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Mitigation Pathways for Net Zero GHG Emission by 2050: A Case of Nepal

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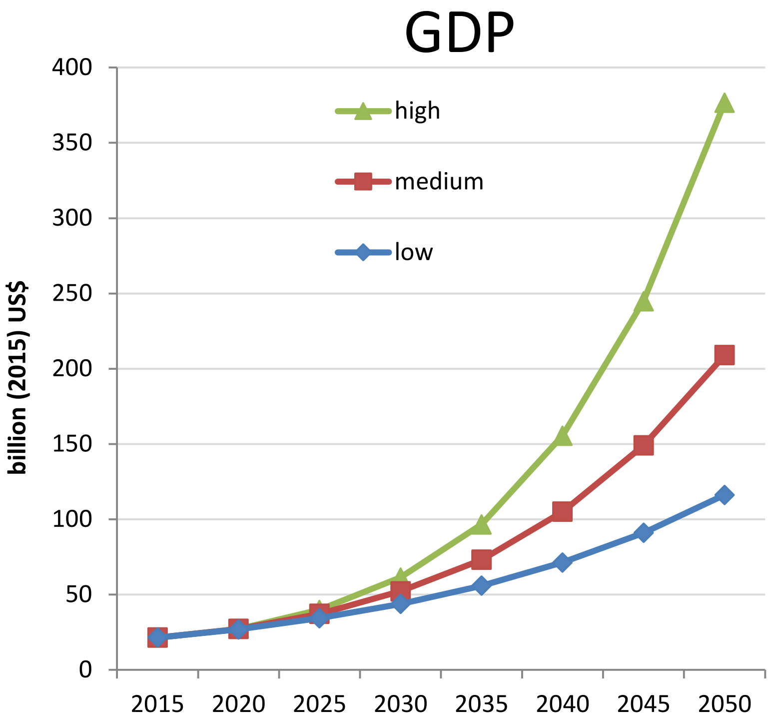
Key Issues

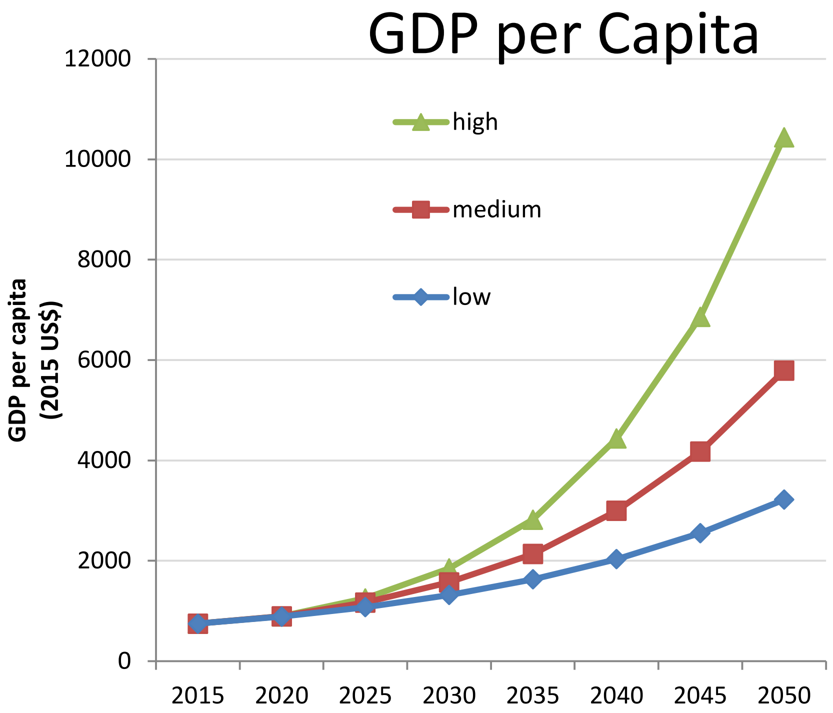
- GHG missions from energy use under different economic growth scenarios
- Would net zero emission be achievable in 2050 under medium economic growth scenario?
- How big should be the carbon price?
- Role of afforestation?

Implications of Different Economic Growth Scenarios

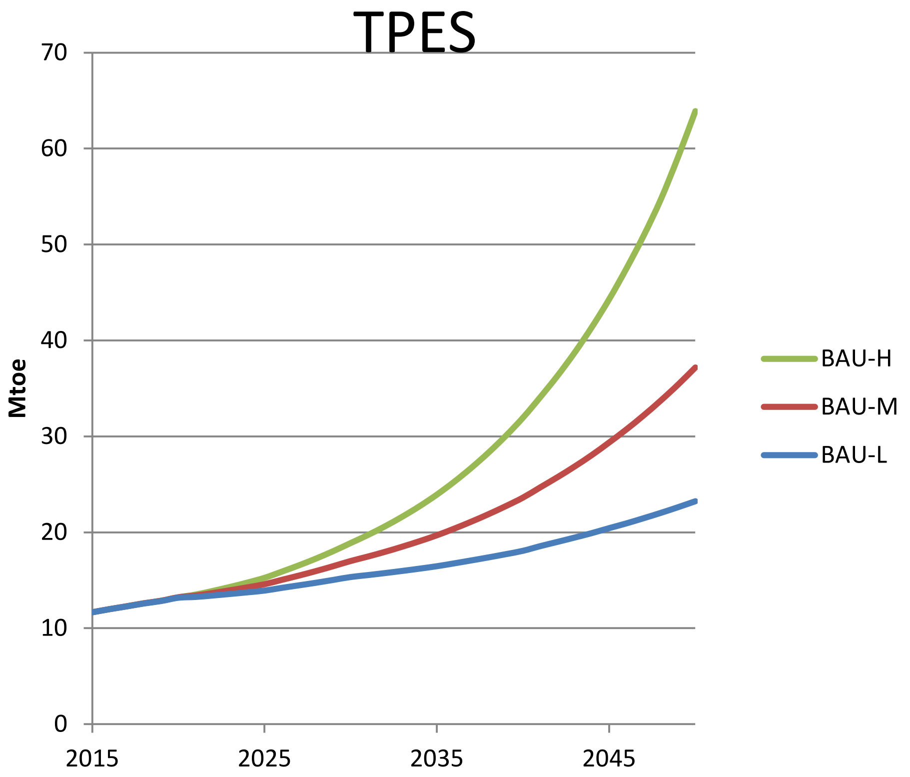
GDP Projection

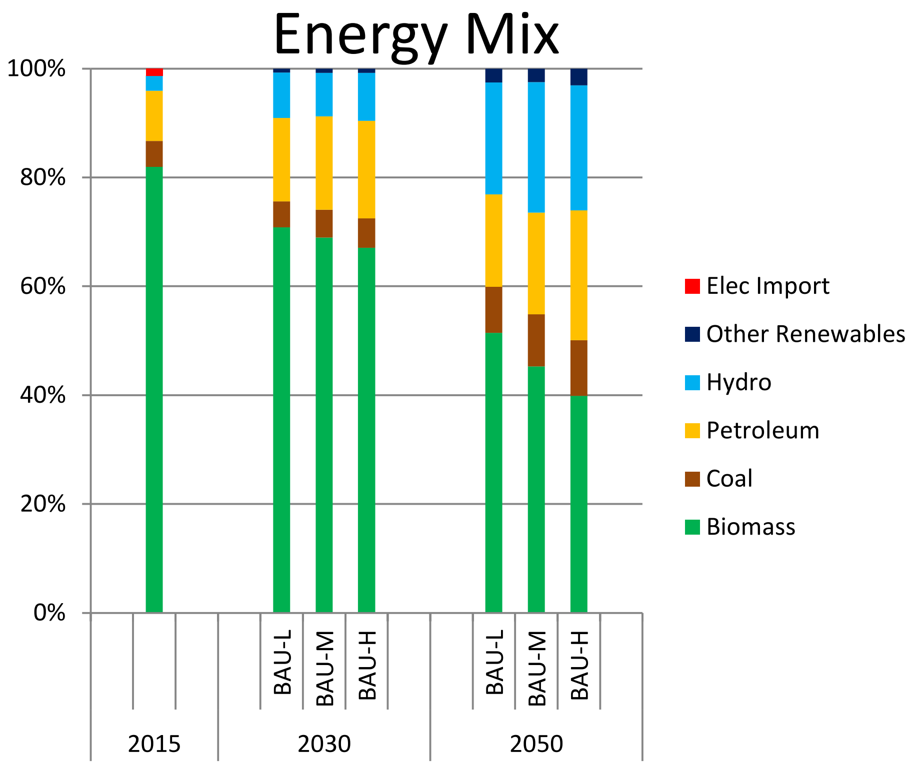
	2018-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
Low	5%	5%	5%	5%	5%	5%	5%
Medium	5.5%	6.5%	7%	7%	7.5%	7.25%	7%
High	5.5%	8%	9%	9.5%	10%	9.5%	9%





Total Primary Energy Supply under Different Economic Growth Scenarios





TPES would grow at CAGR of

- 2.0% in BAU-L to 5.0% in BAU-H

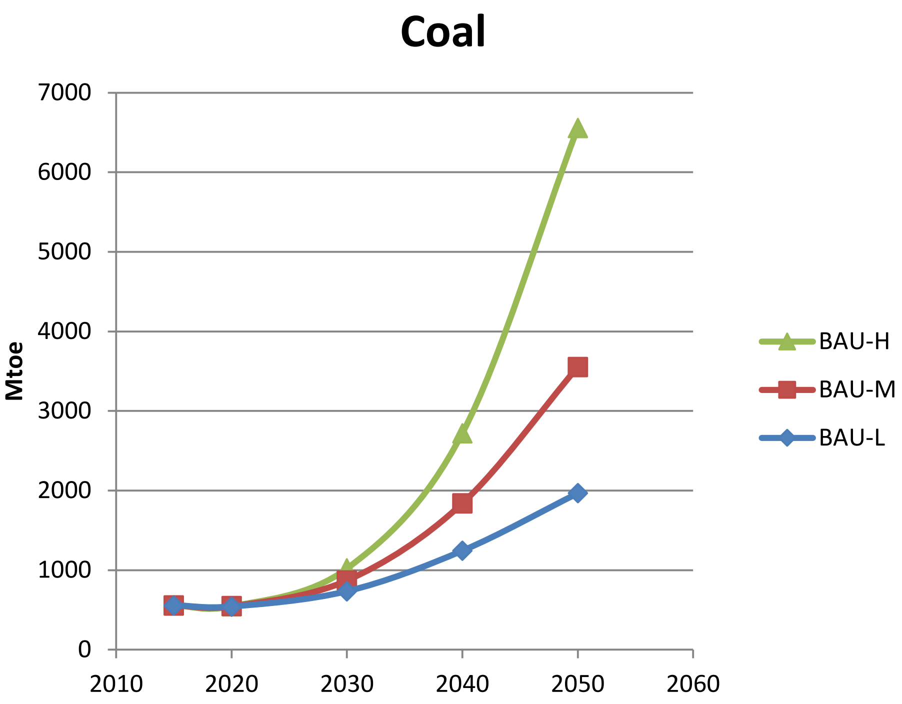
Biomass would grow less rapidly at CAGR of

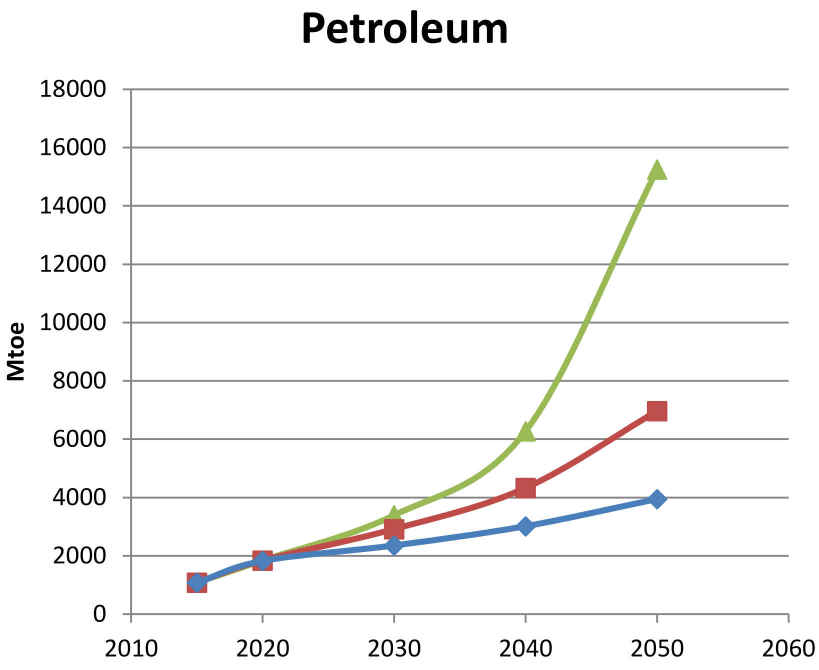
- 0.6% in BAU-L, 1.6% in BAU-M and 2.8% ir BAU-H

Hydro power would grow more rapidly at CGAR of

- 8.1% in BAU-L, 10.0% in BAU-M and 11.6% in BAU-H

Fossil Fuel Consumption under Different Economic Growth Scenarios





Coal use would increase at a CAGR of

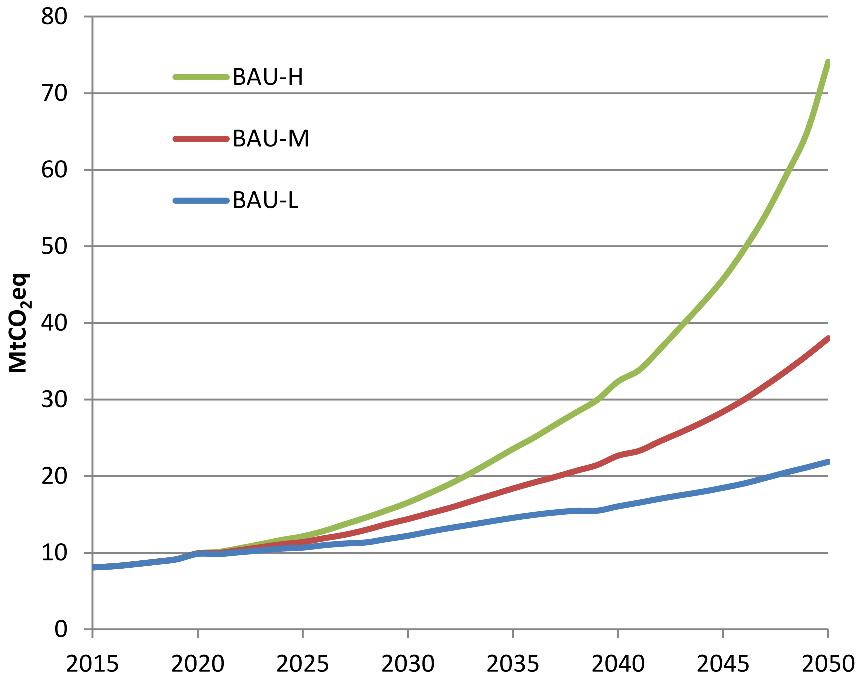
- 3.7% in BAU-L, 5.4% in BAU-M and 7.3% in BAU-H

Oil use would increase at a CAGR of

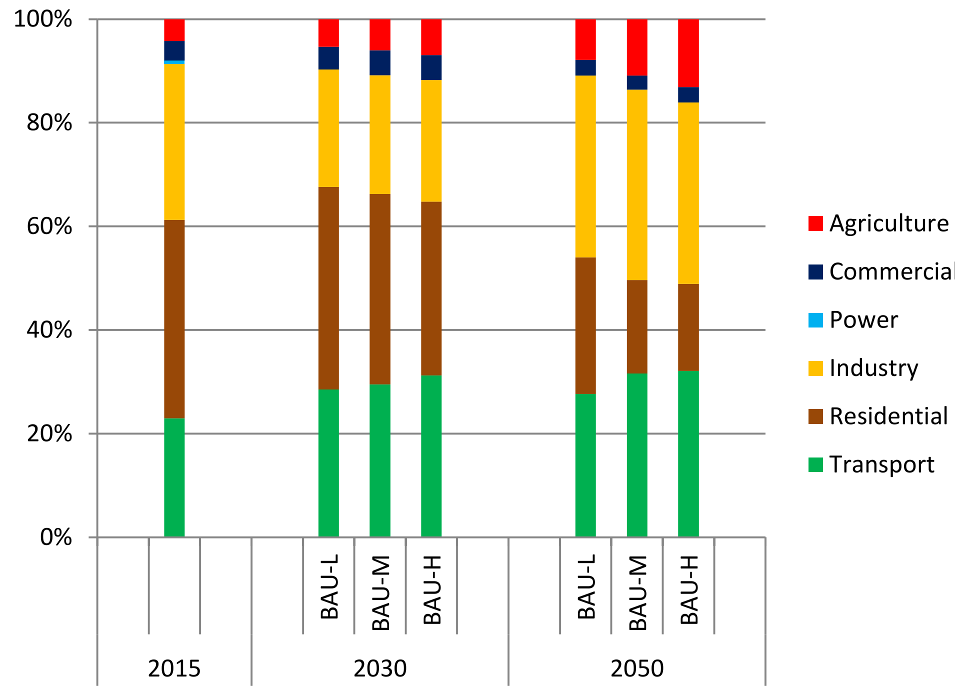
- 3.8% in BAU-L, 5.5% in BAU-M and 7.9% in BAU-H

GHG Emissions

Growth of GHG Emission



Sectoral Shares in GHG Emission



GHG emissions would grow during 2015-2050 at

- 2.9% in BAU-l
- 4.5% in BAU-M
- 6.5% in BAU-H

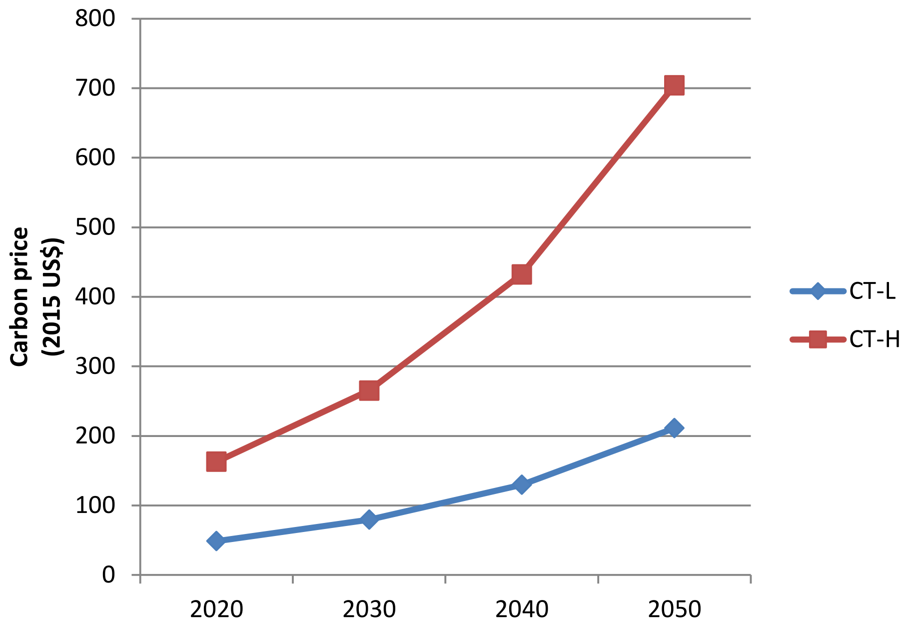
Cumulative GHG emissions during 2015-2050

- 497 MtCO2e in BAU-L
- 658 MtCO2e in BAU-M
- 927 MtCO2e in BAU-H

Achieving the Net Zero Emission Target in Medium Economic Growth Scenario

- Effect of carbon tax on energy related GHG emission reduction?
- Role of sequestration?

Carbon Tax Profile

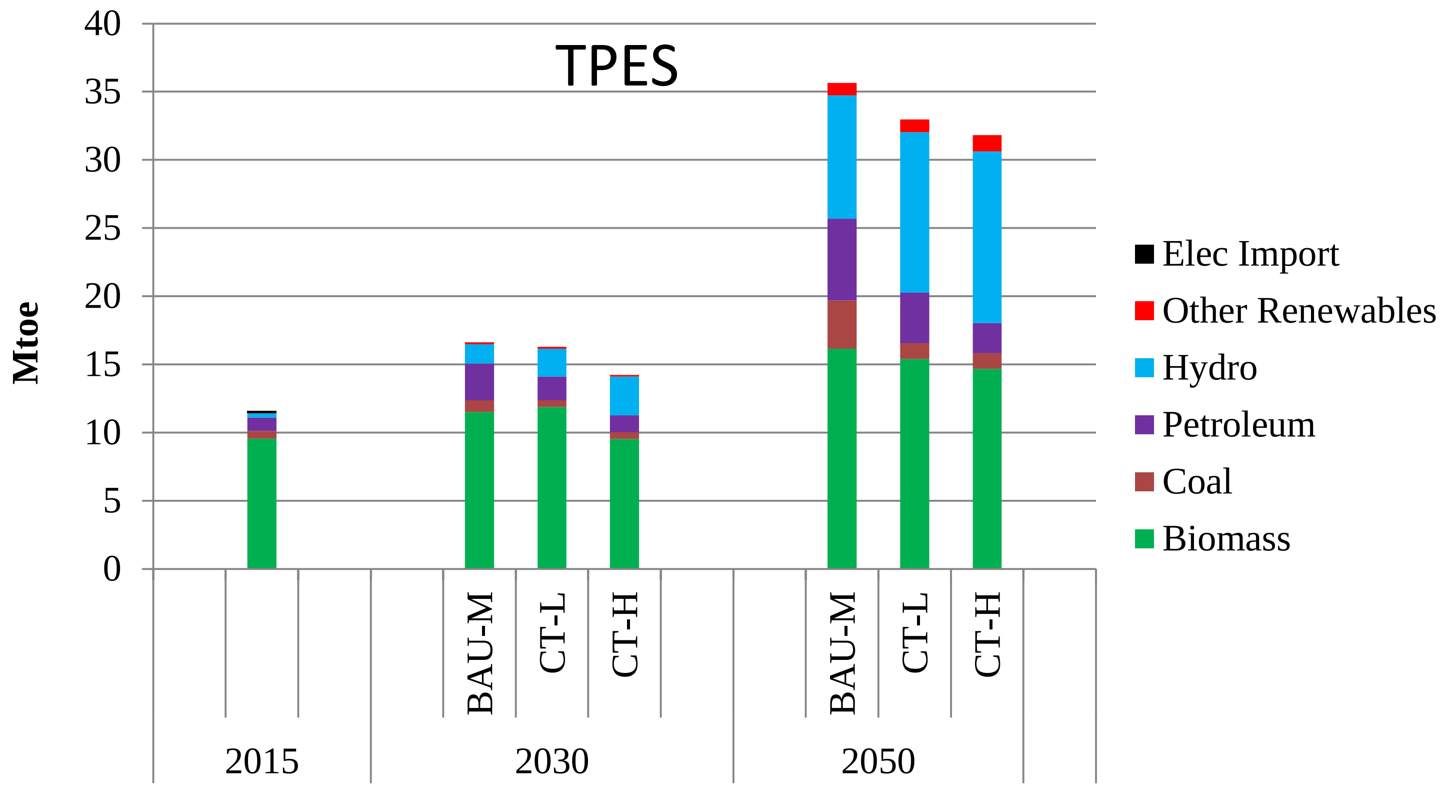


	2020	2030	2040	2050
CT-L	49	80	130	211
CT-H	163	265	432	704

CT-L: average discounted carbon price of 30US$ at 2010 US$ based on GCAM model (discounted at 5%)

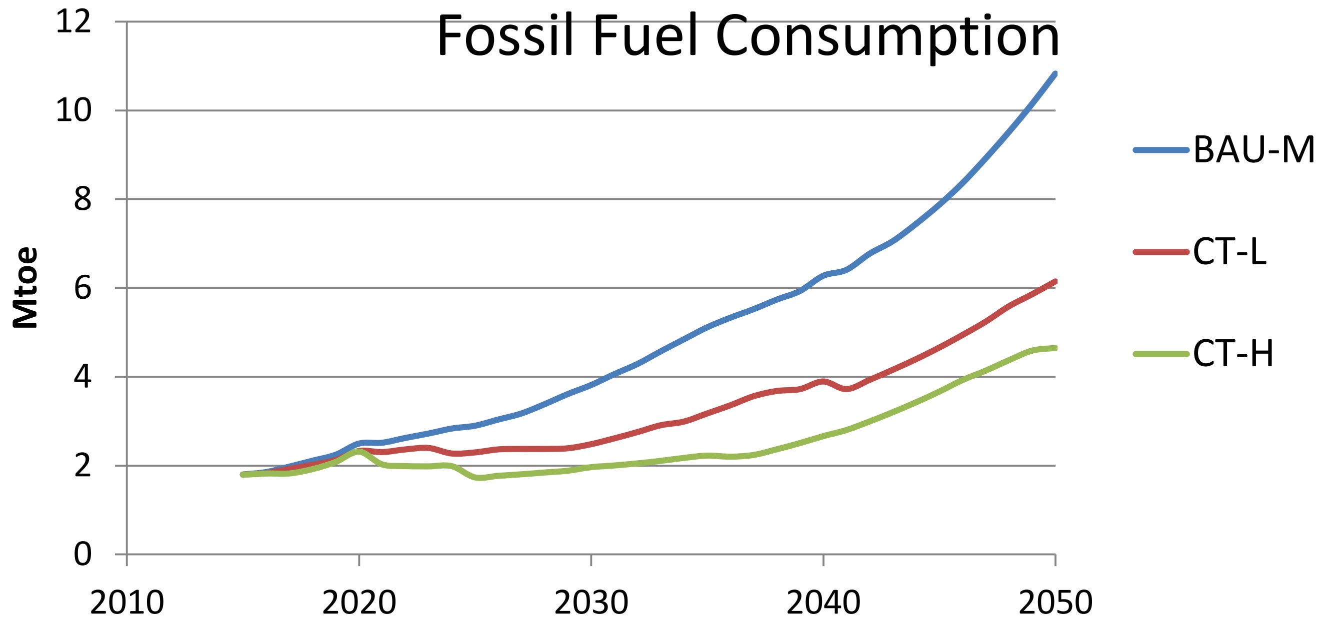
CT-H: average discounted carbon price of 100 US$ at 2010 US$ based on REMIND model (discounted at 5%)

Primary Energy Supply under Carbon Tax Scenarios



TPES in 2050 would decrease by 7.6% in CT-L and 10.8% in CT-H

Fossil Fuel Consumption under Carbon Tax Scenarios



In 2030, Fossil fuel consumption would decrease by

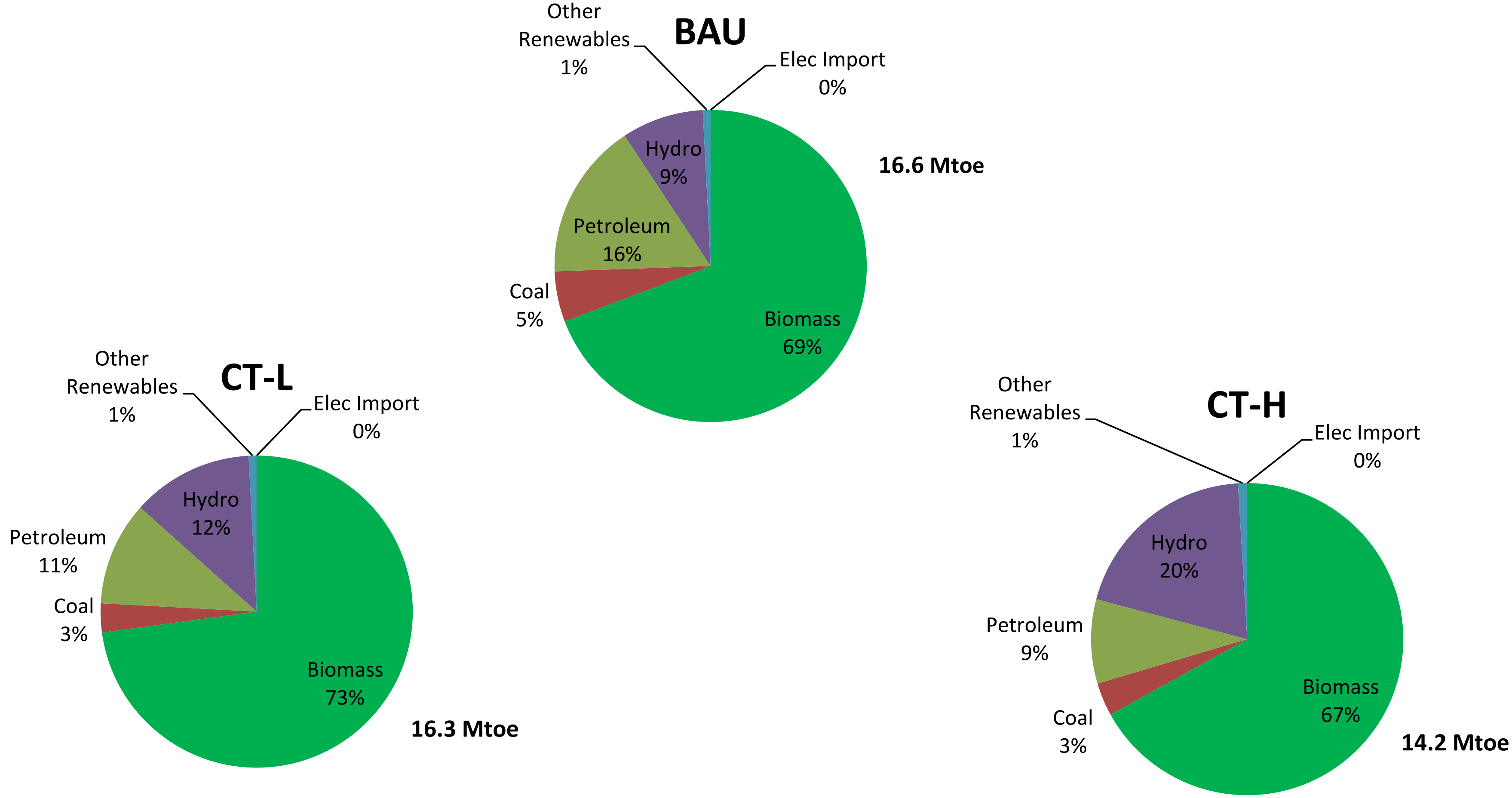
- 35.0% in CT-L and 48.4% in CT-H

In 2050, Fossil fuel consumption would decrease by

- 43.2% in CT-L and 57.1% in CT-H

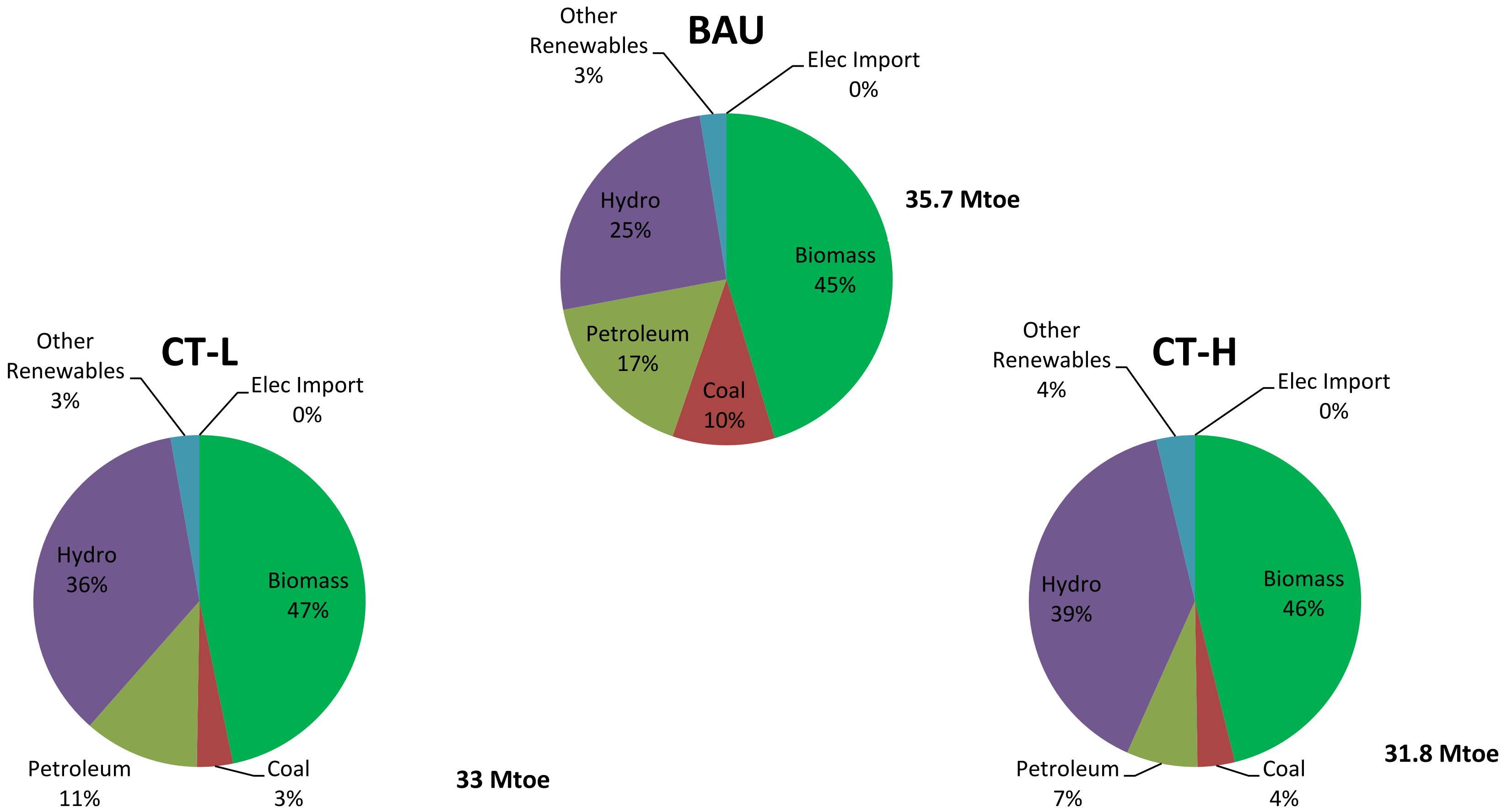
During 2015-2050, cumulative fossil fuel consumption would decrease by 34.4% in CT-L and 48.8% in CT-H

Primary Energy Mix in 2030 under Carbon Tax Scenarios



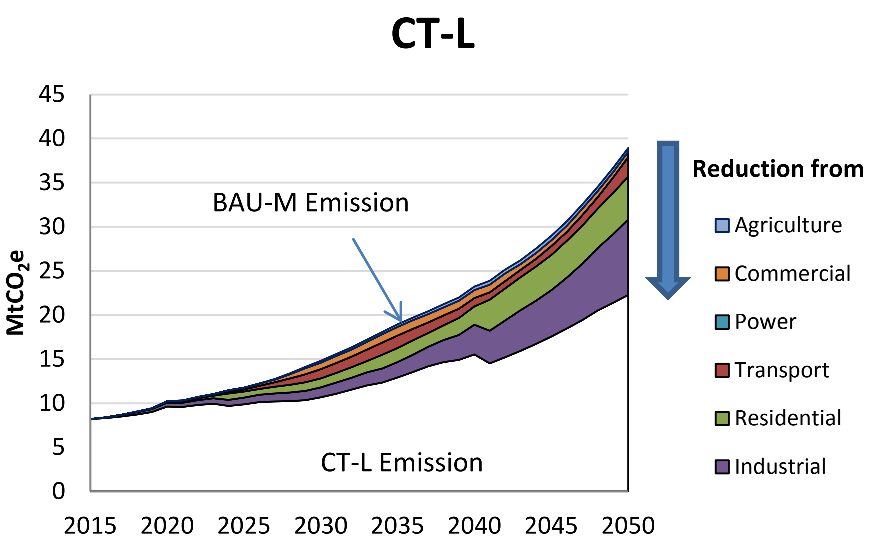
- Biomass use in industrial sector would increase under both CT-L and CT-H
- In CT-H, biomass use in residential sector would be displaced by electricity

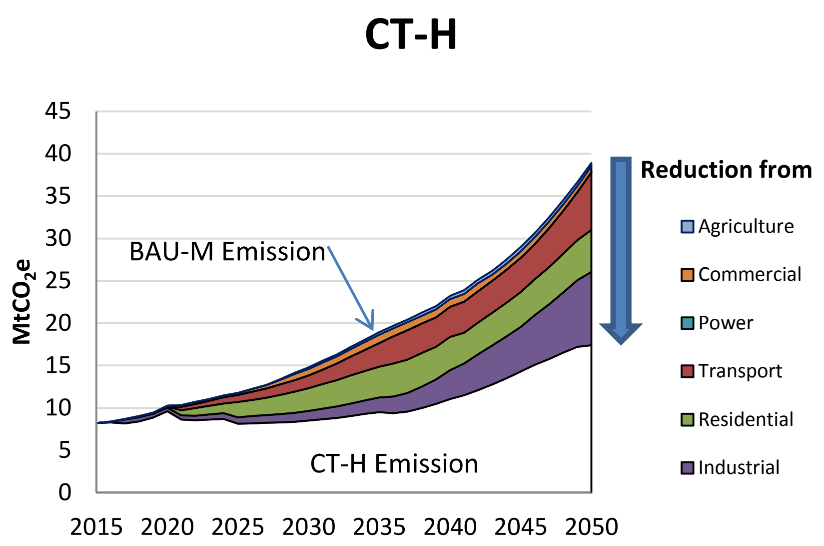
Primary Energy Mix in 2050 under Carbon Tax Scenarios



- Biomass use in industrial sector would increase under both CT-L and CT-H
- Electricity would replace biomass use in residential sector under both CT-L and CT-H

GHG Emissions under Carbon Tax Scenarios





In 2030, GHG emissions would be reduced by

- 28% in CT-L and 43% in CT-H

In 2050, GHG emissions would be reduced by

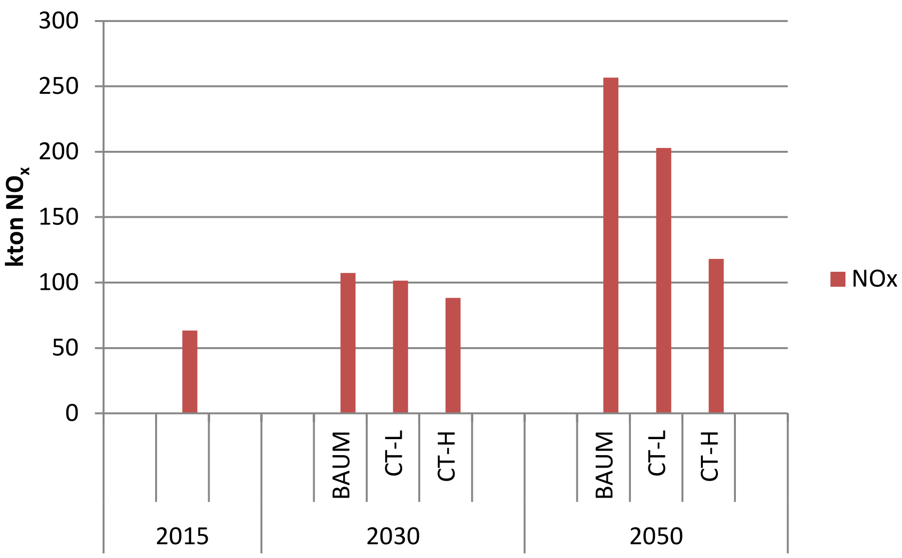
- 43% in CT-L and 55% in CT-H

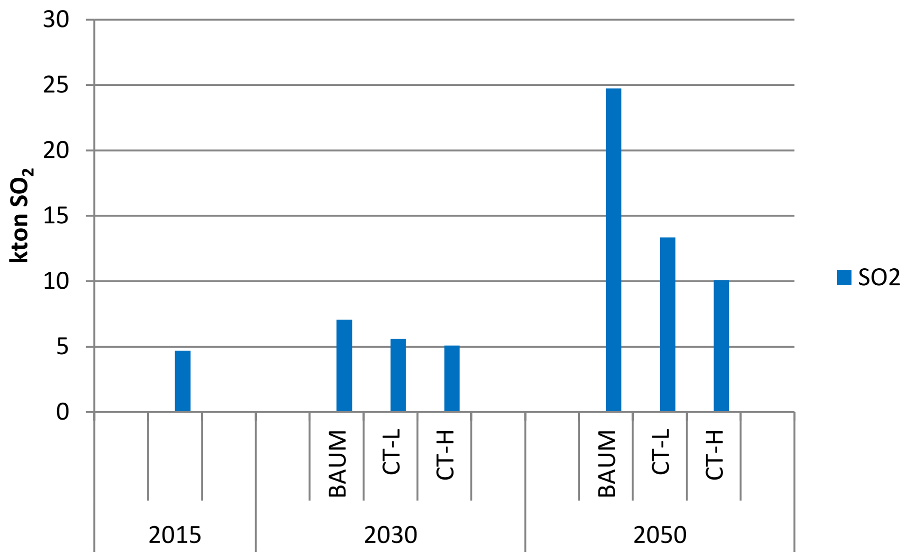
In 2050

CT-H: Largest reduction from Industrial sector, then from transport, residential and others

CT-L: largest reduction from industrial, then from residential, transport and others

Local Pollutant Emissions





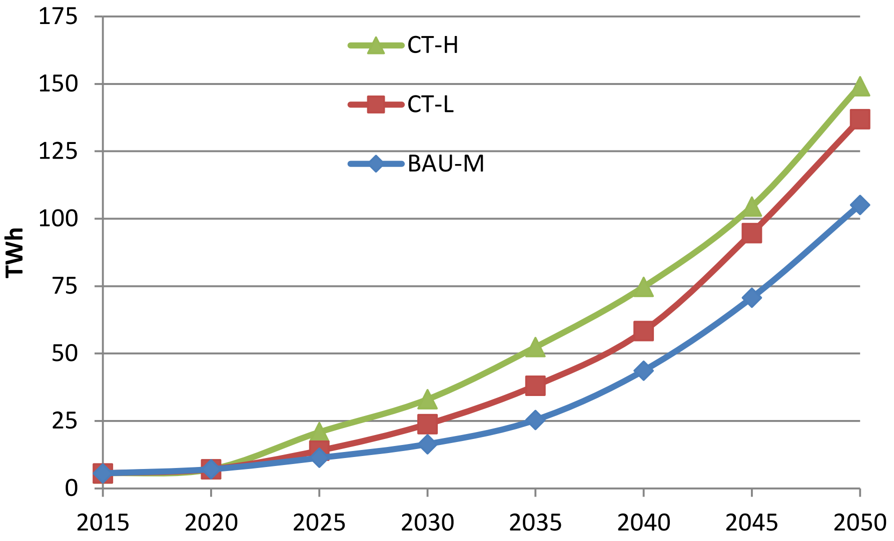
NOx emission would decrease by

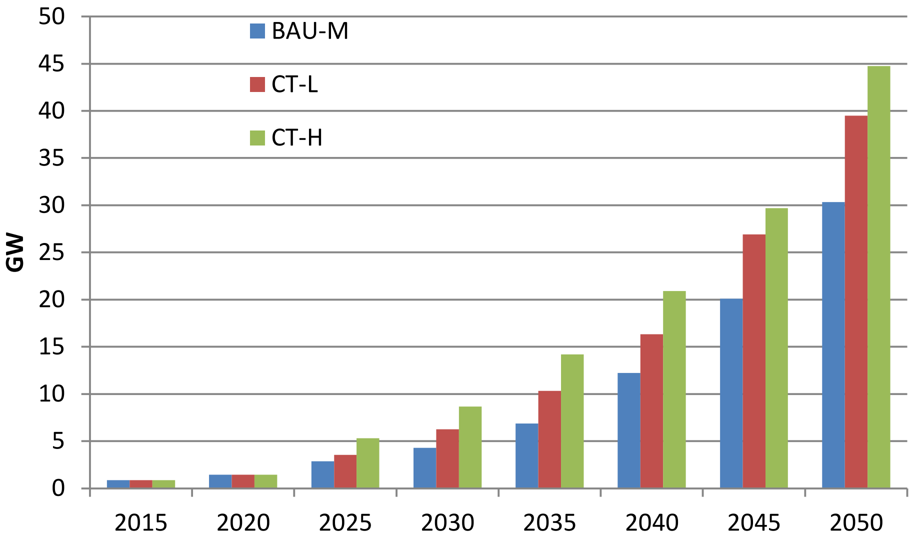
- 5% in CT-L and 18% in CT-H in 2030
- 21% in CT-L and 54% in CT-H in **2050**

SO_2 emission would decrease by

- 21% in CT-L and 28% in CT-H in 2030
- 46% in CT-L and 59% in CT-H in **2050**

Electricity Generation





In 2030, electricity generation would increase by

- 45% in CT-L and 101% in CT-H

In 2050, electricity generation would increase by

- 30% in CT-L and 15% in CT-H

In 2030, installed capacity would increase by

- 1,772 MW in CT-L and 8,325 MW in CT-H

In 2050, installed capacity would increase by

- 3,969 MW in CT-L and 13,119 MW in CT-H

Solar PV is cost-effective at $600/kW

Energy Security Implications

Net Energy Import Dependency, %

	BAU-M	CT-L	CT-H
2015	14.8	14.8	14.8
2030	21.5	13.8	12.2
2050	26.8	14.7	10.6

Major technological shift

Mitigation options in the Transport Sector:

- Biofuel vehicles (ethanol and biodiesel blend) in CT-L
- Flexi-fuel vehicles in CT-L
- Electric cars in both scenarios
- Fully Electric vehicles in CT-H (including trucks and buses)

Mitigation options in the Residential and Commercial Sectors:

- Improved cook stoves
- Biogas cooking
- Electric cooking
- Solar water heater
- LED lamps in lighting

Mitigation options in the Industrial Sector

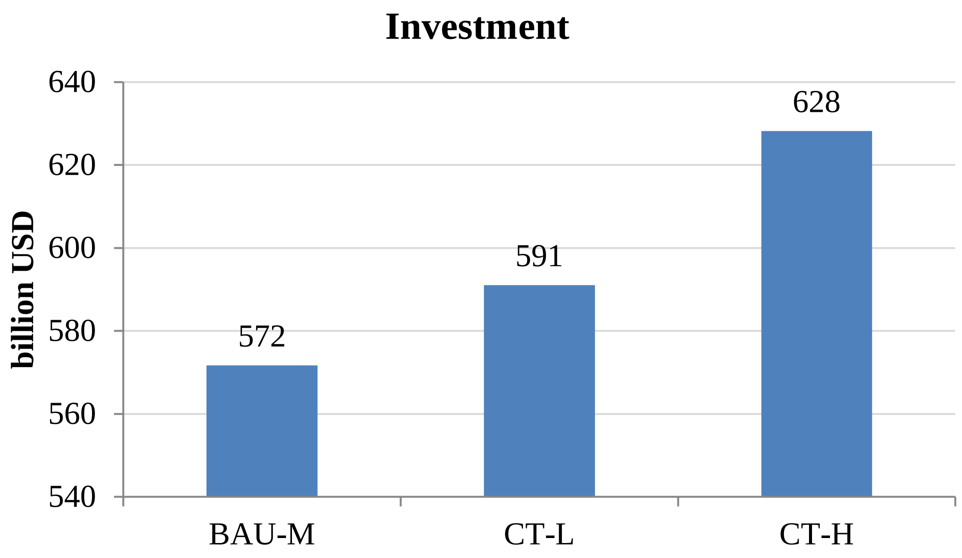
- Efficient electric motor (motive power)
- Improved fixed chimney brick kiln
- Energy efficient boilers
- Biomass fired boiler
- Biomass in Brick industry

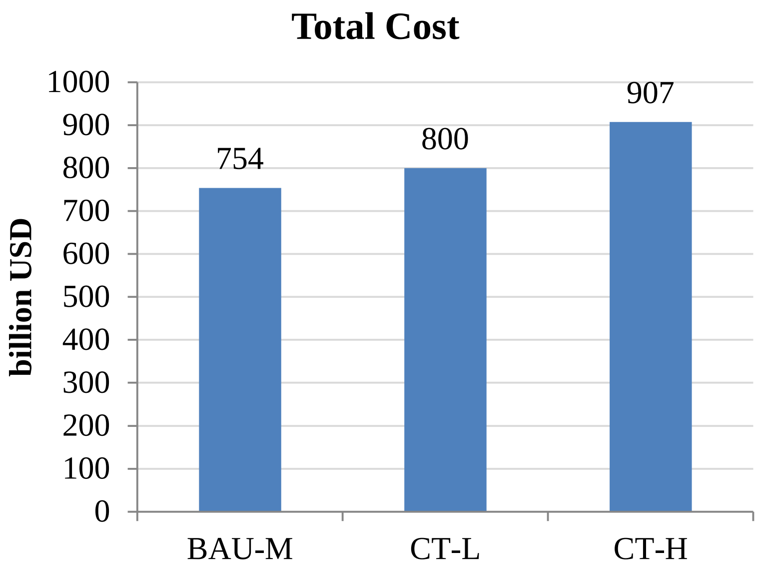
Mitigation options in Agriculture

- Electric pumps
- Electric tractors

- **Fuel mix changes to significantly higher use of renewable energy (mainly hydro) based electricity and bioenergy**
- **Use of energy efficient technologies**

Total cost and investment Requirement (2015-2050)





Investment Requirement would increase by

- 3.4% (19.4 billion USD) in CT-L and
- 9.9% (56.5 billion USD) in CT-H

Total cost would increase by

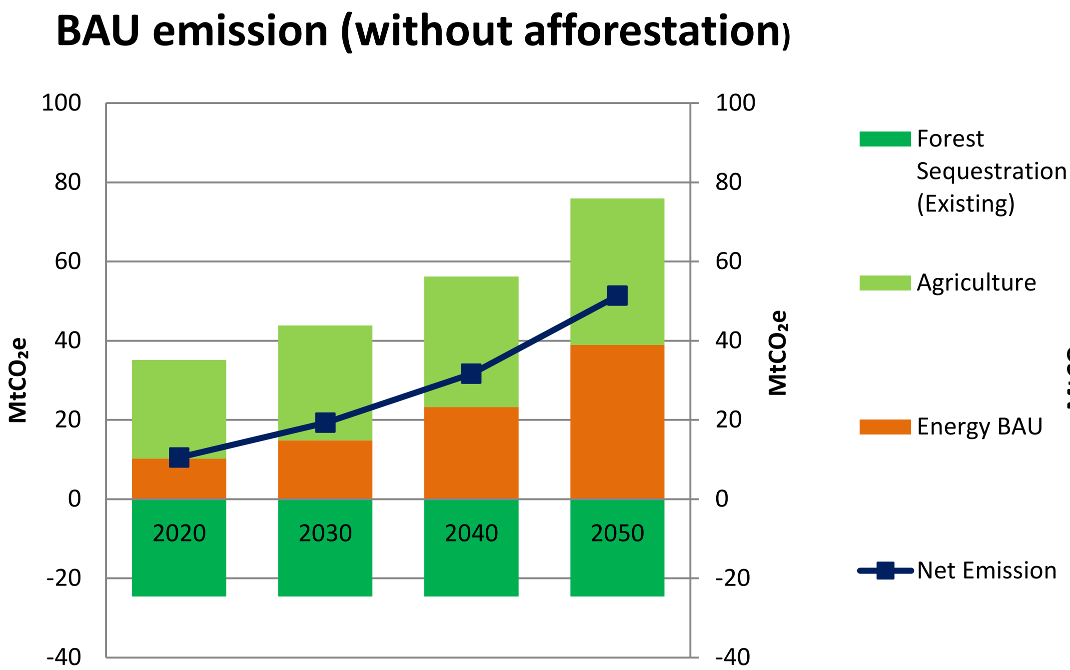
- 6.1% (46 billion USD) in CT-L and
- 20.3% (153.3 billion USD) in CT-H

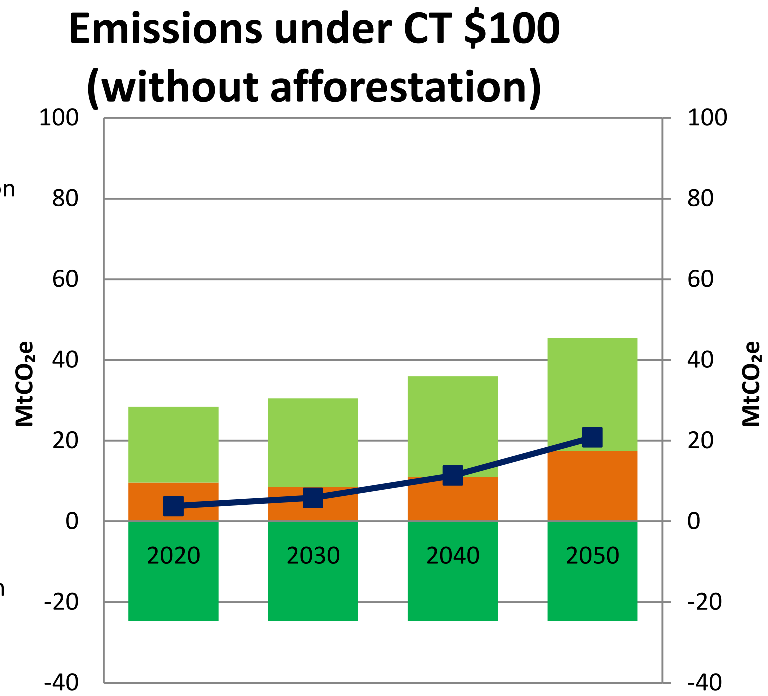
Role of Carbon Price and Afforestation

Afforestation Potential

- Forest coverage is 44% in the BAU case during 2020-2050.
- Sequestration rate of existing forest would remain at 24.5 $MtCO_2$/year in the BAU case.
- Additional 8% of land available for afforestation (Sequestration potential = 13 MtCO2e).

Would net zero emission be possible under CT $100?





Net emission in 2050 without afforestation = 51.3 MtCO2e

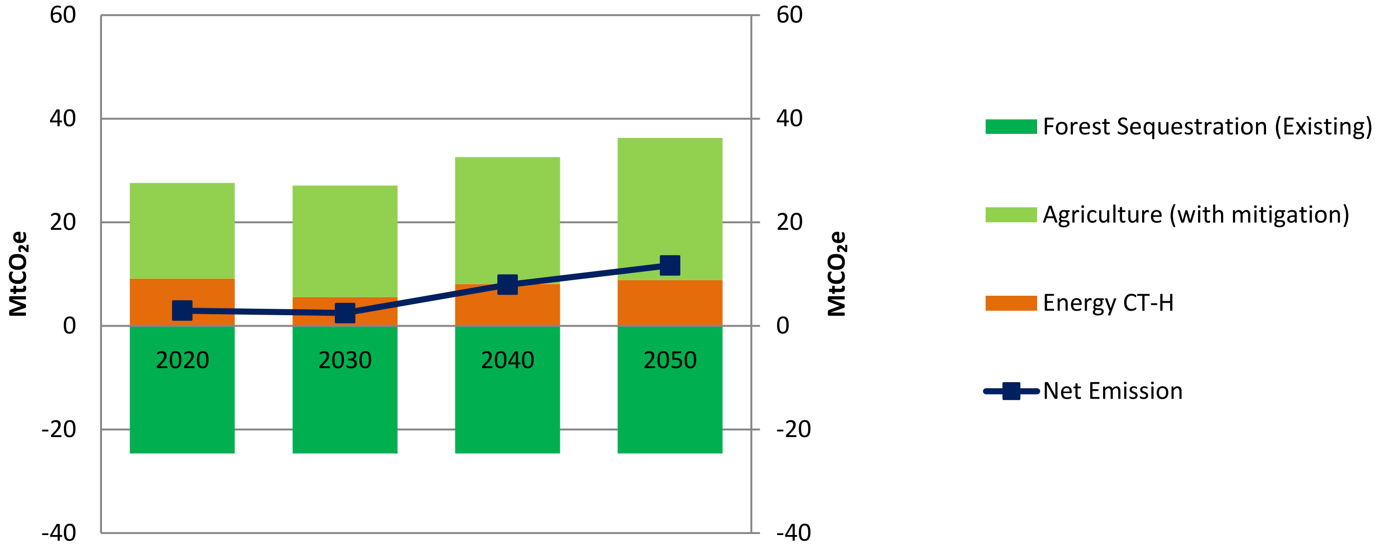
Net emission in 2050 without afforestation = 20.8 MtCO2e

Additional sequestration potential = 13 MtCO2e

With the afforestation potential, net zero emission (NZE) feasible during 2020-2040 but infeasible in 2050 and thereafter.

What is needed to achieve net zero emission by 2050?

Emissions with CT $325 (without afforestation)



Net emission in 2050 without afforestation = 11.7 MtCO2e

With carbon tax of $325, additional sequestration required to achieve net zero emission:

2.9 MtCO2e in 2020; 2.5 MtCO2e in 2030

8.0 MtCO2e in 2040; 11.7 MtCO2e in 2050 (about 90% of afforestation potential)

High carbon tax of $325 needed to achieve net zero emission in 2050.

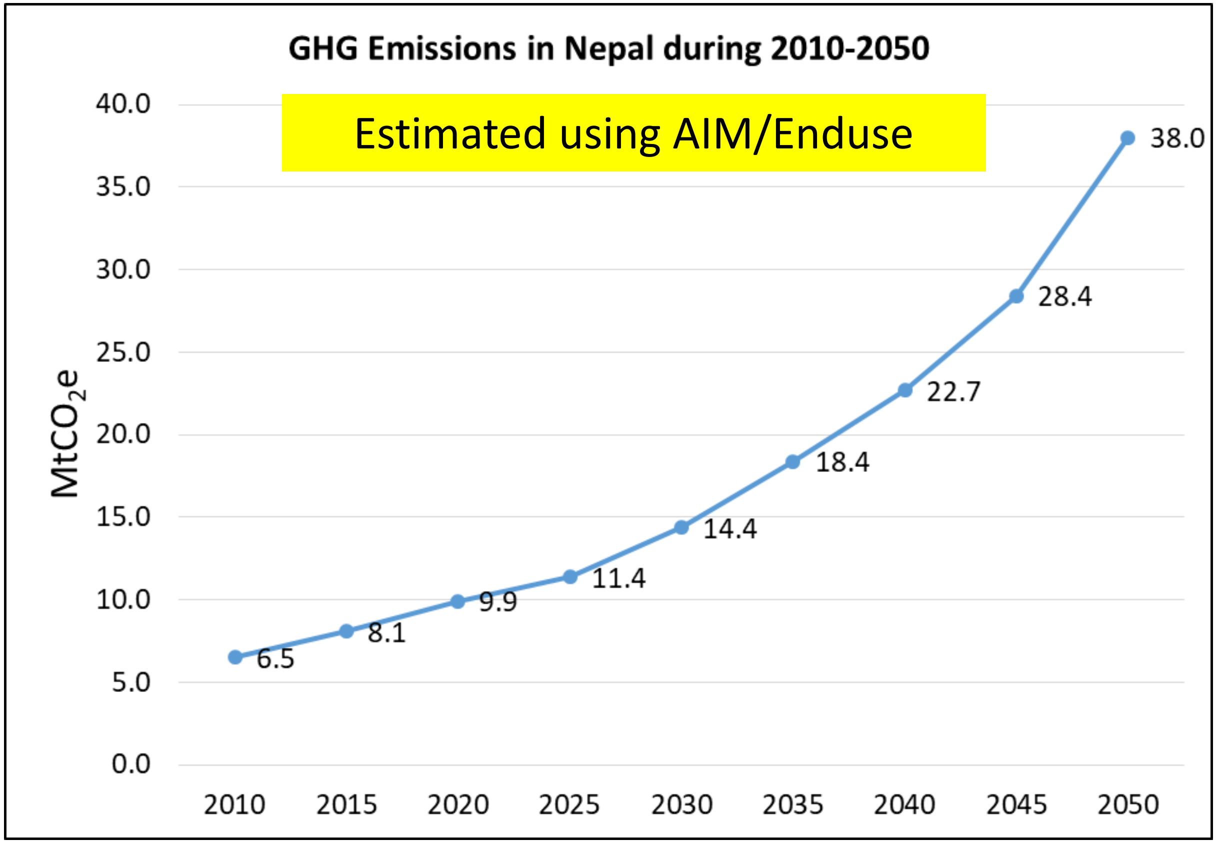
Key Insights

- Achieving 1.5°C target would require very high use of electricity based mainly on hydropower in all sectors.
- Carbon tax of $325/tCO2e (average discounted value) would be needed for achieving net zero emission by 2050 under medium economic growth.
- Higher tax above $325/tCO2e would not achieve significant decrease in energy related emissions
- In addition 90% of afforestation potential would have to be used to achieve net zero emission by 2050.

Preliminary Results of CGE Analysis on Economy-wide Effects of GHG Emission Reduction

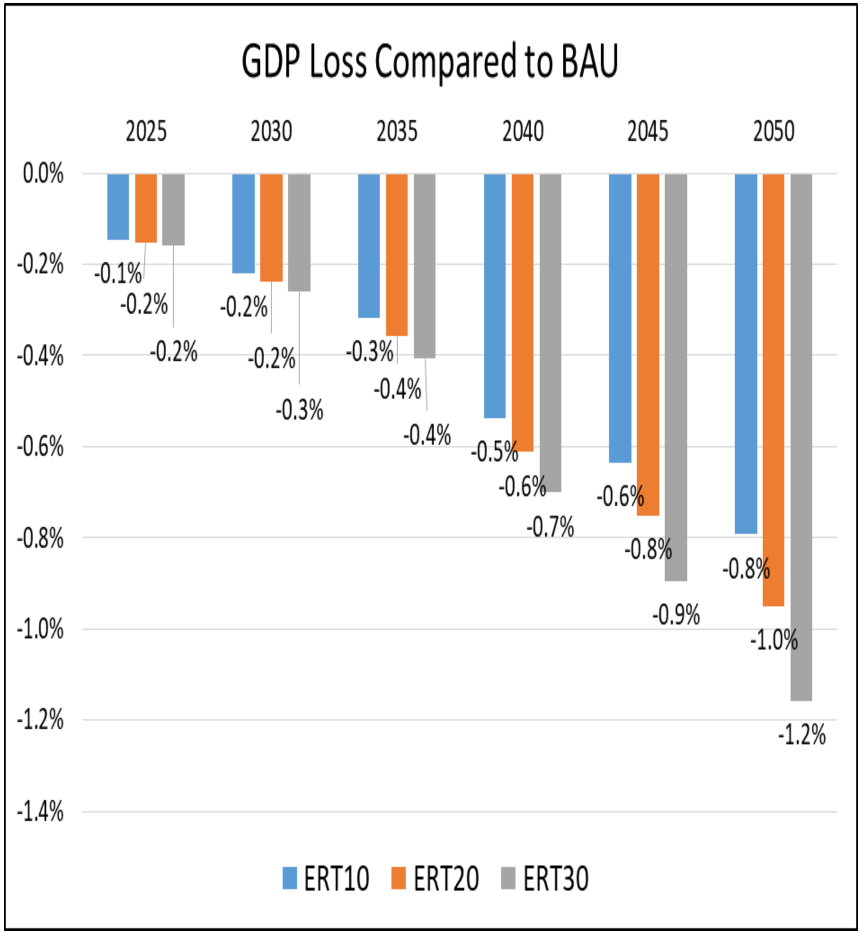
- Based on an ongoing work by Salony Rajbhandari et al.,2018.

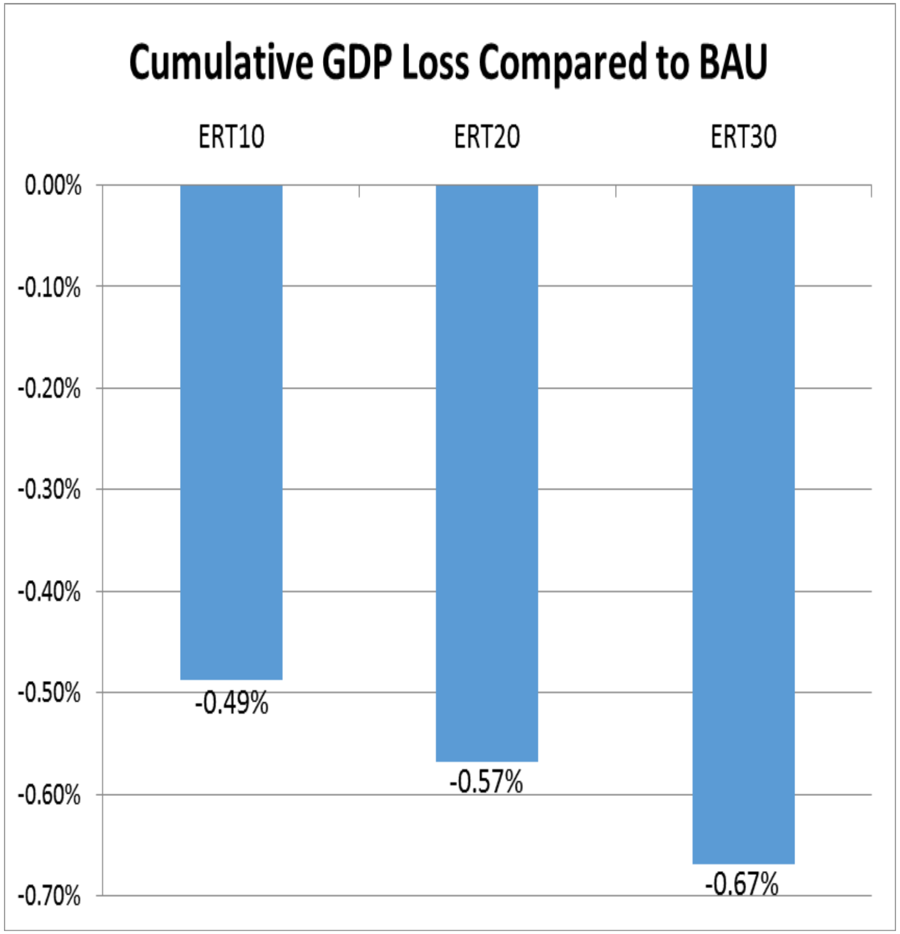
GHG Emissions in Nepal under Medium Economic Growth Scenario



CAGR during 2010-2050 = 4.51%

Preliminary Results: Impact on GDP





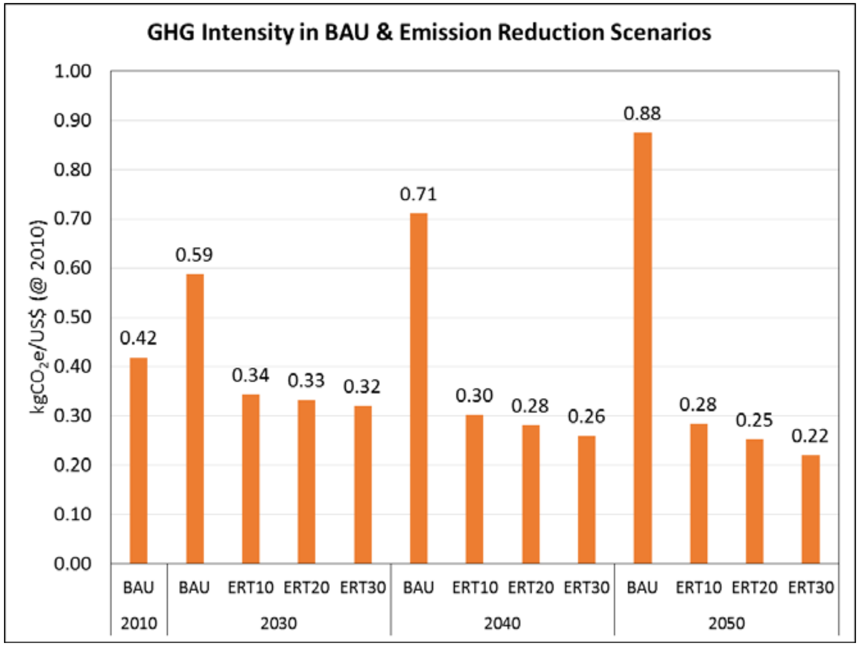
GDP loss of 0.8% to 1.2% in 2050 under ERT scenarios

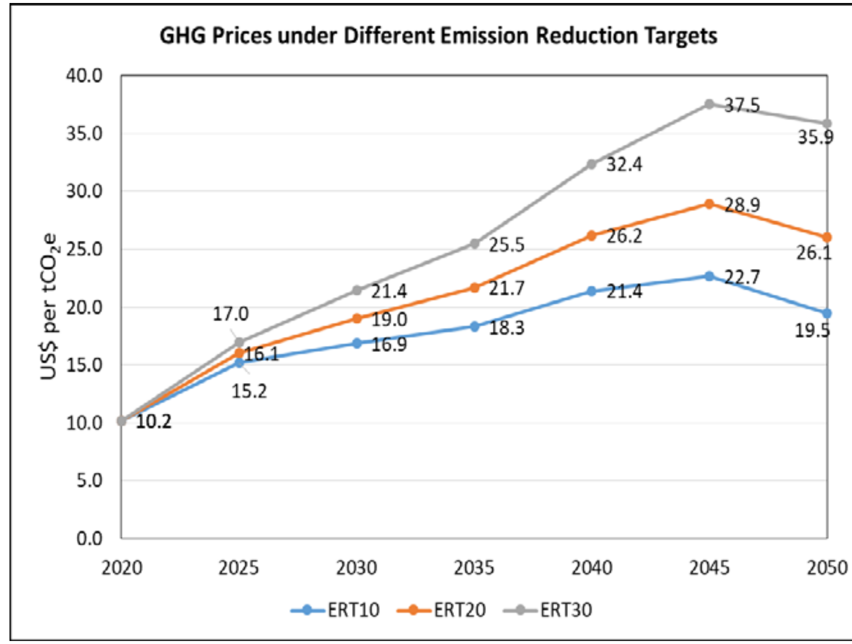
Cumulative GDP loss in the range of 0.49% to 0.67%

Preliminary Results:
GHG Intensity & GHG Price

Increasing emission reduction targets causes reduction in the GHG emission intensities

Higher GHG emission reduction targets imposes higher GHG prices





- GHG reductions vary from 37% to 40% in 2030 and 55% to 59% in 2050 under the ERT10 to ERT30 scenarios as compared to the BAU emissions.

Manufacturing Industries & land transport sectors
- The major contributors to GHG reductions

Increasing electricity use & decreasing fossil fuel consumptions

Some Future Tasks of Nepal CGE Model

Assessment of energy, environmental & economy-wide implications of

- Carbon tax
- Energy efficiency improvement in the energy supply and final demand sectors.

Thank You