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Low Carbon Development with INDC Targets and Carbon Tax in Selected Sectors of Nepal

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Sector Overview

- The agriculture, forestry and forest and grassland conversion accounts for as high as over 80% of the total GHG emission in 2000

- Forestry sector sequestered 69% of the total GHG emissions from the country in 2000

Source: Nepal Second National Communication (MOSTE, 2014)

This Study

1. Analyses emissions from the agriculture, forestry and other land use (AFOLU) sector using AFOLU-B model.
2. Assesses the implications of Nepal's Nationally Determined Contributions (NDCs) through electrification and fossil fuel reduction targets (using the AIM/Enduse model) during 2010-2050 on:
   - GHG emissions,
   - Local/regional environmental emissions,
   - Energy security,
   - Renewable energy usage,
   - Hydropower development,
   - Total cost and Investment requirements and
   - Incremental abatement cost

GHG Emission Mitigation from AFOLU in Carbon Tax Scenarios

AFOLU Scenarios

The BAU Scenario:

- Assumes the technology shares during 2010-2050 to continue to be the same as that in the base year (i.e., 2010).

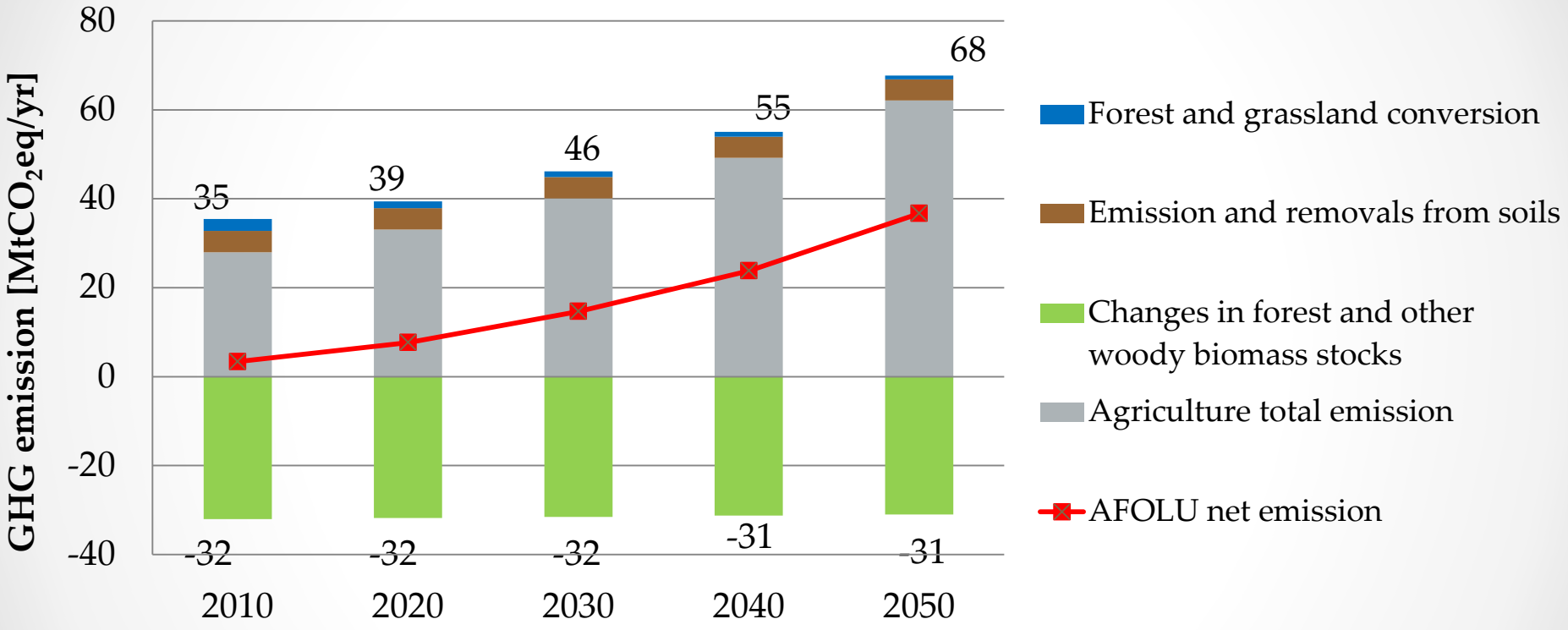
The Reference Scenario:

- No constraint on the shares of the mitigation technologies that are in BAU.
- Considers additional GHG abatement countermeasures.

Seven different carbon tax scenarios:

- \$10, \$25, \$50, \$75, \$100, \$300 and \$500/tCO_2e

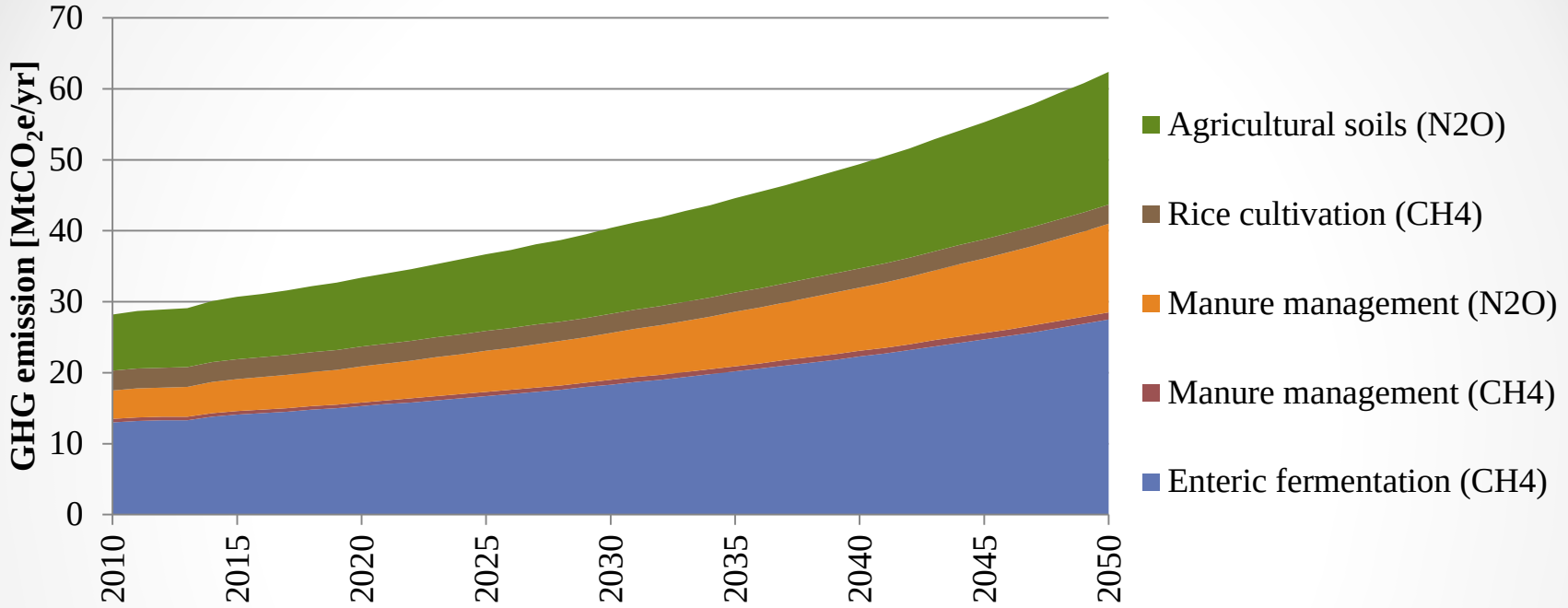
GHG emission from the AFOLU sector during 2010-2050 in BAU



During 2010-2050, increase of GHG Emissions in:

- Agriculture sector by 120%
- AFOLU gross emissions by 90%
- AFOLU net emissions by 9.8 times

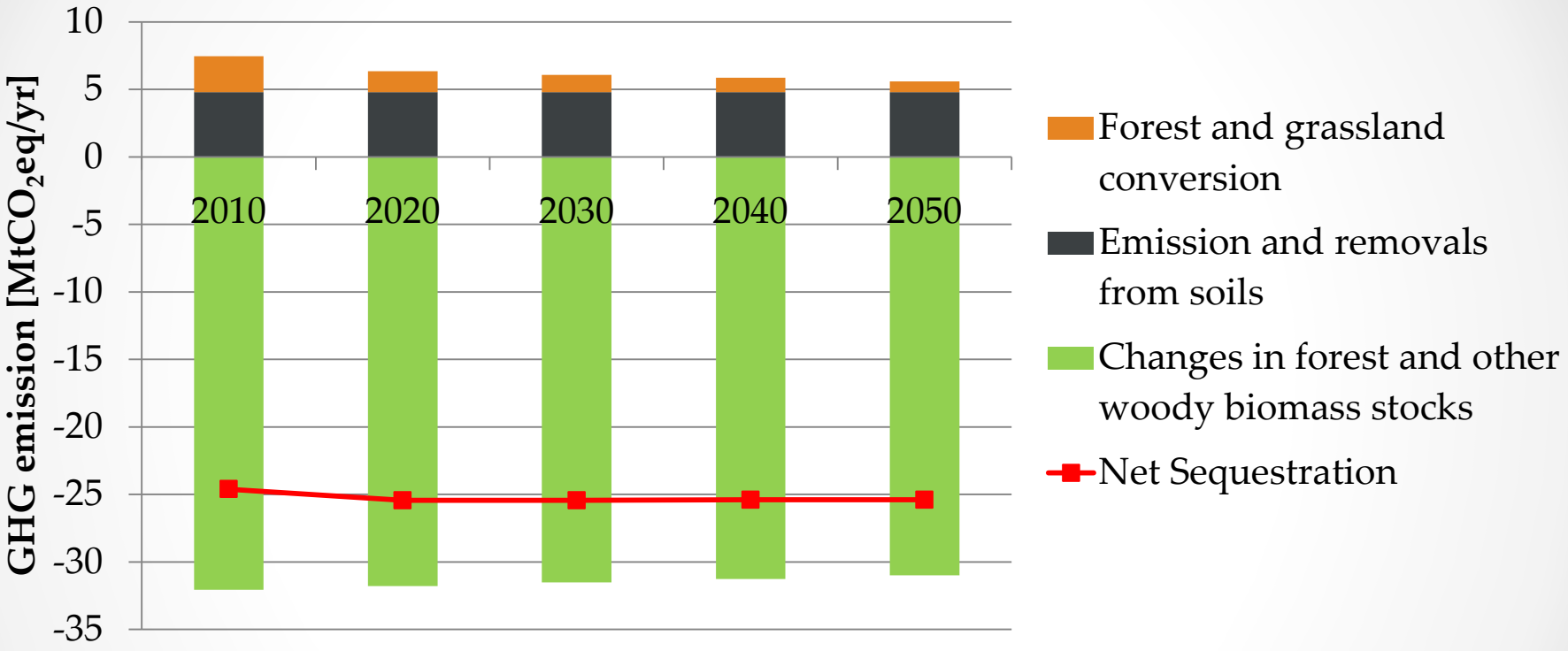
GHG emission from agriculture during 2010-2050 in the BAU scenario



During 2010-2050:

- Highest GHG emitter: Enteric fermentation (Share decreases from 46.1% to 44.1%).
- Rice cultivation: Share decreases from 9.9% to 4.3%.
- Change in GHG emission shares of:
  - Agriculture soils: from 28% in 2010 to 30% in 2050.
  - Manure management (N2O): from 14% in 2010 to 20% in 2050.
  - Manure management (CH4): from 1% in 2010 to 2% in 2050.

GHG emission from LULUCF during 2010-2050 in BAU



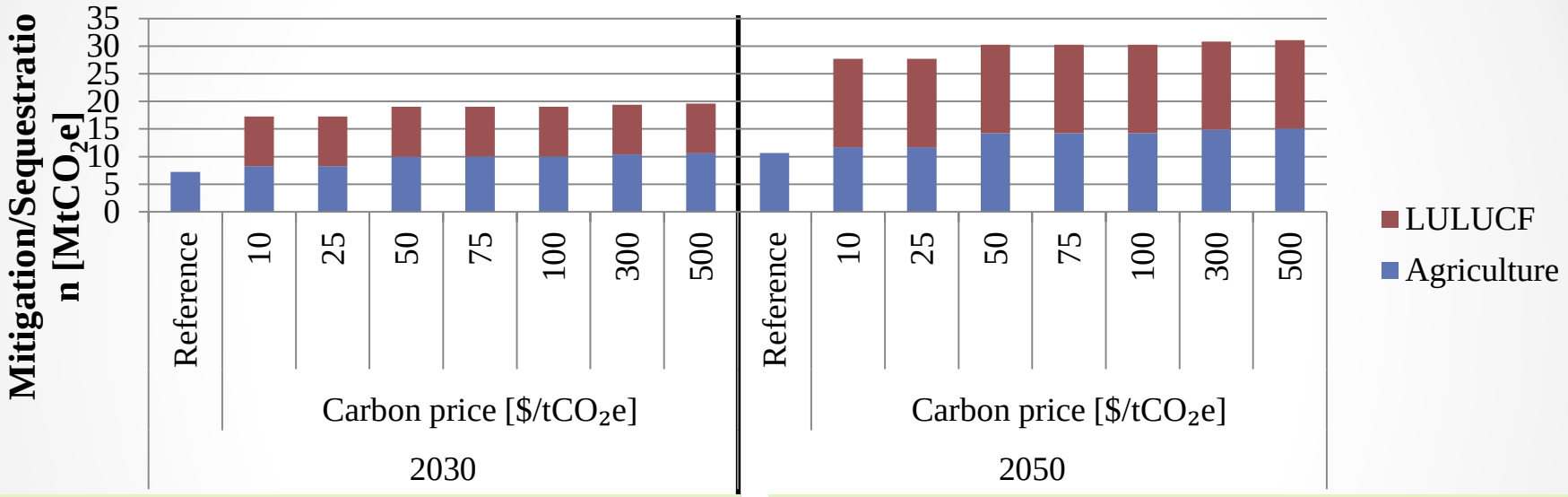
During 2020-2050:

- **Net sequestration from LULUCF would remain at 25.4 $MtCO_2eq$/year**

Carbon Tax and Annual AFOLU sector GHG abatement potential in 2030 and 2050

-Indicates the presence of no-regret options in agriculture.

-No significant increase in the abatement potential at carbon taxes above $50/tCO$_2$e



Net Emissions in BAU in 2030: 14.7 MtCO2e

The net abatement potential in 2030:

- 7.2 MtCO$_2$e in the reference scenario (compared to BAU)

When compared to the reference scenario, mitigation potential increases by

- 1.4 times at $10/tCO$_2$e and
- 1.7 times at $500/tCO$_2$e

Net Emissions in BAU in 2050: 36.7 MtCO2e

The net abatement potential in 2050:

- 10.7 MtCO$_2$e in the reference scenario (compared to BAU)

When compared to the reference scenario, mitigation potential increases by:

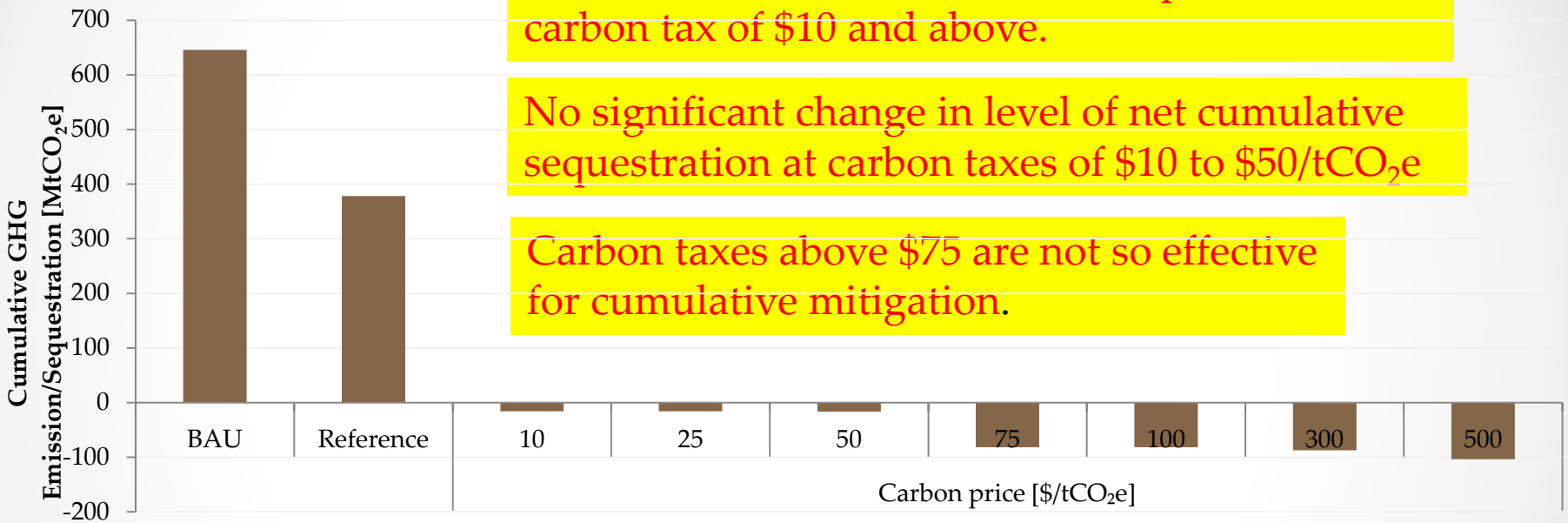
- 1.5 times at $10/tCO$_2$e and
- 1.9 times at $500/tCO$_2$e

Cumulative GHG emission & sequestration from the AFOLU sector during 2016-2050

There would be cumulative net sequestration at carbon tax of $10 and above.

No significant change in level of net cumulative sequestration at carbon taxes of $10 to $50/tCO$_2$e

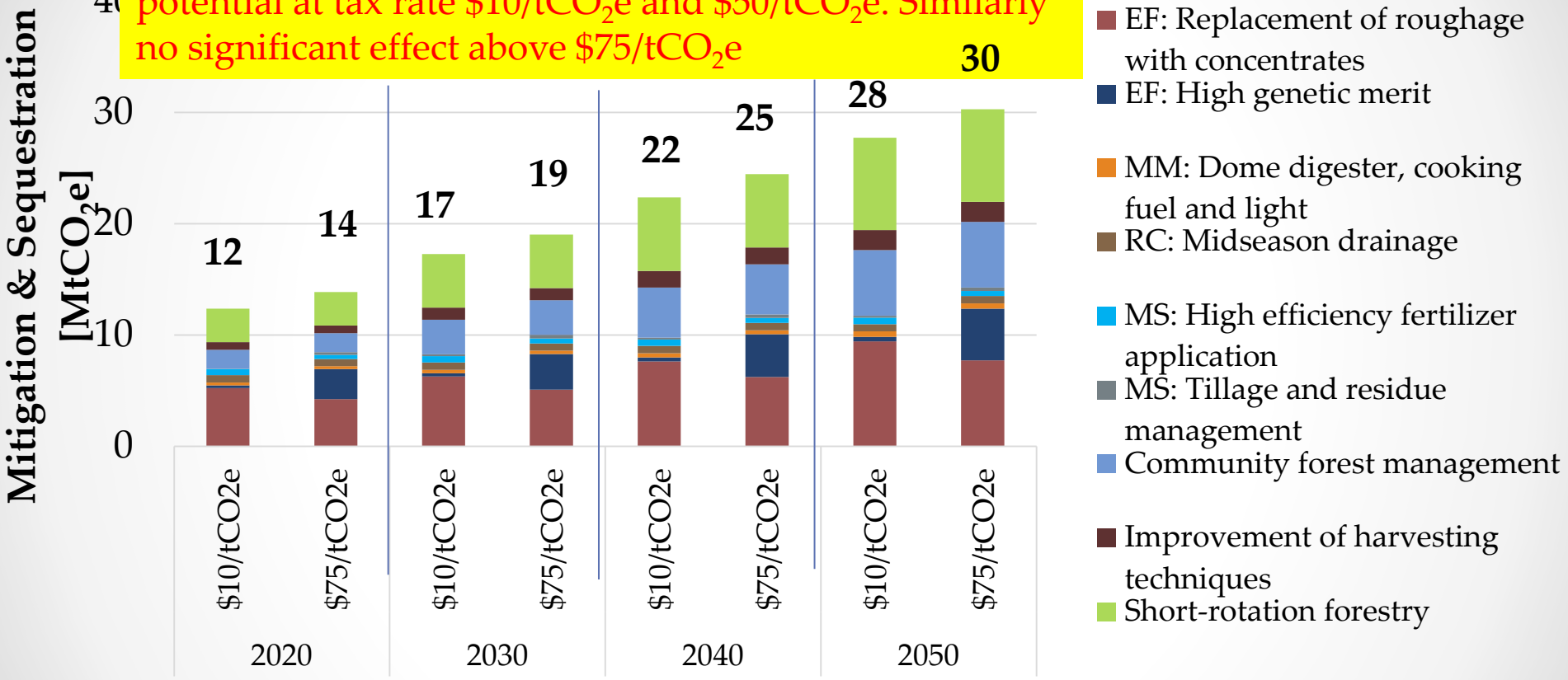
Carbon taxes above $75 are not so effective for cumulative mitigation.



- Cumulative **net emission** in the BAU is 646 MtCO$_2$e
- Cumulative emission in the Reference scenario is 41.5% less than that in the BAU
- At carbon tax of $10 and above, there is **cumulative net sequestration:**
  - 16 MtCO$_2$e at $10/MtCO2e
- At $75 the cumulative net carbon sequestration would be 4 times of that at $10.

Annual GHG mitigation from the AFOLU sector at carbon tax of $\$10/tCO_2e$ & $\$75/tCO_2e$

No significant increase in mitigation & sequestration potential at tax rate $\$10/tCO_2e$ and $\$50/tCO_2e$. Similarly no significant effect above $\$75/tCO_2e$



- Share of "EF: Replacement of roughage with concentrates" decreases from 42% in 2020 to 34% in 2050 in $\$10/tCO_2e$ and 31% in 2020 to 25% in 2050 in $\$75/tCO_2e$
- Share of "Short-rotation forestry" increases from 24% in 2020 to 30% in 2050 in $\$10/tCO_2e$ and from 22% in 2020 to 27% in 2050 in $\$75/tCO_2e$

GHG Emission Mitigation from Energy Using Sectors under NDC Scenarios

The BAU Scenario in the Energy Using Sector

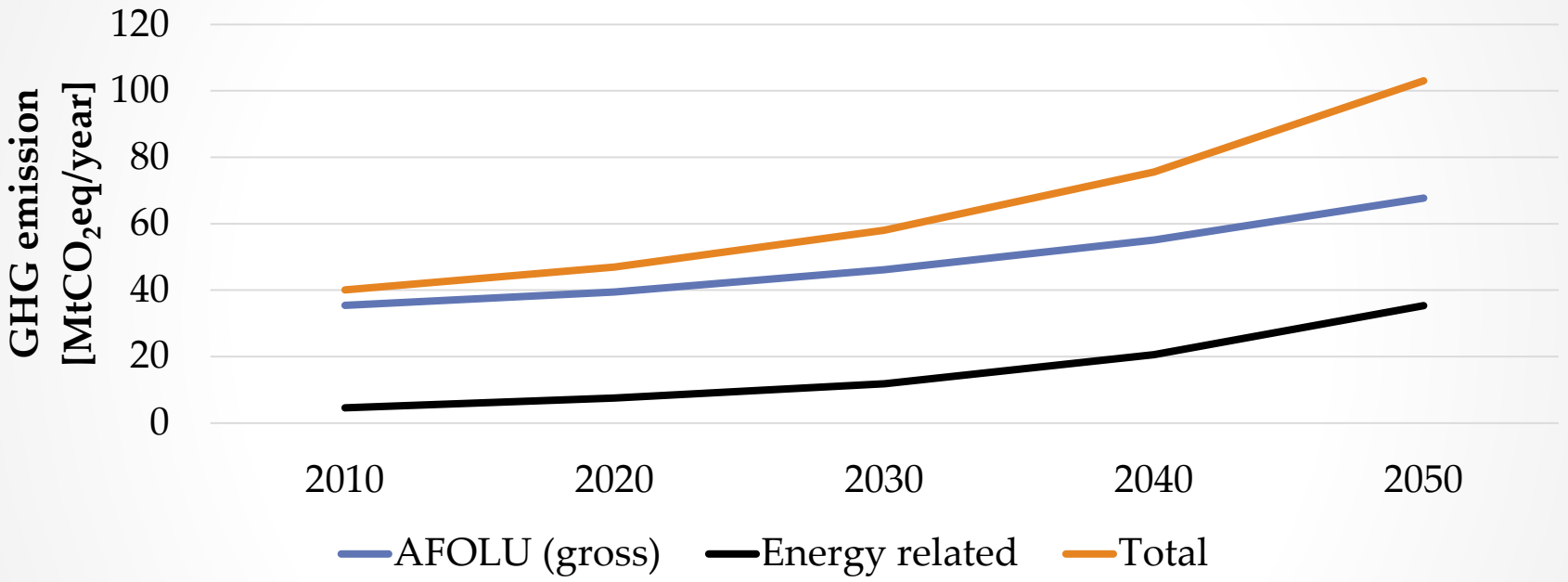
- Does not consider any climate change policy (e.g., GHG emission reduction targets and carbon tax);
- Urban population to grow at CAGR of 2.7% and rural population to grow at CAGR of 0.2% during 2010-2050
- GDP growth at 6% per annum during 2015-2050

INDC Electrification and Fossil Fuel Reduction Scenarios

The government NDC electrification related targets are mostly qualitative in nature. This study considers some specific quantitative targets in electrification scenarios by 2050, which are presented in the table below.

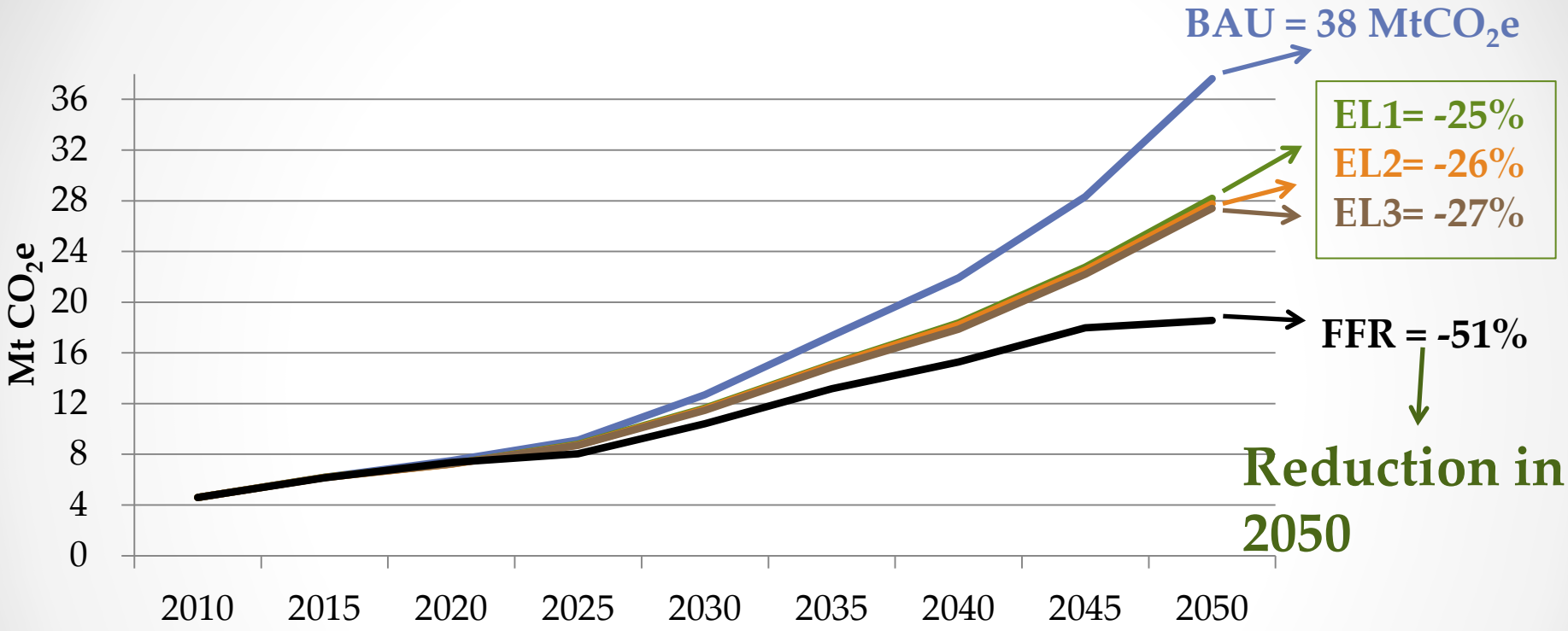
Sector	NDC Scenarios by 2050			
	Electrification			Fossil fuel
	EL1	EL2	EL3	FFR
Transport	• 30% EVs • Introduction of 20% passenger train in 2040 to 30% in 2050 • 10% Fossil fuel reduction in 2020 to 50% reduction in 2050	• 40% EVs • Introduction of 30% passenger train in 2040 to 40% in 2050 • 10% Fossil fuel reduction in 2020 to 50% reduction in 2050	• 50% EVs • Introduction of 40% passenger train in 2040 to 50% in 2050 • 10% Fossil fuel reduction in 2020 to 50% reduction in 2050	50% reduction in fossil fuel consumption
Residential/Commercial	50% electrification in cooking and heating	60% electrification in cooking and heating	70% electrification in cooking and heating	
Agriculture	30% electrification	40% electrification	50% electrification	
Industrial	None			

Gross GHG emission from the AFOLU and energy using sectors in BAU



Growth rates (CAGR) of GHG emissions:
(a) AFOLU sector gross emissions: 1.6%
(b) Energy using sectors' emissions: 5.2%
(c) Combined emissions of (a) and (b): 2.4%

GHG Emission Reduction in the Energy Using Sectors



Cumulative GHG emission in 2010-2050 in BAU: 145 $MtCO_2e$

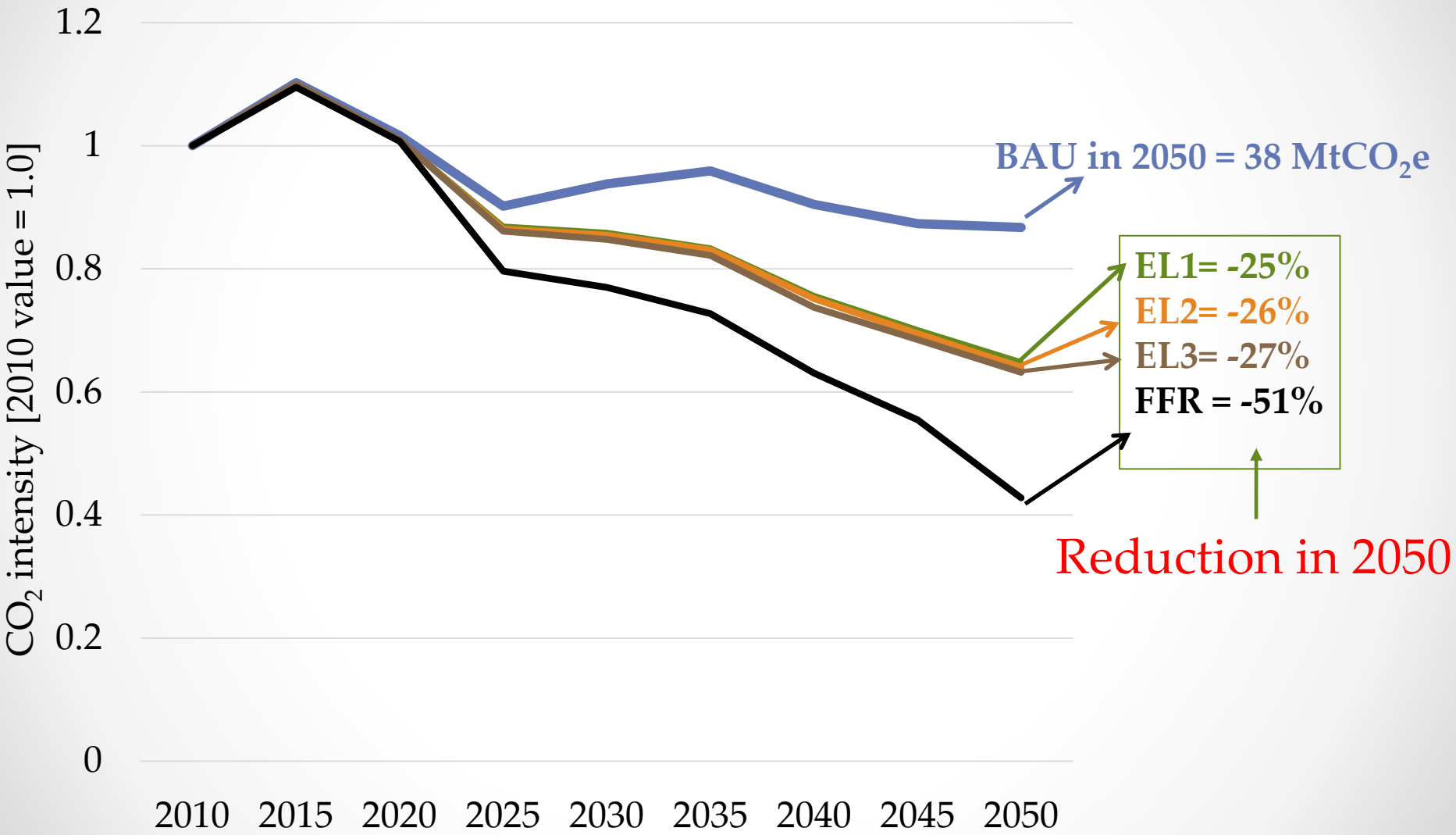
Cumulative GHG emission in 2020-2050 in BAU: 135 $MtCO_2e$

Cumulative GHG reduction during 2020-2050:

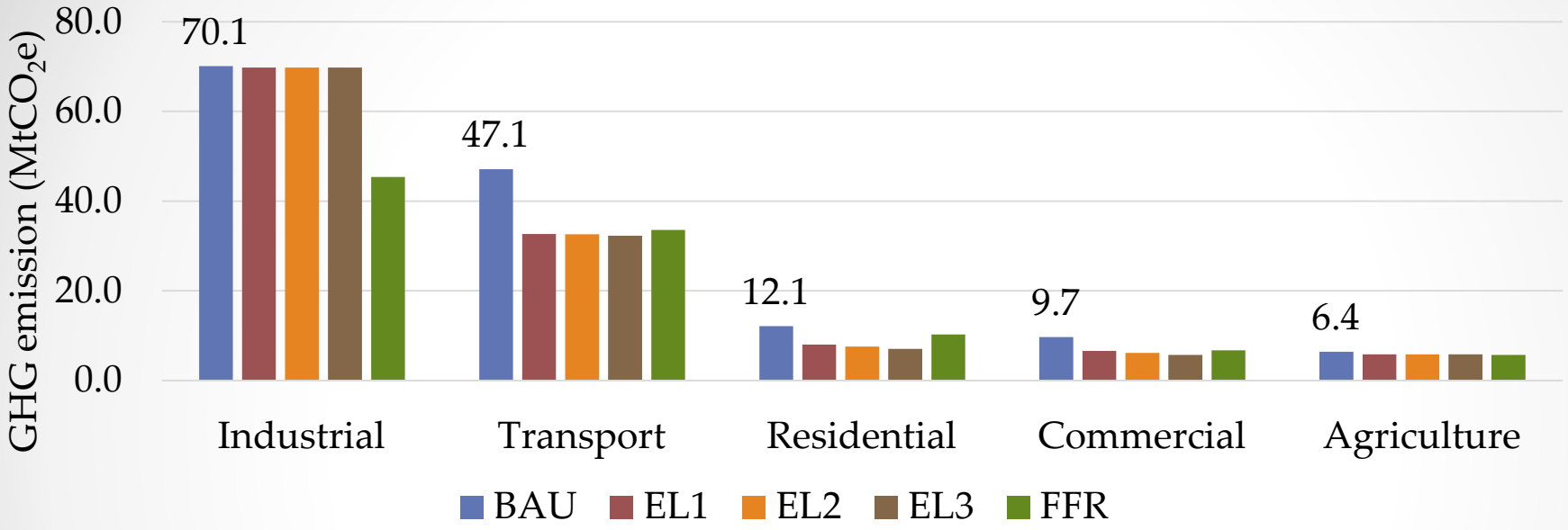
- 15% in EL1,
- 16% in EL2,
- 17% in EL3 and
- 30% in FFR scenarios

Significant decline in GHG emission in FFR between 2045 and 2050 due to dramatic increase in electricity use.

Overall CO_2 Intensity



Sectoral Cumulative GHG Emission from Energy Use during 2010-2050



Compared to the BAU, cumulative GHG emission during 2010-2050 would **decrease** by:

- 29% in FFR and 31% in EL3 in Transport Sector
- 15% in FFR and 42% in EL3 in Residential Sector
- 31% in FFR and 41% in EL3 in Commercial Sector
- 9% in EL3 and 11% in FFR in Agriculture Sector

35% decrease in the Industrial Sector in the FFR Scenario

Options considered in different sectors

Transport Sector:

- Fuel cell vehicle
- Biofuel vehicle
- MRT
- Trolley bus
- Electric ropeway
- Electric rail

Industrial Sector:

- CCS in cement manufacturing
- Efficient electric motor
- Vertical shaft brick kiln in brick industry
- Energy efficient fuelwood boiler

Residential and Commercial Sector:

- Briquette stove
- Solar cooker
- LED display TV
- Energy efficient air conditioner/fan

Agriculture Sector:

- Solar water pump
- Energy efficient electric pump
- Energy efficient diesel pump

Cost-effective Mitigation Options in the FFR Scenario

Mitigation options in the Transport Sector:

- Biofuel vehicles
- Electric vehicles (i.e., car, bus, micro-bus)
- Gasoline hybrid vehicles (i.e., car and taxi)
- Diesel hybrid vehicles (i.e., Pickup)
- Diesel hybrid vehicles (i.e., Trucks)

Mitigation options in the Residential and Commercial Sectors:

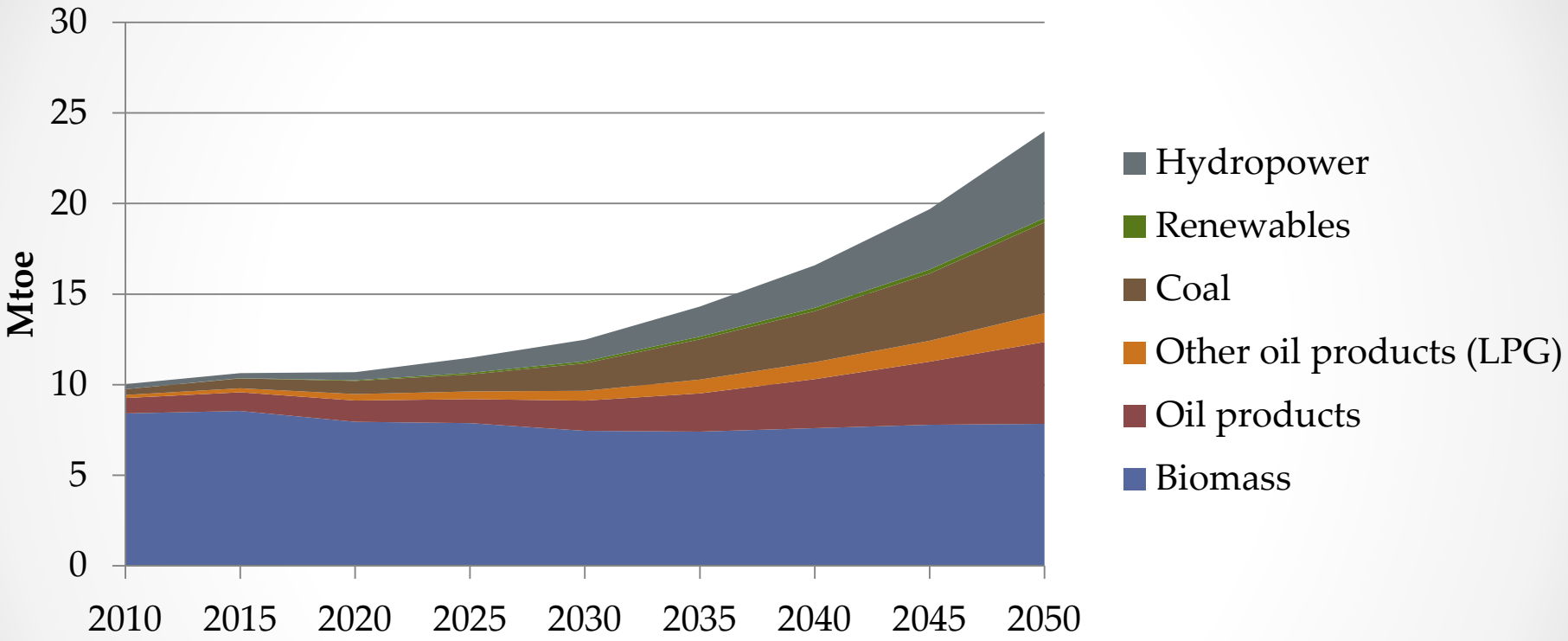
- Biogas cooking
- Electric cooking
- Solar water heater
- Energy efficient bulbs (CFL&LED)

Mitigation options in the Industrial Sector

- Electric motor (motive power)
- Improved fixed chimney brick kiln
- Energy efficient coal boiler
- Bagasse boiler
- Fuelwood boiler

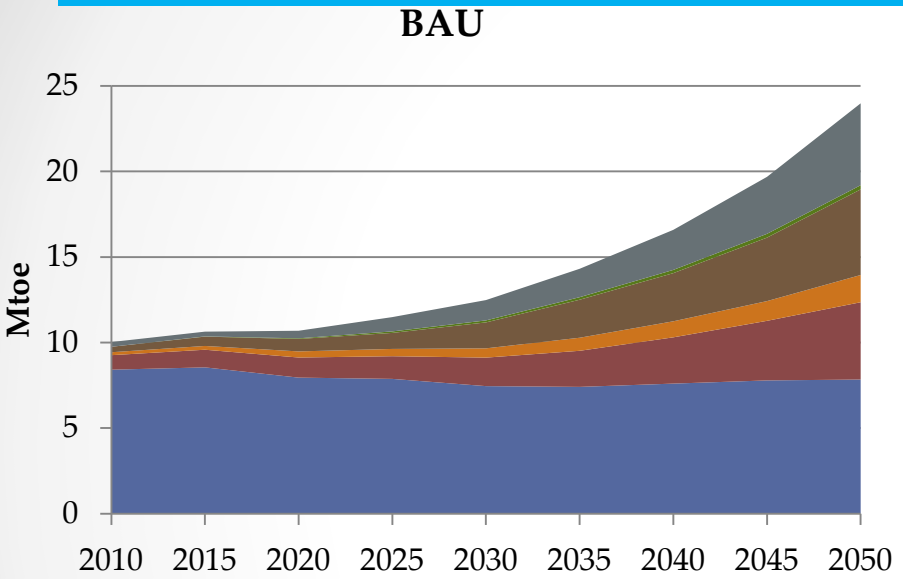
Changes in Energy Supply and Consumption in INDC Scenarios

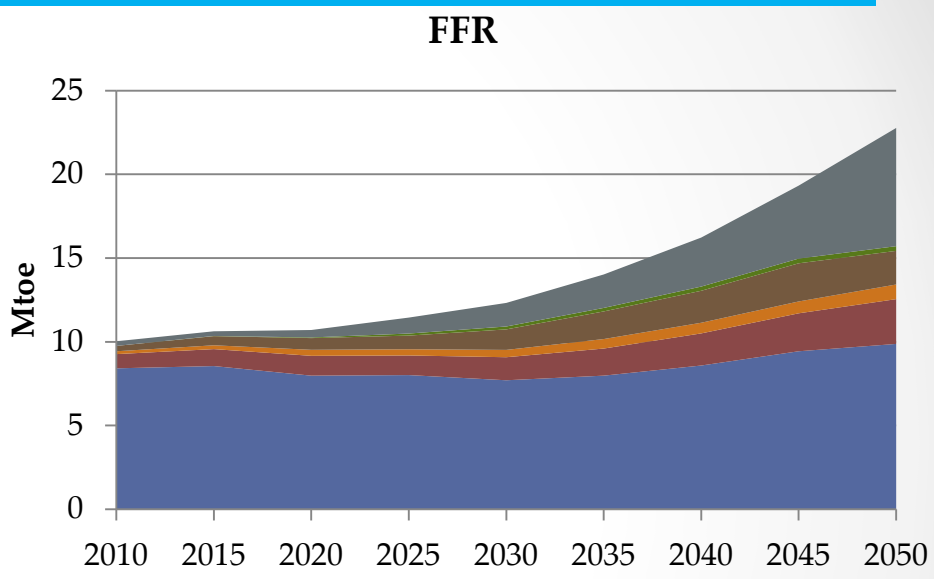
TPES in the BAU Scenario

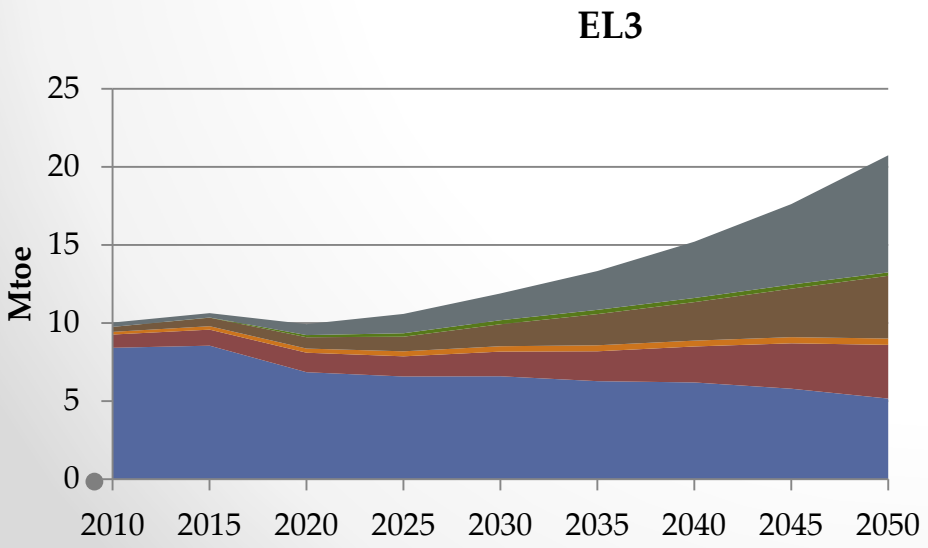


- share of oil products increase from 10% to 26% during 2010-2050
- share of renewables (mainly hydropower) increase from 3% to 21%
- share of biomass decrease from 84% to 35%

Total Primary Energy Supply in NDC Electrification and Fossil Fuel Reduction Scenarios







Hydropower

Renwables

Coal

Other oil products (LPG)

Oil products

Biomass

Cumulative TPES during 2010-2050:

- In FFR is 2% lower than in BAU and
- In EL3 is 8% below that in BAU

Total Primary Energy Supply in NDC Electrification and Fossil Fuel Reduction Scenarios

Cumulative biomass consumption during 2010-2050:

- 8% higher In FFR (than in BAU)
- 15% lower In EL3

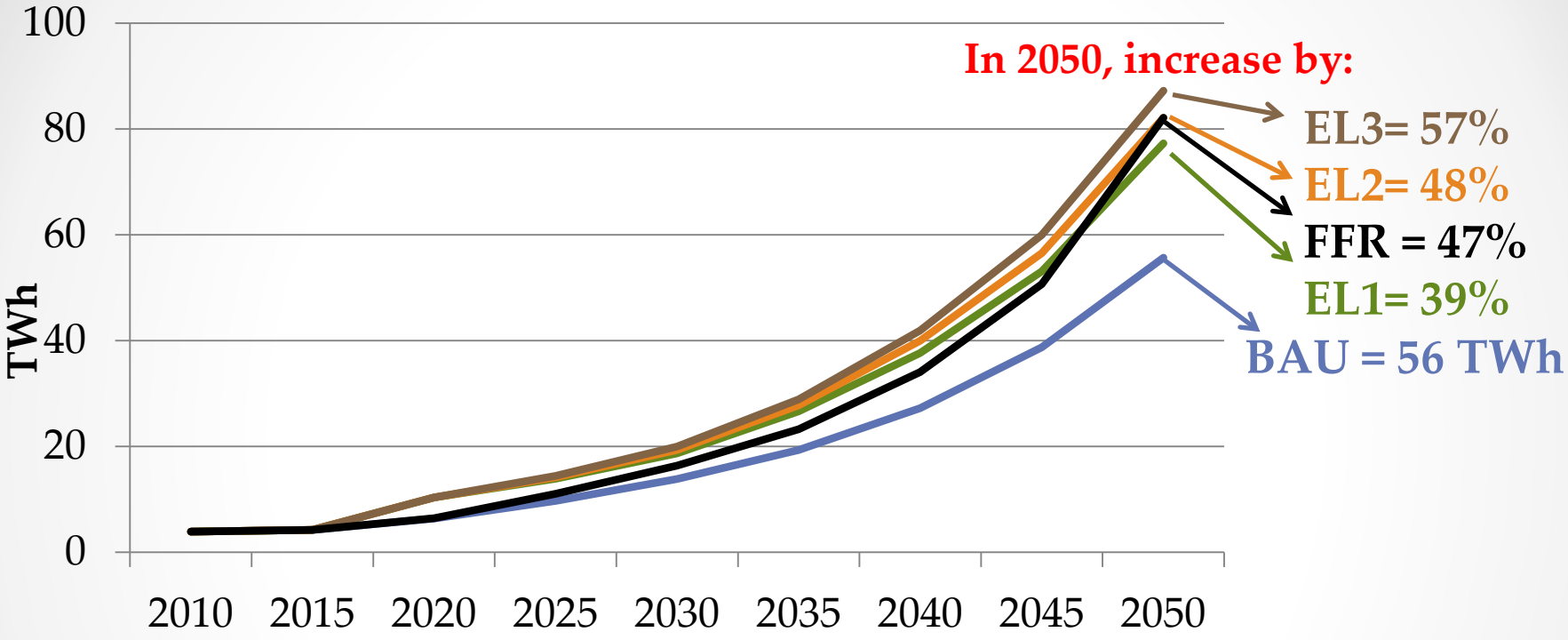
Cumulative renewable supply (mainly from hydropower generation) during 2010-2050 in EL3 is higher than in FFR:

- 30% higher in FFR (than in BAU)
- 52% higher in EL3

Cumulative fossil fuel supply during 2010-2050:

- 30% lower in FFR (than in BAU)
- 18% lower In EL3

Electricity Supply



Electricity consumption in the BAU in 2020: 6 TWh

Cumulative electricity supply during 2020-2050 in BAU: 171 TWh

Cumulative electricity supply during 2010-2050, compared to that in BAU:

- Would increase by 37% in EL1, 44% in EL2 and 51% in EL3
- Would increase by 30% in the FFR scenario

Implications of INDCs for Hydropower Development

Total Hydropower Capacity (MW)				
Scenarios	2020	2030	2040	2050
BAU	2,333	4,232	7,887	17,028
EL1	2,484	5,327	10,941	22,229
EL2	2,483	5,510	11,687	23,249
EL3	2,483	5,680	12,316	24,216
FFR	2,340	4,662	9,830	23,198

During **2010-2040**, the total hydropower capacity would increase by:

- 8 times in BAU,
- 12 times in EL1 ,
- 13 times in EL2,
- 13 times in EL3 and
- 10 times in FFR.

During **2010-2050**, the total hydropower capacity would increase by:

- 19 times in BAU,
- 25 times in EL1 ,
- 26 times in EL2,
- 27 times in EL3 and
- 26 times in FFR.

Final Energy Consumption in INDC Scenarios

- Total electricity consumption:
  - 30% higher in FFR and 52% higher in EL3 than in BAU
- Total biofuel consumption:
  - 14% higher in FFR and 42% lower in EL3 than in EL1 (note: no biofuel consumption in BAU).
- Total biomass consumption:
  - 8% higher FFR and 15% lower in EL3 than in BAU
- Total fossil-fuel consumption:
  - 30% lower In FFR and 18% lower in EL3 than in BAU

INDC Co-benefits

Co-benefits: Cumulative Air Pollutant Reduction

Percentage change compared to BAU during 2010 - 2050								
Cases	BC	CO	NMVOC	OC	PM_{10}	$PM_{2.5}$	NO_x	SO_2
EL1	-8	-11	-9	-9	-8	-8	-9%	-4
EL2	-12	-14	-13	-13	-12	-11	-11%	-5
EL3	-15	-17	-15	-16	-14	-14	-12%	-7
FFR	8	25	0	19	7	23	-14	-20

Increases due to replacement of fossil fuel by biomass

- Reduction in BC, CO, NMVOC, OC, PM_{10} and $PM_{2.5}$ emissions in the EL1, EL2 and EL3 scenarios
- Increased emissions of these pollutants in FFR
- Higher reduction in NO_x and SO_2 emissions in FFR than that in EL1, EL2, and EL3 scenarios

Energy Security Co-benefits

- Oil intensity in FFR is lower than that in EL1, EL2 and EL3.
- Electricity intensity in EL scenarios mostly higher than that in FFR.
- The electricity intensity in FFR is below that of the EL scenarios
- The biomass intensity in FFR is higher than in EL1, EL2 and EL3
- Lower diversification of energy resources in FFR with the increased use of local resources (such as Hydropower and biomass)

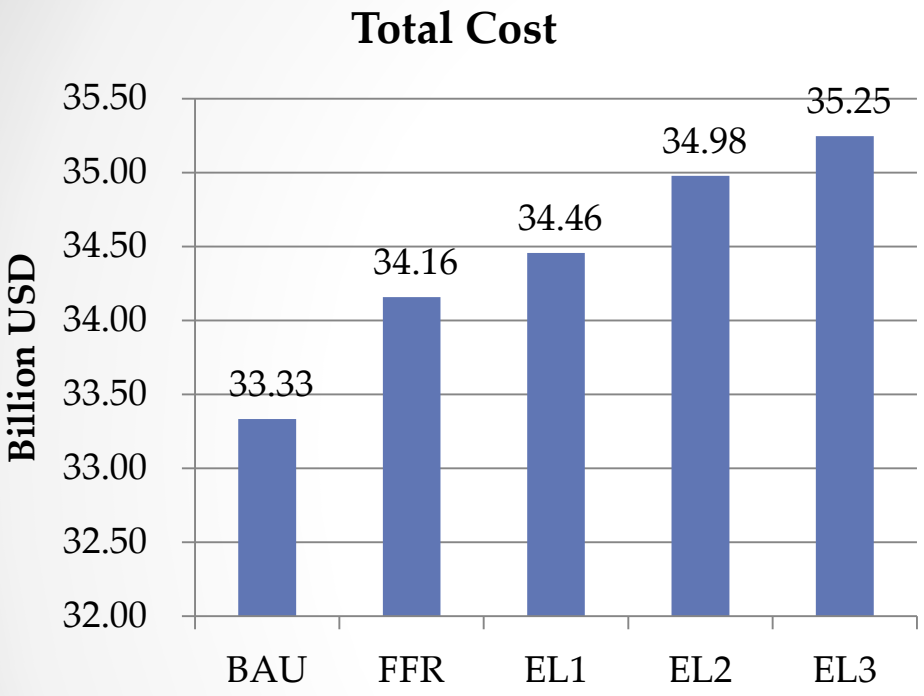
Net Energy Import Dependency (%)

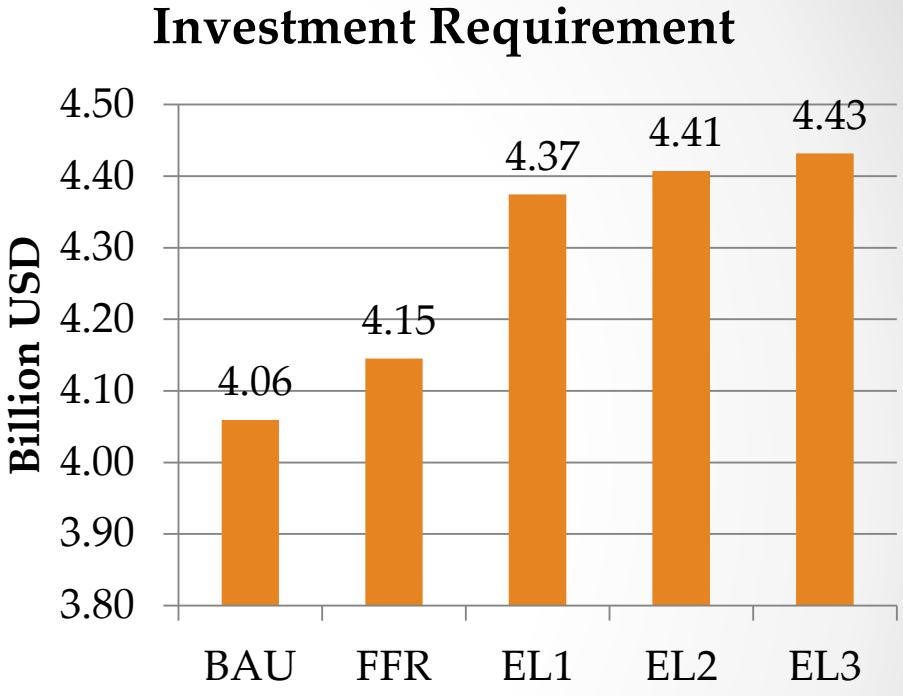
	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	13	17	21	23	30	36	39	42	46
EL1	13	16	21	21	24	27	28	29	29
EL2	13	16	21	22	25	28	28	29	28
EL3	13	17	23	24	28	32	34	36	38
FFR	13	17	21	21	25	27	28	27	24

Lower net energy (mainly oil) import dependency in FFR (i.e., Higher Energy Security)

Cost Implications of INDCs

Cost





The total cost of FFR will be 3% less than the total cost in EL3 scenario

Total cost in FFR and EL3 cases would be 2% and 6% higher respectively than that in BAU.

Investment requirement in FFR and EL3 cases would be 2% and 9% higher respectively than that in BAU

Incremental Abatement Cost

Total Incremental Abatement Costs ($/ton CO_2e)				
	FFR	EL1	EL2	EL3
Total	91.5	224.3	309.9	340.7

- **IAC of FFR is lower than that of EL1, EL2 and EL3 scenarios.**
- **Electrification NDC strategies are not so cheap!**
- **Total IAC:** ranges from \$91.5/tonCO_2e in FFR to \$340.7/tonCO_2e in the EL3 scenario.

Conclusion

- There are no-regret abatement options in the agriculture sector.
- There would be cumulative net sequestration at carbon tax of $10 and above. No significant change in level of net cumulative sequestration at carbon prices of $10 to $50/tCO2e. Carbon taxes above $75 are not so effective for cumulative mitigation.
- Role of energy related emissions is growing. Total GHG emissions from energy using sectors are estimated to grow by 7 times during 2010-2050. The AFOLU sector gross emissions is estimated to increase by 0.9 times during the same period. Sequestration remains the same throughout the period at 31MtCO_2e/year.
- INDC overall FFR target is found to be more cost effective to reduce GHG emission than the INDC electrification targets: GHG emission In FFR scenario is 30% lower than that in the BAU and16% lower than that in the EL3 scenario.
- However, investment in FFR is 6% less than that in the EL3 scenario.
- Emissions of most local air pollutants are higher in the FFR scenario due to larger usage of biomass energy.
- FFR would result in higher energy security than the Electrification scenarios.

Conclusion (contd..)

- Cumulative electricity generation during 2010-2050 in FFR would be lower than that in the EL scenarios.
- Hydropower capacity requirement in FFR would be 36% more than that in BAU and 4% less than in EL3.
- Cumulative biomass use during 2010 - 2050 in FFR would be 8% more than in BAU and 27% more than in EL3.
- IAC is in the range of $91.5 in FFR to 340.7/ton CO_2e in EL3 scenario.
- CO_2 intensity decreases in the range of 25% in EL1 to 51% in FFR in 2050.

Thank You!!

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