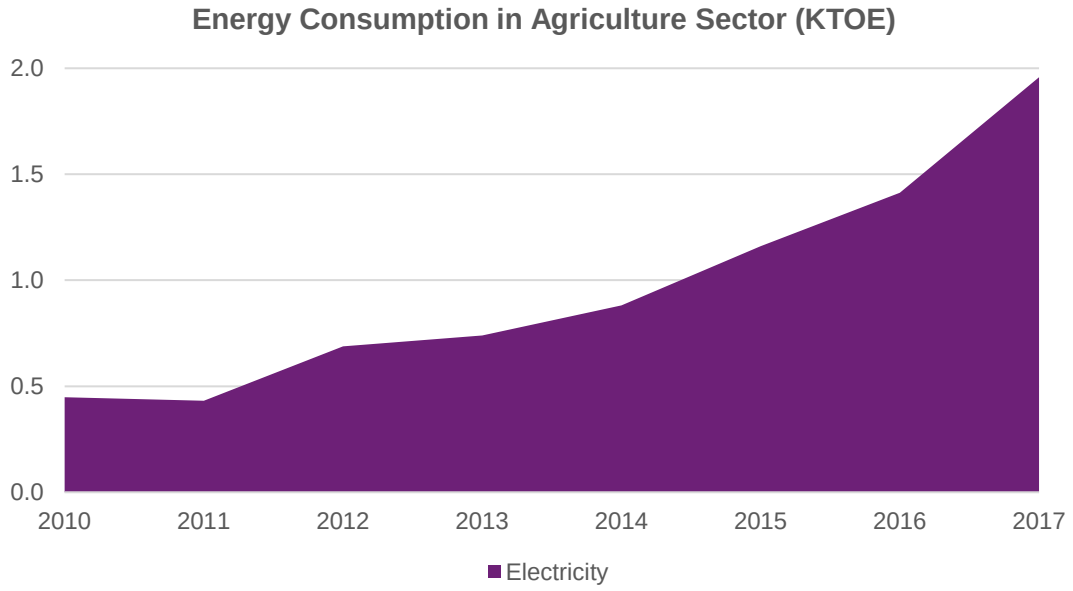
BAU Scenario – Agriculture & Fisheries Sector

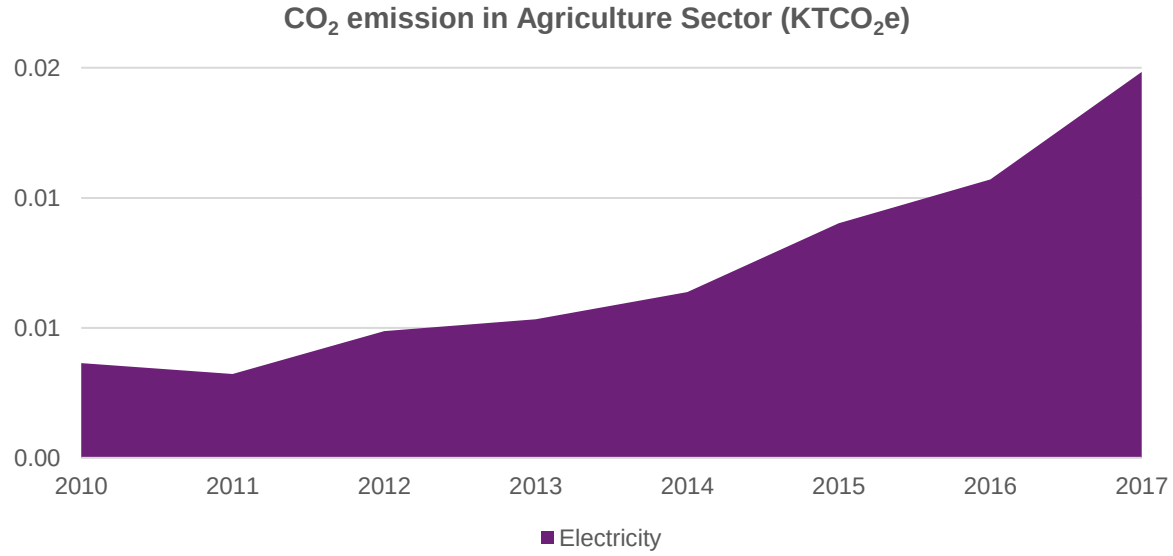
Key Characteristics of Sector

- Agriculture important contributor to economic output of Da Lat
- Sector includes crop production & aquaculture
- Level of mechanization limited and electricity is utilized for running irrigation pumps

Methodology







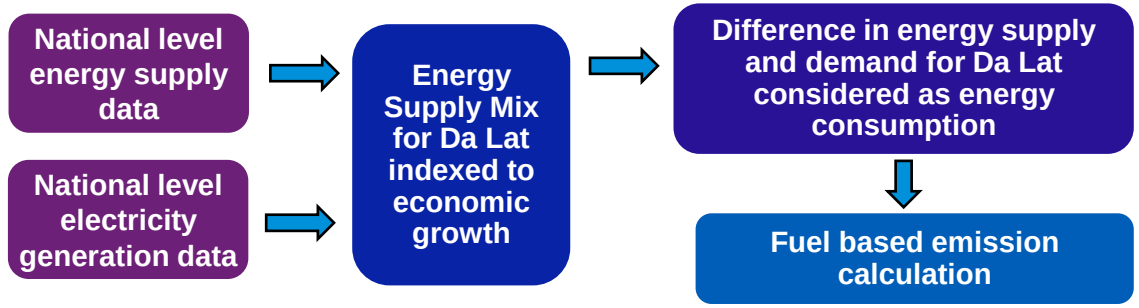
- ***Agriculture accounts for >99% of energy consumption of this sector while the rest is due to aquaculture***
- ***Overall energy demand increased by 23% CAGR & emissions increase by 22% CAGR***

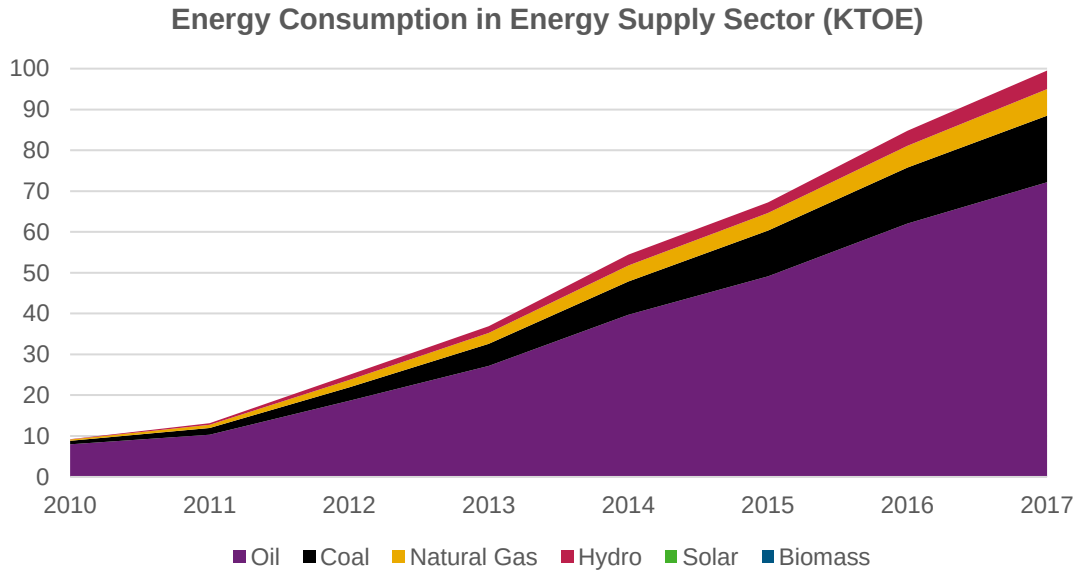
BAU Scenario – Energy Supply

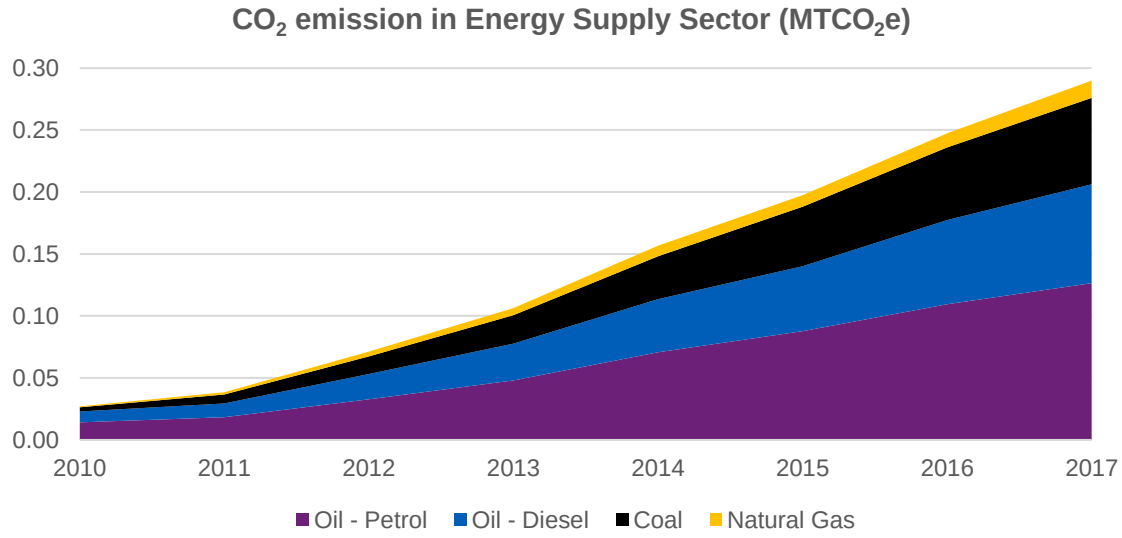
Key Characteristics of Sector

- Oil products like petrol, diesel contribute to 58% of energy supply for Da Lat due to consumption of transport sector[1]
- Coal in primary form contributes to 5%, in residential sector[1]
- Power supply exclusively from national grid, emissions trend similar to national level scenario[2]
- Coal (49%), natural gas (29%) and hydro (20%) key sources of electricity[1]

Methodology







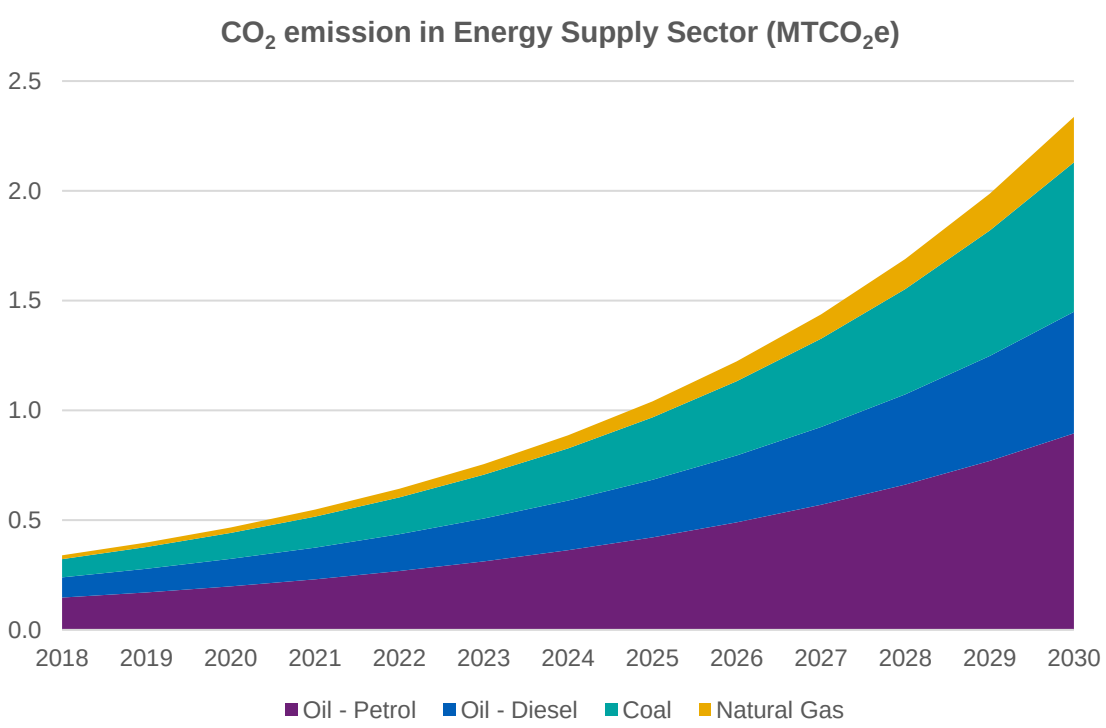
Energy supply for Da Lat is dependent on fossil fuels (>90%) and increased focus on renewables, untapped sources of energy can help reduce this dependence and reduce emissions

Source: [1]IEA, [2]Stakeholder consultation

BAU GHG Projection of overall city

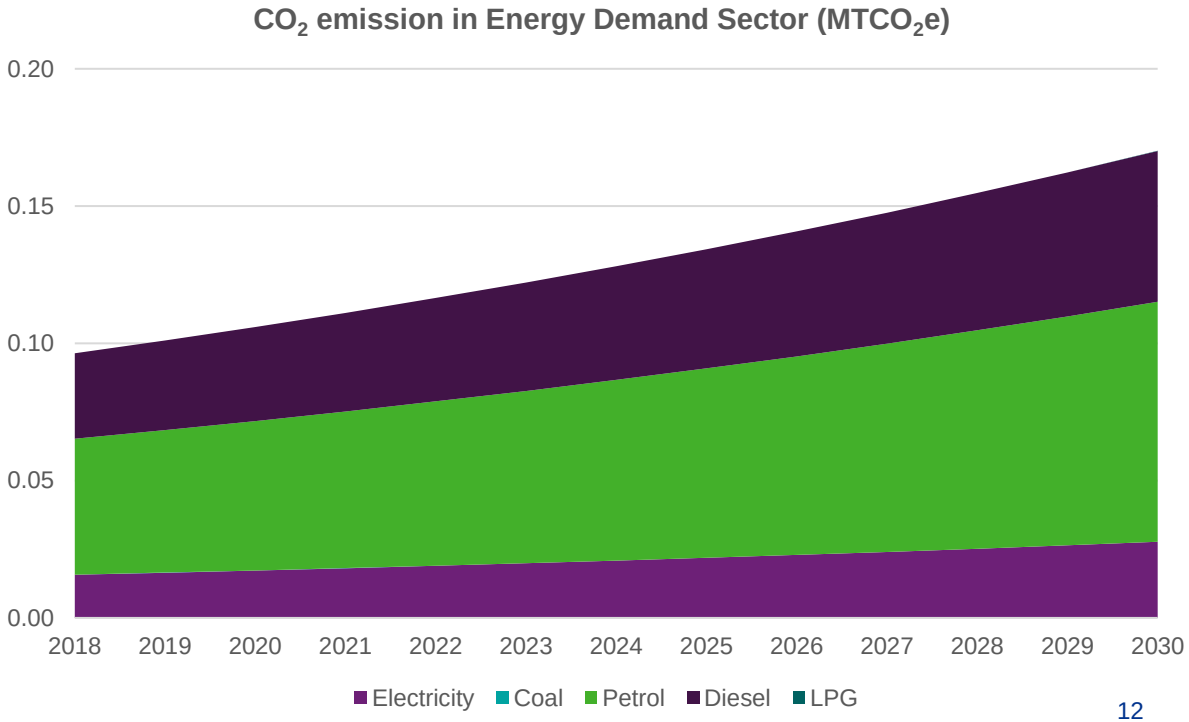
Energy Supply Sector

- Losses in conversion of primary fuel to final usable form leading to emissions in supply side
- Dependence on coal for power generation will also lead to increase in emissions
- In order to reduce emissions, ***reduction in fossil fuel consumption*** in power generation and ***increased focus on alternate energy sources*** can contribute to lower emissions



Energy Demand Sector

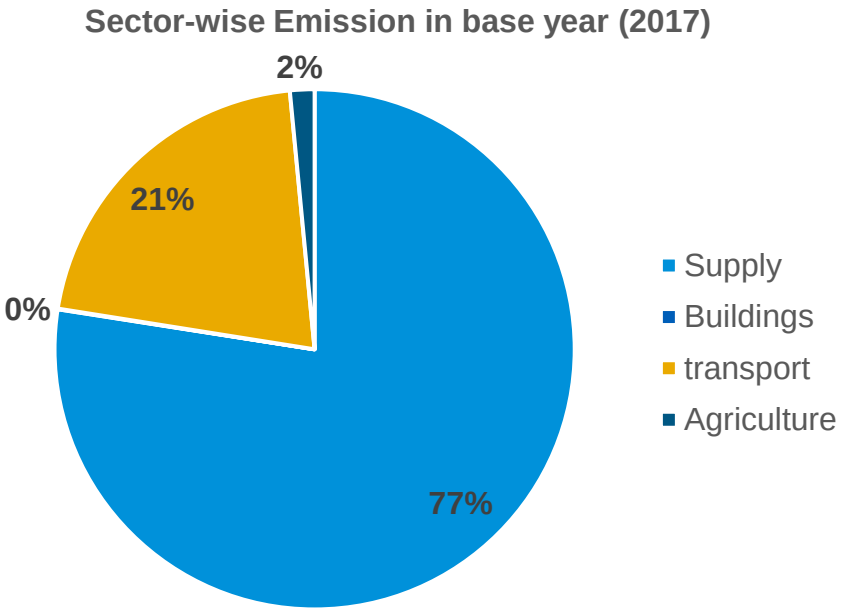
- Continued use of fossil fuels (especially in transport sector) will be major contributor of emissions (~83% in 2030). Use of low emission fuels can help reduce emissions
- Use of measures to increase efficiency in demand side can also help reduce demand for power which is expected to contribute to 16% of total emissions in 2030.

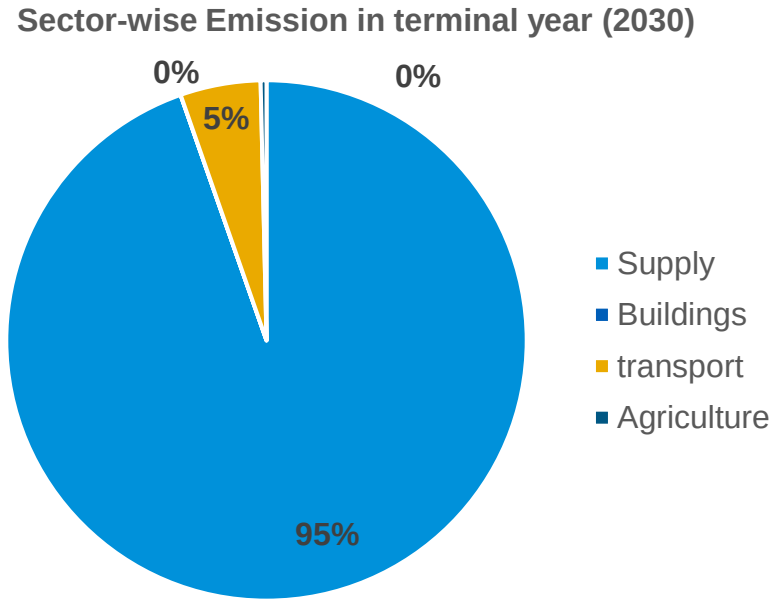


Sectoral contribution to GHG emissions

Observation on sectoral share of emissions

- Emissions in supply side set to increase by 18% CAGR between 2017 and 2030 in case BAU scenario continues
- Increase in emissions for other sectors to be about 4% CAGR during same period
- Share of supply side in emissions will increase from 77% to 95% due to continued dependence on fossil fuel especially coal and natural gas in power generation
- Losses in primary energy present in petrol and diesel due to inefficiencies in transportation systems will further contribute to emissions in supply side





Best Practices & Learnings

Learnings from case studies for Da Lat

Case studies of regions/activities closely resembling operating scenario of Da Lat had been selected and they provide following learnings:

1. **Waste to Energy plant - Ngu Hanh Son District (Vietnam), Hanoi (Vietnam)**
   - Potential to prevent emissions caused by incineration of >160MT of solid waste
   - Contribute to generation of electricity for local consumption
2. **Introduction of EVs - Ngu Hanh Son District (Vietnam)**
   - Reduce dependence on fossil fuel run vehicles & reduce GHG emission
3. **Modal shift - Establishment of bike network - Ho Chi Minh City & Hanoi (Vietnam)**
   - Lower dependency on fossil fuel run vehicles and reduce GHG emission
   - Also reduce road congestion and provide added attraction to tourists
4. **Implementation of Green Building Standards – Jakarta (Indonesia)**
   - Increase energy requirement in buildings and reduce GHG emissions
5. **Introduction of ride sharing options & improving public transport system – Ho Chi Minh City & Hanoi (Vietnam)**
   - Reduce requirement of fossil fuel vehicles and provide business opportunities for locals
6. **Energy Management System - Ngu Hanh Son District (Vietnam)**
   - Energy consumption in buildings expected to increase by 10% CAGR between 2010 & 2030 under existing conditions
   - EMS system as and when installed helps in energy reduction by up to 20%

Low Carbon Intervention in pre-selected assessment areas

Low Carbon Interventions – Town Structure & Buildings

Town Structure

Interventions related to town planning that aim to reduce carbon emissions

PROPOSED INTERVENTION	RATIONALE
Transit oriented development (TOD)	1. Maximize amount of residential, business and leisure space within walking distance of public transport. 2. Increase public transport ridership by reducing use of private cars and promoting sustainable urban growth.
Green city land-use planning	1. Increase green/forest spaces within city 2. Develop green channels/green pathways for pedestrian movement 3. Develop mixed use plans to reduce distance between areas of activities & minimize need for motorized transport
Infill of vacant land and redevelopment of existing landuse	1. Development of vacant parcels within previously built areas to optimize prior infra investment & land use. 2. Conversion of existing property to another use to increase economic value & reduce emissions

Appropriate planning & town structure related intervention can reduce overall emissions by ***15-20%***

Assessment of areas to be considered under Town Structure intervention currently underway

Buildings

Reduction in overall energy demand in buildings by implementation of Green Building Code

Energy Simulation to estimate energy savings achieved by implementing Green Building Code

Energy simulation using eQUEST software for 7 different building types, in conformance with local Green Building guidelines

- Energy Efficiency Case: Results of using energy efficient building envelope, HVAC, lighting equipment for 5 orientation to be developed
- Base Case: Results of using conventional building materials, HVAC, lighting equipment developed

Key areas where outputs of software simulation will be developed

- Whole Building Simulation
- Daylighting Simulation
- Exterior Lighting Simulation
- Thermal Performance Simulation

Simulation modelling underway for 5 different orientation for building envelope of each box model at building envelope level and not site level

Low Carbon Interventions – Transportation

PROPOSED INTERVENTION	RATIONALE
Shift to Electric Vehicles (Public and Private)	• Adoption of Electric buses and taxis reduces dependence in fossil fuels i.e. petrol & diesel
Solar powered battery swapping station	• Utilizing solar power for charging EV batteries can increase use of renewables
Use of bio-fuels for freight vehicles	• Freight vehicles, covering long distances in one journey, appropriate for use of bio-diesel • Da Lat, having vast swathes of agricultural land, can be used to grow input for the biofuels. • Use of bio-diesel requires no additional investment & can be used by normal diesel vehicles
Developing non-motorized transport Infrastructure	• Development of dedicated routes for use by cycles & pedestrians supplement needs of tourists & reducing need for fossil fuel vehicles
Aggregation of passenger through ride sharing options	• Ride sharing options, which convey two to four people in a ride would lead to lesser trips as compared to personal vehicles. • Lesser fuel consumption and hence, reduced emissions. • 2-wheelers being widely used option can be transformed in to bike taxis to reduce number of vehicles on road.

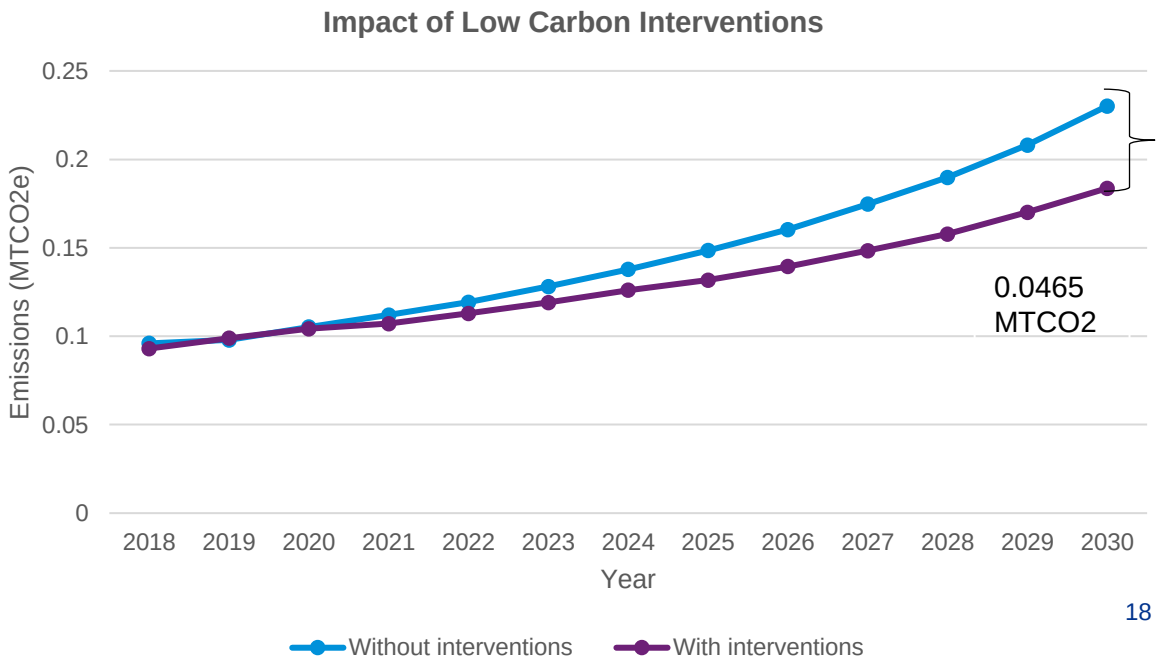
Financial Implication of intervention

Low Emission Vehicles (Electric Vehicles)[1]

Cost (USD)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2W	2002	2263	4821	7851	8835	15406	17304	19385	21664	24157	26883
4W	1249	1787	4341	8309	11541	22395	30768	41706	55924	74330	98065

Non-Motorized Transport

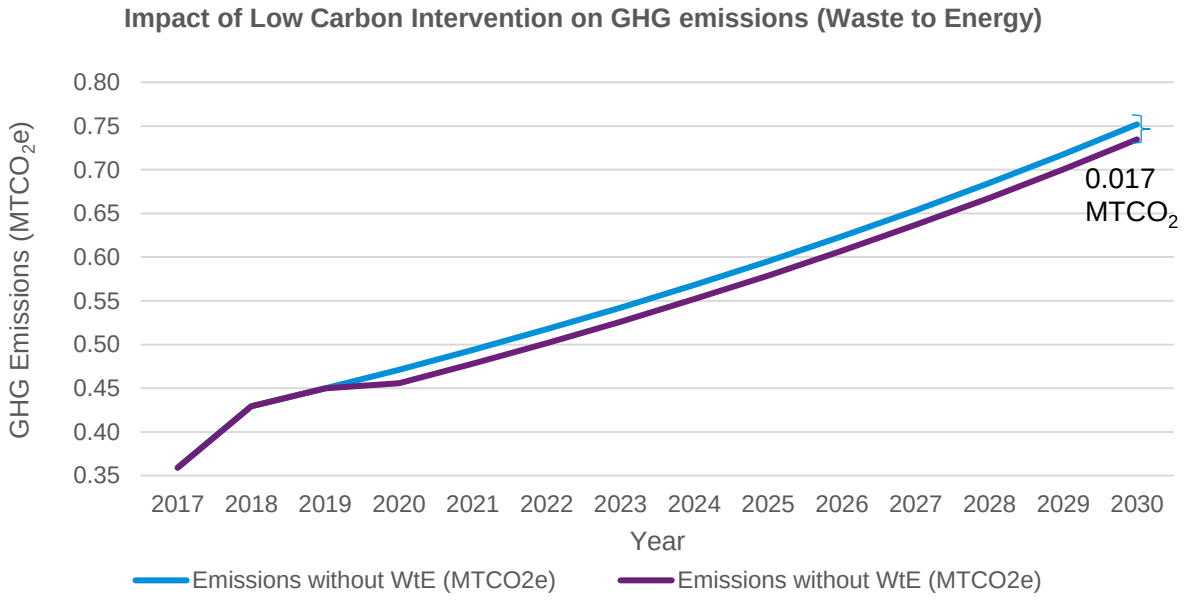
Total Cycle length (km)	60
Cost to construct cycle track (USD per foot)	3
Total Cost (In Million)	0.6

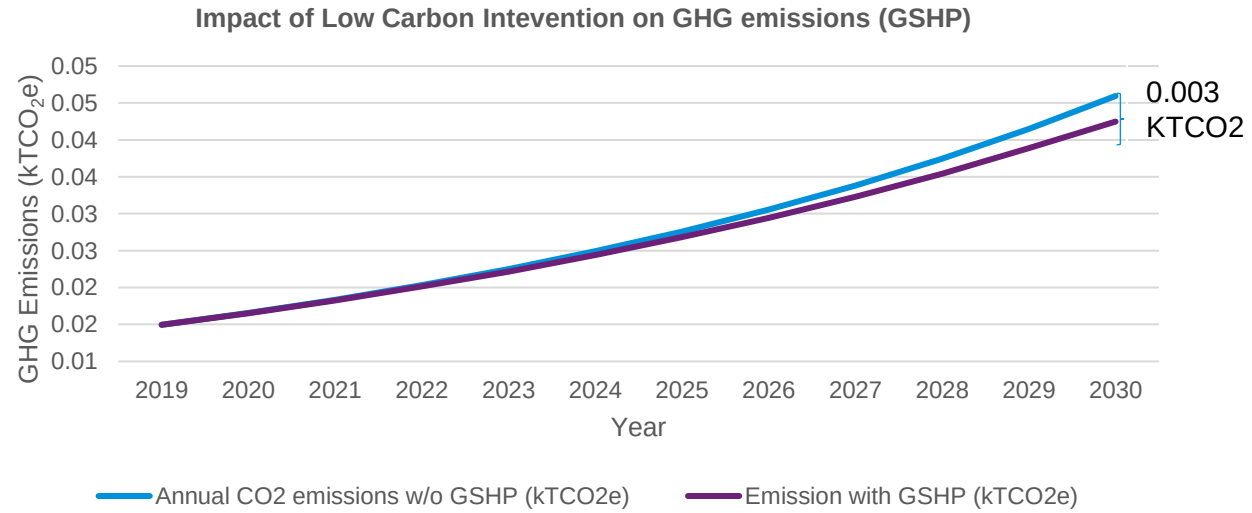


Low Carbon Interventions – Untapped Energy

PROPOSED INTERVENTION	RATIONALE
Generation of energy in the form of electricity through incineration of solid waste	• 160MT of solid waste in2017 • Based on population growth expected to produce 185MT by 2030 which can supply fuel to 5MW WtE plant. • Existing incinerators can be retrofitted with requisite equipment to develop a WtE plant. • Assist in waste management & provide alternate means of power generation.
Ground source heat pump (GSHP) for heating in residential buildings	• Da Lat being a hill station, there is a need in heating commercial and residential buildings • In most cases grid electricity is utilized. • Energy available in the Earth's crust can be utilized to act as alternate source of energy to provide for the heating requirements • Reduces dependence on external source of energy as well as reducing emissions related to power generation.

Cumulative Financial Requirement for intervention till 2030	
Waste to Energy	USD 75,000,000
GSHP	USD 11,525





Low Carbon Interventions – Multi-Energy & Area Energy System

Multi-Energy System

PROPOSED INTERVENTION	RATIONALE
Cogen (CHP) plants	• CHP capture and utilizes heat otherwise wasted in power generation • CHP require less fuel to produce the same amount of energy. • Also CHP systems can be used for power supply as well as heating/cooling requirement

Preliminary estimate of investment requirement for CHP in Da Lat

Year	Power generation Capacity (kW)	Investment required (USD)
2020	0.00005	166
2021	0.00011	202
2022	0.00019	243
2023	0.00038	517
2024	0.00071	621
2025	0.00125	742
2026	0.00196	1187
2027	0.00287	1413
2028	0.00420	1674
2029	0.00591	1975
2030	0.00809	2782

Assessment of areas for detailed feasibility study of CHP systems is currently underway

Area Energy System

PROPOSED INTERVENTION	RATIONALE
Aggregated heating/ cooling systems	• Aggregated systems connect renewables, waste heat, thermal storage, power grids and heat pumps for heating/cooling of multiple buildings through single system • Requires up to 50% less primary energy consumption than individual heating/cooling units

Considerations for estimating feasibility of intervention

Step 1:
Gathering input data
- Built-up area of building
- Occupancy of building
- Development time
- Power & water tariff
- Cooling demand per sqm
- Operational parameter (COP, EFLH)
- Costs of setting up systems
- CO_2 emission baseline

Step 2:
Development of model for emission reduction:
- End-user description
- Hourly cooling demand of typical design day
- Estimate technical requirements of plant
- O&M cost of plant
- Estimate emission reduction

Step 3:
Financial assessment of intervention to assess feasibility:
- Tariff structure for district cooling
- End-user discount for using district cooling

Assessment of areas to be considered for feasibility of Area Energy System is currently underway

Low Carbon Intervention – Renewables & Energy Management System

Renewables

PROPOSED INTERVENTION	RATIONALE
Grid tied Gross metering - Rooftop Solar Power Generation	• Available rooftop area in residential buildings can be utilized to install solar panels • Reduce dependence on grid electricity which in turn depends on fossil fuel for generation

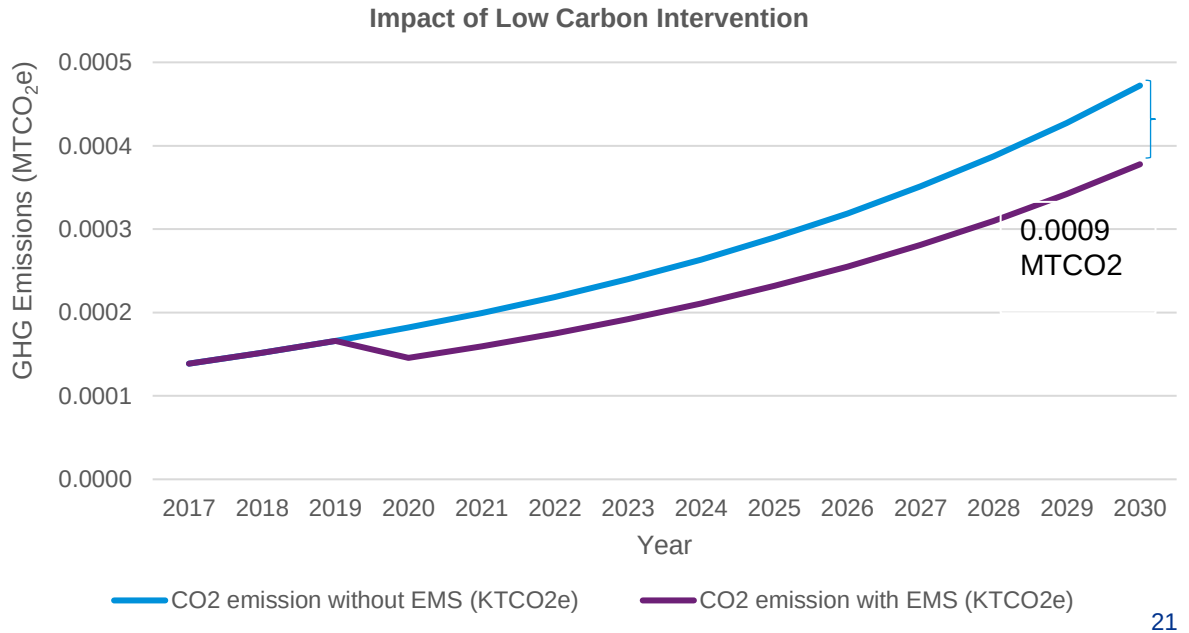
Calculation for maximum solar power potential of Da Lat

Parameter	Value
Total residential area (as per Land Use Plan of Da Lat)	14449300 sqm
Total available rooftop area	3612325 sqm
Maximum power generation capacity (as per standard conversion)	0.36 GW_{peak}
Financial requirement for installing solar panel (as per case studies)	433 million USD
Maximum emissions savings (based on electricity generation avoided)	0.162 MTCO2e

Assessment of available rooftop area in Da Lat for estimation of achievable targets currently underway

Energy Management System

PROPOSED INTERVENTION	RATIONALE
Installation of EMS in buildings	1. Reduce energy consumption by 20% by automatically optimizing consumption & helping user make controlled decision on power consumption 2. Phase-wise installation recommended to ensure maximum penetration: • Phase I: Existing public buildings • Phase II: Existing commercial buildings • Phase III: Existing private office building • Phase IV: Existing residential building



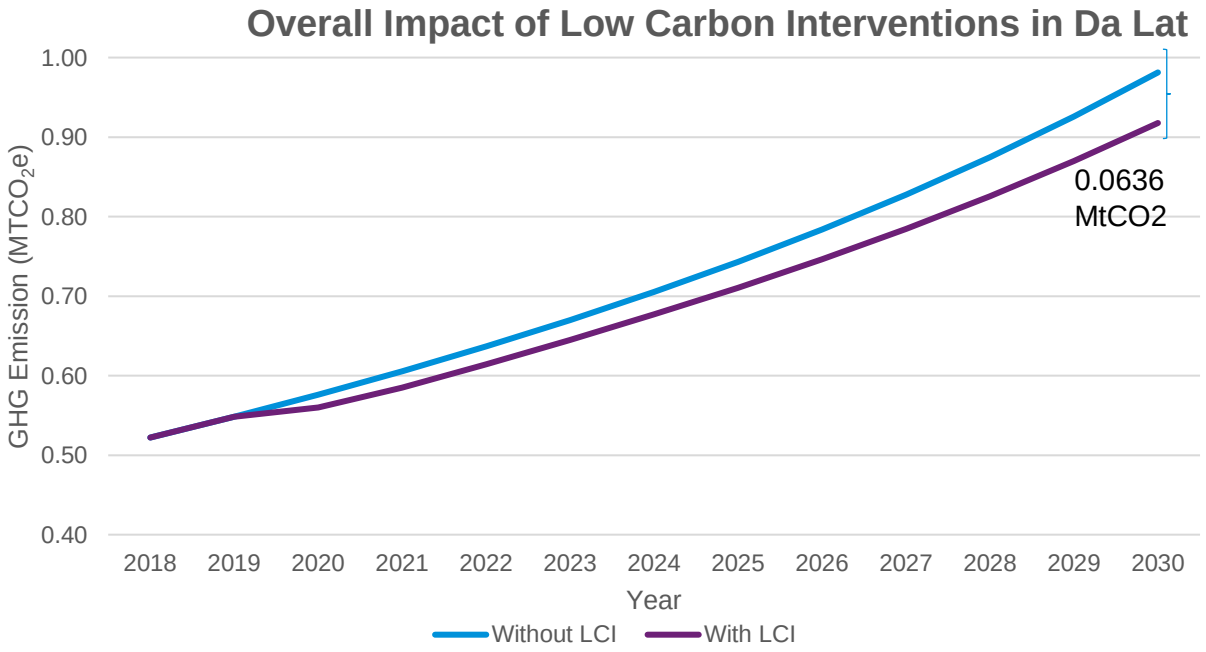
Low Carbon Intervention – Overall city

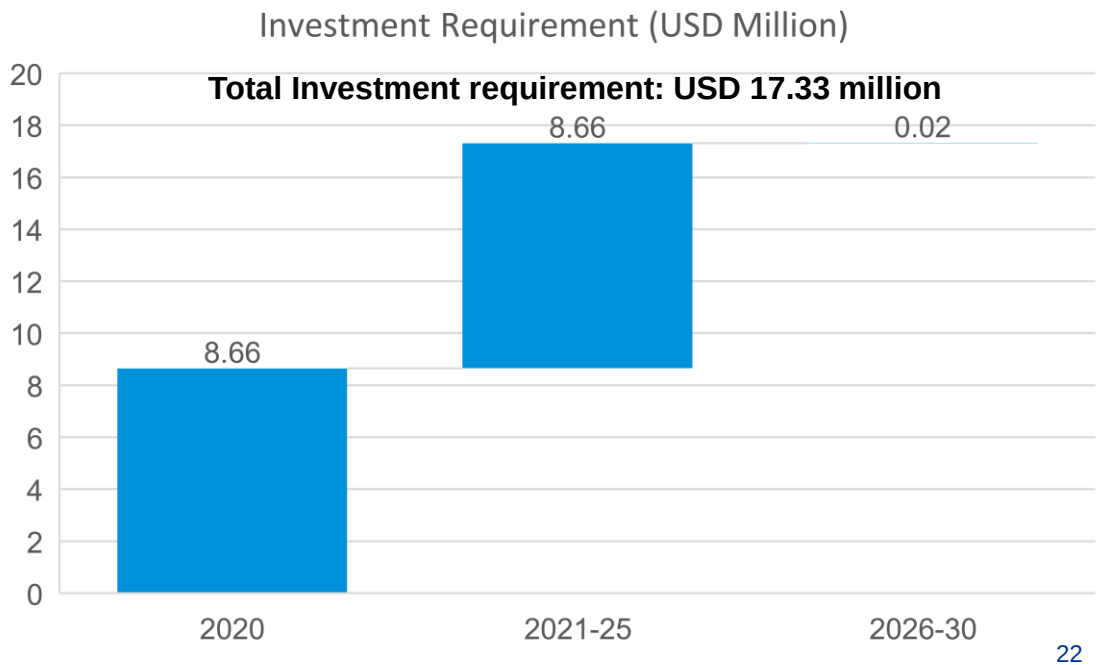
Emission Reduction

- Adoption of Low Carbon Interventions will lead to cumulative savings of 0.40 $MTCO_2e$
- Savings from WtE intervention, low emission vehicles, NMT infrastructure will account for 46%, 33% and 21% of cumulative savings
- Savings in other interventions are area-based & will be determined after stakeholder consultation

Investment Requirement

- Cumulative investment of USD 17.33 million required for implementing interventions between 2020-2030.
- WtE plant cost alone comprises USD 16.7 million followed by construction of non-motorized infrastructure (USD 0.6 million)
- Investment in procuring EVs is USD 11620 and in installation of GSHP is USD 11525
- Investment in other interventions to be calculated based on





Source of funding for low carbon interventions

Multi-lateral funding agencies	*Government Funding*	*Private sector entrepreneurs*
• ADB funding USD 100 mn for WtE project in Mekong Delta (Vietnam)[1] • World Bank funding USD 500 mn in solar rooftop project in India[2]	• Use of biofuels for commercial transport is part of Da Lat Green Growth Plan • Government funds can be utilized by developing robust implementation mechanism	• Private sector players already introducing ride sharing facilities in Hanoi & HCM • Local govt. can invite such private players to invest in Da Lat

Proposals can be prepared for sourcing of funds from Govt. & multilateral agencies
Private sector players can be invited to invest in new business propositions

Detailed assessment of funding sources and mechanisms to be conducted as part of feasibility study
Feasibility study also provide information relevant for preparing proposals

Post-workshop consultation to be undertaken to gather data to facilitate assessment in feasibility study

Source: [1]ADB Website, [2]World Bank website

Thank You

IRSD, Viet Nam

KPMG

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