PRELIMINARY

Egypt GHG emissions, reduction strategy

برنامج تحديث الصناعة
INDUSTRIAL MODERNISATION PROGRAMME

End product Phase 2

January, 2010

McKinsey&Company

McKinsey has provided analytic support to IMC in the preparation of this deliverable

Content

- **Overall country perspective**
- Industry overview
- Deep dive on selected sectors

Executive summary

Approach	▪ Emission baseline and abatement potential have been estimated on a macro sector basis (with a focus on 5 key sectors Power, Building, Cement, Road transport, Agriculture) ▪ Data has been collected from available public sources (local and international), syndicated by interviews with local experts and using values from comparable countries ▪ Greenhouse Gas (GHG) abatement analysis has been developed with the objective of providing an integrated perspective on emissions reductions and cost. It cannot be used to forecast exact CO2 prices/ CO_2 regulation or forecast individual technologies
Overall Business as Usual (BAU)	▪ Emissions in 2005 are in the range of 220 Mt CO_2e and are expected to grow up to ~550 Mt CO_2e by 2030 contributing to ~0.9% of world emissions ▪ In 2005 emissions per capita versus GDP per capita in Egypt are in line with other developing regions (such as India, Latin America and Middle East), and throughout 2030 are expected to follow a typical growth pattern of a developing country ▪ The 5 main sectors (Power, Building, Cement, Road transport, Agriculture) account for ~75% of total emissions in 2005 and are expected to slightly increase their relative importance by 2030 (~77% of total emissions) ▪ Overall industry related emissions account for ~29% of the total emissions in 2005 and are expected to increase their relative share to ~36% by 2030
Potential abatement	▪ Overall abatement potential is in the range of ~200 Mt CO_2e, equivalent to ~36% of BAU at 2030 ▪ The overall potential is slightly lower than comparable developing regions mainly due to lower potential from the power sector (absence of coal plants, in BAU most of the total power production is already generated by relatively low gas plants) ▪ Total abatement potential of ~200 MtCO_2e is fragmented into multiple levers and can be partially implemented with economic benefits ▪ Most of the abatement potential comes from the 5 key sectors (Power, Transport, Cement, Building, Agriculture) which account for ~80% of the total abatement

A specific methodological approach has been followed..

Methodological approach

- **Emission baseline and BAU at 2030** has been estimated mainly
  - Applying a bottom-up approach at sector level
  - Collecting data from available public sources (local and international)
  - Applying proxy from comparable countries (in absence of local data)
  - Discussing assumptions with local experts
- Each sector has been considered mainly in terms of **direct emission** (e.g., electricity consumed in cement included in "power" sector")

The GHG abatement cost analysis …

… can be used for

- Construction of an **integrated perspective on abatement potential and opportunities** to be compared with a given target CO_2e concentration level
- **Order of magnitude** evaluation and prioritization of abatement measures within and across sectors
- Providing a **fact base** to support the assessment of possible regulatory arrangements

… cannot be used for

- **Definition of target CO_2e concentration level** to solve climate change issues
- **Forecasting exact CO_2 prices** or CO_2 regulation
- **Forecasting individual technologies** – while there is a view on learning rates and volume development for individual technologies, in the database, the value of this work is its comprehensive scope more than the depth in individual technologies

SOURCE: Global GHG Abatement Cost Curve v2.0

…with the support of local experts to syndicate local and international data sources and assumptions applied

Experts syndication

Power
- Emad Ghaly (Siemens)
- Mohammed Metwalli
- Sherin Mosben
- Mona Shafei Abdel Hamid (Arabiyya lel Istithmaraat)
- Mohammed Salah Elsobki (IMC)

Building
- Kaled El Mekati (Ormet)
- Mohamed Zaki ElSewedy (Zaki El Sewedy Group)

Cement
- Hisham Harouni (Industrial Development Agency)

Transport
- Moh'd Salah El-Hadary (EAMA)

Agriculture
- Eid M. A Mageed (Ministry of Agriculture)
- Magdalena Kloibhofer (Heliopolis Academy)

Main data sources

National relevant sources

Elements	Sources
GHG baseline GHG Historical data	▪ **Initial National Communication Plan on climate change** (EEAA)
Driver baseline/ forecast Driver historical data	▪ Iron & Steel and Cement production forecast from **IDA** ▪ Power capacity projection **from IDA/ Enerdata** ▪ **Electricity demand from IDA/ Enerdata/ INC** ▪ **Egyptian electricity holding company** annual report ▪ Oil and Gas production forecast by **departments of planning and projects in petroleum organizations**

International sources

Elements	Sources
GHG baseline 2005 GHG Historical data	▪ **CAIT** database
GHG Forecast	▪ **Poles** database
Comparable countries GHG trends	▪ Set of comparable regions/ countries from **McKinsey climate desk database**: – Developing Asia/ India – Rest of Latin America – Rest of Africa – Middle East – Mexico
Macro-economic trends	▪ Global Insight (WMM)

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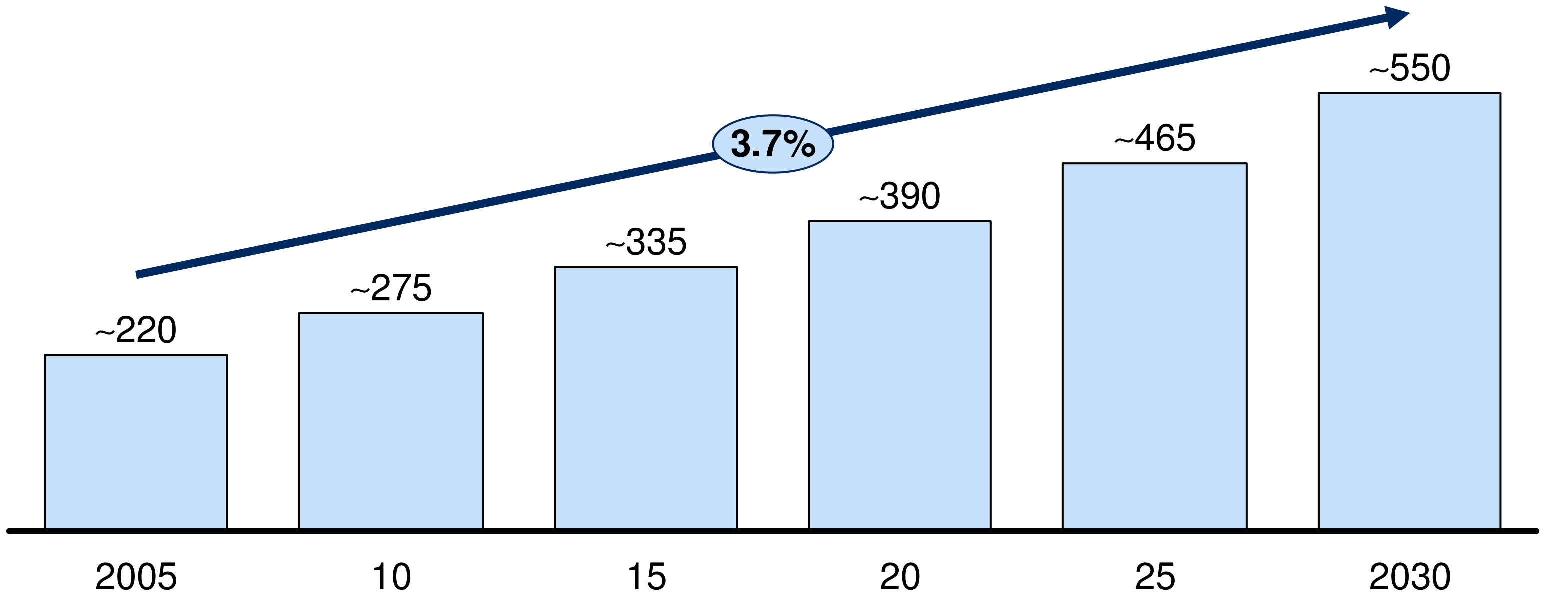
Overall Egypt's 2005 BAU emissions are in the range of 220 Mt and are expected to grow to ~550 Mt by 2030, equal to ~0.9% of world emissions

$MtCO_2e$



	2005	10	15	20	25	2030
World emissions[1] $Mt\ CO_2e$	~38,500	~44,400	~49,300	~53,800	~57,700	~62,800
Egypt share of world emissions Percent	~0.6	~0.6	~0.7	~0.7	~0.8	~0.9

1 Does not include forestry; includes global air and sea transports

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Loca experts interviews; team analysis

In 2005, emissions vs. GDP per capita in Egypt will continue to be in line with other developing regions

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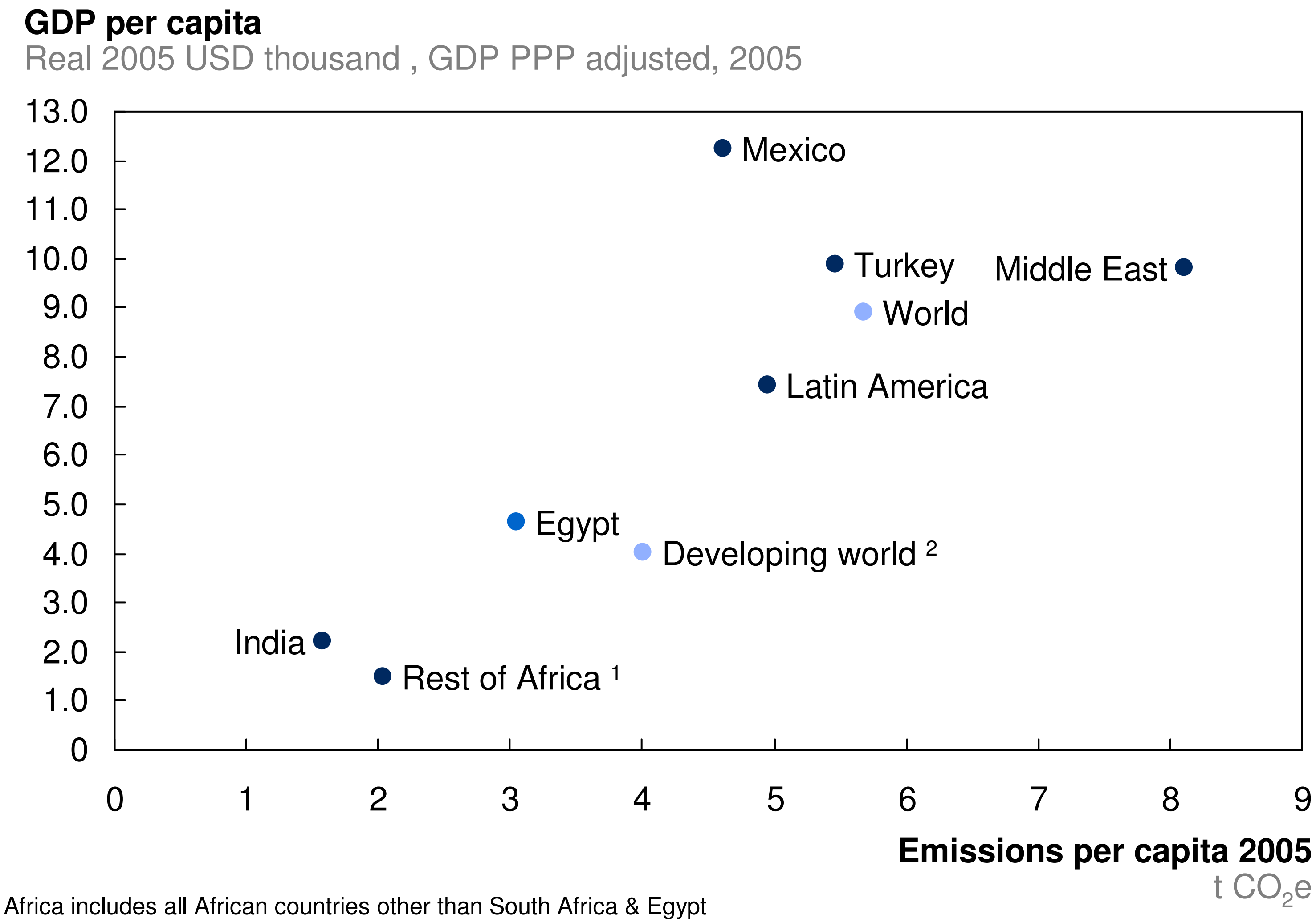

1 Rest of Africa includes all African countries other than South Africa & Egypt

2 Developing world includes all of Asia except Japan and OECD Pacific countries, East Europe, Russia, Latin America & Africa

SOURCE: CAIT database on Egypt; POLES projections; CDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

In 2005 5 main sectors account for ~75% of total emissions…

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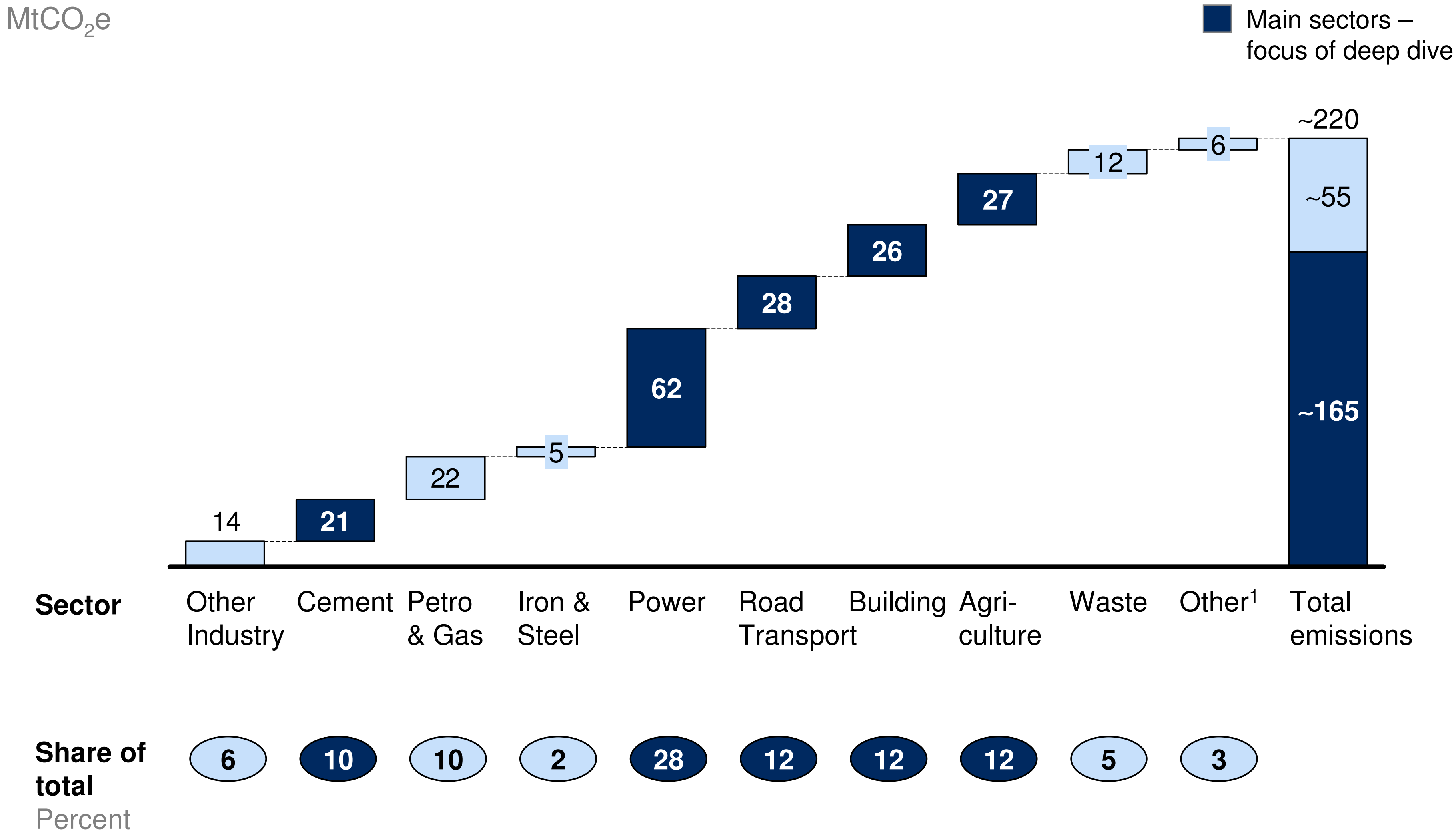

1 Includes land use & other transports

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

… and overall, industry-related emissions account for ~29% of total emissions

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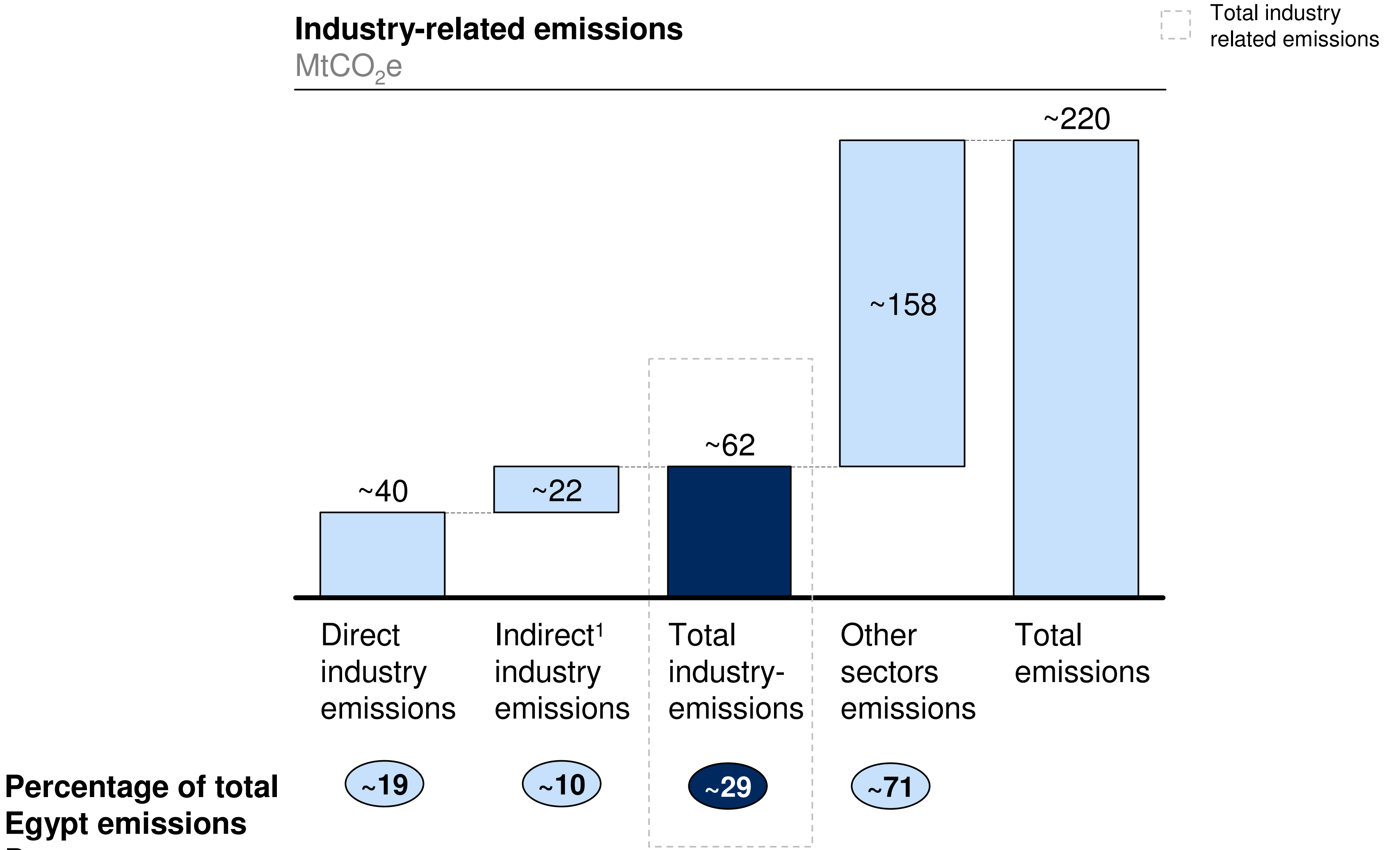

1 Electricity consumption

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

By 2030, emissions vs. GDP per capita in Egypt will continue to be in line with other developing regions

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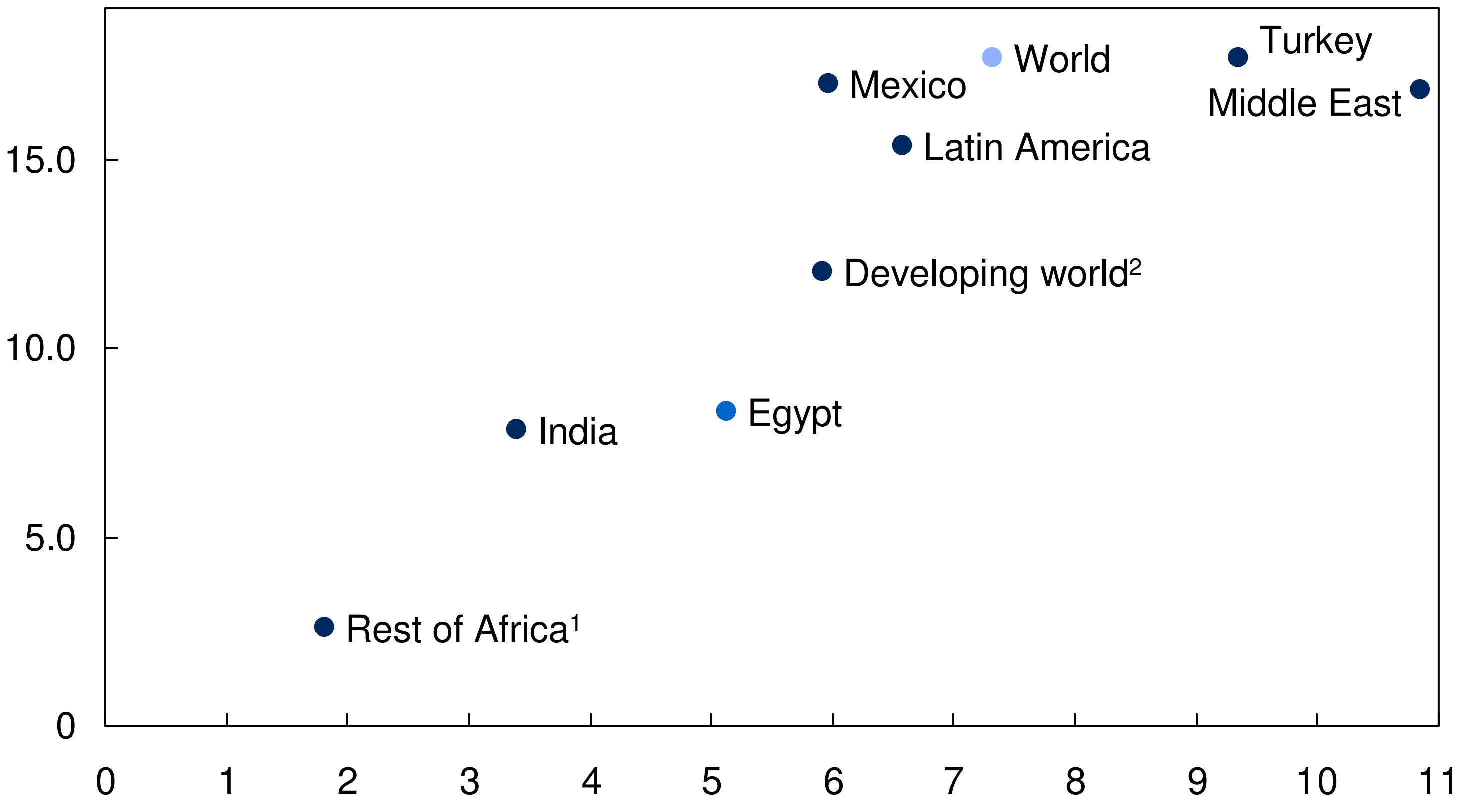
GDP per capita
Real 2005 USD thousand , GDP PPP adjusted, 2030



Emissions per capita 2030
t CO_2e

1 Rest of Africa includes all African countries other than South Africa & Egypt
2 Developing world includes all of Asia except Japan and OECD Pacific countries, East Europe, Russia, Latin America & Africa

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

By 2030 BAU the contribution of the 5 main sectors is expected to slightly increase to ~77% of total emissions

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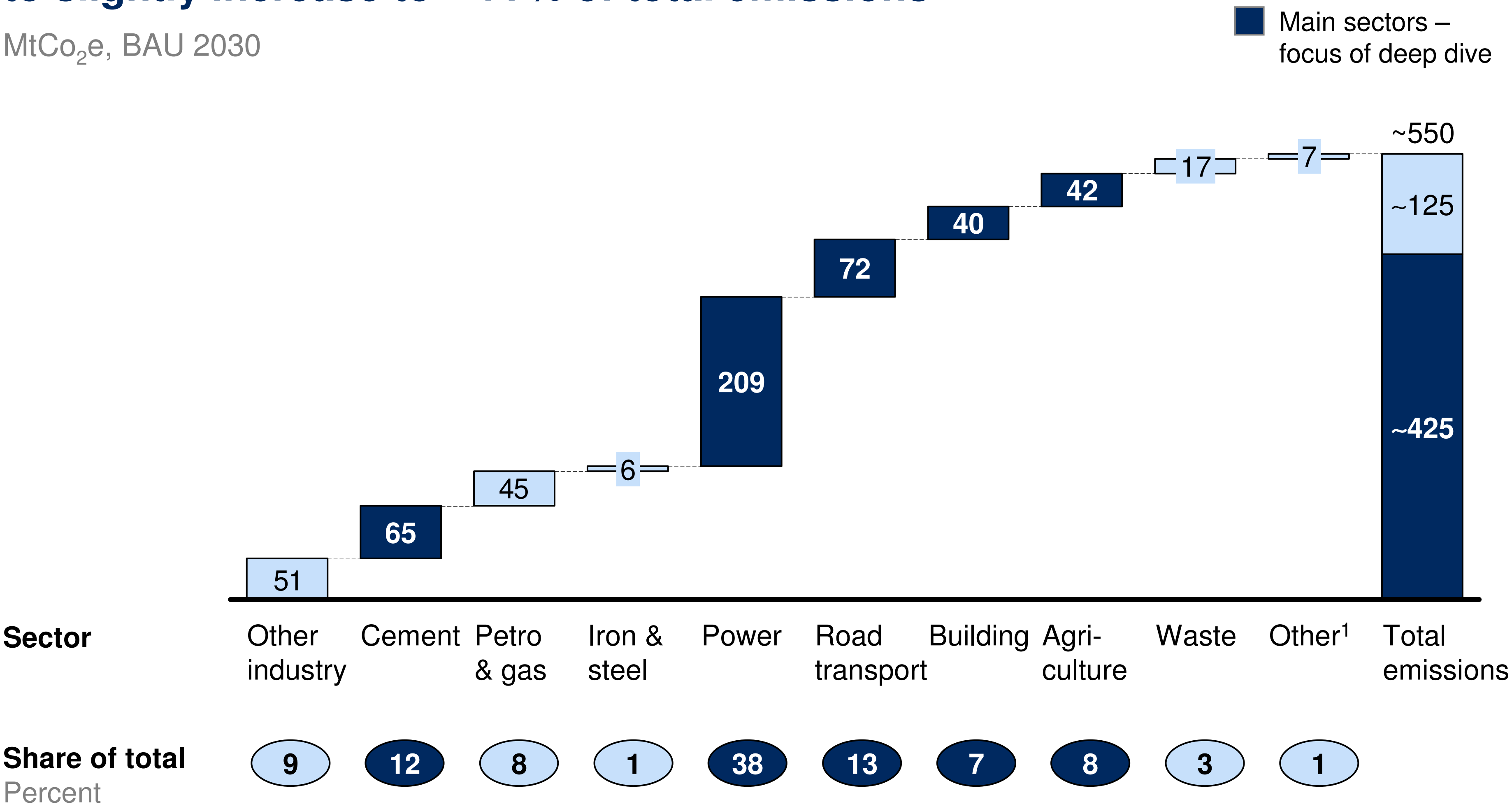
$MtCo_2e$, BAU 2030



1 Includes land use & other transports

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

Power, cement, transport and other industry will increase their share of total emissions

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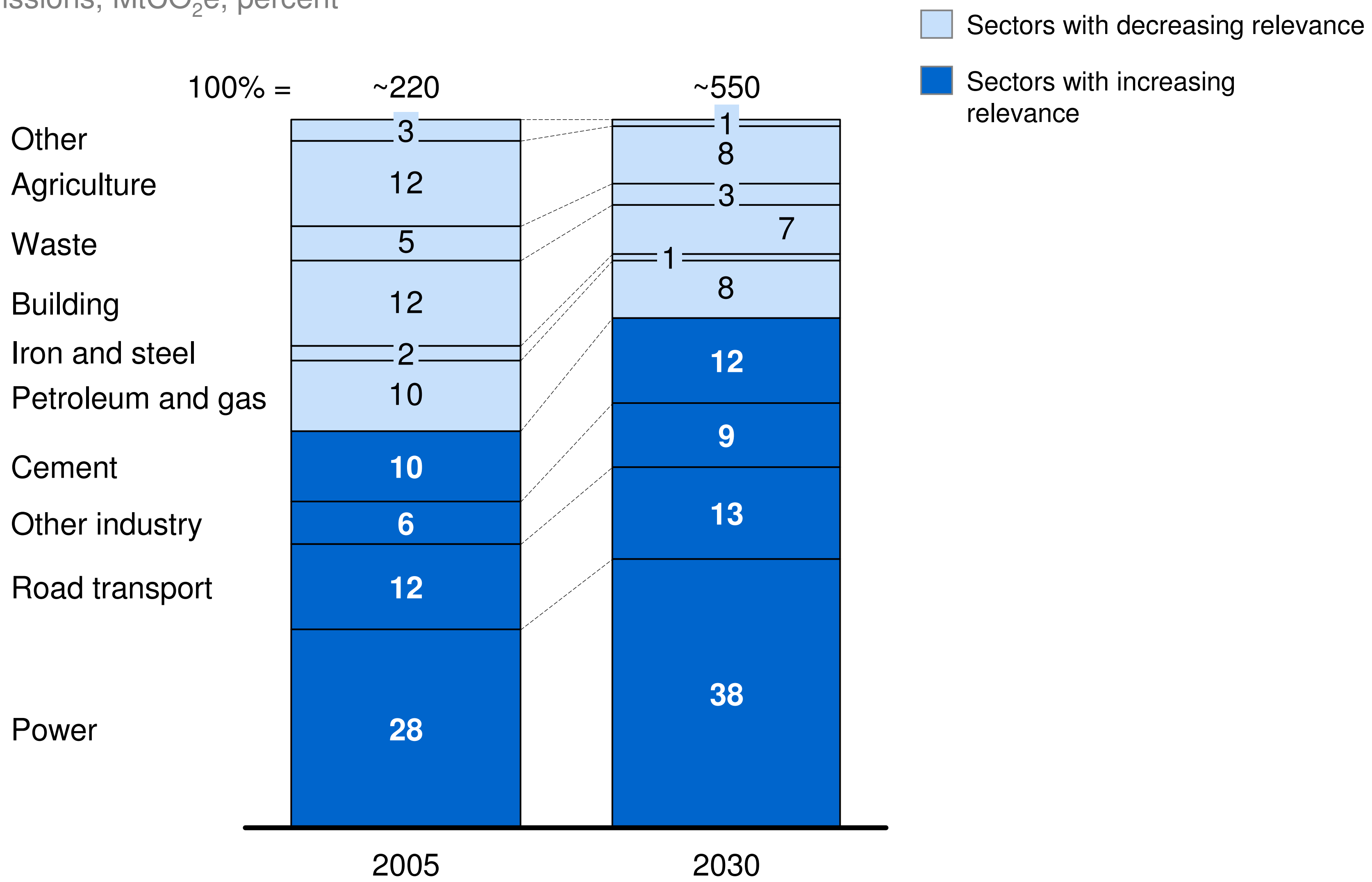
Direct emissions, $MtCO_2e$, percent



SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Loca experts interviews; team analysis

In 2030 overall industry-related emissions is expected to grow up to ~36% of total emissions

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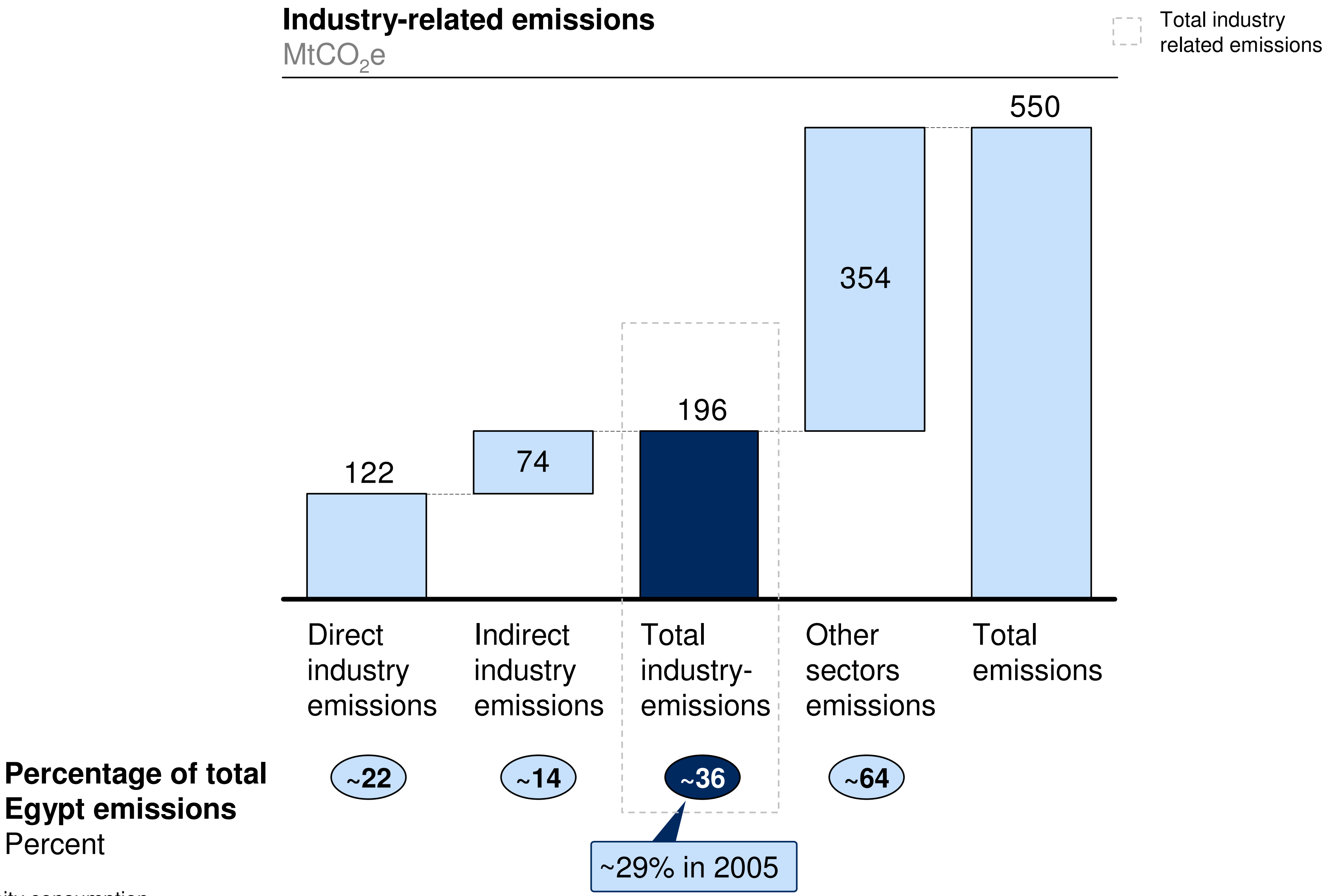

1 Electricity consumption

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Loca experts interviews; team analysis

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Overall Business as Usual (BAU)

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Potential abatement

- Overall abatement potential is in the range of ~200 Mt CO_2e, equivalent to ~36% of BAU at 2030
- The overall potential is slightly lower than comparable developing regions mainly due to lower potential from the power sector (absence of coal plants, in BAU most of the total power production is already generated by relatively low gas plants)
- Total abatement potential of ~200 MtCO_2e is fragmented into multiple levers and can be partially implemented with economic benefits
- Most of the abatement potential comes from the 5 key sectors (Power, Transport, Cement, Building, Agriculture) which account for ~80% of the total abatement

Overall abatement potential is in the range of ~200 Mt CO2e, equivalent to ~36% of BAU at 2030

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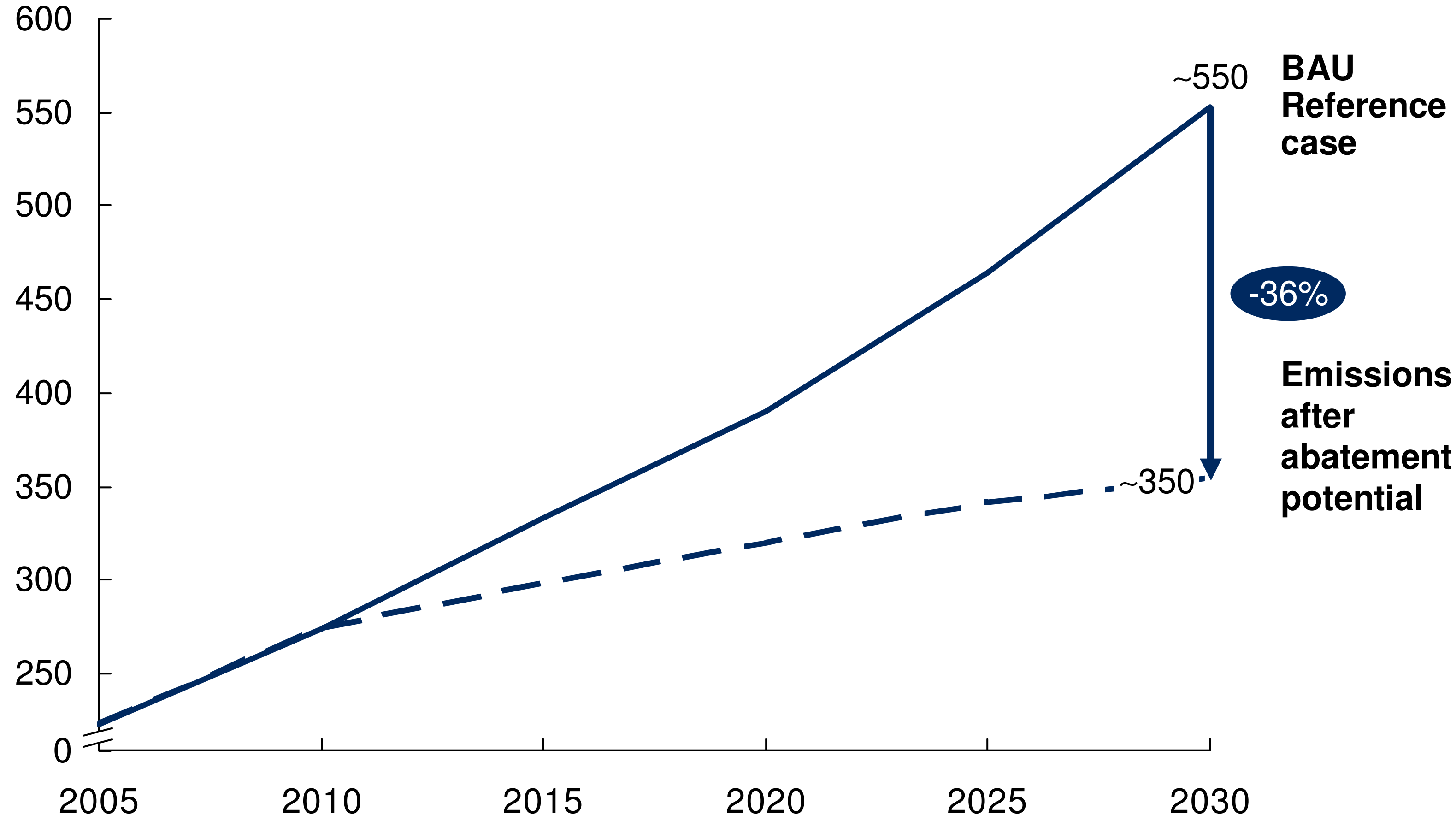
MtCO2e per year



SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

… slightly lower than comparable developing regions mainly due to the lower potential from power sector

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	Abatement potential (Percent)	BAU 2030 ($MtCO_2e$)	2030 emissions after abatement ($MtCO_2e$)
Mexico	45	~800	~450
Middle East	40	~3,200	~1,900
Rest of Africa	40	~2,900	~1,800
Rest of Latin America [1]	40	~2,200	~1,300
Egypt	36	~550	~350

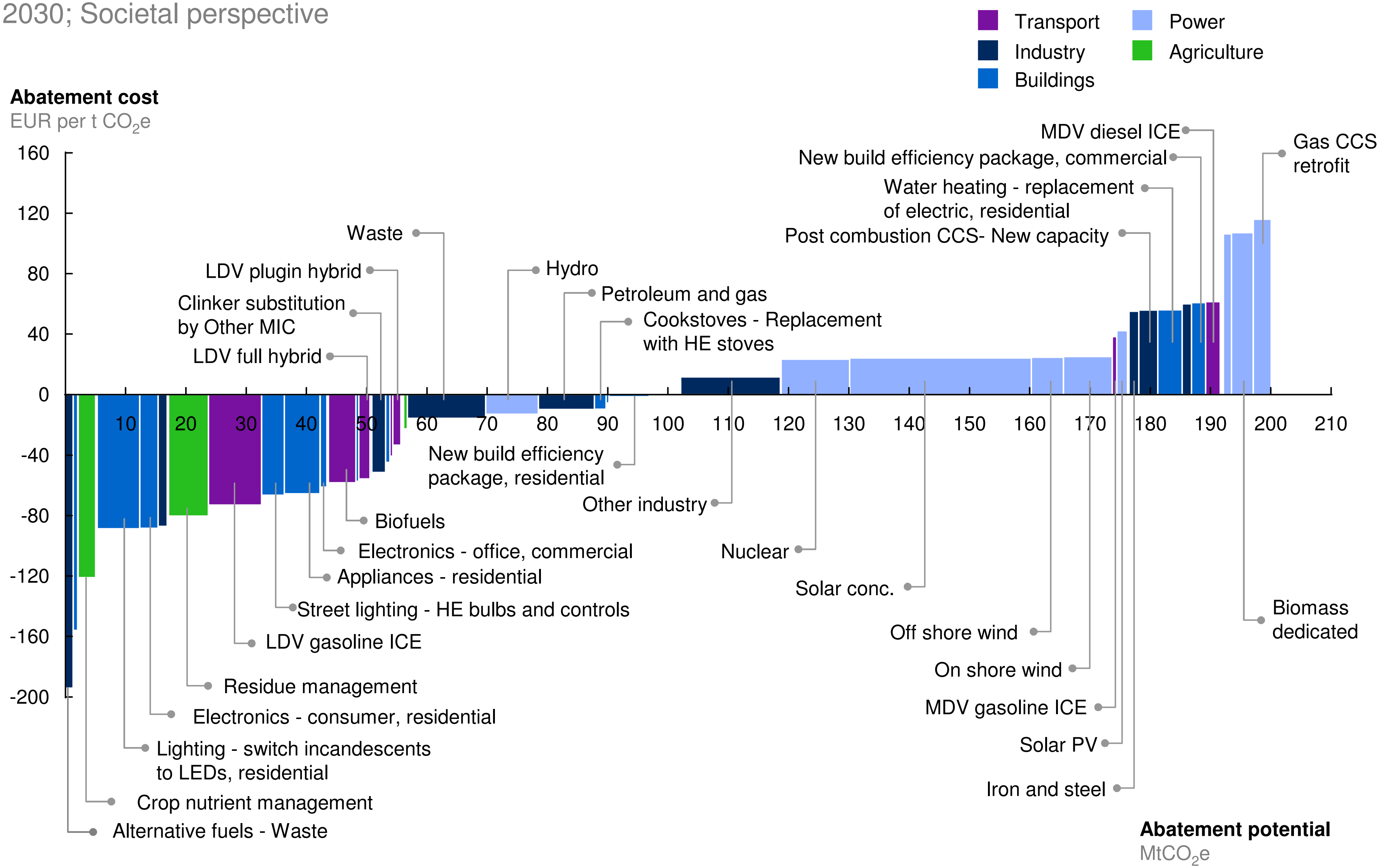
- Egypt seems to have a slightly lower abatement potential than other comparable regions
- This is mainly due to lower abatement potential from power sector:
  - High share of gas already used to produce power
  - Absence of coal plants in BAU

1 Excluding Brazil and Mexico

SOURCE: Global GHG Abatement Cost Curve v2.0. Includes direct and indirect emissions; excludes emissions from forestry

Total abatement potential of ~200 MtCO2e is fragmented into multiple levers of which ~50% can be implemented with economic benefits

2030; Societal perspective



SOURCE: McKinsey GHG V2.0 models; team analysis

Most potential abatement comes from key sectors which account for ~80% of the total abatement

Direct abatement
Indirect abatement

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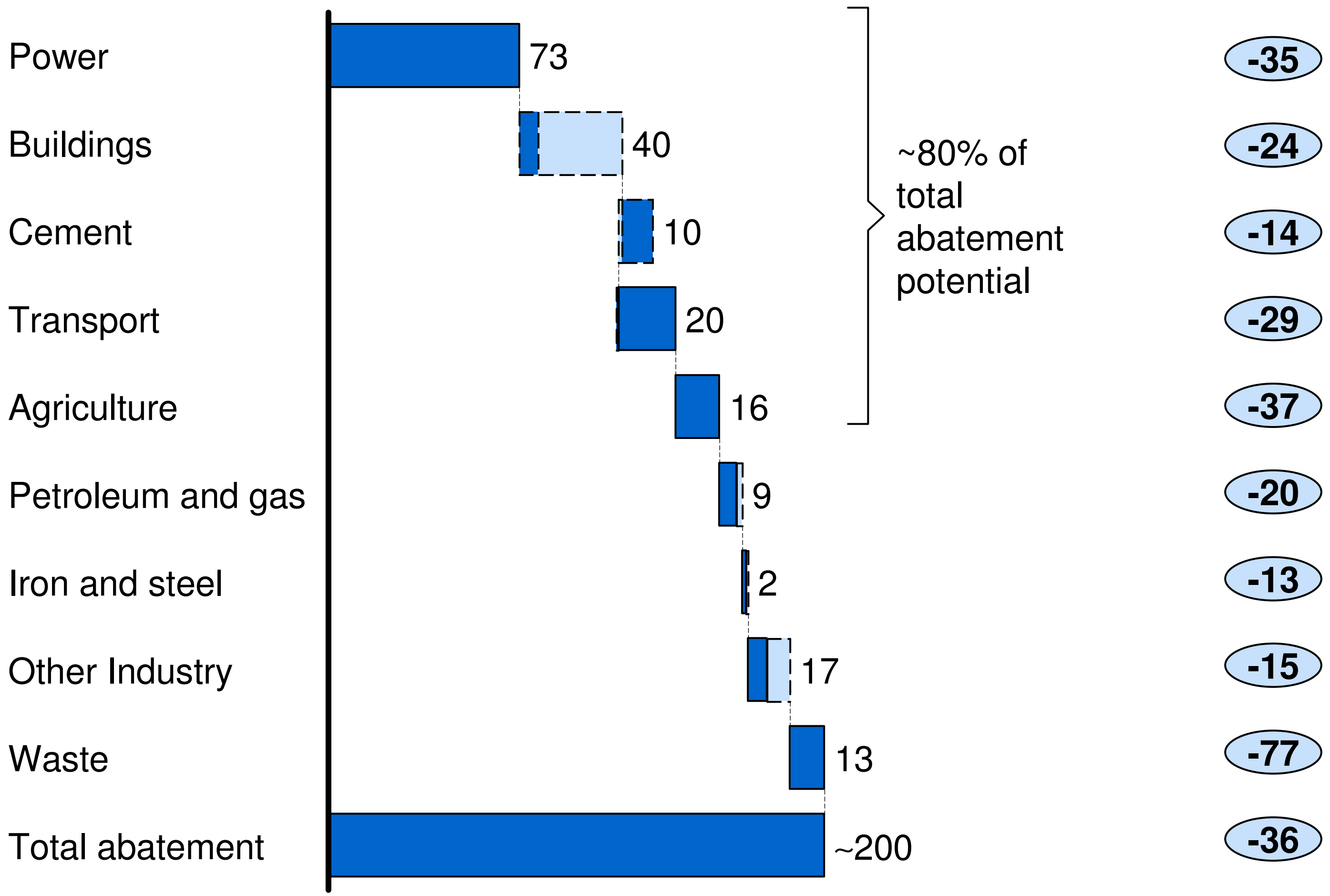
Abatement potential 2030
$MtCO_2e$ per year

Emissions reduction relative to 2030 BAU
Percent



SOURCE: Global GHG Abatement Cost Curve v2.0

Content

- Overall country perspective
- **Industry overview**
- Deep dive on selected sectors

Executive summary

Overall Business as Usual (BAU)	1. Egypt's emissions in 2005 are in the range of 220 $MtCO_2e$ and are expected to grow to ~550 $MtCO_2e$ by 2030 equal to ~0.9% of world emissions 2. Overall industry related emissions in 2005 account for ~30% (~62 $MtCO_2e$) of Egypt's total emissions and relative share is expected to increase to ~35% of Egypt's total emissions (~196 $MtCO_2e$) by 2030 3. Cement sector is and is expected to remain the main contributor of total industry related emissions
Potential abatement	4. Egypt's total abatement potential is in the range of ~200 Mt CO2e, equivalent to ~36% of BAU at 2030 5. Total industry related emissions can be reduced by ~15% of BAU at 2030, equivalent to ~30 Mt CO2e 6. Industry sectors account for ~15% of total Egypt's potential abatement 7. Cement sector is one of the main sources of industry abatement potential 8. Additional abatement potential can be achieved from Iron& steel and other industry sectors

Egypt's overall 2005 BAU emissions are in the range of 220 MtCO2e and are expected to grow to ~550 MtCO2e by 2030, equal to ~0.9% of world emissions

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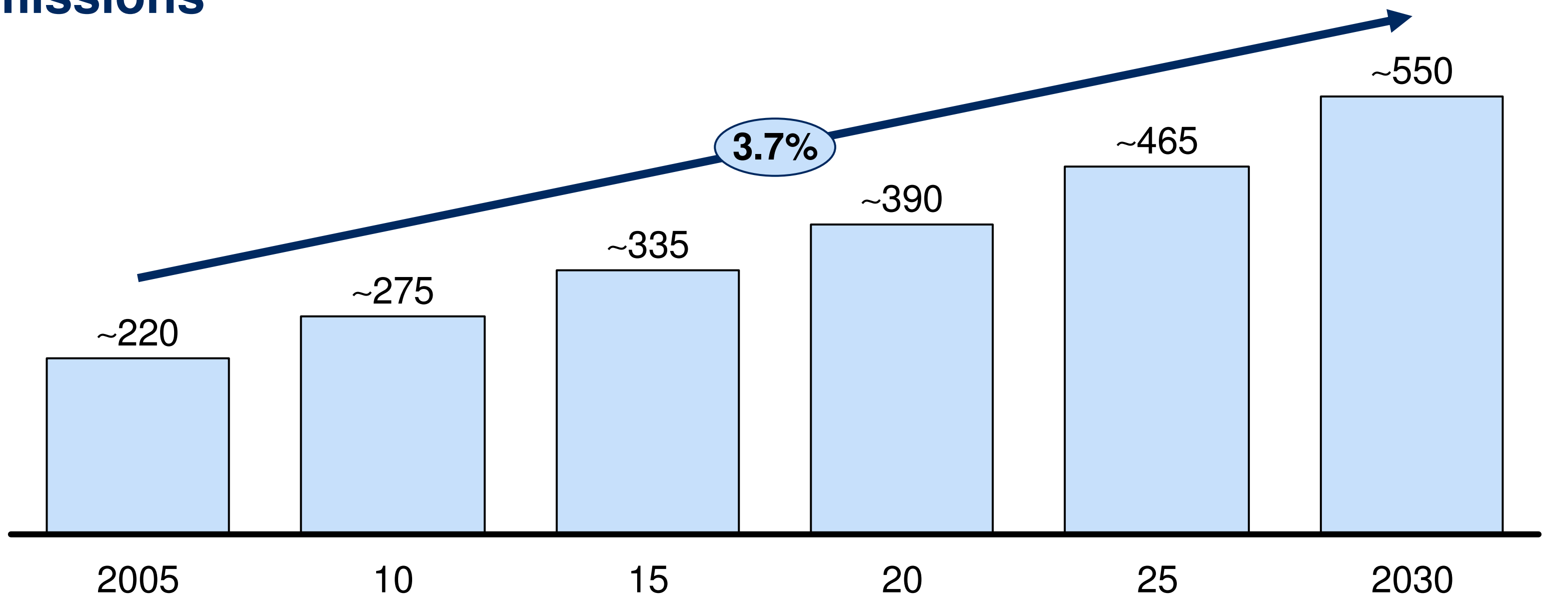
$MtCO_2e$



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SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

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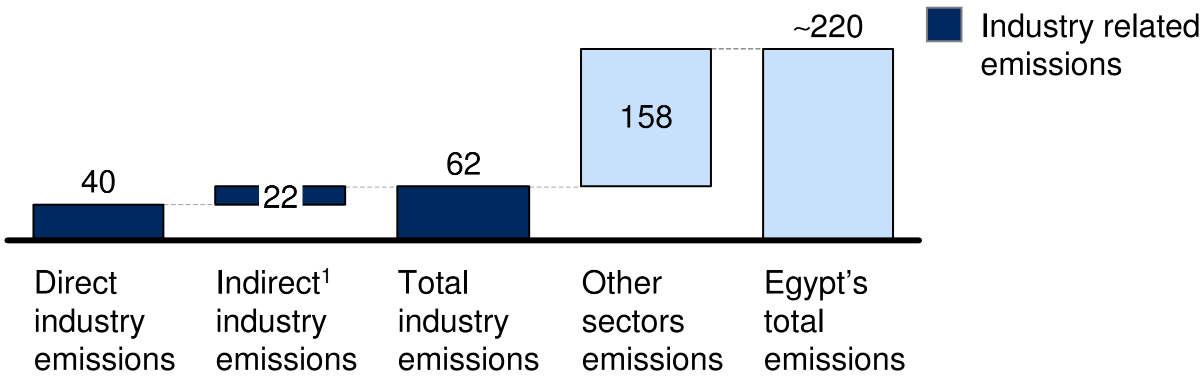
2 Total industry-related emissions account for ~29% of Egypt's total emissions in 2005 and relative share is expected to grow to ~36% in 2030

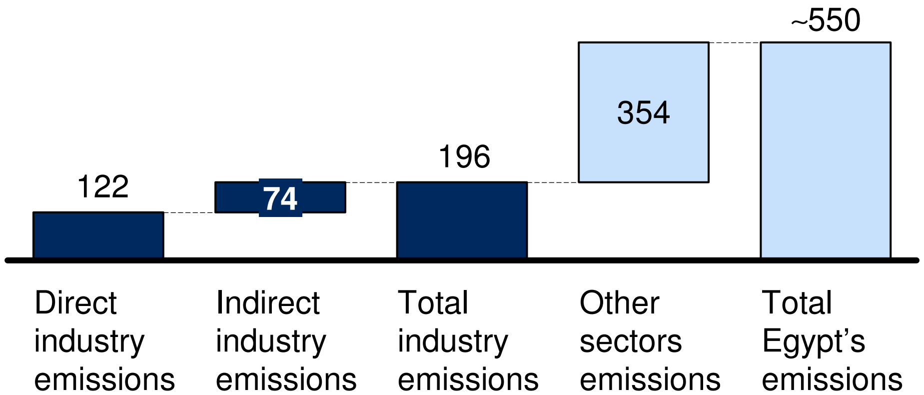
2005 Industry-related emissions
MtCO2e



Share of total emissions
Percent

Direct industry emissions	Indirect industry emissions	Total industry emissions	Other sectors emissions
~19	~10	~29	~71

2030 Industry-related emissions
MtCO2e



Share of total emissions
Percent

Direct industry emissions	Indirect industry emissions	Total industry emissions	Other sectors emissions
~22	~14	~36	~64

1 Electricity consumption

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

3 Cement sector is and is expected to remain the main contributor of total industry related emissions

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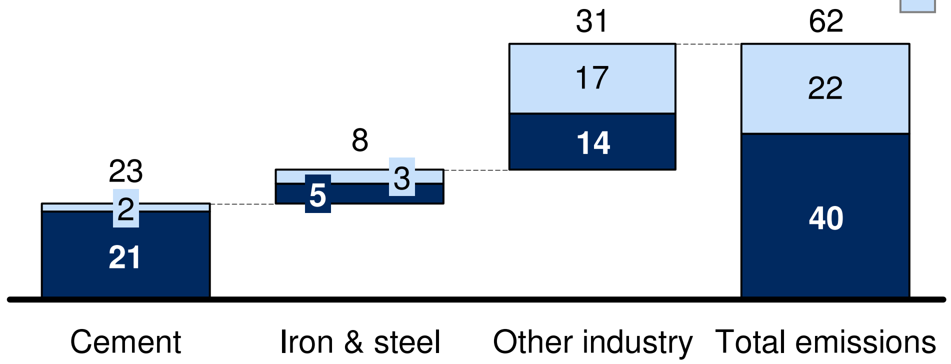
$MtCO_2e$, 2030

Direct emissions
Indirect emissions

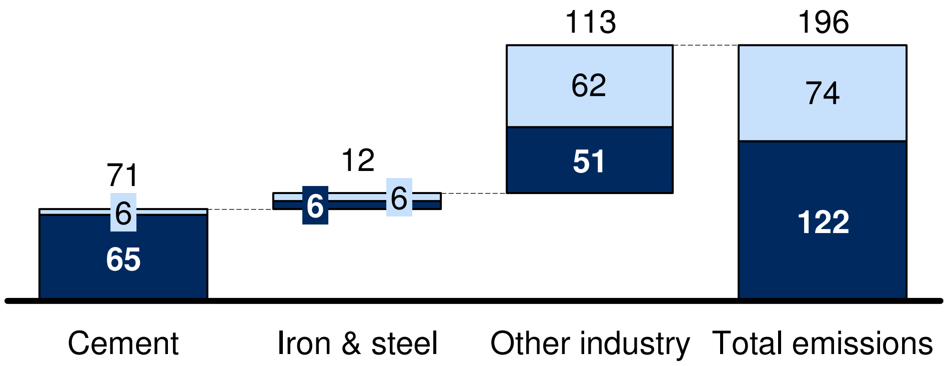
2005 Industry-related emissions
MtCO2e



Share of industry-related emissions
Percent

Cement	Iron & steel	Other industry
~38	~12	~50

2030 Industry-related emissions
MtCO2e



Share of industry-related emissions
Percent

Cement	Iron & steel	Other industry
~36	~6	~58

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

4 Egypt's overall abatement potential is in the range of ~200 Mt CO2e, equivalent to ~36% of BAU at 2030

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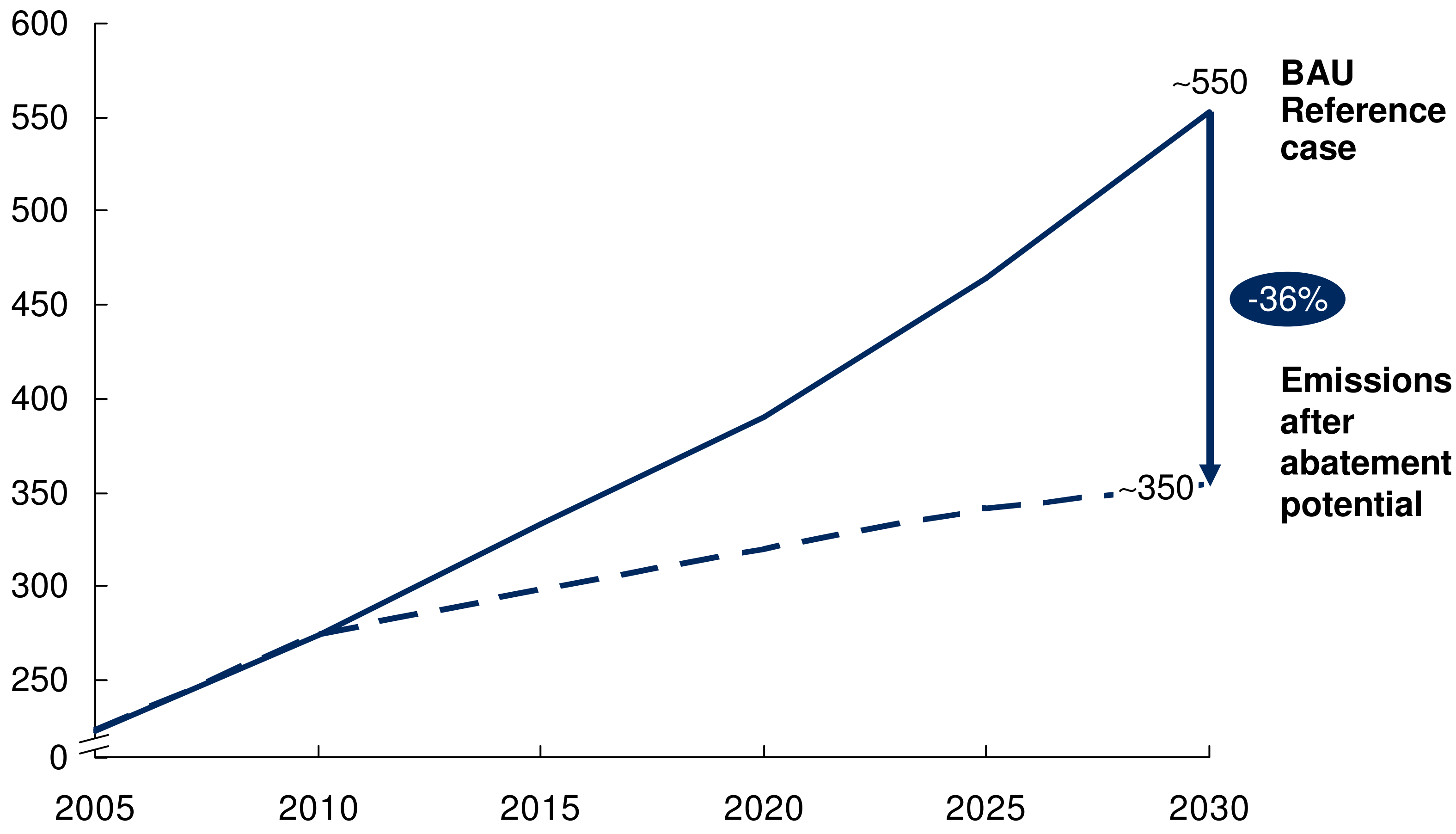
MtCO2e per year



SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

5 Total industry emissions can be reduced by ~15% of BAU at 2030, equivalent to ~30 Mt CO2e

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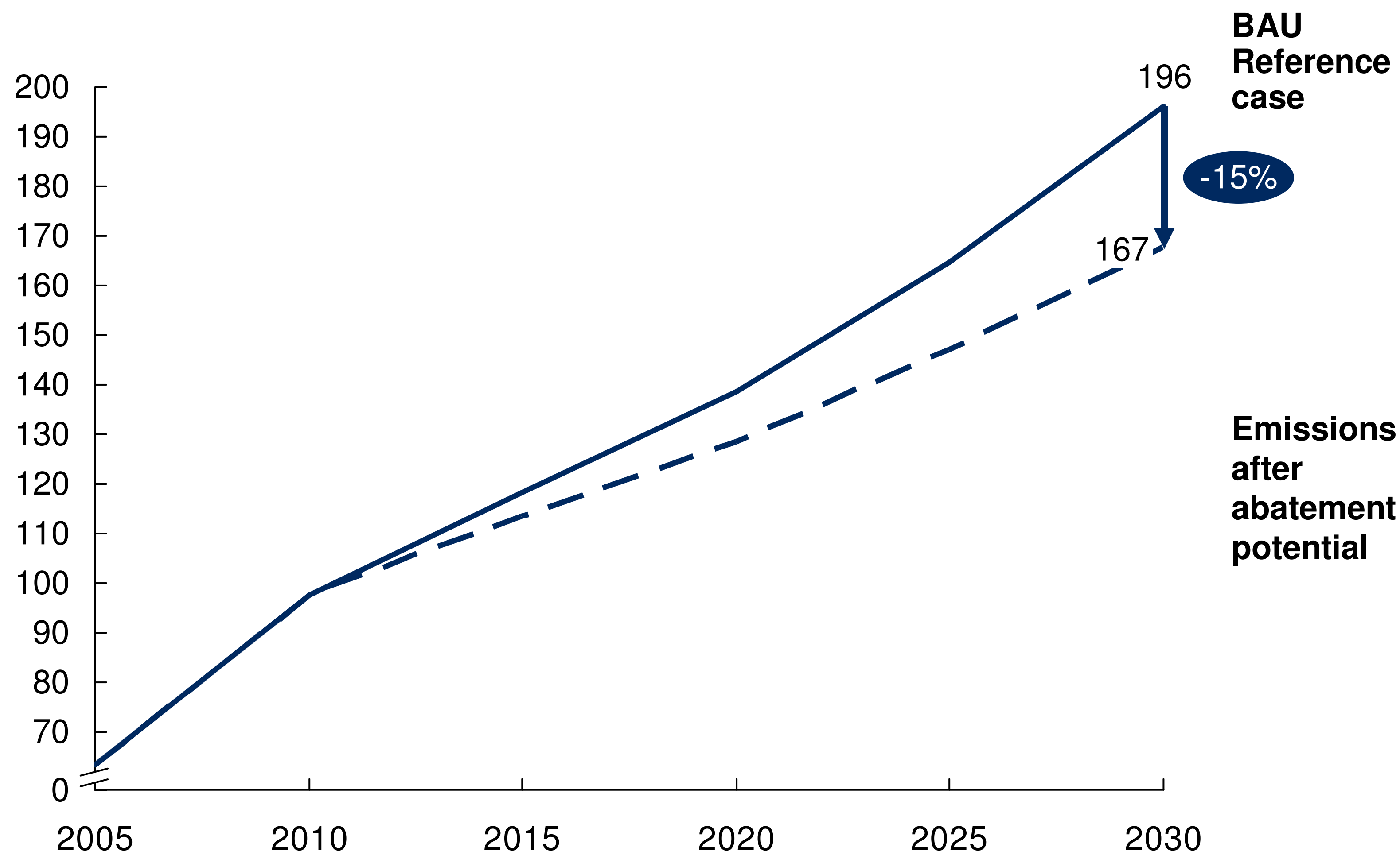
MtCO2e per year



SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

6 Industry abatement potential accounts for ~15% of the total abatement potential

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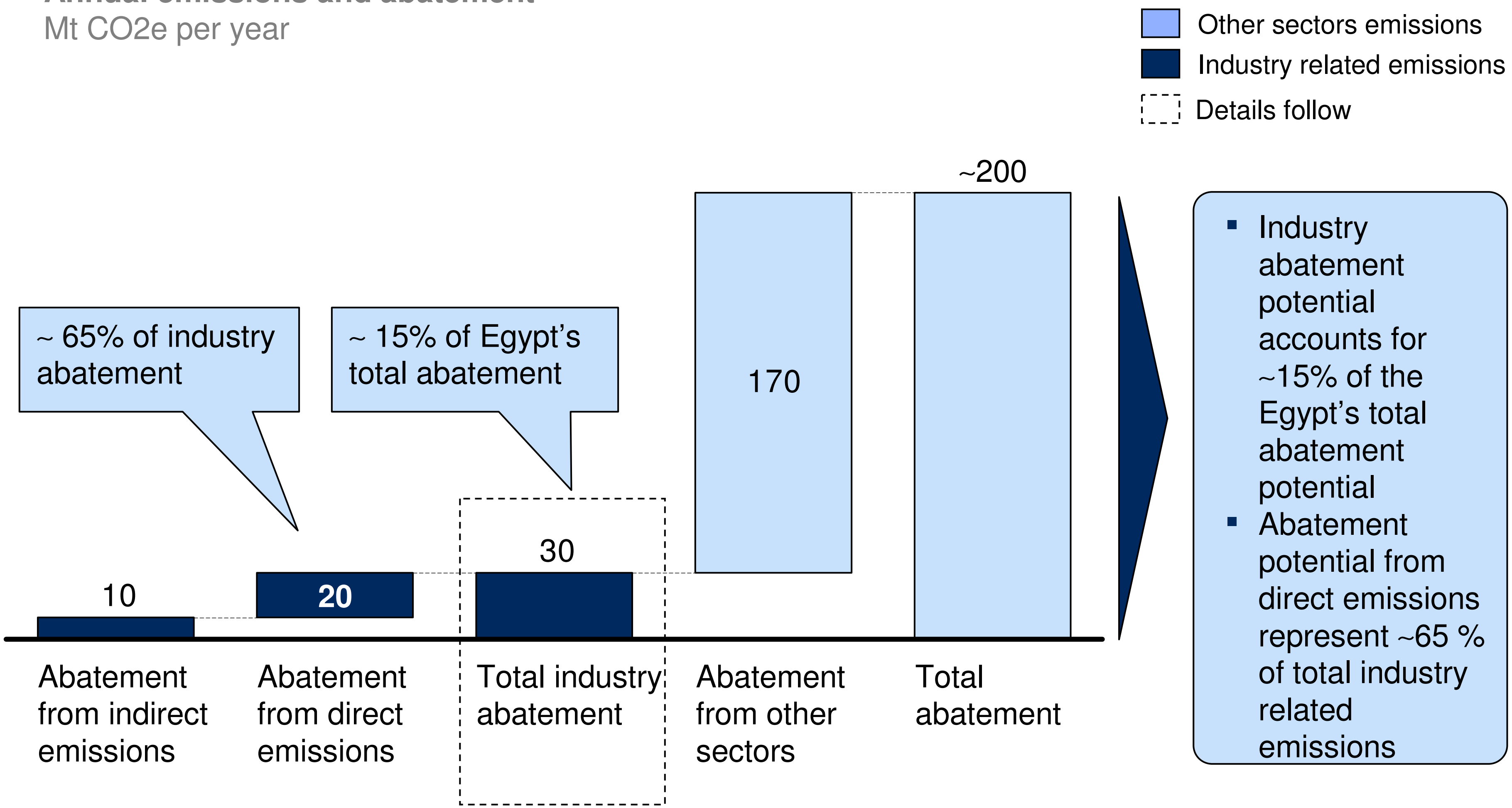
Annual emissions and abatement
Mt CO2e per year



- Industry abatement potential accounts for ~15% of the total Egypt's total abatement potential
- Abatement potential from direct emissions represent ~65 % of total industry related emissions

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Loca experts interviews; team analysis

7 Cement sector is one of the main sources of industry abatement potential

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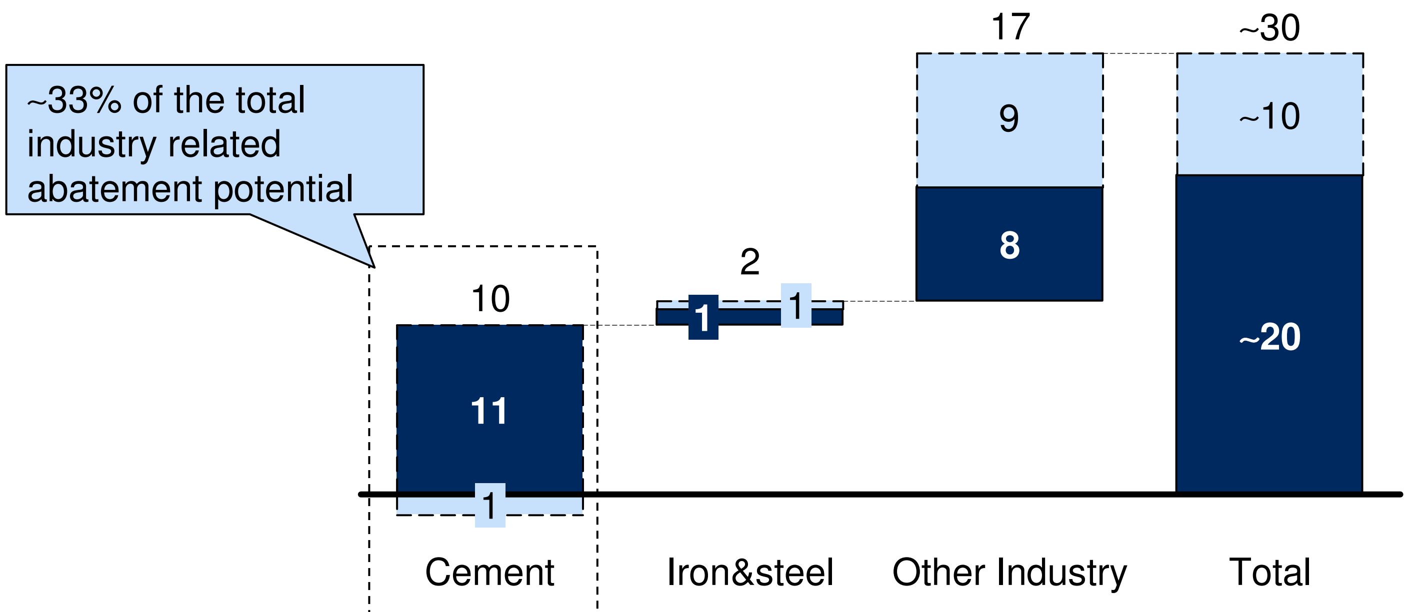
Abatement potential 2030
MtCO$_2$e per year



- Direct abatement
- Indirect abatement
- Deep dive follows

	Cement	Iron&steel	Other Industry	Total
Emissions reduction relative to 2030 BAU Percent	-14%	-13%	-15%	-15%
2030 BAU emissions MtCO2e	71	12	113	196

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Loca experts interviews; team analysis

7 Abatement potential based on assessment of local feasibility of levers (1/2)

PRELIMINARY

✓ Fully applicable
✗ Not applicable

Lever		Applicability	Comment
Clinker substitution	Fly ash	✗	▪ Fly ash and slag levers assumed to be not applicable since available fly ash and slag in Egypt is assumed to be already used in the BAU case
	Slag		
	Other MIC	✓	▪ Usage of Other MIC is assumed to be 10% of cement ingredients, the maximum average share to maintain quality European standards *(*see backup). Assume sufficient availability in Egypt (syndicated with IDA)
Alternative fuels	Waste fuels	✓	▪ Assume that in the abatement case, waste fuel will be available to provide 25% of energy for fuel combustion increased from 6% in BAU case. This 25% share is in line with other comparable countries with similar availability of waste fuel (syndicated with IDA)
	Biomass	✗	▪ Lever assumed not applicable due to unavailability of biomass fuel in Egypt, even in the abatement case

1 Mineral industrial components: fly ash, slag, rice husk ash, silica fume, metakaolin, calcined clay, and calcined shale
2 Assuming waste was incinerated for waste disposal reasons, resulting in CO2emissions, if not used as a kiln fuel

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

7 Abatement potential based on assessment of local feasibility of levers (2/2)

PRELIMINARY

✓ Fully applicable
✗ Not applicable

Lever	Applicability	Comment
CCS[1] – CCS newbuild	✓	▪ Based on the current availability of potential CCS locations (depleted oil and gas fields; natural underground formations with saltwater i.e. deep saline aquifers), it is assumed that: – CCS technology would be implemented starting in 2021, in line with expected cost and technology evolution of CCS – Share of CCS newbuild capacity for the period 2021-2025 is ~13% and for the period 2026-2030 ~37% This is in line with other comparable countries with similar availability of CCS locations
CCS[1] – CCS retrofit (on "old" plants)	✓	▪ CCS retrofits on "old" plants are assumed to begin 2026 and share of CCS retrofitted capacity is ~4% on average during the period 2026-2030. This is: – Based on the relative physical position of existing plants from potential CCS locations (currently plants located in Suez, Alexandria, Ameriya and Ain Soukhna are near potentials CCS locations) – In line with CCS implementation in other comparable countries
Waste heat recovery	✗	▪ Waste heat recovery procedure is already used to reduce fuel consumption from the majority of plants in Egypt in BAU

1 Carbon capture and storage

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

8 Additional abatement potential can be captured by the implementation of levers in Iron&steel sector

✓ Potentially applicable
✗ Not applicable

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Lever	Description	Applicability
Co-generation	▪ **Cogeneration integrated in the BF/BOF steel-manufacturing process** to reduce the total energy demand (Blast Furnace/Basic Oxygen Furnace (BF/BOF) steel-manufacturing process generates gas as a by-product; this gas can be recovered, cleaned and used for for power generation)	✗
Direct casting	▪ Direct casting: **integrated casting and hot rolling of steel into one step**, to reduce the need for reheat before rolling ("Near net-shape casting" and "Strip casting" are two newly developed direct casting techniques)	✓
Smelt reduction	▪ Smelt reduction: **integrated preparation of coke with iron-ore reduction** to reduce energy use at the iron production stage (the emission savings are achieved as less direct fuel is used when integrating preparation of coke with iron-ore reduction)	
Energy Efficiency	▪ Annual improvement in direct energy efficiency above reference case, caused **multiple levers**: shift from BF/BOF to EAF production, preventative maintenance, improved process flow (management, logistics, IT-systems), new efficient burners, capacity utilization management, heat recovery, sinter plant heat recovery, coal moisture control, pulverized coal injection, oxygen injection in EAF, scrap preheating, laser analysis of scrap, insulation of furnaces, reduction of air leakage, improved oxygen level control, heat recovery in annealing line, flue gas monitoring systems, recuperative burners	✓
CCS	▪ **Carbon capture and storage (CCS);** (carbon stored can also be then used in cement production)	✓
Coke substitution	▪ **Substitution of coke used in BF/BOF** furnaces with fuel based on biomass, with zero carbon intensity	✗
BF/BOF to EAF-DRI shift	▪ **Increased share of EAF-DRI relative BF/BOF in future steel making** (EAF-DRI uses natural gas as fuel in EAF furnaces to produce direct reduced iron (DRI) direct from iron ore, without the need fro scrap metal as a basis for electric arc furnaces)	✗

Source: McKinsey GHG abatement cost curve 2.0 team

8 A feasibility assessment of additional lever in other industry sectors can generate additional abatement potential

PRELIMINARY

- Potential levers for Chemicals sector
- Levers potentially Applicable to other industries

Lever	Description
Motor systems	Introduction of energy saving measures in motor systems, such as adjustable speed drive, more energy efficient motors, and mechanical system optimization
CCS Direct	Applying Carbon Capture and Storage to the exhaust emissions coming from direct energy use in the chemical plants
CHP	CHP, combined heat and power, is a technique to involve the energy losses in power production to generate heat for processes, in order to increase system efficiency and decrease the amount of fuel needed for power generation
CCS Ammonia	Introduction of Carbon Capture and Storage to the CO_2 emitted as a process emission from Ammonia production
Nitric acid	Applying filtering measures in order to decompose N2O from the tailgas of nitric acid production, where N2O is produced as a process emission
Process intensification	Process intensification in chemical processes, leading to an annual emission decrease. The improvements are caused by a number of individual levers, including continuous processes, improved process control, preventative maintenance, more efficient burners and heaters and logistical improvements
Catalyst optimization	Catalyst optimization in chemical processes, leading to an annual process and direct energy emissions decrease above the business-as-usual. The improvements are caused by a number of individual levers, including improved chemical structure of catalysts, design to lower reaction temperatures, and chain reaction improvements
Ethylene cracking	Ethylene Cracking improvement includes furnace upgrades, better cracking tube materials and improved separation and compression techniques that lowers the direct energy used in the cracking process

Source: Global V2.0 team

Content

- Overall country perspective
- Industry overview
- **Deep dive on selected sectors**

Deep dive – Selected sectors

- **Power**
- Buildings
- Cement
- Road Transport
- Agriculture

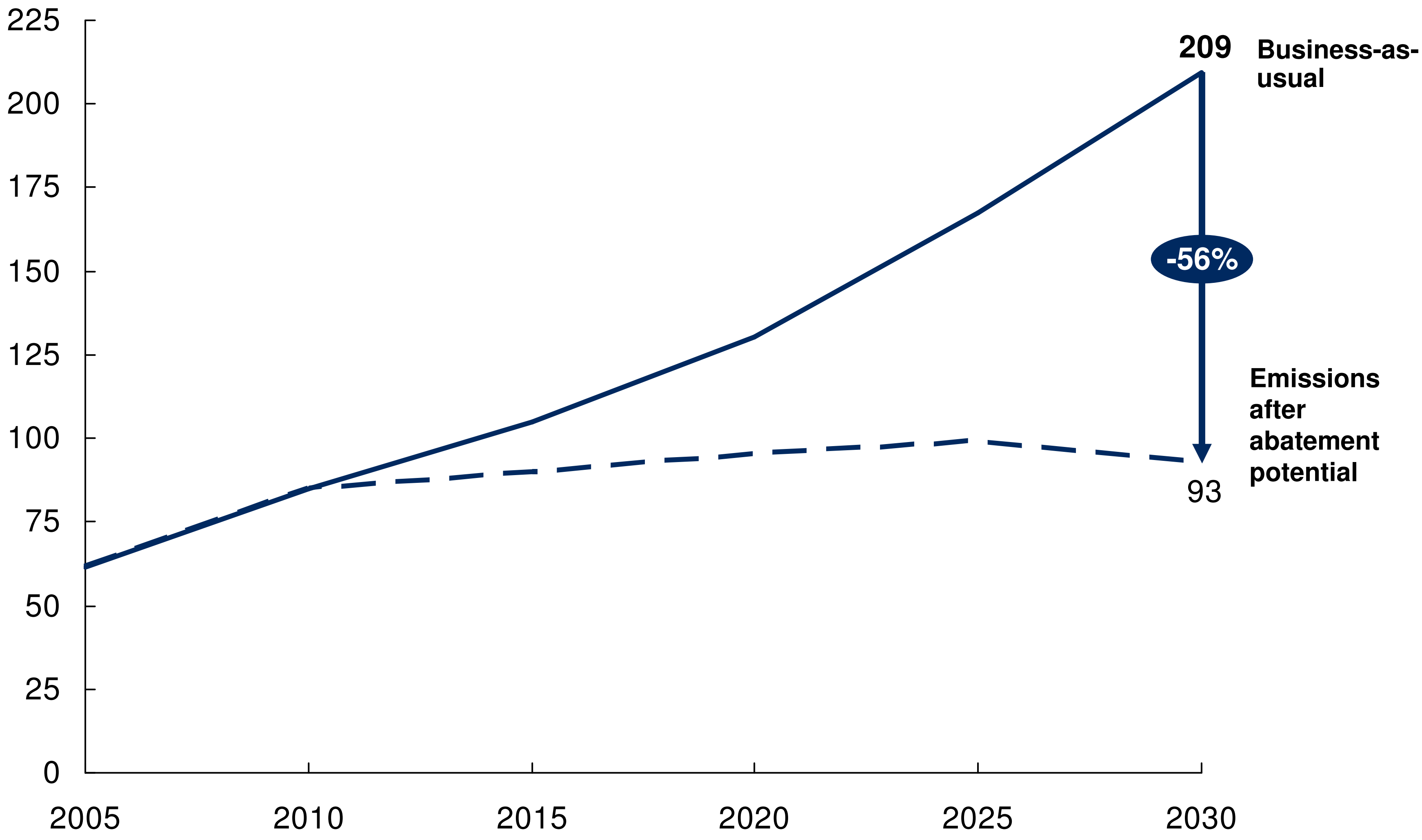
Sector summary

BAU	▪ Power sector emissions totalled 61.6 Mt CO_2e in 2005 ▪ Under a business as usual (BAU) scenario, emissions are expected to grow to ~210 Mt CO_2e by 2030 at a growth rate equal to ~5.0% CAGR ▪ The primary driver of emissions growth is expected increased electricity demand (from ~85 TWh in 2005 to ~350 TWh in 2030) ▪ Emissions growth rate is slightly lower than production growth rate due to higher share of less CO_2 intensive gas plant and some renewable and nuclear plants
Abatement potential	▪ Overall abatement potential is in the range of ~116 Mt CO_2e, equivalent to ~56% of total power BAU emissions in 2030 ▪ ~37% of the overall abatement potential (~43 Mt CO2e) is driven by reduction of electricity demand in consuming sectors (mainly from building sector) ▪ Solar, Wind and Hydro, with a total abatement potential of ~54 Mt CO_2e represent the most relevant levers ▪ Total incremental Capex required through 2011-2030 to capture the overall potential is in the range of EUR ~22 billion offset by opex savings of ~9 billion EUR during the same period

SOURCE: CAIT, Egypt GHG Abatement Cost Curve

Expected BAU emissions in 2030 are ~210 $MtCO_2e$ with abatement potential of ~55%

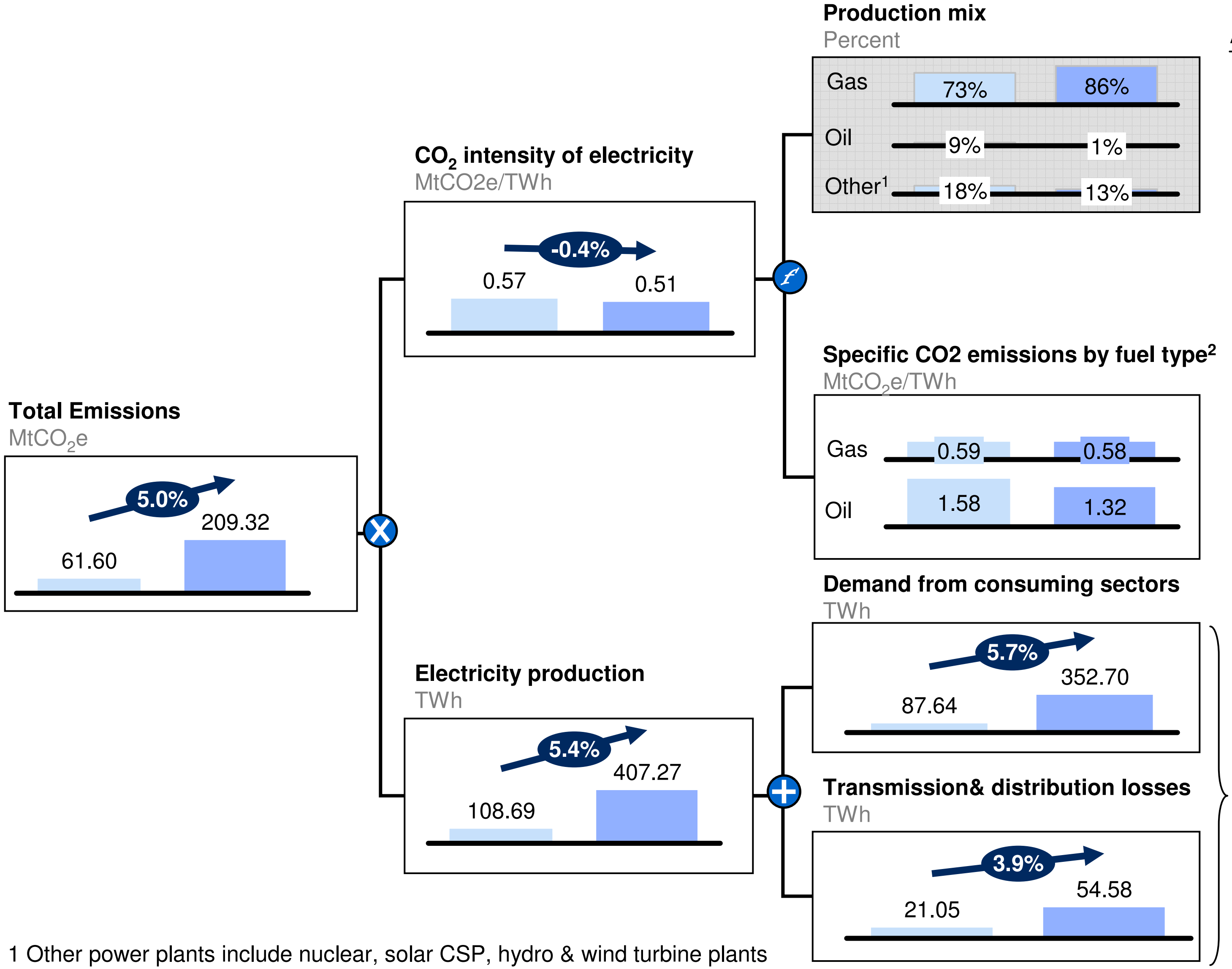
PRELIMINARY



SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Local experts interviews; team analysis

BAU scenario is mainly driven by expected electricity production

2005
2030
Details follow



Assumptions/Sources

- Production mix 2005 based on data provided by Enerdata and validated with local experts
- Production mix evolution driven by introduction of 2 GW nuclear; partial substitution of oil with gas plants; evolution of renewables (onshore wind, hydro and solar CSP) – validated with local experts
- Specific emission intensity of gas remains fairly constant (in line with comparable countries)
- Specific emission intensity of oil decreases according to historical rate in Egypt (in line with comparable countries)
- 2005 baseline and 2030 projections from *IDA/ Enerdata/ INC*

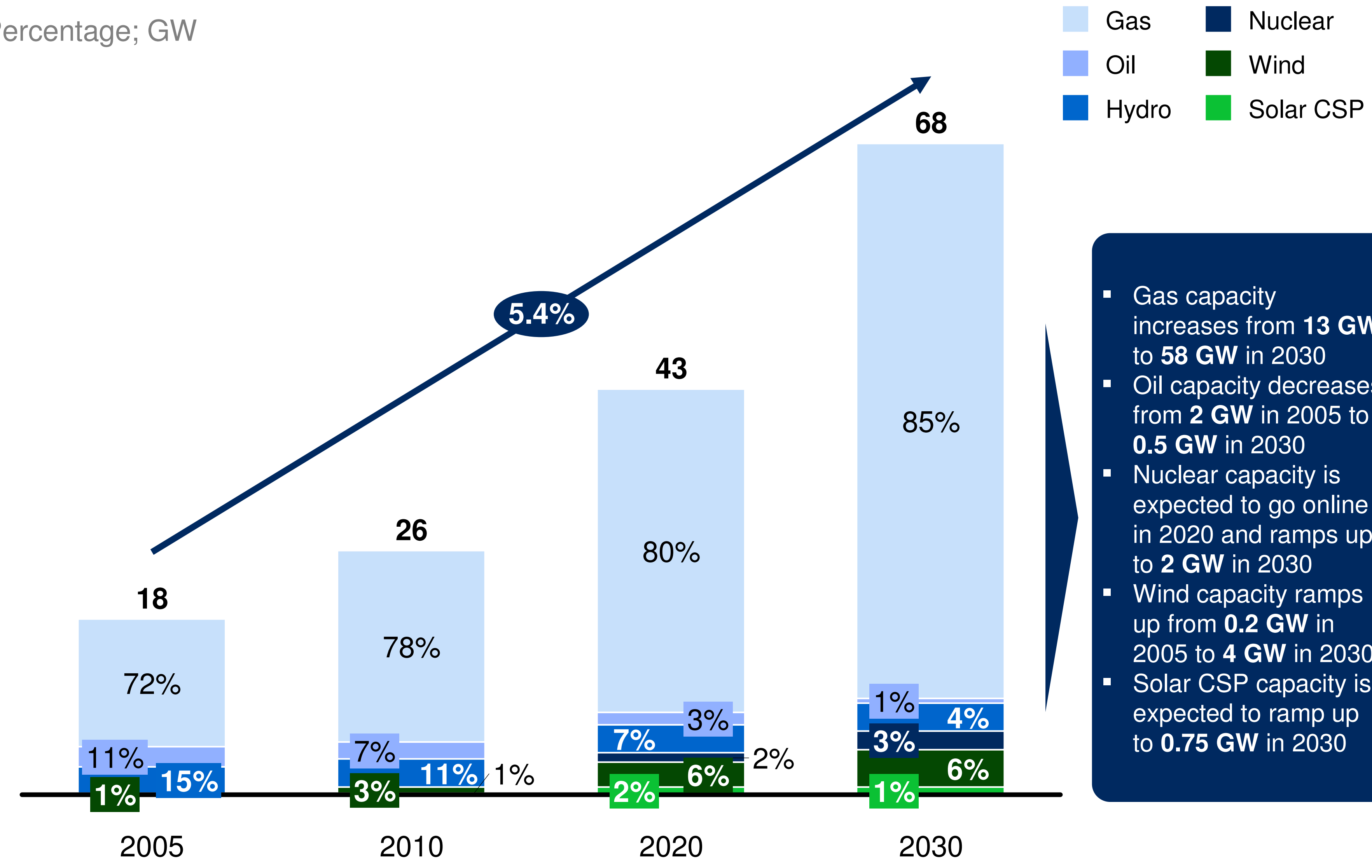
1 Other power plants include nuclear, solar CSP, hydro & wind turbine plants
2 Only gas & oil plants are considered; nuclear & renewable contribute to 0 emissions

SOURCE: CAIT database on Egypt; POLES projections; CIDIAC; Enerdata; IEA Egypt profile; Global Insight; McKinsey Global GHG Abatement Cost Curve V2.0; Loca experts interviews; team analysis

In BAU, total capacity is expected to increase to ~70 GW by 2030

PRELIMINARY

Percentage; GW



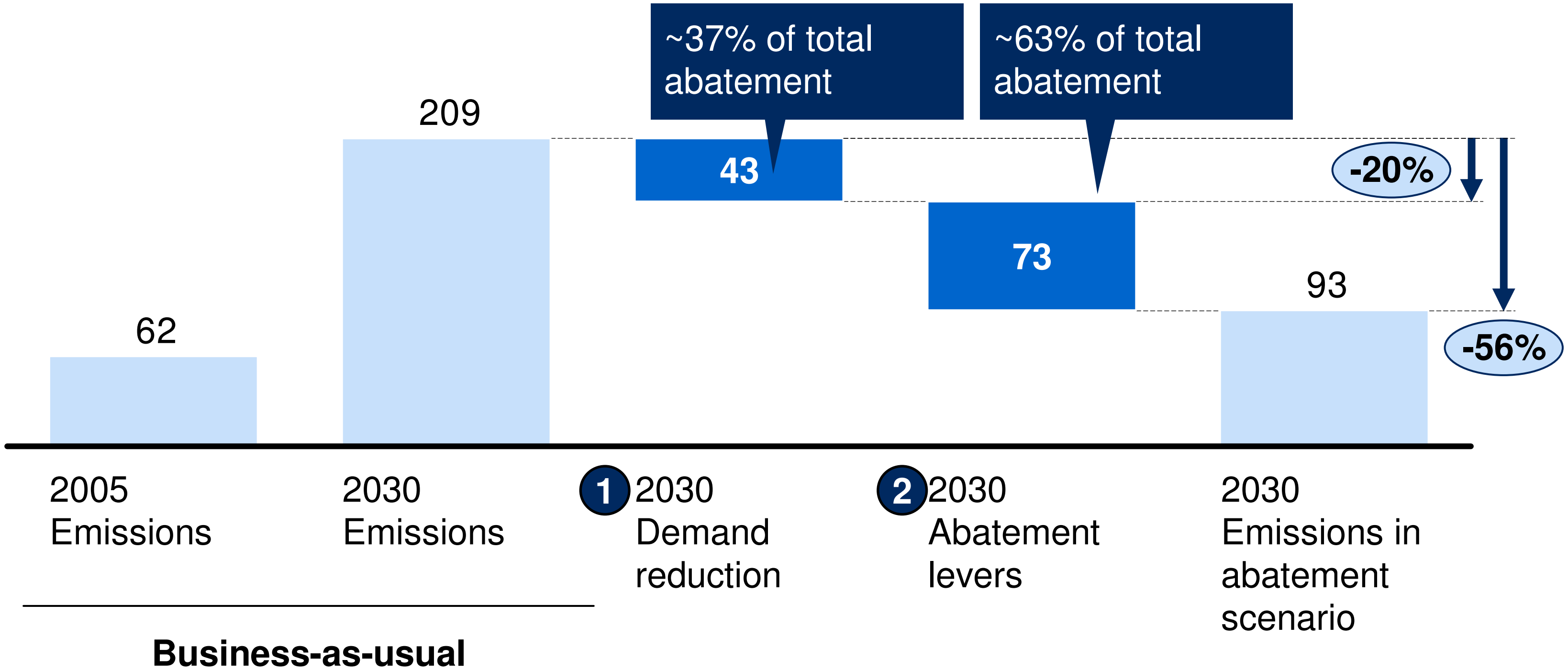
- Gas capacity increases from **13 GW** to **58 GW** in 2030
- Oil capacity decreases from **2 GW** in 2005 to **0.5 GW** in 2030
- Nuclear capacity is expected to go online in 2020 and ramps up to **2 GW** in 2030
- Wind capacity ramps up from **0.2 GW** in 2005 to **4 GW** in 2030
- Solar CSP capacity is expected to ramp up to **0.75 GW** in 2030

SOURCE: INC; IMC Data; Enerdata; Mckinsey GHG V2.0 models; Team analysis

Potential abatement is in the range of ~116 MtCO_2e equivalent to ~56% of 2030 power emissions

PRELIMINARY

Mt CO_2e



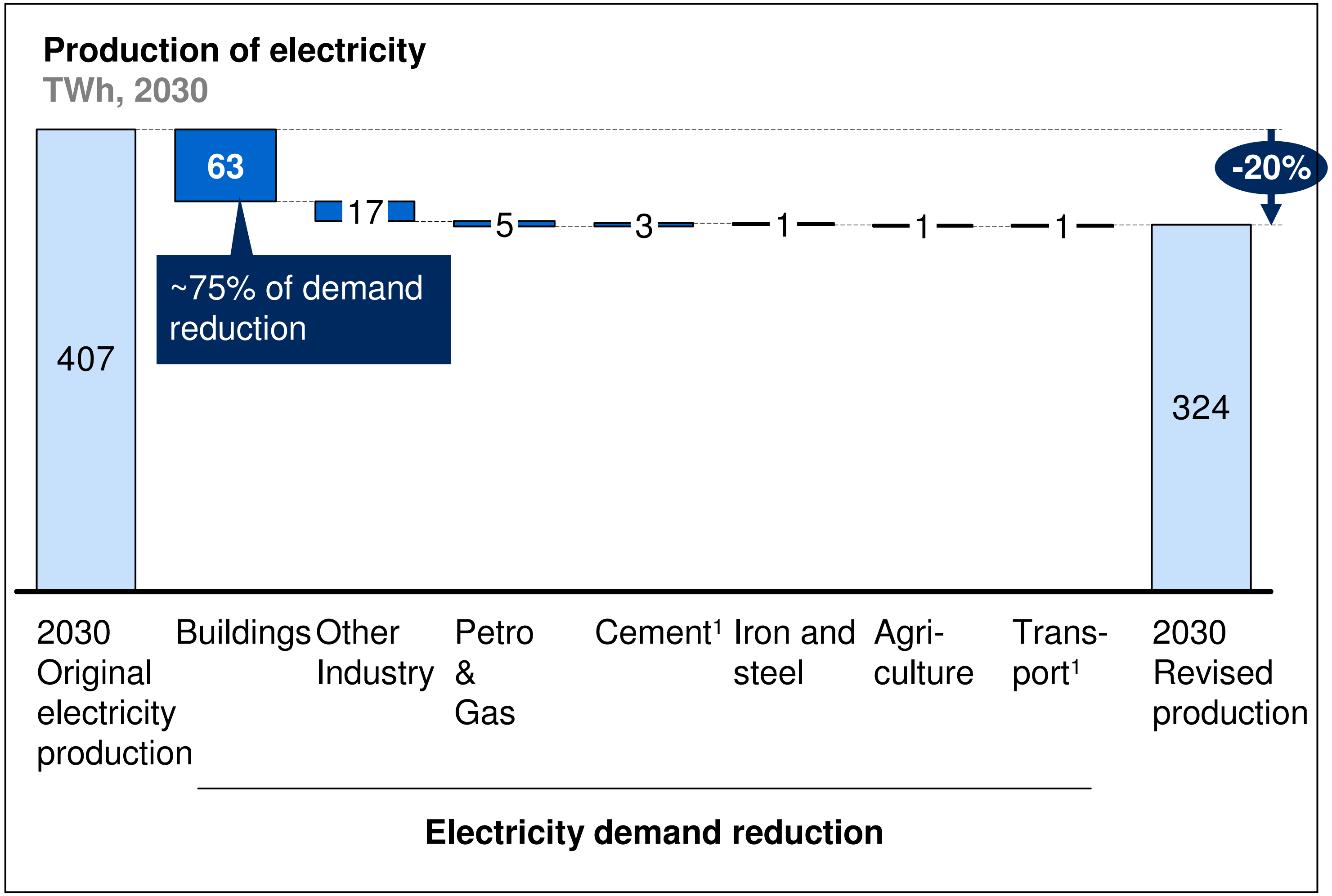
Comments

- Emissions growth mainly driven by increasing electricity demand
- Abatement potential driven by reduction in consuming sectors
- Abatement potential coming from the Implementation of "green power sector" levers

SOURCE: McKinsey Global GHG Model V2.0; INC; IDA; Client data; team analysis

1 Abatement from demand reduction is driven mainly by reduction in electricity consumption in building sector

PRELIMINARY



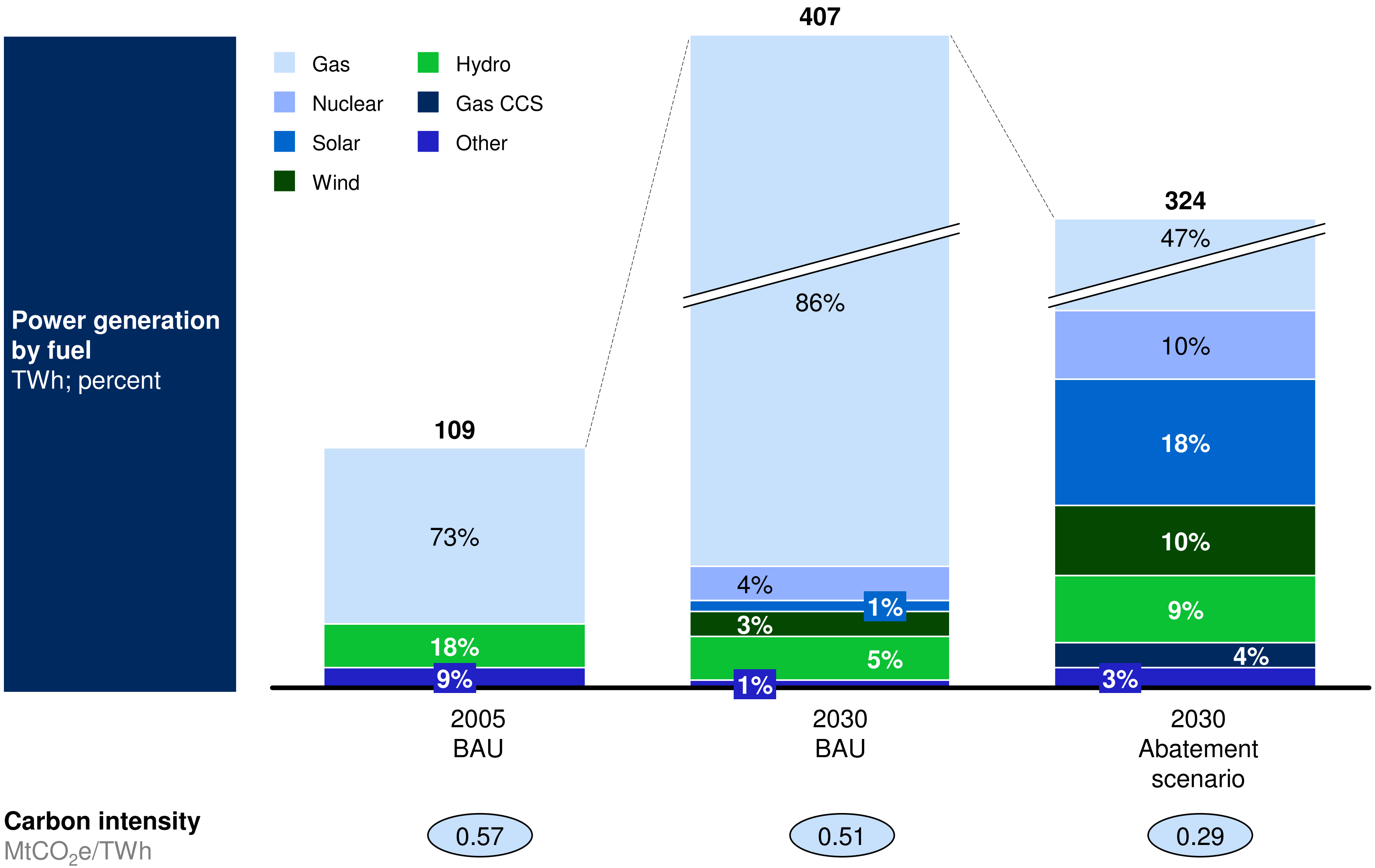
43 $MtCO_2e$ of abatement in 2030 due to decreased electricity consumption of 83 TWh

1 Cement & Transport have increased electricity consumption in the abatement scenario

SOURCE: McKinsey Global GHG Model V2.0; INC; IDA; Client data; team analysis

2 The carbon intensity of the power sector decreases from 0.51 in 2030 BAU to 0.29 MtCO2e/TWh in the 2030 abatement scenario

PRELIMINARY



SOURCE: McKinsey Global GHG Model V2.0; INC; IDA; Client data; team analysis

PRELIMINARY

2 The power mix is changed in abatement scenario based local applicability of levers (1/2)

✓ Fully applicable
✗ Not applicable

Lever	Applicability	Comment
Wind	✓	▪ In 2030, maximum potential - validated with local experts - is assumed to be: – **8 GW** for **onshore wind** – **3 GW** for **offshore wind** ▪ Only **4 GW** of onshore wind is included in the **BAU** (attributed to Zafarana wind farm) through 2030 – validated with local experts
Solar	✓	▪ In 2030, maximum potential – validated with local experts - is assumed to be: – **9 GW** for **solar CSP** – **2 GW** for **solar PV** ▪ In the BAU **0.75 GW** of solar CSP (with thermal backup) is included till 2030 - attributed to ongoing projects with New and Renewable Energy Authority (NREA)
Hydro	✓	▪ In 2030, maximum potential – validated with local experts - is assumed to be **4 GW**. This includes large hydro (Katara and Ataqa) as well as small hydro (below 35 MW capacity) ▪ In BAU, **2.87 GW** of hydro capacity is included in 2030 (Enerdata)

SOURCE: NREA website, expert interviews, GHG abatement cost curve 2.0 team

PRELIMINARY

2 The power mix is changed in abatement scenario based on local applicability of levers (2/2)

✓ Fully applicable
✗ Not applicable

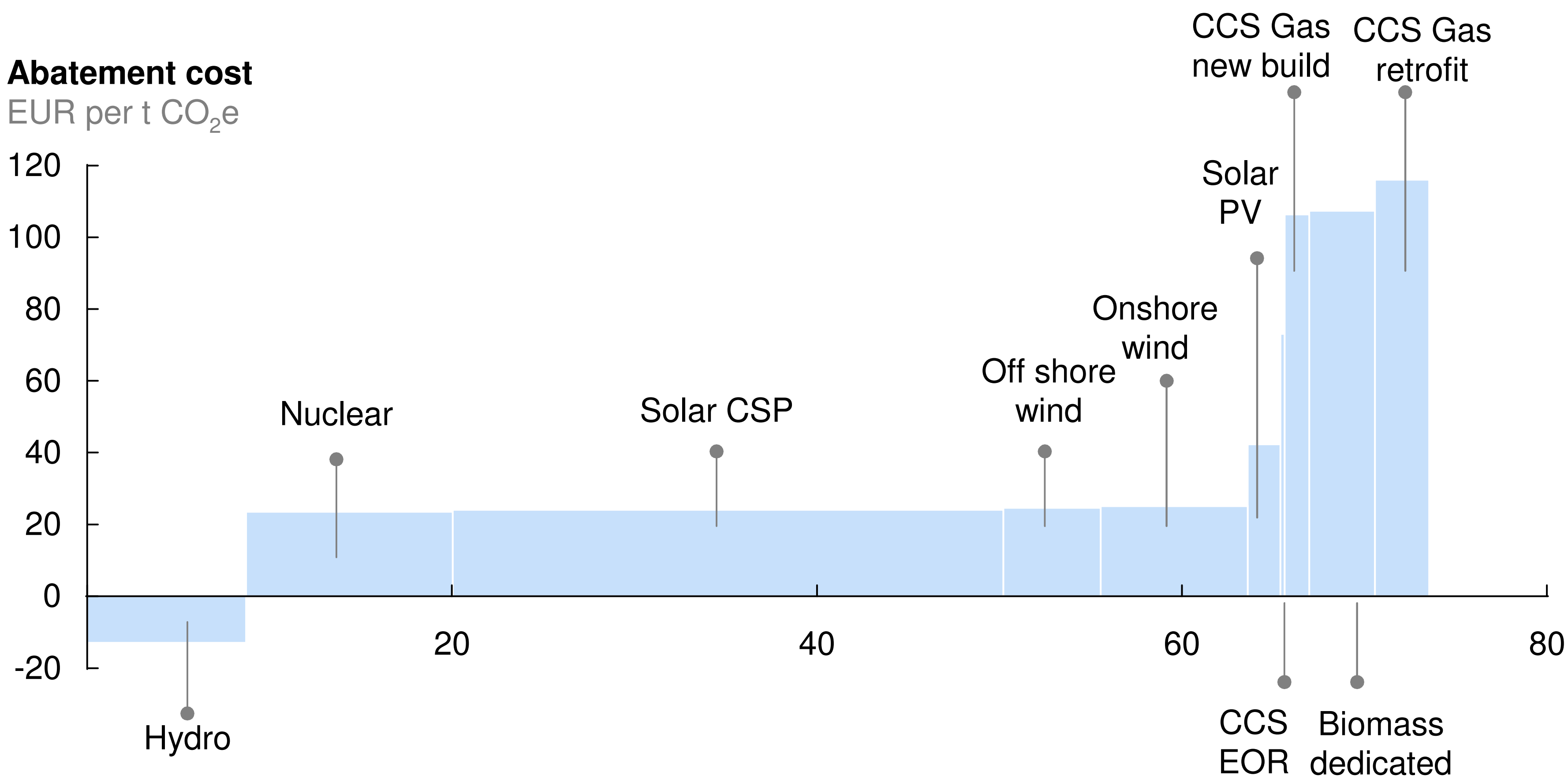
Lever	Applicability	Comment
Dedicated biomass	✓	▪ In 2030, maximum potential is assumed to **1 GW** (similar to comparable regions and syndicated with local experts) ▪ **No biomass capacity** is assumed in the **BAU scenario** by 2030
Nuclear	✓	▪ In 2030, maximum potential is assumed to be **4 GW** (syndicated with local experts) ▪ In the BAU **2 GW** of nuclear capacity is included by 2030 (based on planned project and syndicated with local experts)
CCS	✓	▪ In 2030, maximum potential is assumed to be around **5 GW.** CCS levers are applicable for gas plants (new build and retrofit) and for oil plants using Enhanced Oil Recovery ▪ **No CCS capacity** is assumed in the BAU scenario by 2030
Geothermal	✗	▪ No potential sites for geothermal generation identified

SOURCE: NREA website, EAEA, WNA website, GAFI study on renewables, expert interviews, GHG abatement cost curve 2.0 team

2 Renewable power sources (hydro, wind and solar) account for ~73% of total abatement potential

PRELIMINARY

2030, Societal perspective[1]



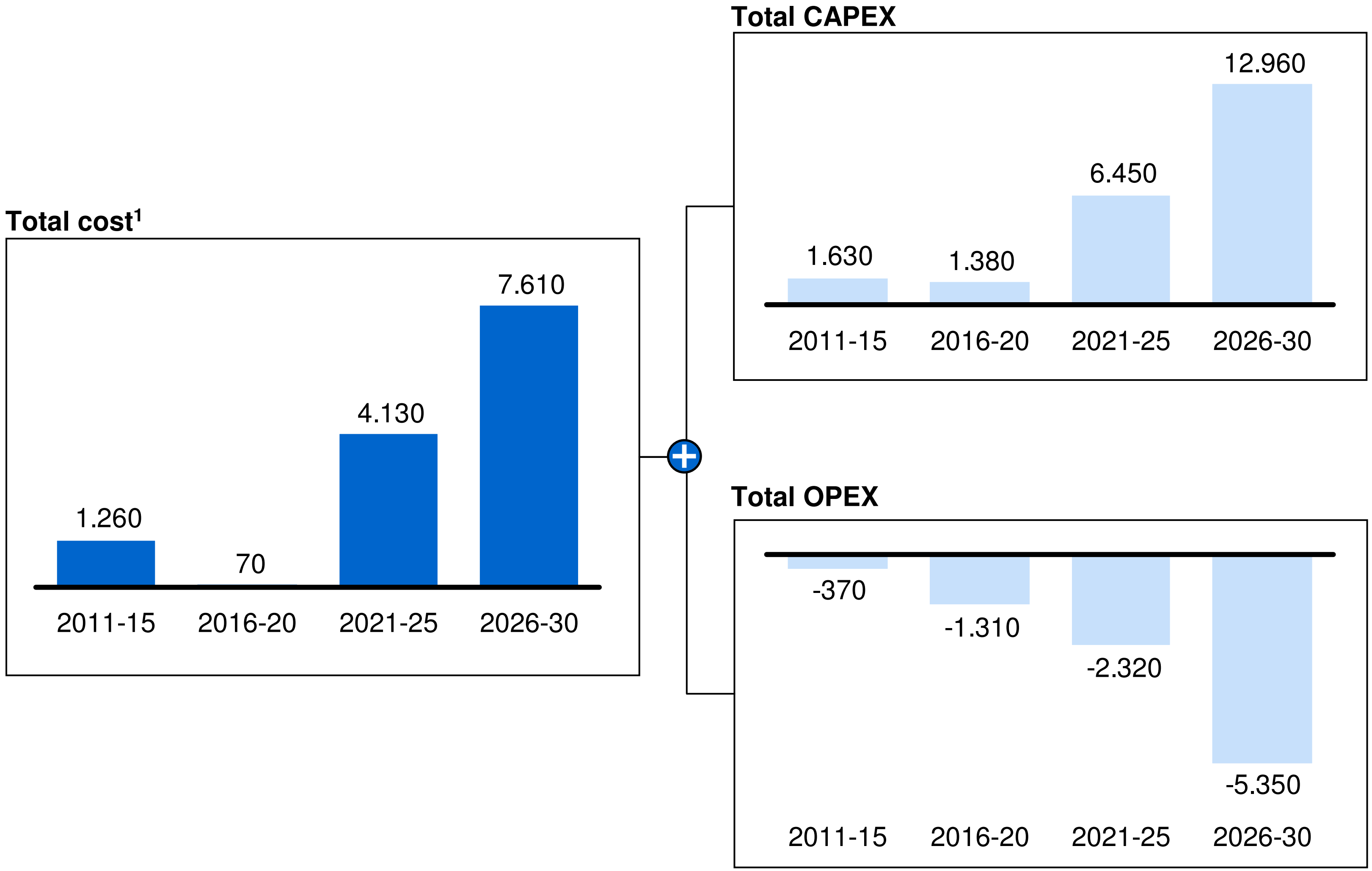
1 Societal perspective (i.e., excluding taxes, subsidies, and with a capital cost similar to government bond rates)

SOURCE: Global GHG Abatement Cost Curve v2.0

❷ This incremental investment is only partially offset by lower OPEX…

PRELIMINARY

Real EUR millions



1 Cash flow form CAPEX and OPEX cost/savings

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

2 …although Hydro OPEX savings fully offset the required investment

Real 2005 EUR millions

BACK UP

CAPEX / OPEX

Total cost[1]

Total	1,260	70	4,130	7,610
CAPEX	1630	1380	6450	12960
OPEX	-370	-1310	-2320	-5350
	-1940	2016-20	2021-25	2026-30

	2011-15	2016-20	2021-25	2026-30	Comments
Hydro	450	80	-360	-1,010	▪ OPEX reduction due to lower gas consumption
CAPEX	660	780	950	1010	
OPEX	-210	-700	-1310	-2020	
Wind	1,500	650	220	350	▪ OPEX reduction due to lower gas consumption
CAPEX	1660	1210	1260	2140	
OPEX	-160	-560	-1040	-1790	
Solar	1,120	1,520	2,830	4,920	▪ OPEX reduction due to lower gas consumption
CAPEX	1120	1790	3990	8550	
OPEX	0	-270	-1160	-3630	
Nuclear	0	0	2,000	1,420	▪ OPEX reduction due to lower gas consumption
CAPEX	N/A	N/A	1930	1590	
OPEX	N/A	N/A	70	-170	
CCS	30	560	2,130	4,310	▪ CCS will require investment CAPEX as well as incremental ongoing storage and transport OPEX to achieve additional abatement
CAPEX	N/A	340	1010	2050	
OPEX	N/A	220	1120	2260	
Demand reduction	-1,840	-2,740	-2,690	-2,380	▪ **Demand reduction** leads to a decrease in CAPEX required for new builds ▪ OPEX saving due to demand reduction are considered in consumer sectors
CAPEX	-1840	-2740	-2690	-2380	
OPEX	N/A	N/A	N/A	N/A	

1 Cash flow from CAPEX and OPEX cost/savings

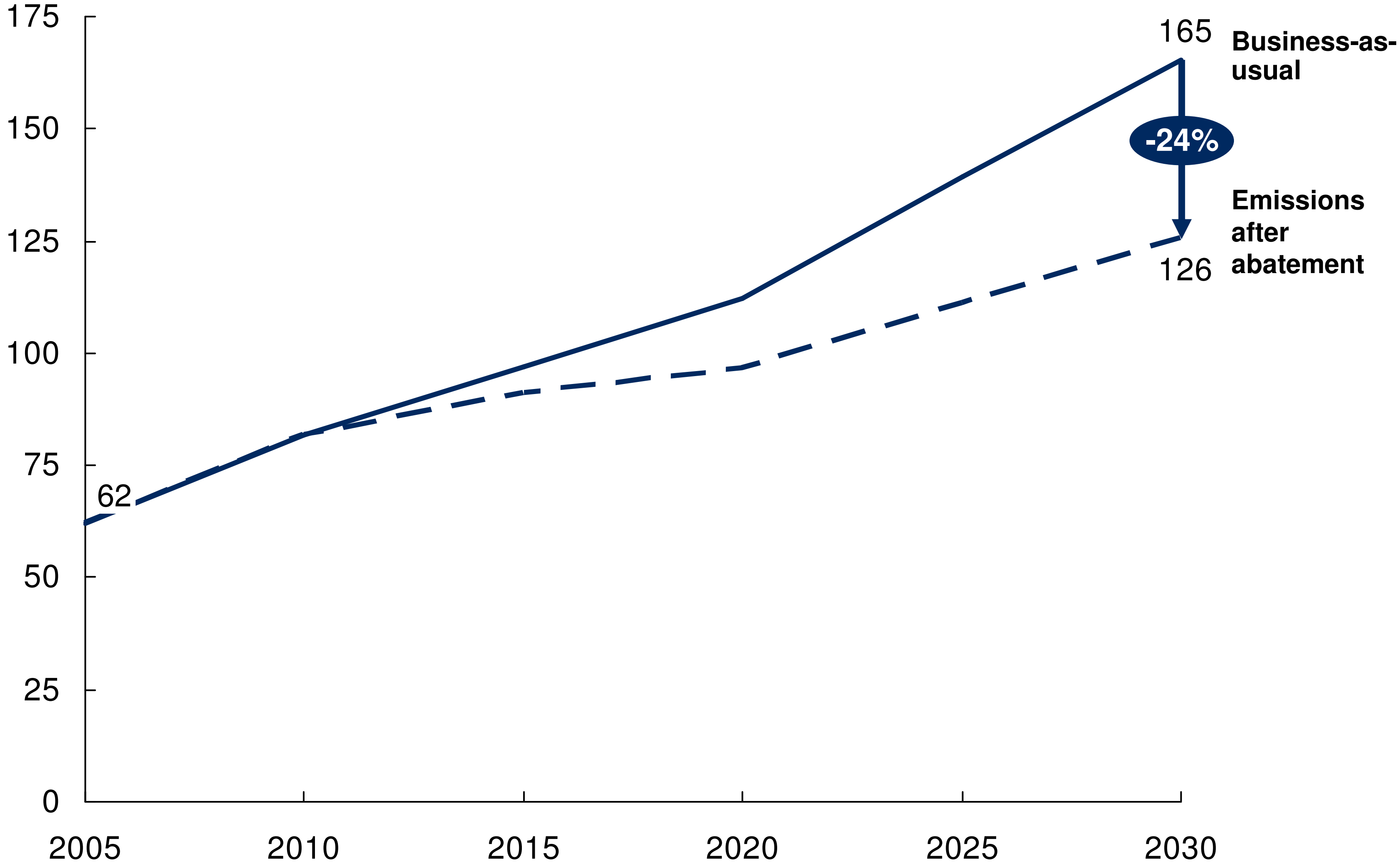
Deep dive – Selected sectors

- Power
- **Buildings**
- Cement
- Road Transport
- Agriculture

Sector summary

BAU	▪ Buildings accounted for ~62 $MtCO_2$ in 2005 (36 $MtCO_2$ indirect emissions and 26 $MtCO_2$ direct emissions) mainly driven by residential building (~65%) ▪ In 2030 emissions are expected to increase to ~165 $MtCO_2e$ mainly driven by increase in electricity consumption of residential buildings also reinforced by shift in electricity consumption (e.g. electric cooking replacing gas cooking)
Abatement potential	▪ Abatement potential of ~40 $MtCO_2e$ in 2030 equal to ~24% of the total emissions in the buildings sector ▪ Over 50% of the potential abatement comes from implementing – Lighting levers – Appliances & electronics levers ▪ Total incremental investment (Capex ~27 Bn EUR) in the period 2011-2030 is fully offset by Opex savings (~32 Bn EUR) for the same period after implementing abatement levers ▪ The majority share of the abatement opportunities in buildings are in fact cost negative; however they have not been implemented so far due to several factors: – Lack of building standards targeting energy efficiency in Egypt – Lack of schemes to incentivise home or business owners to adopt "green measures" – No widespread access to green financing schemes (investment is up front whereas levers generate economic benefits overtime)

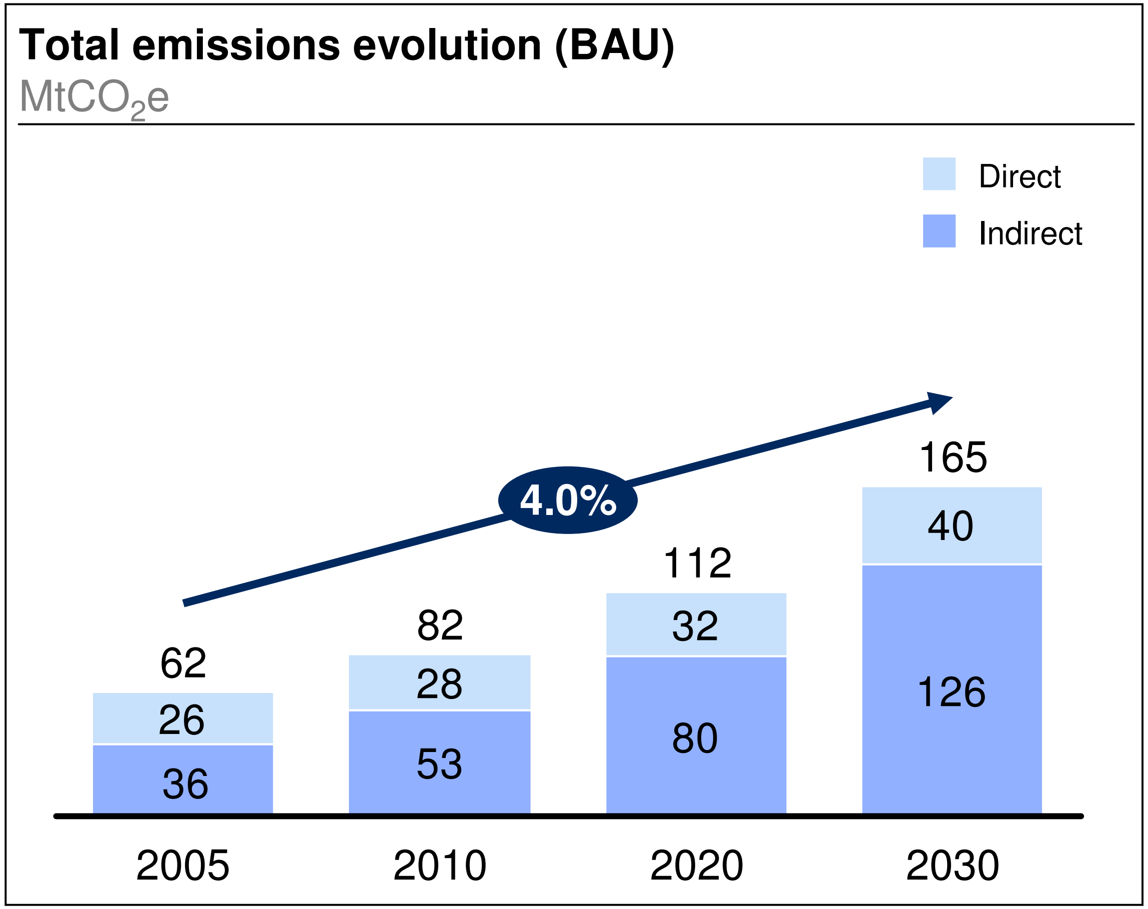
Expected BAU emissions in 2030 are ~165 $MtCO_2e$ with abatement potential of ~24%



SOURCE: Global GHG Abatement Cost Curve v2.0

The majority share of buildings emissions is attributable to electricity consumption

PRELIMINARY

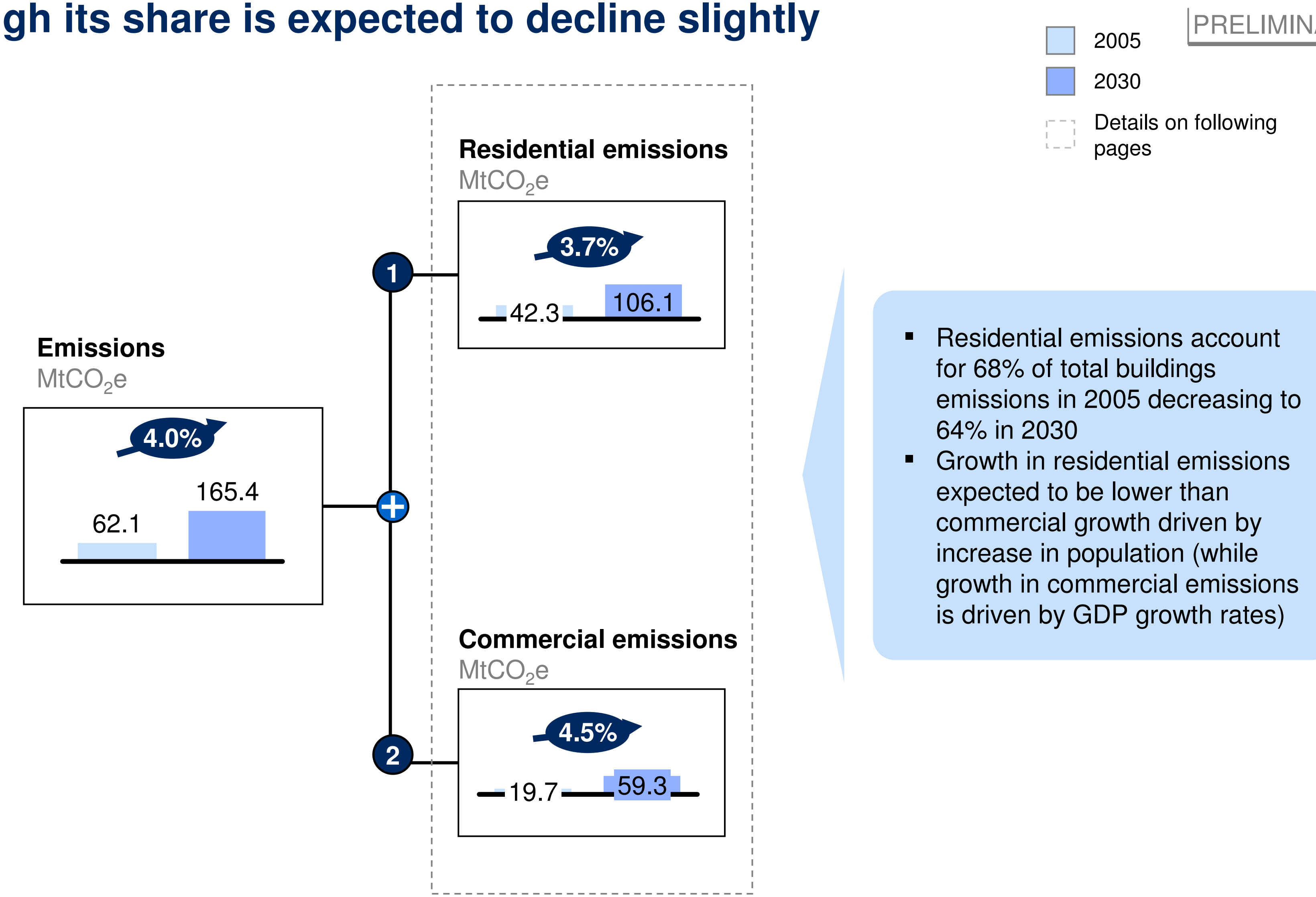


Electricity accounts for ~60% of emissions in 2005 increasing to ~75% in 2030

SOURCE: Enerdata, INC, McKinsey Global GHG Model V2.0, McKinsey GI, Team analysis

Residential emissions will be the major driver of total Buildings emissions, though its share is expected to decline slightly

PRELIMINARY



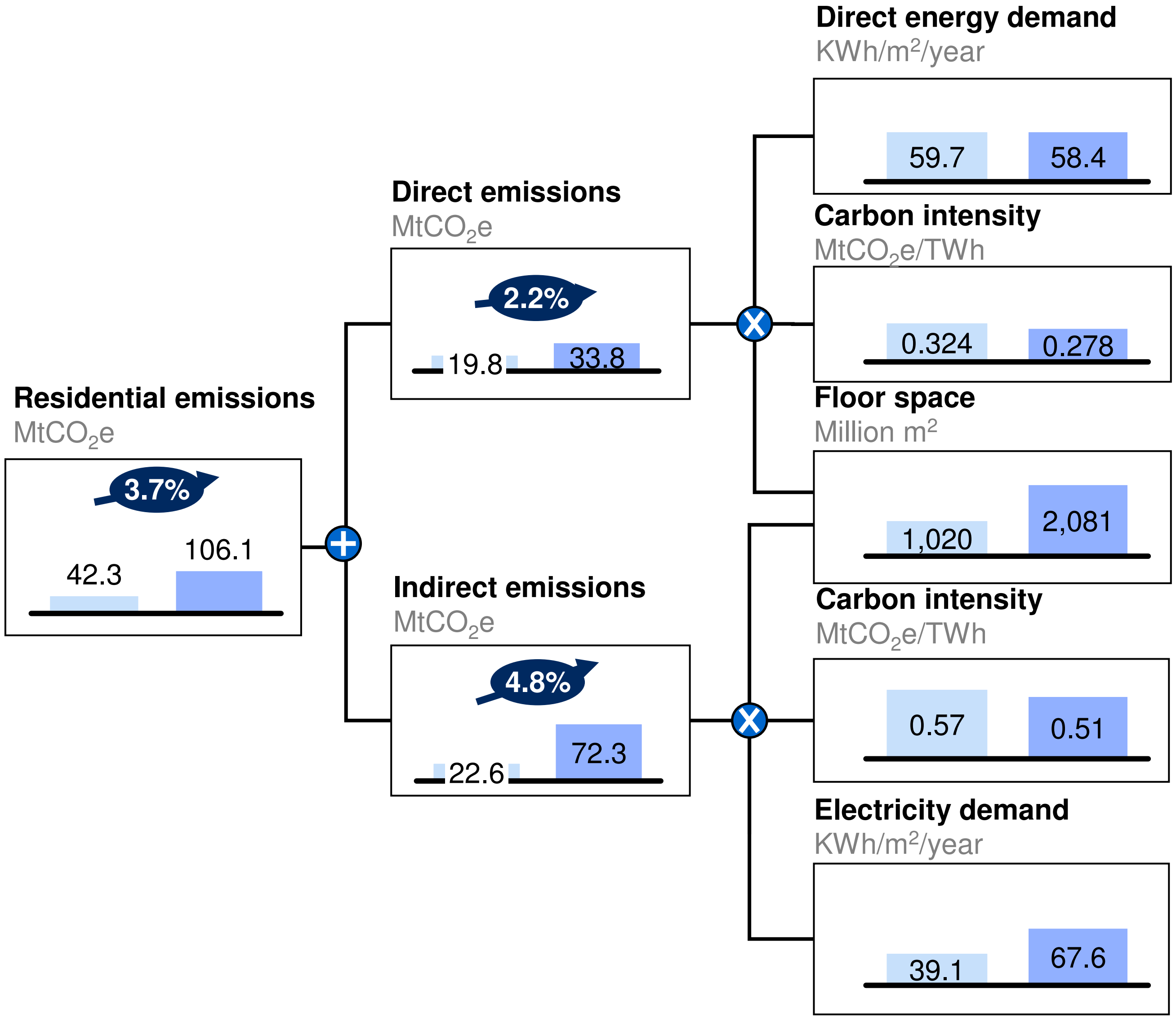
- Residential emissions account for 68% of total buildings emissions in 2005 decreasing to 64% in 2030
- Growth in residential emissions expected to be lower than commercial growth driven by increase in population (while growth in commercial emissions is driven by GDP growth rates)

SOURCE: McKinsey Global GHG Model V2.0; McKinsey GI

PRELIMINARY

1 Residential emissions are mainly driven by indirect emissions growth as a result of shift towards electricity

2005 2030



Assumptions/Sources

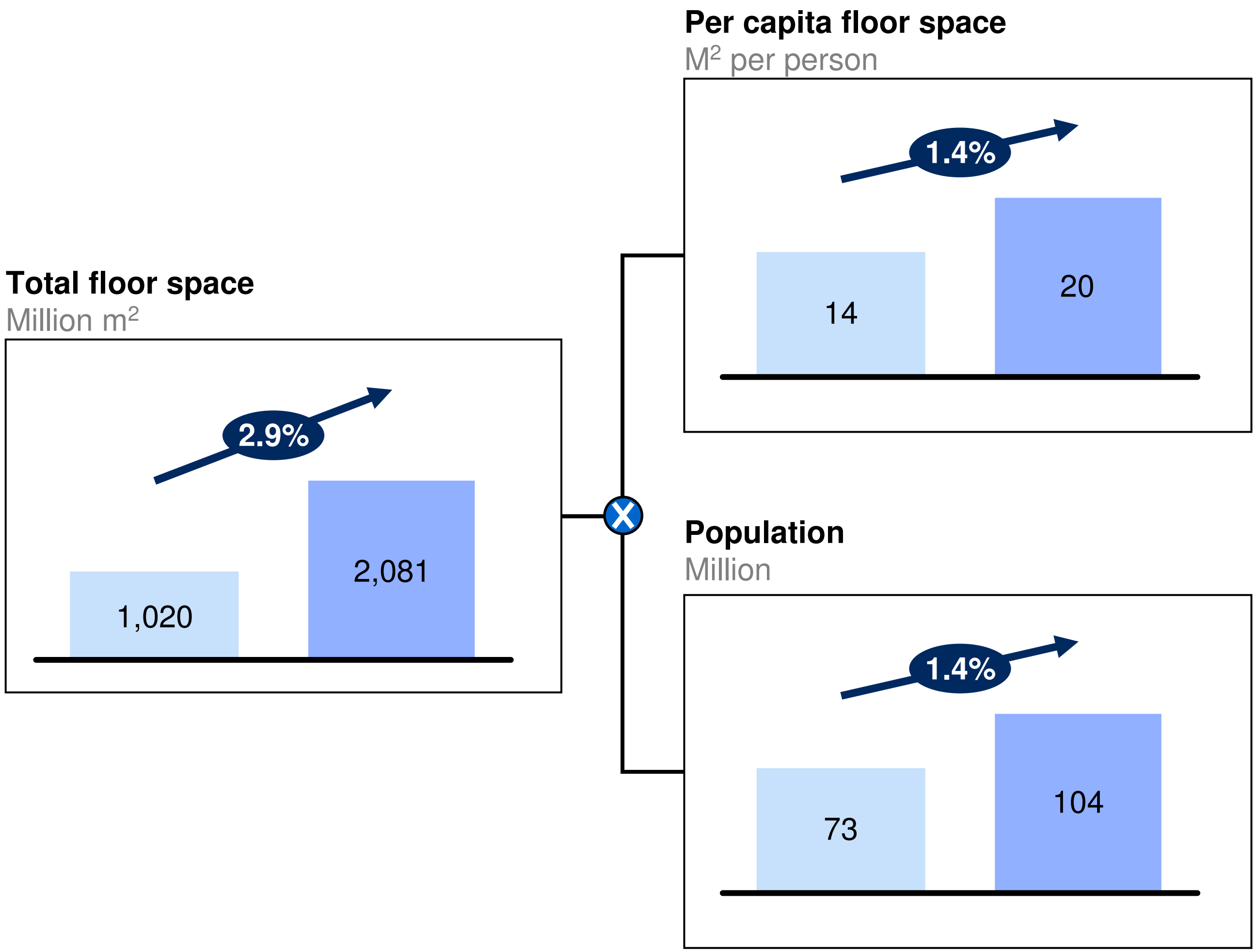
- 2005 direct fuel consumption split by commercial and residential provided by *Enerdata*
- Carbon intensity based on fuel mix (gas, oil, wood); in line with comparable countries and validated with local experts
- *Details on following page*
- Carbon intensity decrease detailed in power sector section
- Electricity demand forecasts provided by IDA; cross validated with India proxy (*McKinsey Global Cost Curve)*

SOURCE: McKinsey Global GHG Model V2.0; INC; IDA; Client data; India GHG Abatement model; team analysis

1 Total floor space in Egypt is driven by increase in per capita floor space and population

PRELIMINARY

2005 2030



Assumptions/Sources

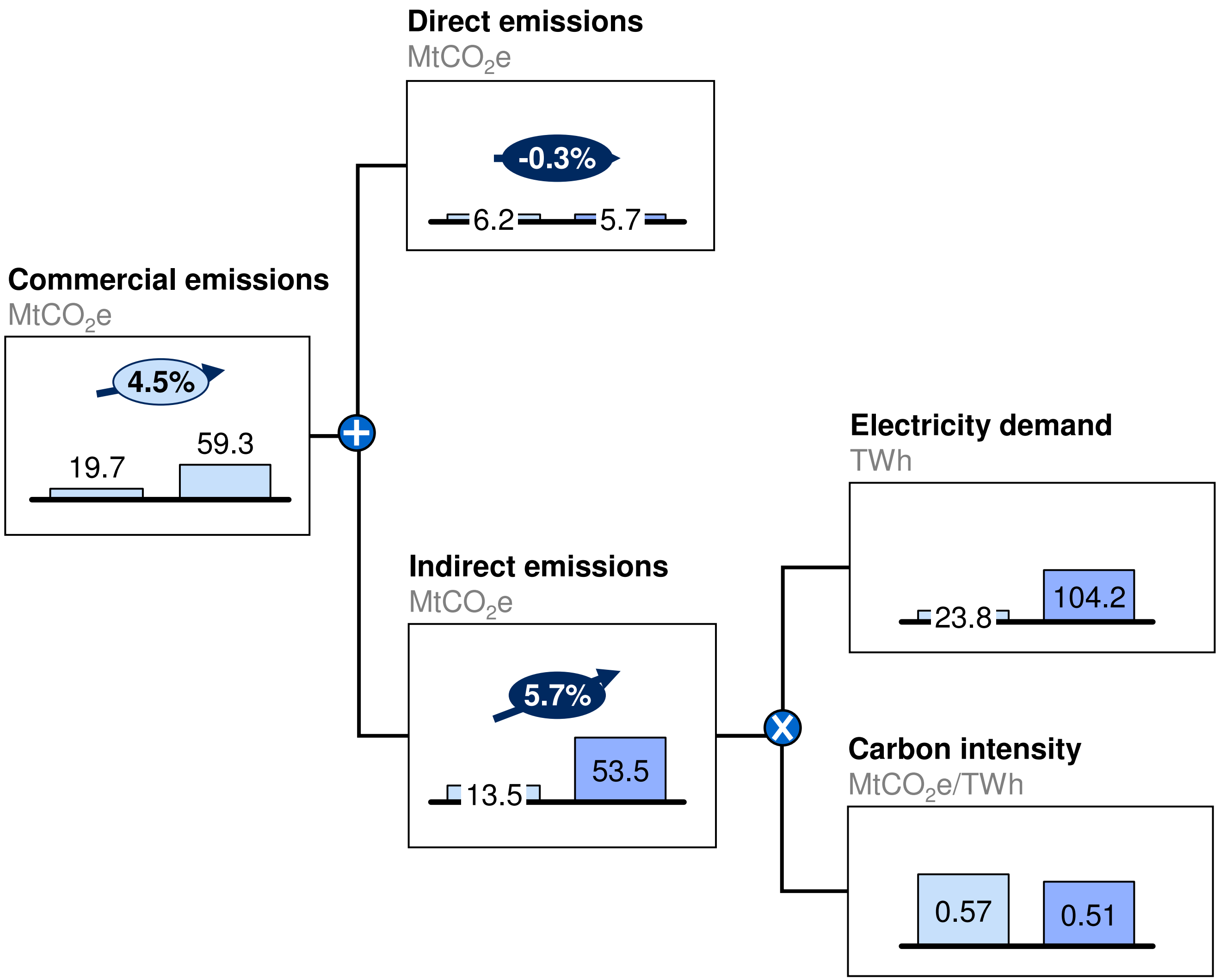
- Based on direct input of local expert (cross validated by comparable regions)
- Data from Global Insight

SOURCE: Global Insight, IEA, MGI analysis, expert interviews, team analysis

2 Commercial emissions increase is driven by electricity consumption

PRELIMINARY

2005 2030



Assumptions/Sources

- Based on 2005 direct fuel consumption split by commercial and residential (provided by *Enerdata)*

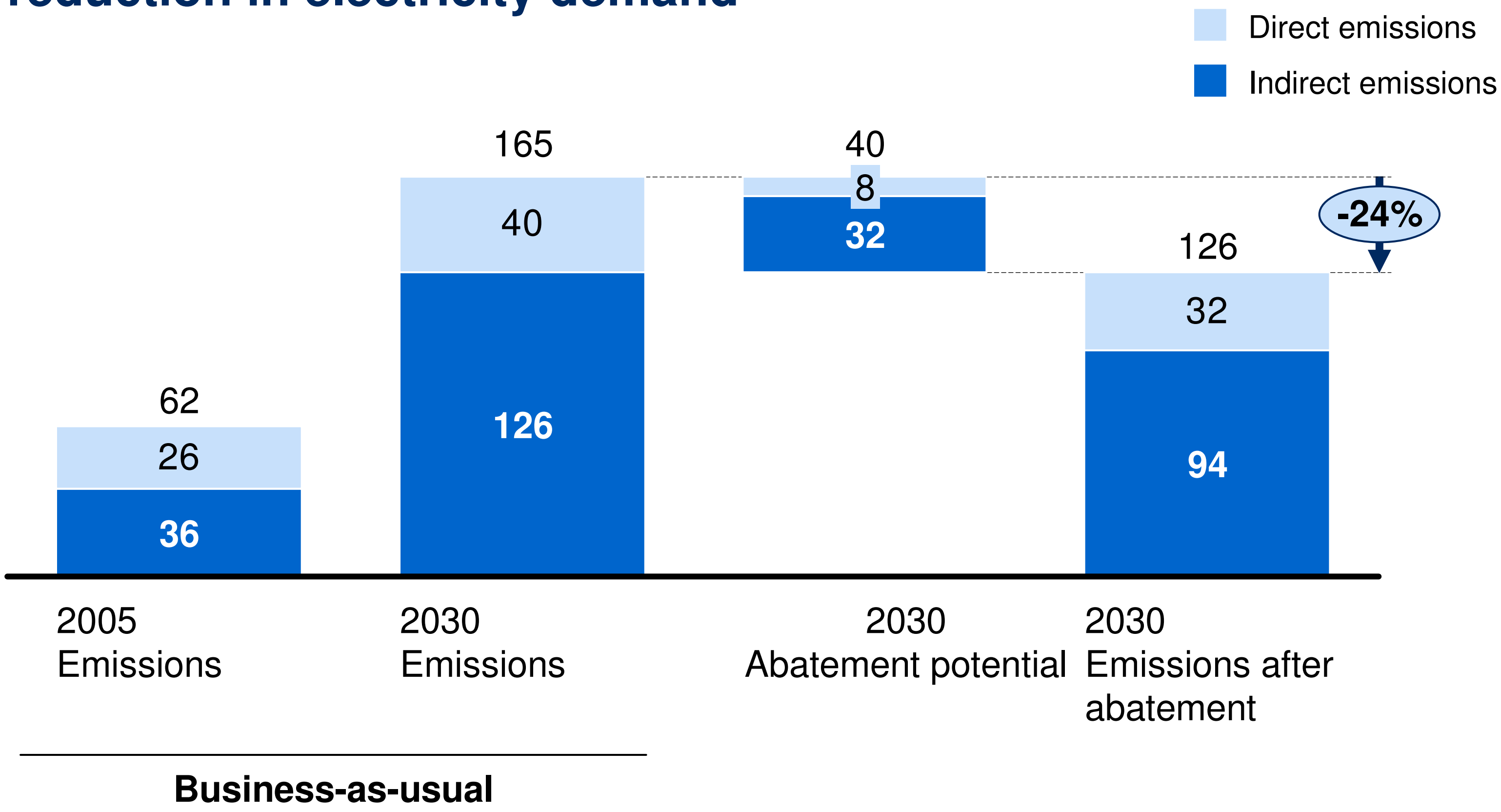
Assumptions/Sources

- Electricity demand forecasts provided by IDA; data cross validated with India proxy (*McKinsey Global Cost Curve)*:
- Carbon intensity decrease detailed in power sector section

SOURCE: McKinsey Global GHG Model V2.0; INC; IDA; Client data; team analysis

Potential abatement in buildings sector is ~24% of 2030 emissions, driven mainly by a reduction in electricity demand

PRELIMINARY



Comments

- Growth driven by increase in floor space for residential & commercial buildings
- Abatement potential driven by the reduction of energy consumption (electricity and direct fuel)

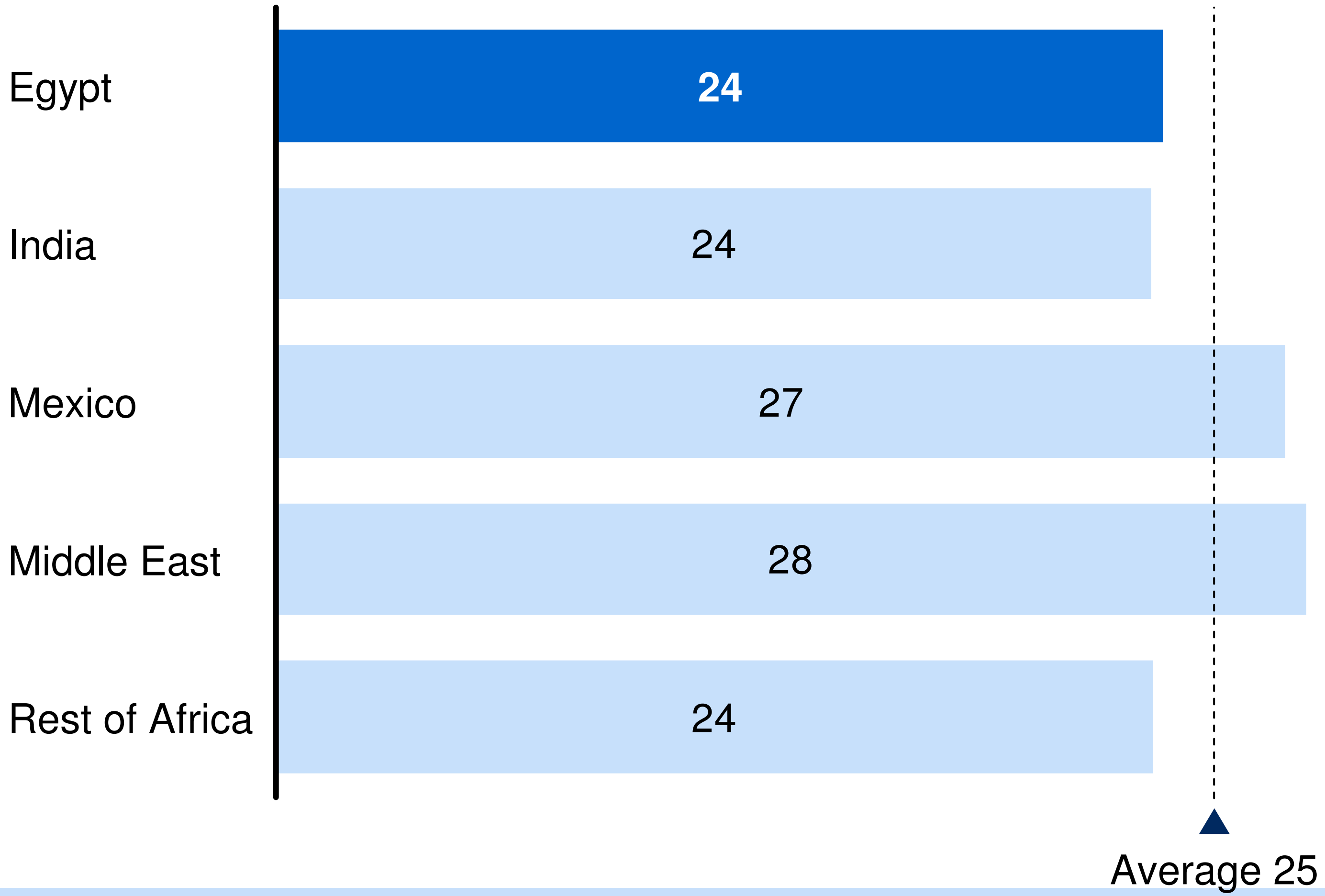
SOURCE: McKinsey Global GHG Model V2.0; INC; IDA; Client data; team analysis

This potential is in line with other comparable countries

PRELIMINARY

Abatement potential

Percentage of 2030 Business as Usual



SOURCE: McKinsey Global GHG Model V2.0; INC; IDA; Client data; team analysis

Abatement potential based on assessment of local feasibility of levers- residential (1/2)

PRELIMINARY

✓ Fully applicable

✗ Not applicable

Lever	Description	Applicability	Comment
New build efficiency package	▪ Improved building orientation and design ▪ Improved air tightness; improve materials and construction	✓	▪ In abatement scenario, **90%** of new buildings are built to HE[1] standard of **20 KWh/m^2** down from **46 KWh/m^2** in BAU ▪ In BAU, **0%** of new buildings are built to HE standard. This assumption is validated by the fact that no standard energy efficiency building code is currently in place for Egypt
Retrofit building package, level 1 and level 2	▪ Renovation packages for existing buildings around improved air tightness and insulation – Retrofit package 1 reduces building consumption on cooling by 20% – Retrofit package 2 reduces to HE standard of 20KWh/m^2 and includes triple glazed windows	✓	▪ In abatement scenario, **90%** of existing 2005 stock is retrofit to retrofit package 1, while **69%** are retrofit to retrofit package 2. ▪ In BAU, **6%** of the houses are retrofit to the lowest possible standard
Retrofit air-conditioning, residential	▪ Replacement of current air conditioning units with highest efficiency (HE) model ▪ Reduction of energy consumption from AC through improved maintenance	✓	▪ In abatement scenario, **100% penetration** of HE[1] AC units in stock by 2030 ▪ In BAU scenario, **12%** of AC stock is HE[1] by 2030 ▪ In abatement scenario, **86%** of AC stock undergo proper maintenance by 2030 ▪ In BAU scenario, **23%** of AC stock undergo proper maintenance by 2030
Retrofit water heating systems	▪ Replacement of existing standard gas water heaters with solar water heater, or with tankless / condensing models ▪ Replacement of existing electric water heater with solar water heater or electric heat pumps	✓	▪ In abatement scenario, **15%** of existing gas/oil heaters shift to **solar heaters** with **27%** shift to **HE[1] gas/oil models** ▪ In BAU scenario, **1%** of stock converts to **solar heating** and **26%** to **HE models** ▪ In abatement scenario, **21%** of electric heaters shift to **solar heaters** with **33%** shift to **heat pumps** ▪ In BAU scenario, **1**% of stock converts to solar heating and **0%** to **heat pumps**

1 High efficiency

Data in line with comparable countries and validated with local experts

SOURCE: NREA website, EAEA, WNA website, GAFI study on renewables, expert interviews, GHG abatement cost curve 2.0 team

Abatement potential based on assessment of local feasibility of levers- residential (2/2)

PRELIMINARY

✓ Fully applicable
✗ Not applicable

Lever	Description	Applicability	Comment
New and retrofit lighting systems	▪ Replacement of incandescent bulbs with LEDs ▪ Replacement of CFLs with LEDs ▪ LFLs/Halogen lamps are not included in residential lighting abatement	✓	▪ In abatement scenario, full share of incandescent lamps and CFLs shift to LEDs in line with comparable countries ▪ In BAU, **0%** of lighting is through **LEDs** , around **23%** of lighting is through **incandescents** and around **27%** through **CFL**
New and "retrofit" appliances and electronics	▪ Replacement of refrigerator/freezer, washer / dryer, dishwasher, and fan high efficiency model ▪ High efficiency consumer electronics (e.g., PC, TV, VCR / DVD, home audio, set-top box, external power, charging supplies) instead of standard items	✓	▪ In abatement scenario, penetration of **HE appliances** in stock is **100%** by 2030 ▪ In BAU, penetration of HE appliances in stock increases from 18% in 2005 to **43%** in 2030 ▪ In abatement scenario, penetration of **HE electronics** in stock is **100%** by 2030 ▪ In BAU, penetration of HE electronics in stock increases from 2% in 2005 to **20%** in 2030
Cooking stoves, replacement with high efficiency	▪ Replacement of old gas stoves by high efficiency gas stoves at the end of their life ▪ Replacement of old electric stoves by high efficiency electric stoves ▪ No fuel shift assumed outside BAU	✓	▪ In abatement, **100%** of stoves are high efficiency type leading to 20% saving on reference technology in 2030 ▪ In BAU, **10%** of stoves are high efficiency type by 2030

Data in line with comparable countries and validated with local experts

SOURCE: NREA website, EAEA, WNA website, GAFI study on renewables, expert interviews, GHG abatement cost curve 2.0 team

PRELIMINARY

✓ Fully applicable
✗ Not applicable

Abatement potential based on assessment of local feasibility of levers- commercial (1/2)

Lever	Description	Applicability	Comment
New build efficiency package	▪ Improved building orientation and design ▪ Improved air tightness; improve materials and construction	✓	▪ In abatement scenario, **90%** of new buildings are built to HE standard of **20 KWh/m^2** down from **46 KWh/m^2** in BAU ▪ In BAU, **0%** of new buildings are built to HE standard. This assumption is validated by the fact that no standard energy efficiency building code is currently in place for Egypt
Retrofit building package	▪ Renovation packages for existing buildings around improved air tightness and insulation	✓	▪ In abatement scenario, **90%** of existing 2005 stock is retrofit to passive standard ▪ In BAU, **6%** of stock are retrofit to the lowest possible standard
Retrofit air-conditioning, residential	▪ Replacement of current air conditioning units with highest efficiency (HE) model ▪ Reduction of energy consumption from AC through improved maintenance	✓	▪ In abatement scenario, **100% penetration** of HE AC units in stock by 2030 ▪ In BAU scenario, **27%** of AC stock is HE by 2030 ▪ In abatement scenario, **86%** of AC stock undergo proper maintenance by 2030 ▪ In BAU scenario, **8%** of AC stock undergo proper maintenance by 2030
Retrofit water heating systems	▪ Replacement of existing standard gas water heaters with solar water heater, or with tankless / condensing models ▪ Replacement of existing electric water heater with solar water heater or electric heat pumps	✓	▪ In abatement scenario, **15%** of existing gas/oil heaters shift to **solar heaters** with **27%** shift to **HE gas/oil models** ▪ In BAU scenario, **1%** of stock converts to **solar heating** and **26%** to **HE models** ▪ In abatement scenario, **21%** of electric heaters shift to **solar heaters** with **33%** shift to **heat pumps** ▪ In BAU scenario, **1**% of stock converts to solar heating and **0%** to **heat pumps**

Data in line with comparable countries and validated with local experts

SOURCE: NREA website, EAEA, WNA website, GAFI study on renewables, expert interviews, GHG abatement cost curve 2.0 team

PRELIMINARY

Abatement potential based on assessment of local feasibility of levers- commercial (2/2)

✓ Fully applicable
✗ Not applicable

Lever	Description	Applicability	Comment
New and retrofit lighting systems	▪ Replacement of incandescent bulbs with LEDs ▪ Replacement of CFLs with LEDs ▪ LFLs/Halogen lamps are not included in residential lighting abatement	✓	▪ In abatement scenario, **13%** of lighting is through LEDs and **60%** through T5s ▪ In BAU, **0%** of lighting is through **LEDs** and 37% with new T8s and T5s
	▪ Street lighting- shift from 250/200 W sodium vapour lamps to 150 W lamps through use of reflectors		▪ In abatement, **100%** of penetration of lower wattage by 2030 ▪ In BAU, **0%** of lamps are 150 W by 2030
New and "retrofit" appliances and electronics	▪ Use of high efficiency office electronics (e.g., printer, copier, fax) instead of standard items	✓	▪ In abatement scenario, penetration of **HE appliances** in stock is **100%** by 2030 ▪ In BAU, penetration of HE appliances in stock increases from 18% in 2005 to **43%** in 2030
	▪ For food service / grocery, use of high efficiency refrigerators / freezers		▪ In abatement scenario, penetration of **HE electronics** in stock is **100%** by 2030 ▪ In BAU, penetration of HE electronics in stock increases from 2% in 2005 to **23%** in 2030

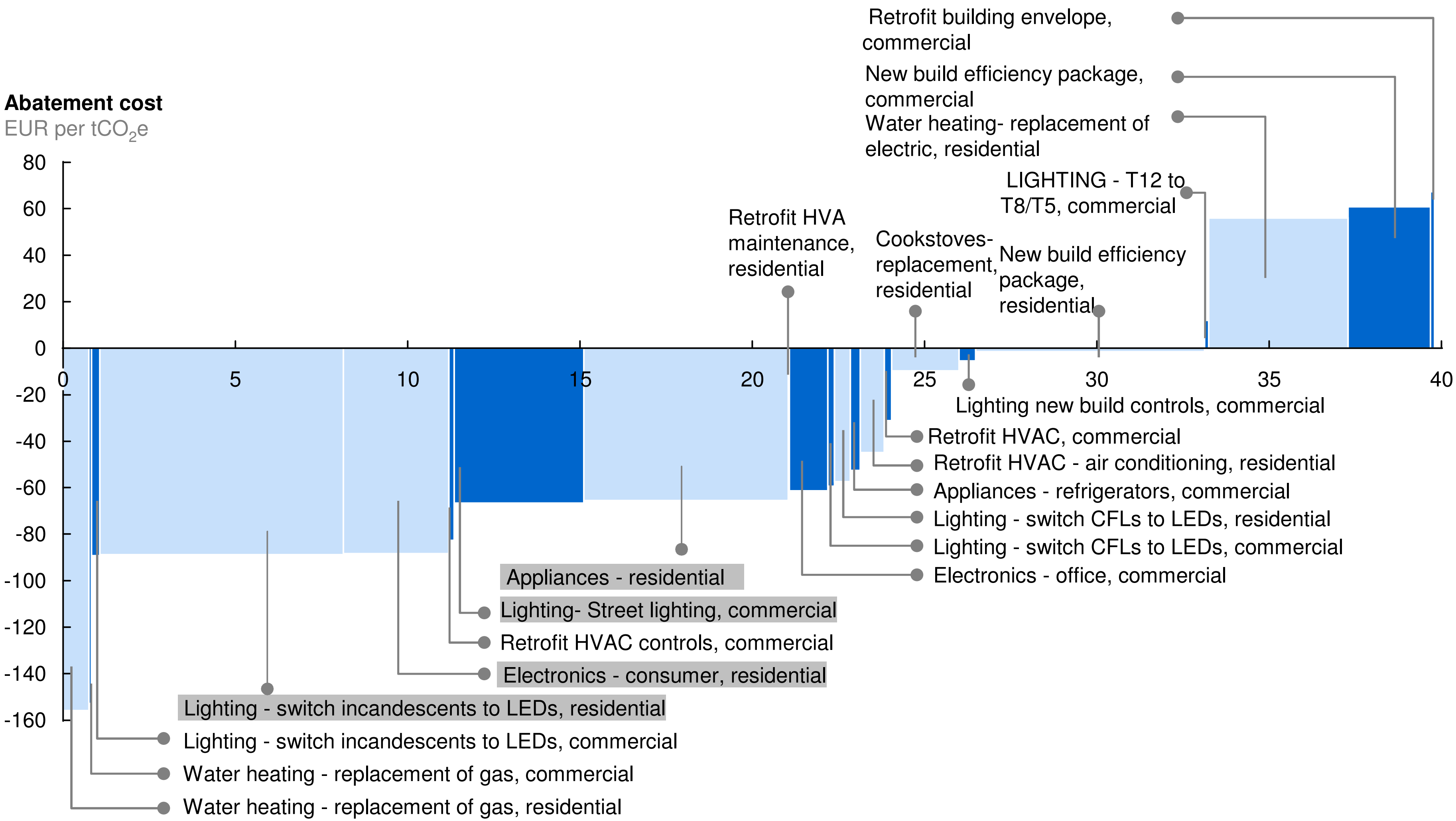
Data in line with comparable countries and validated with local experts

SOURCE: NREA website, EAEA, WNA website, GAFI study on renewables, expert interviews, GHG abatement cost curve 2.0 team

PRELIMINARY

Implementing lighting and appliances & electronics levers lead to high abatement at significant economic savings

2030, Societal perspective[1]



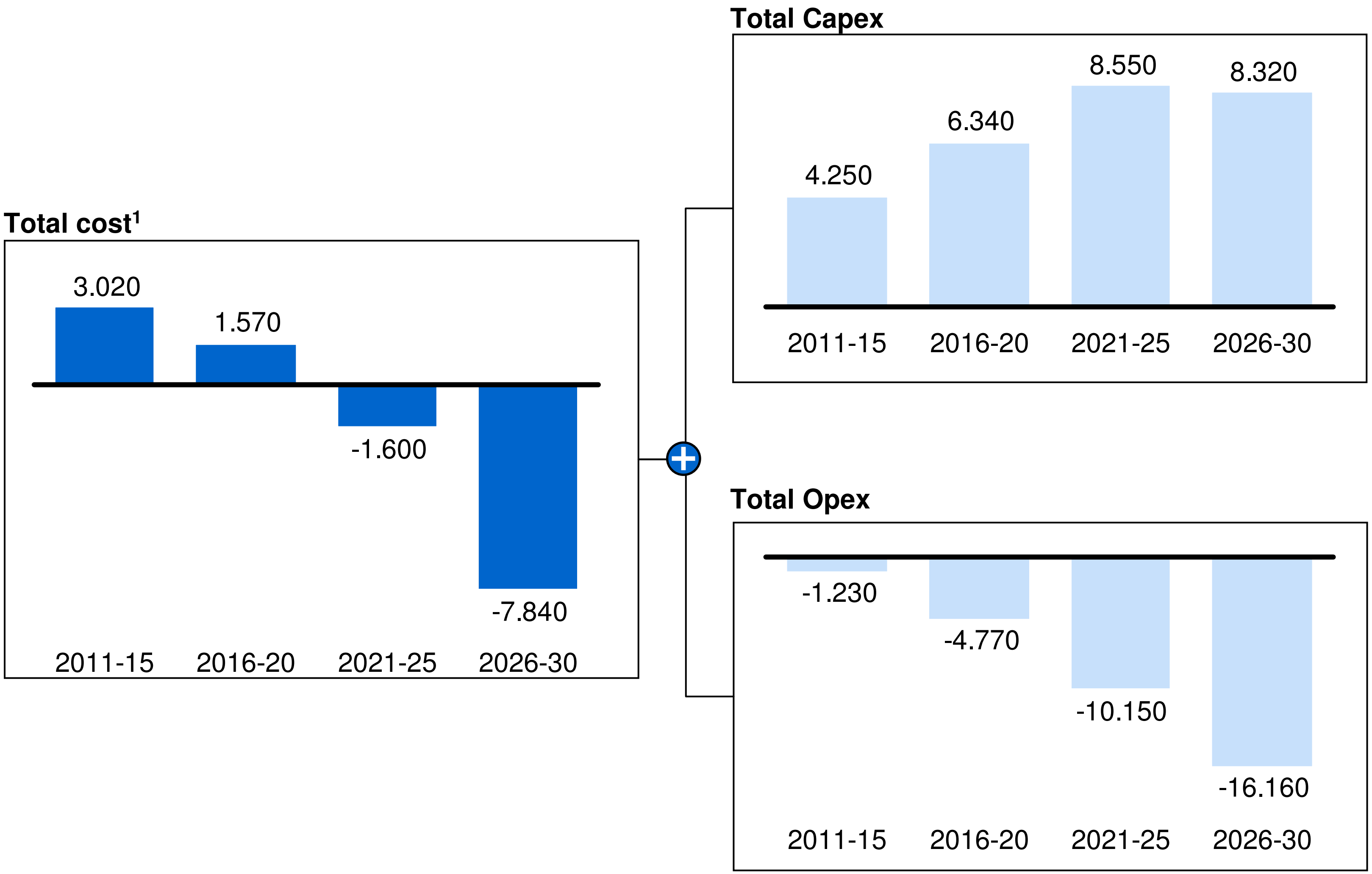
1 Societal perspective (i.e., excluding taxes, subsidies, and with a capital cost similar to government bond rates)

SOURCE: V2.0 GHG models

Overall, implementation of abatement levers would result in economic savings

PRELIMINARY

Real EUR millions



1 Cash flow from CAPEX and OPEX cost/savings

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

Implementation of lighting and appliances & electronics levers have significant economic benefit

BACK UP

CAPEX
OPEX

Real EUR millions

Total cost[1]

	2011-15	2016-20	2021-25	2026-30
Total	3,020	1,570	-1,600	-7,840
CAPEX	4250	6340	8550	8320
OPEX	-1230	-4770	-10150	-16160

Building envelope

	2011-15	2016-20	2021-25	2026-30
Total	1,810	2,200	2,380	320
CAPEX	2090	3320	4890	4490
OPEX	-280	-1120	-2510	-4170

Lighting

	2011-15	2016-20	2021-25	2026-30
Total	530	-1,010	-2,370	-4,230
CAPEX	930	400	500	590
OPEX	-400	-1410	-2870	-4820

Appliances & Electronics

	2011-15	2016-20	2021-25	2026-30
Total	-90	-850	-2,410	-3,630
CAPEX	270	700	860	930
OPEX	-360	-1550	-3270	-4560

Air conditioning & Water heating

	2011-15	2016-20	2021-25	2026-30
Total	800	1,310	920	-160
CAPEX	940	1870	2220	2200
OPEX	-140	-560	-1300	-2360

Cooking stoves

	2011-15	2016-20	2021-25	2026-30
Total	-30	-80	-120	-140
CAPEX	20	50	80	110
OPEX	-50	-130	-200	-250

Comments

- Improvements on the building envelope requires significant incremental investments fully offset by OPEX savings generated by energy consumption reduction
- By 2030, these levers lead to strong cash inflows because of total electricity saved
- Incremental CAPEX 2030 is fully offset by saving of gas and electricity
- Reduction in OPEX compensates for CAPEX every period

1 Cash flow from Capex and Opex cost/savings

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

Deep dive - Selected sectors

- Power
- Buildings
- **Cement**
- Road Transport
- Agriculture

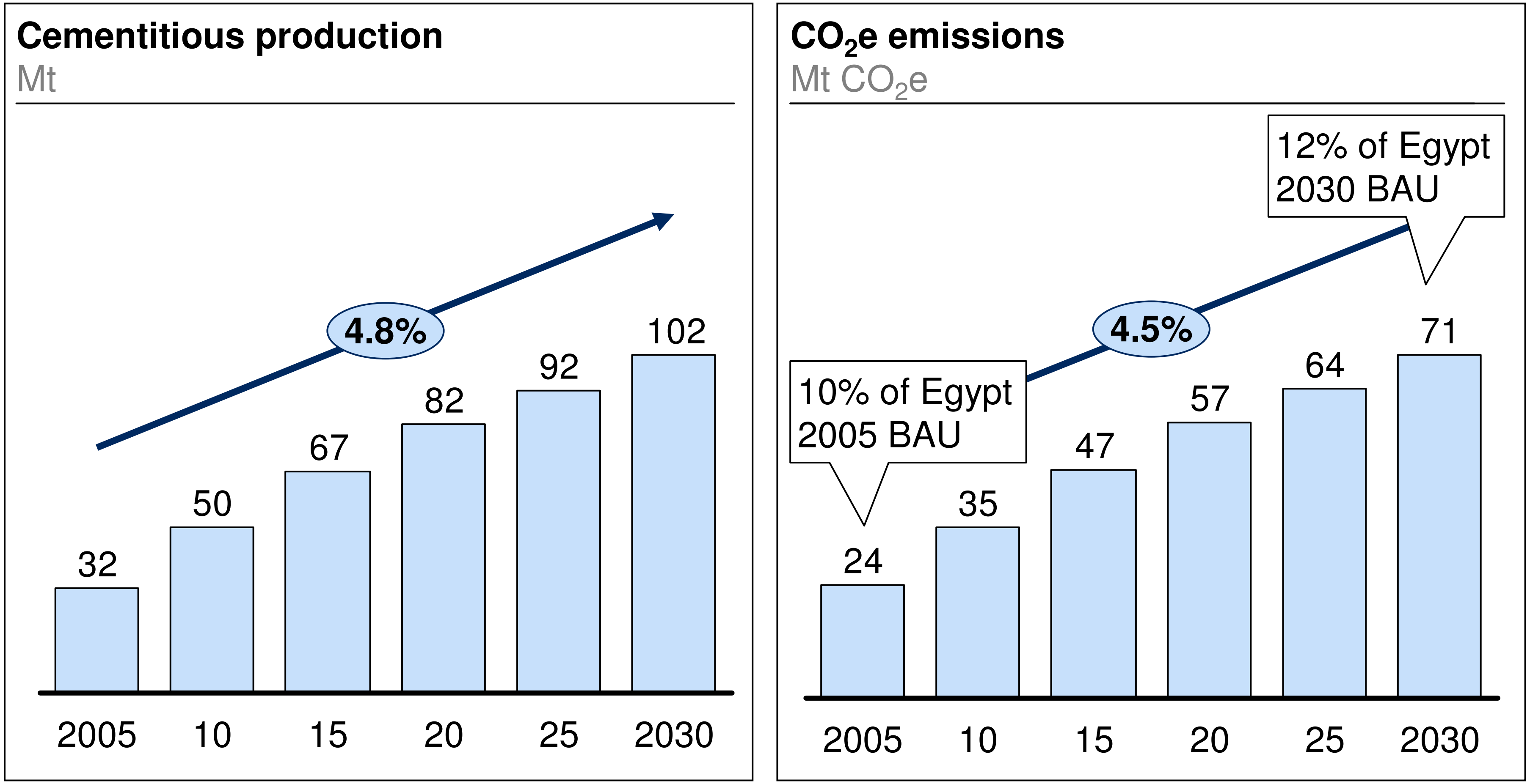
Sector summary

BAU	▪ Cement sector emissions totalled ~ 24 Mt CO_2e in 2005 equal to ~10% of total Egypt emissions ▪ Under a BAU scenario, emissions are expected to grow to ~71 Mt CO_2e by 2030 (including ~6 Mt CO_2e of indirect emissions), 12% share of total Egypt emissions, as cement production increases from ~32 Mt in 2005 to ~102 Mt in 2030 ▪ Expected emissions growth rate (4.5% CAGR) is slightly lower than production growth rate (4.8% CAGR) as efficiency improvements are planned in the BAU
Abatement potential	▪ Overall abatement potential is in the range of ~10 Mt CO_2e, 14% of 2030 BAU, in line with other comparable countries (10-15%) – 50% of abatement (~ 5 Mt CO_2e) is derived from substitution of clinker with MIC,[1] alternative fuels and waste heat recovery for electricity – Remaining 50% of abatement (~ 5 Mt CO_2e) is derived from CCS ▪ ~50% of the abatement potential can be captured while achieving economic benefit

1 Other mineral industrial components: rice husk ash, silica fume, metakaolin, calcined clay, and calcined shale (“Other” excludes fly ash and slag MIC)

In the BAU emissions are expected to grow at a slightly lower pace than cement production, reaching 71 Mt CO_2 by 2030

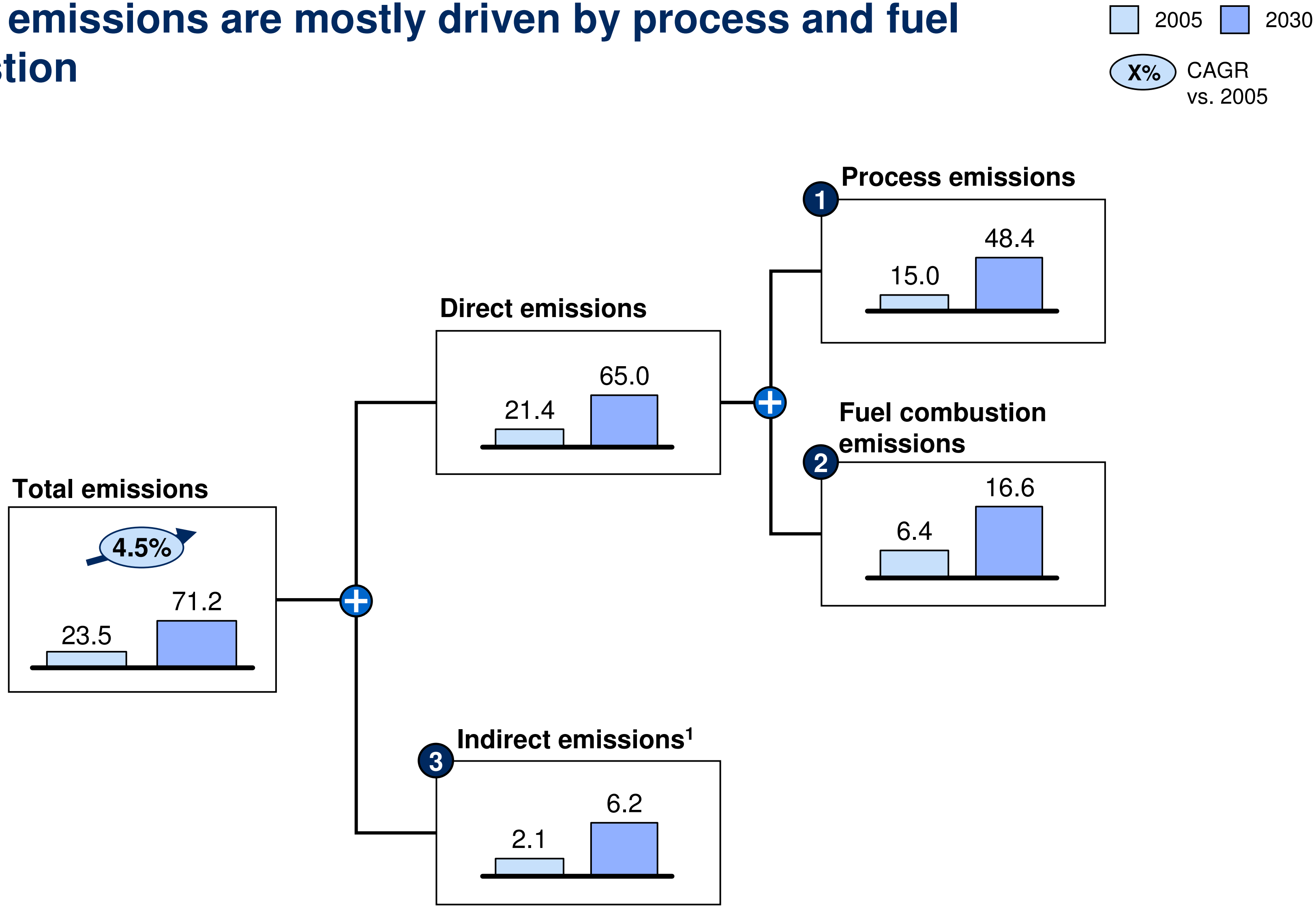
X% CAGR vs. 2005



SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

Cement emissions are mostly driven by process and fuel combustion

MtCO$_2$e



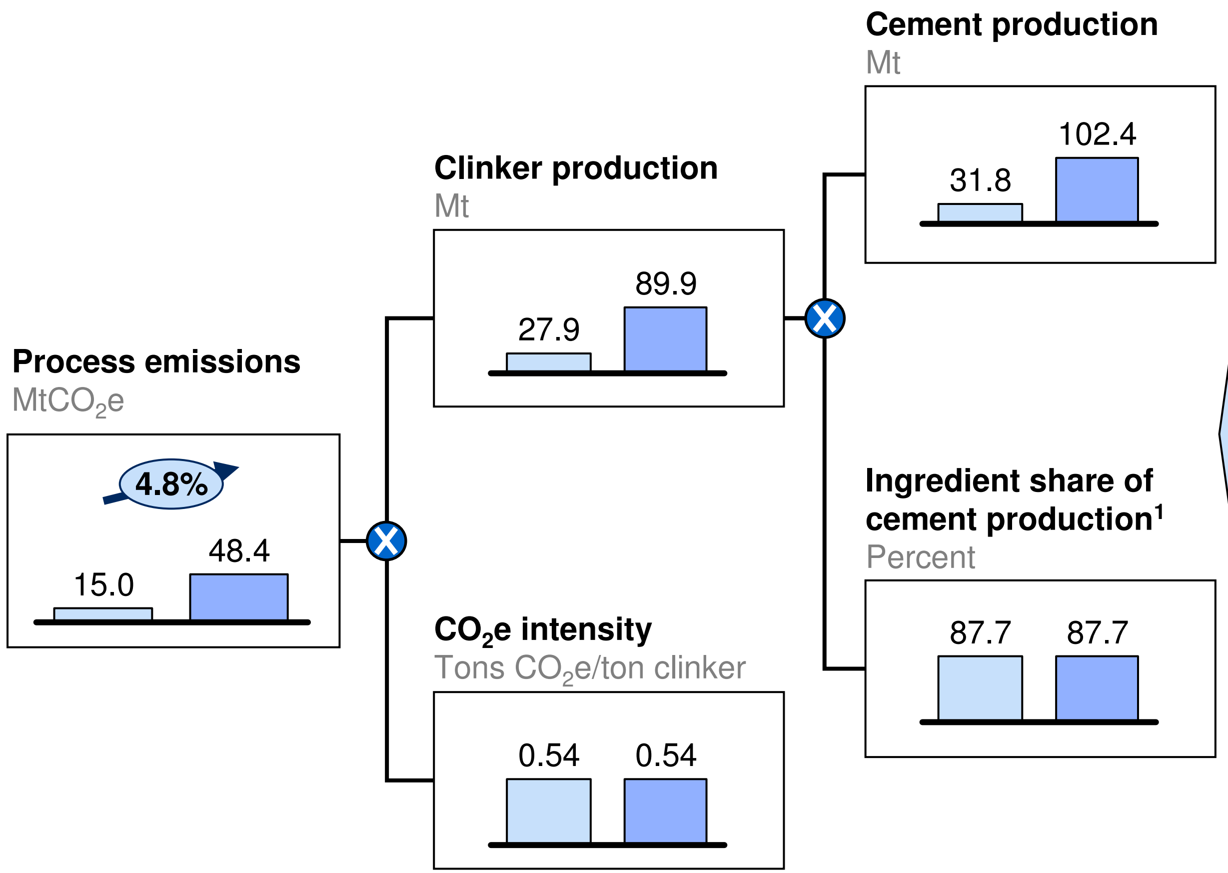
1 Indirect emissions are related to electricity consumption in the cement sector. Abatement included in cement sector. Change in electricity consumption included in power sector.

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

1 Process emissions are driven by clinker share of cement production

2005 2030

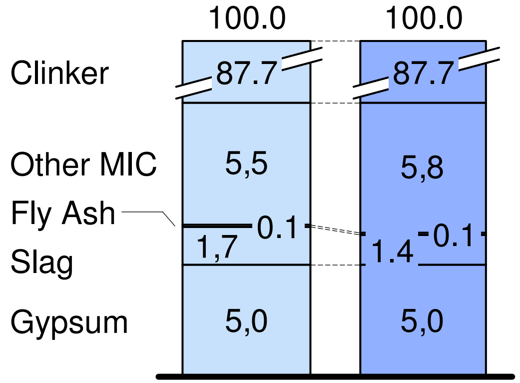
X% CAGR vs. 2005



Assumptions/sources

- Historical and forecasted data from 2005-17 provided by IDA
- Projections after 2017 assume per capita cement production increases at 1.1% CAGR[1], as syndicated with IDA
- Ingredients share data provided by IDA[2]

Share of cement ingredients (%)

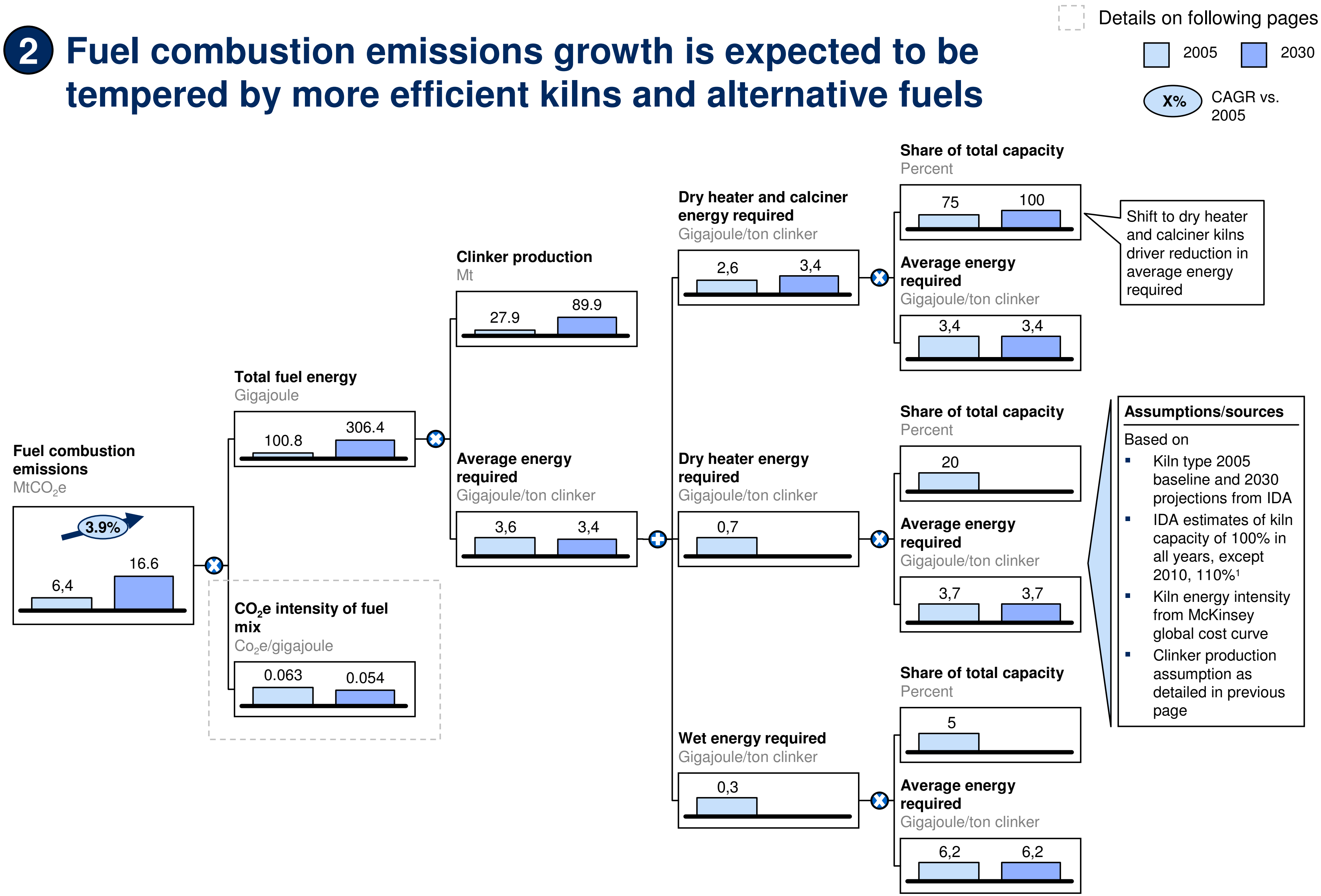


1 In 2017, cement production per capita is expected to be ~0.8 tons. 1.1% CAGR based on cement production per capita CAGR in Middle East from 2005-2030 (in 2005 cement per capita production in Middle East was 0.8 tons and is expected to be capped at ~1 ton per capita in 2030)

2 Slag data calculated with IDA input based on availability in Egypt

SOURCE: Global Insight; McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

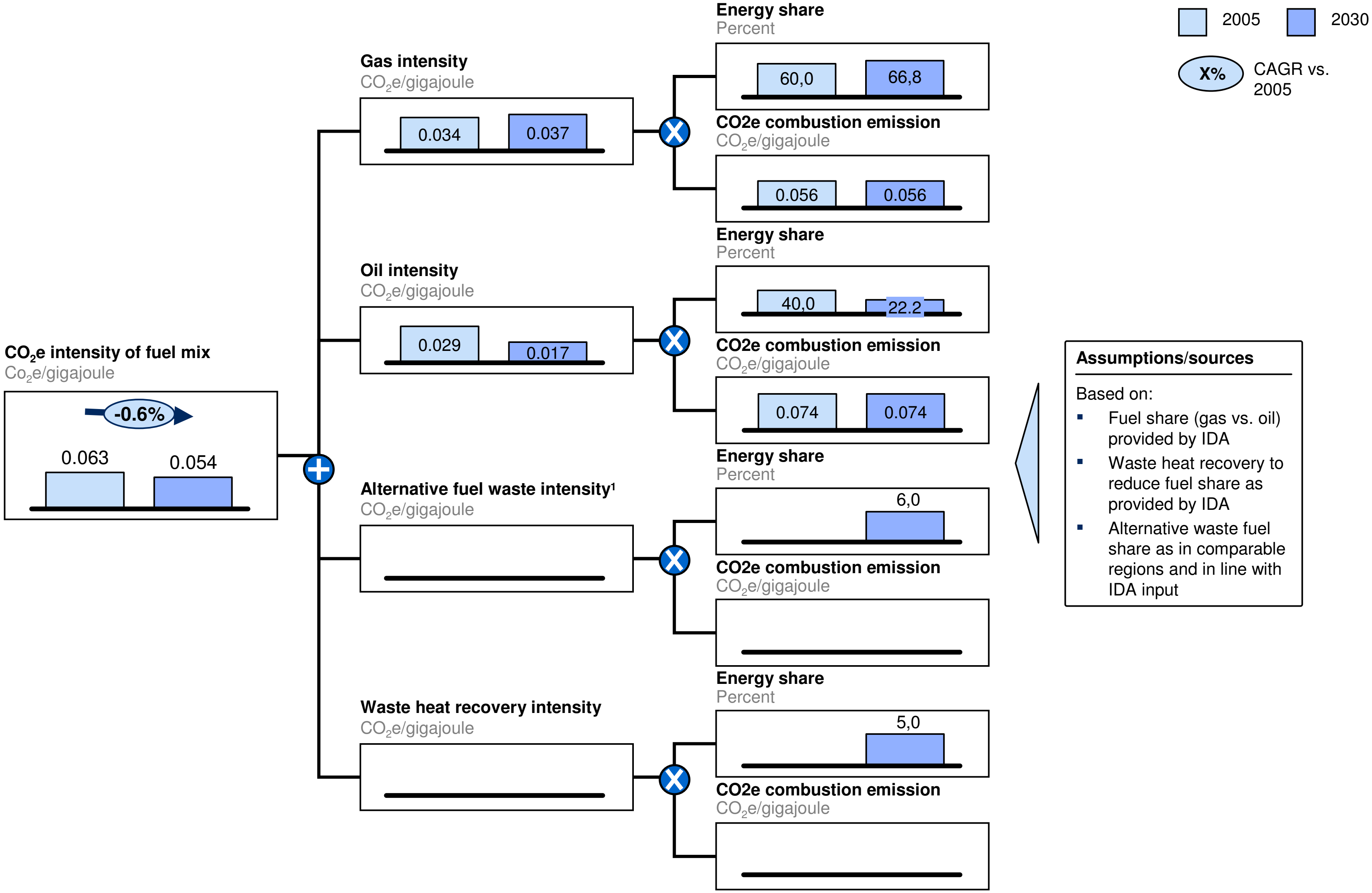
2 Fuel combustion emissions growth is expected to be tempered by more efficient kilns and alternative fuels



1 While global average is 85%, IDA government policy is to provide license at expected 100% production

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

2 CO_2e intensity of fuel mix is reduced as fuel mix shifts towards gas and alternative fuel from waste and waste heat recovery are incorporated



Assumptions/sources

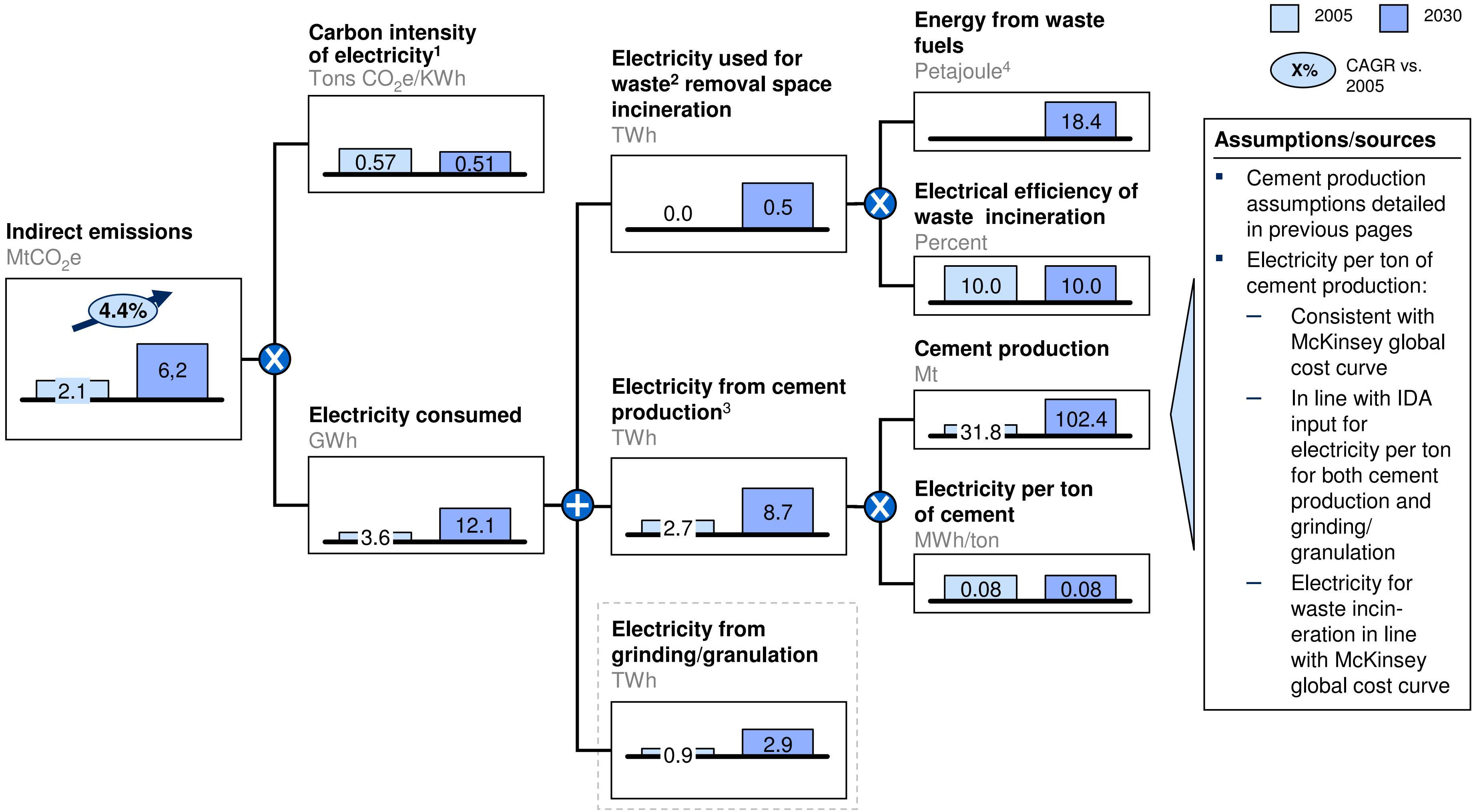
Based on:
- Fuel share (gas vs. oil) provided by IDA
- Waste heat recovery to reduce fuel share as provided by IDA
- Alternative waste fuel share as in comparable regions and in line with IDA input

1 Assuming waste was incinerated for waste disposal reasons, resulting in CO_2 emissions, if not used as kiln fuel

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

3 Indirect emissions driven by increase in electricity utilization of cement ingredients and cement production grinding/granulation

Details on following pages



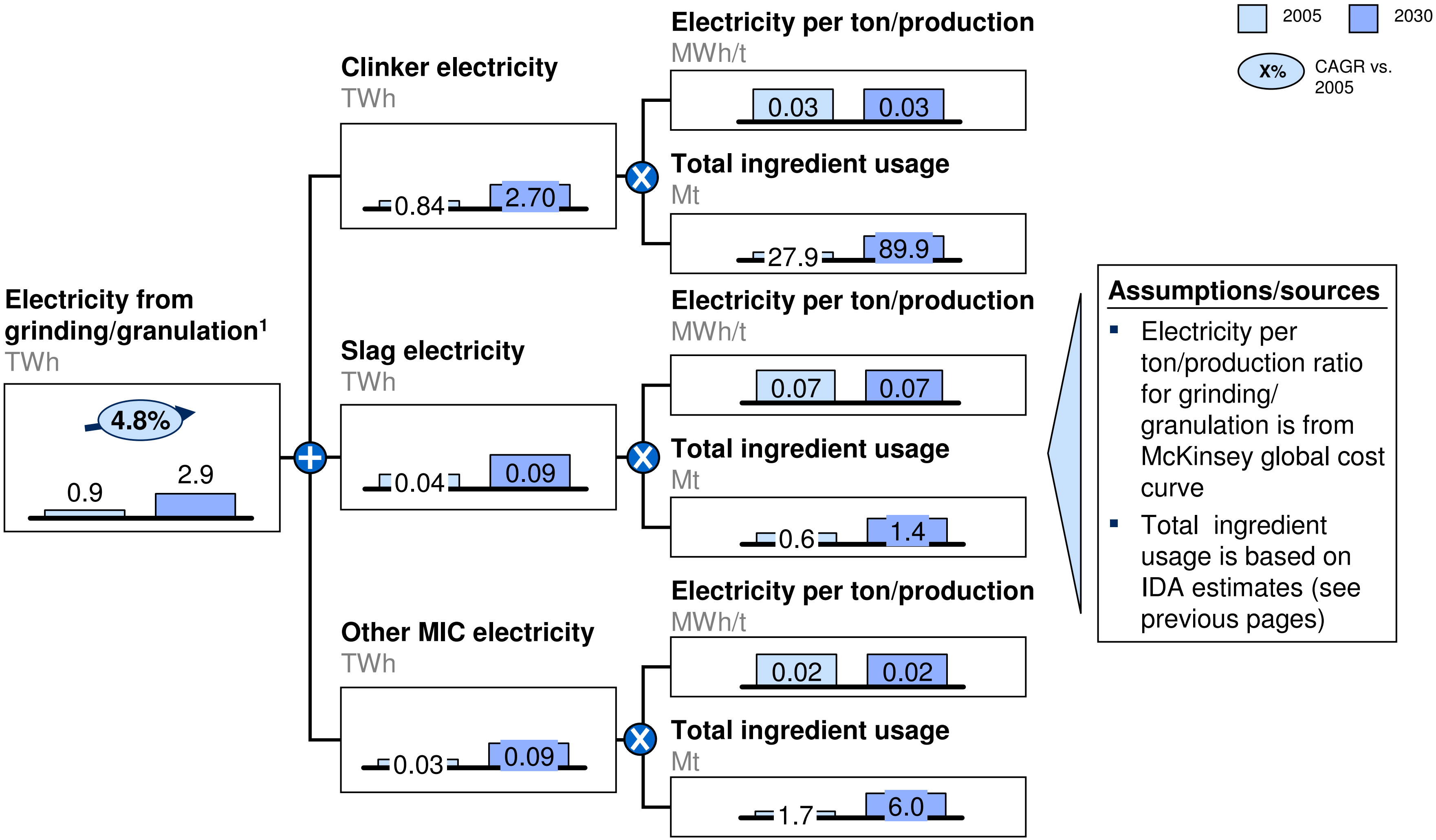
Assumptions/sources

- Cement production assumptions detailed in previous pages
- Electricity per ton of cement production:
  - Consistent with McKinsey global cost curve
  - In line with IDA input for electricity per ton for both cement production and grinding/ granulation
  - Electricity for waste incin-eration in line with McKinsey global cost curve

1 Carbon intensity of electricity dependent on power sector BAU assumptions
2 Waste used as alternative fuel incinerated at cement plant
3 Does not include electricity from grinding/granulation of ingredients
4 Petajoule conversion factor to TWh is 0.28

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

3 Electricity requirement for grinding/granulation is mainly driven by clinker production



Assumptions/sources

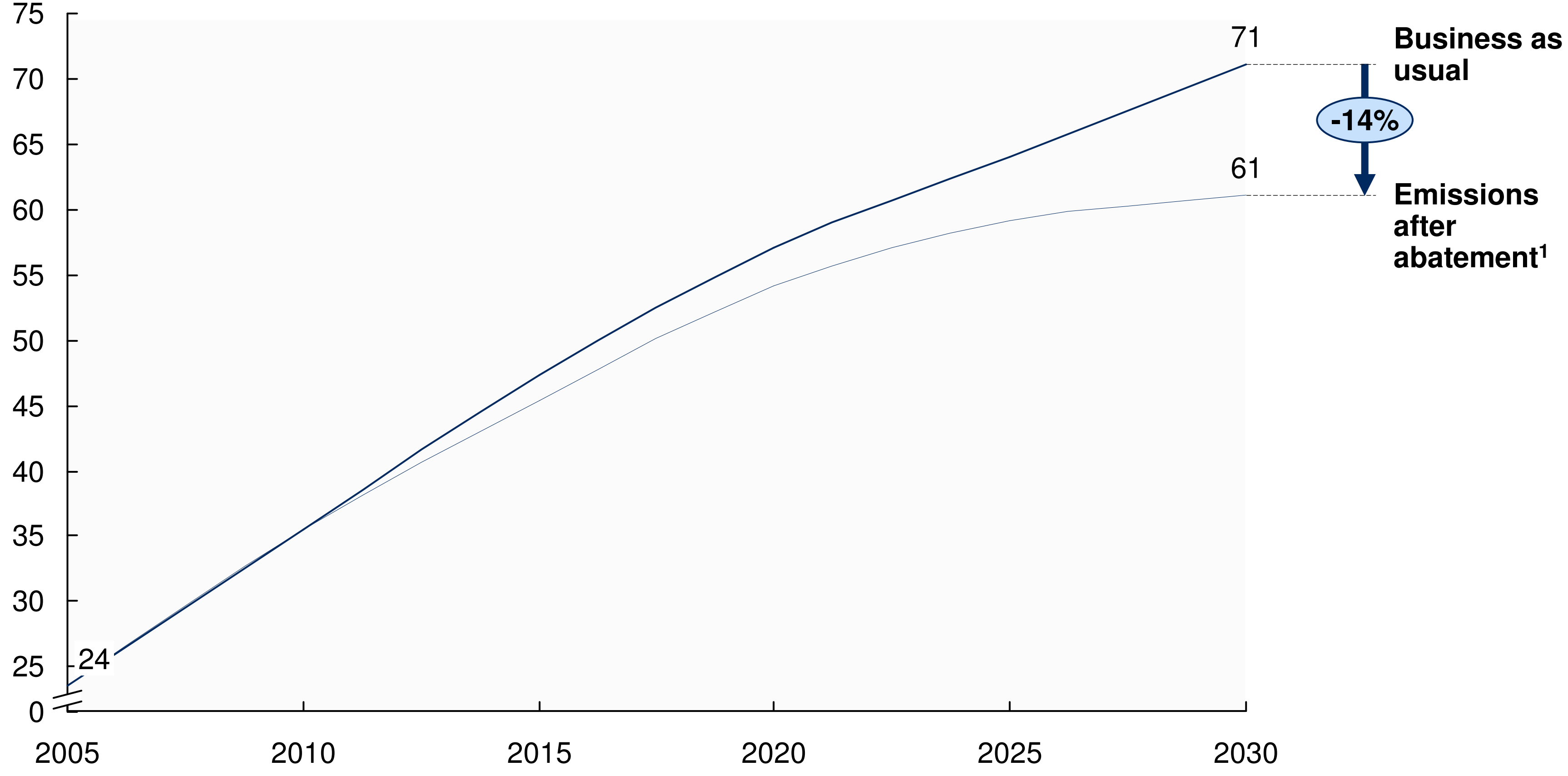
- Electricity per ton/production ratio for grinding/ granulation is from McKinsey global cost curve
- Total ingredient usage is based on IDA estimates (see previous pages)

1 Fly ash is not grinded

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

Applicable abatement levers can reduce 2030 emissions by ~14%

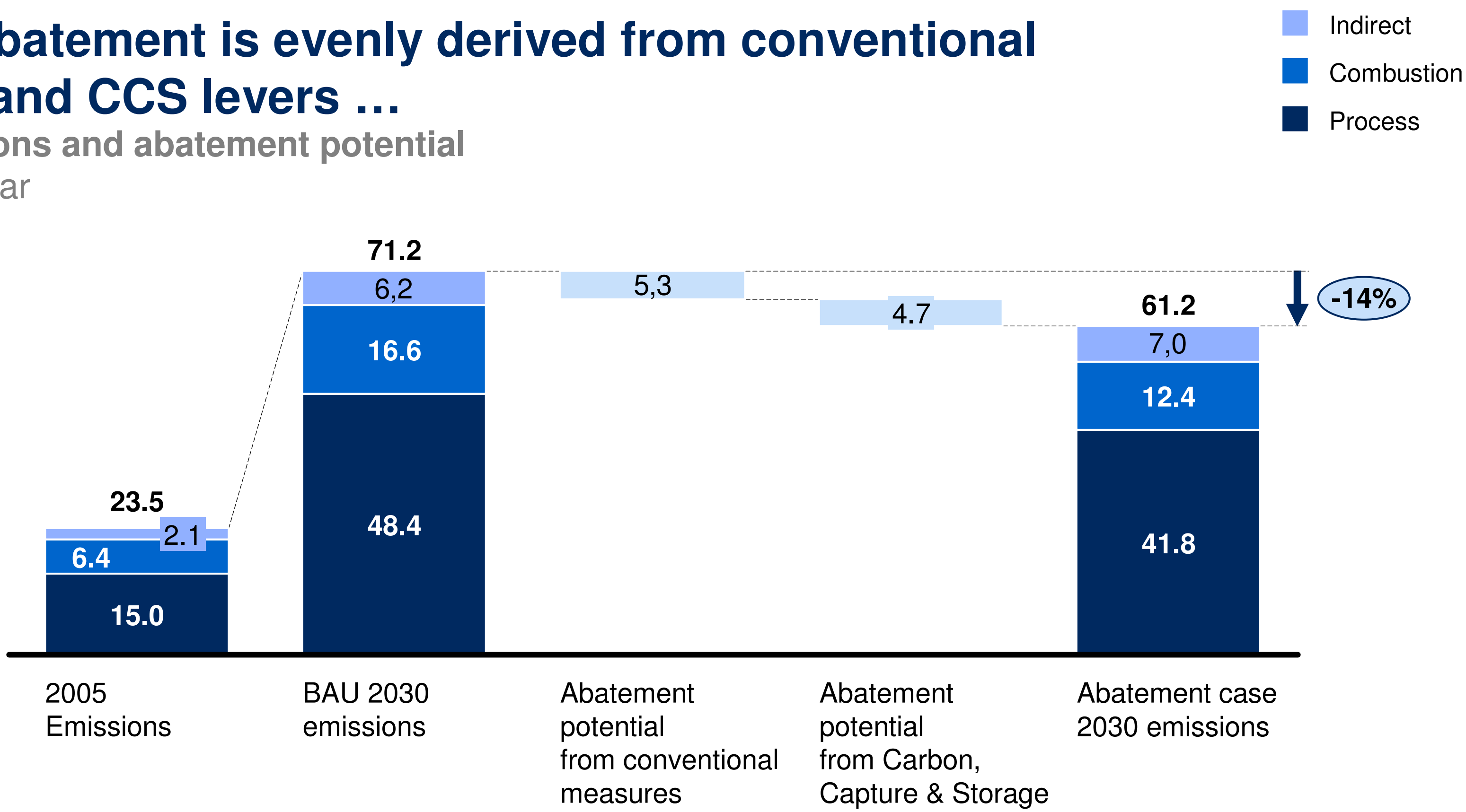
$MtCO_2e$ per year



Potential abatement is evenly derived from conventional measures and CCS levers …

Annual emissions and abatement potential

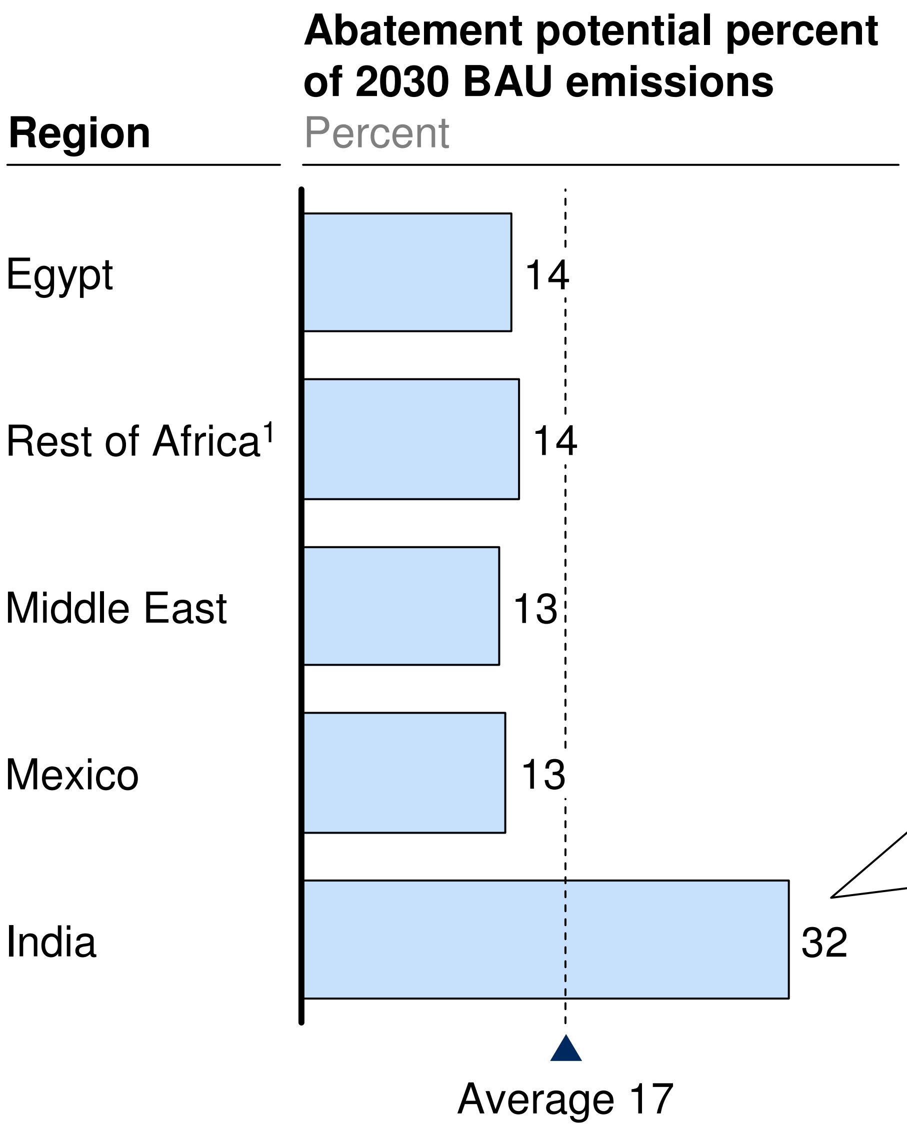
Mt CO2e per year



	2005 Emissions	BAU 2030 emissions	Abatement potential from conventional measures	Abatement potential from Carbon, Capture & Storage	Abatement case 2030 emissions
CAGR 2005-2030		4.5%			3.9%
Comments		High cement production growth tempered by improved efficiency of production base	Alternative fuels, clinker substitution and waste heat recovery contribute to ~50% of abatement	Retrofits and new-builds contribute to ~50% of abatement	Process and combustion emissions are reduced, while indirect emissions increase post abatement due to additional electricity use from alternative fuels and CCS levers only partially offset by waste heat recovery for electricity generation

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

… and is in line with selected comparable regions



Abatement potential is in India significantly higher than other countries due to:

- High availability of fly ash and introduction of Other MIC for clinker substitution
- High potential from the usage of alternative fuels

1 Africa excluding South Africa

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

Abatement potential based on assessment of local feasibility of levers (1/2)

✓ Fully applicable
✗ Not applicable

Lever		Applicability	Comment
Clinker substitution	**Fly ash**	✗	Fly ash and slag levers assumed to be not applicable since available fly ash and slag in Egypt is assumed to be already used in the BAU scenario (syndicated with IDA)
	Slag	✗	
	Other MIC[1]	✓	Usage of Other MIC is assumed to be 10% of cement ingredients, the maximum average share to maintain quality European standards (see backup). Assume sufficient availability in Egypt (syndicated with IDA)
Alternative fuels	**Waste fuels**[2]	✓	Assume that by 2030 in the abatement case, waste fuel will be available to provide 15% of energy for fuel combustion increased from 6% in BAU case. This 15% share is within the range of comparable countries (syndicated with IDA and Integral)
	Biomass[3]	✓	Assume that in the abatement case, biomass will be available to provide 8% of energy for fuel combustion by 2030 (2% starting after 2011). The 8% share is the maximum share assumed in either developed or developing world (syndicated with IDA and Integral)

1 Mineral industrial components: fly ash, slag, rice husk ash, silica fume, metakaolin, calcined clay, and calcined shale
2 Assuming waste was incinerated for waste disposal reasons, resulting in CO_2emissions, if not used as a kiln fuel
3 Assuming 0 emissions for biomass (lifecycle perspective on biomass CO_2e intensity)

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

Abatement potential based on assessment of local feasibility of levers (2/2)

✓ Fully applicable
✗ Not applicable

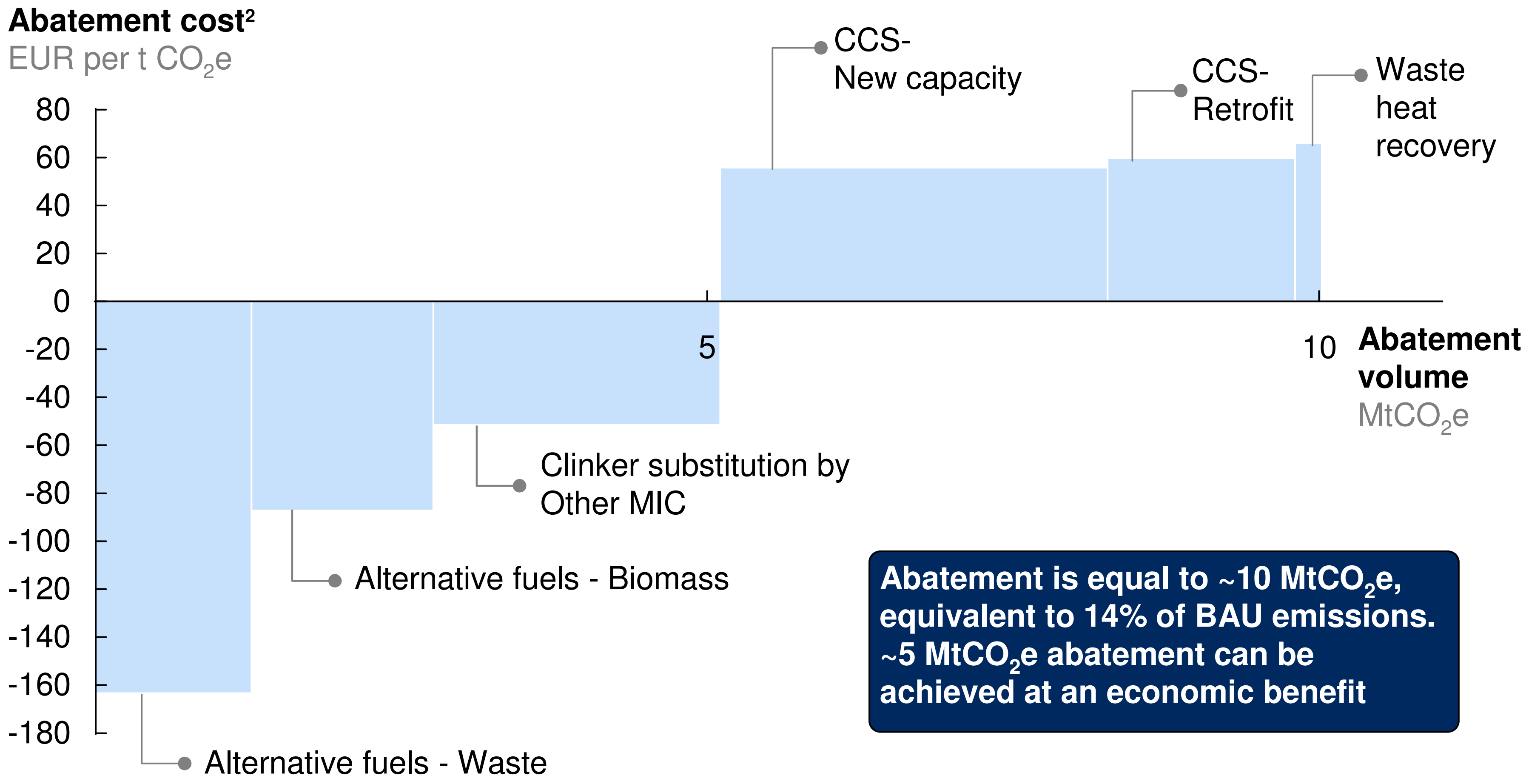
Lever	Applicability	Comment
CCS[1] – **CCS newbuild**	✓	▪ Based on the current availability of potential CCS locations (depleted oil and gas fields; natural underground formations with saltwater i.e. deep saline aquifers), it is assumed that: – CCS technology would be implemented starting in 2021, in line with expected cost and technology evolution of CCS – Share of CCS newbuild capacity for the period 2021-2025 is ~13% and for the period 2026-2030 ~37%. This is in line with other comparable countries with similar availability of CCS locations
CCS[1] – **CCS retrofit (on "old" plants)**	✓	▪ CCS retrofits on "old" plants are assumed to begin 2026 and share of CCS retrofitted capacity is ~4% on average during the period 2026-2030. This is: – Based on the relative physical position of existing plants from potential CCS locations (currently plants located in Suez, Alexandria, Ameriya and Ain Soukhna are within 50km of potential CCS locations; see backup) – In line with CCS implementation in other comparable countries
Waste heat recovery	✓	▪ Assume after 2015, 20% of clinker capacity equipped with waste heat recovery for electricity generation (increasing to 33% by 2030). This is line with comparable countries (syndicated with Integral and IDA)

1 Carbon capture and storage

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

Alternative fuels and clinker substitution account for ~50% of total potential abatement and can be implemented while achieving economic benefit

2030, Societal perspective[1]



Abatement is equal to ~10 $MtCO_2e$, equivalent to 14% of BAU emissions. ~5 $MtCO_2e$ abatement can be achieved at an economic benefit

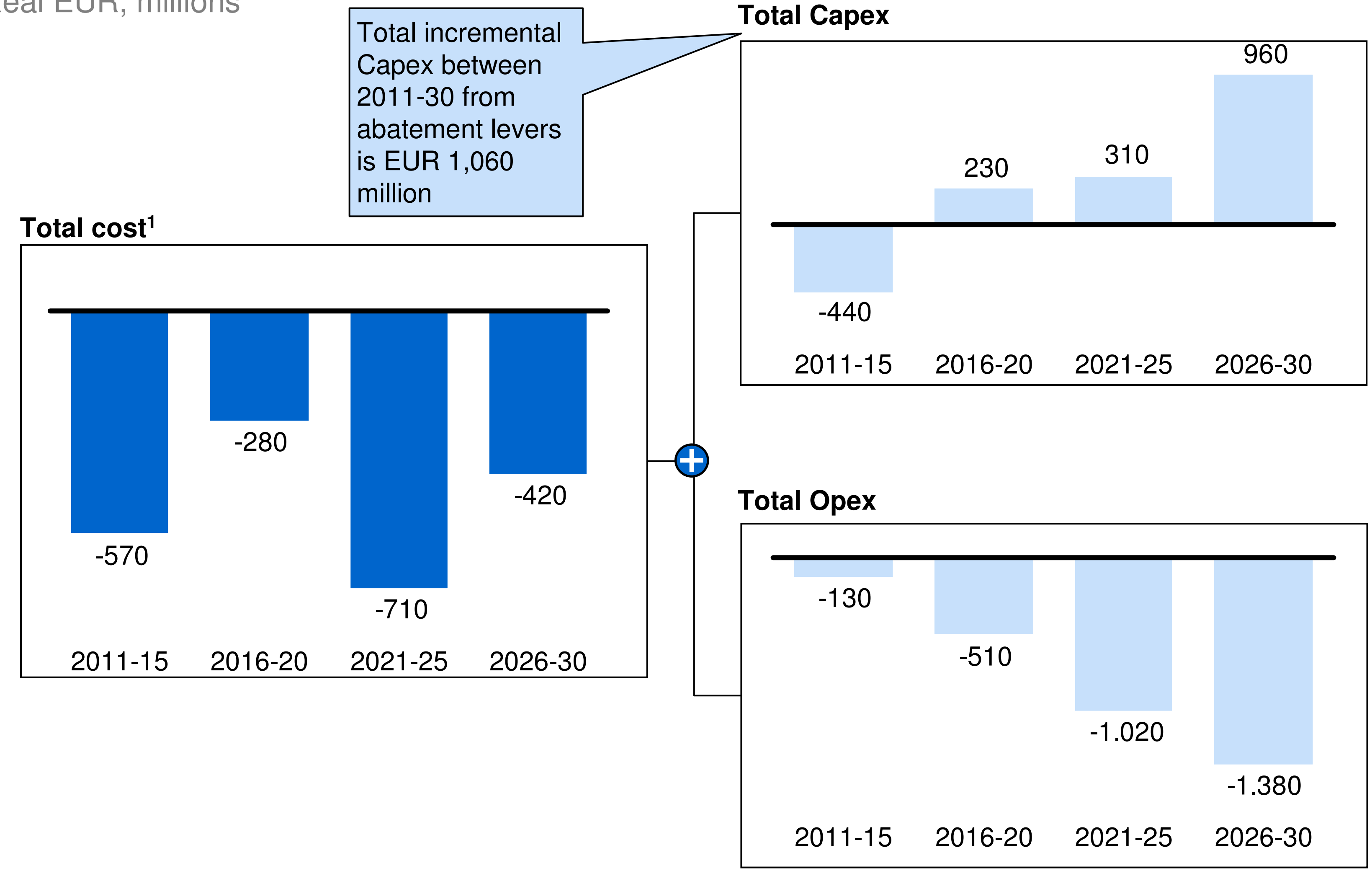
1 Societal perspective (i.e., excluding taxes, subsidies, and with a capital cost similar to government bond rates)
2 The curve represents an estimate of the maximum potential of all technical GHG abatement measures. Cost includes incremental annualized Capex (based on average asset lifetime and Egypt government interest rate of 10%)

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

Total Capex and Opex after implementing abatement levers results in economic savings

PRELIMINARY

Real EUR, millions



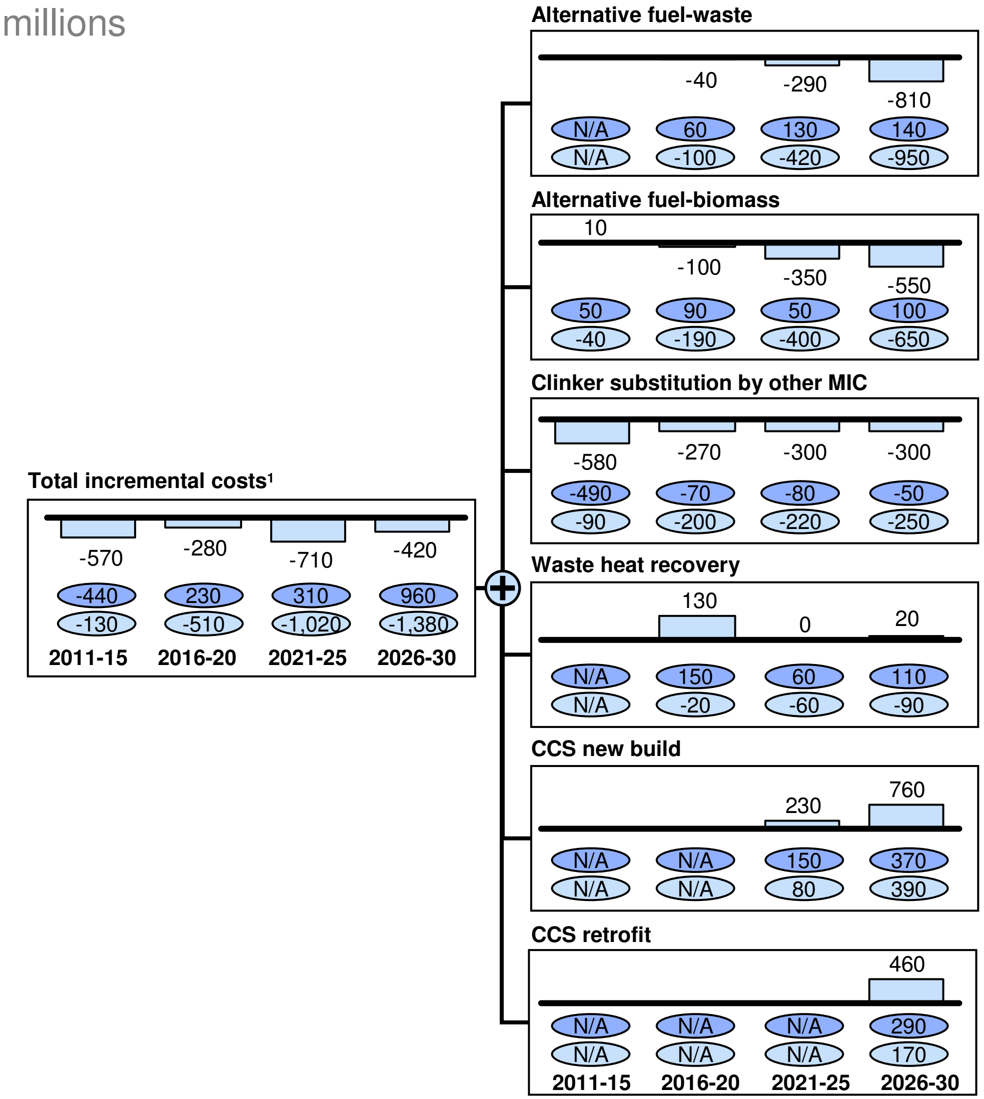
1 Cash flow form capex and opex cost/savings

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

Implementing clinker substitution and alternative fuel levers result in incremental cost savings

Real EUR, millions

Capex
Opex



Comments

- Opex savings offset incremental Capex required for waste alternative fuels
- Opex savings offset incremental Capex required for biomass alternative fuels
- Substituting clinker with other MIC results in significant Capex savings due to reduced clinker capacity build out as well as Opex savings due to reduced material and electricity costs
- Waste heat recovery is implemented gradually after 2015; opex savings will only partially offset capex spending through 2030
- CCS new build out will require investment Capex as well as incremental ongoing storage and transport Opex to achieve additional abatement
- CSS retrofit will require more Capex per Mt of clinker capacity, but Opex capacity per CO_2e captured will be the same as CCS new build

1 Cash flow from Capex and Opex cost/savings

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; assumption sources as detailed in this presentation

Deep dive - Selected sectors

- Power
- Buildings
- Cement
- **Road Transport**
- Agriculture

Sector summary

BAU

- Road transport emissions[1] totalled 28 Mt CO_2e in 2005, equal to ~12% of total Egypt emissions, and are expected to grow up to 72 Mt CO_2e (~13% of total Egypt emissions) in 2030
- Emissions from LDVs (light duty vehicles including passenger cars and taxis) and from MDVs (medium duty vehicles consisting of commercial vehicles such as pick-ups, light trucks, medium trucks weighing <16 tons) account for ~44% and ~53%, respectively, of total emissions while emissions from HDVs (heavy duty vehicles consisting of commercial vehicles that are long-haul trucks weighing >16 tons) account for the remaining ~3% of total emissions
- Emissions growth is expected to be driven primarily by LDV fleet growth due to increasing population, GDP growth and per capita car ownership

Abatement potential

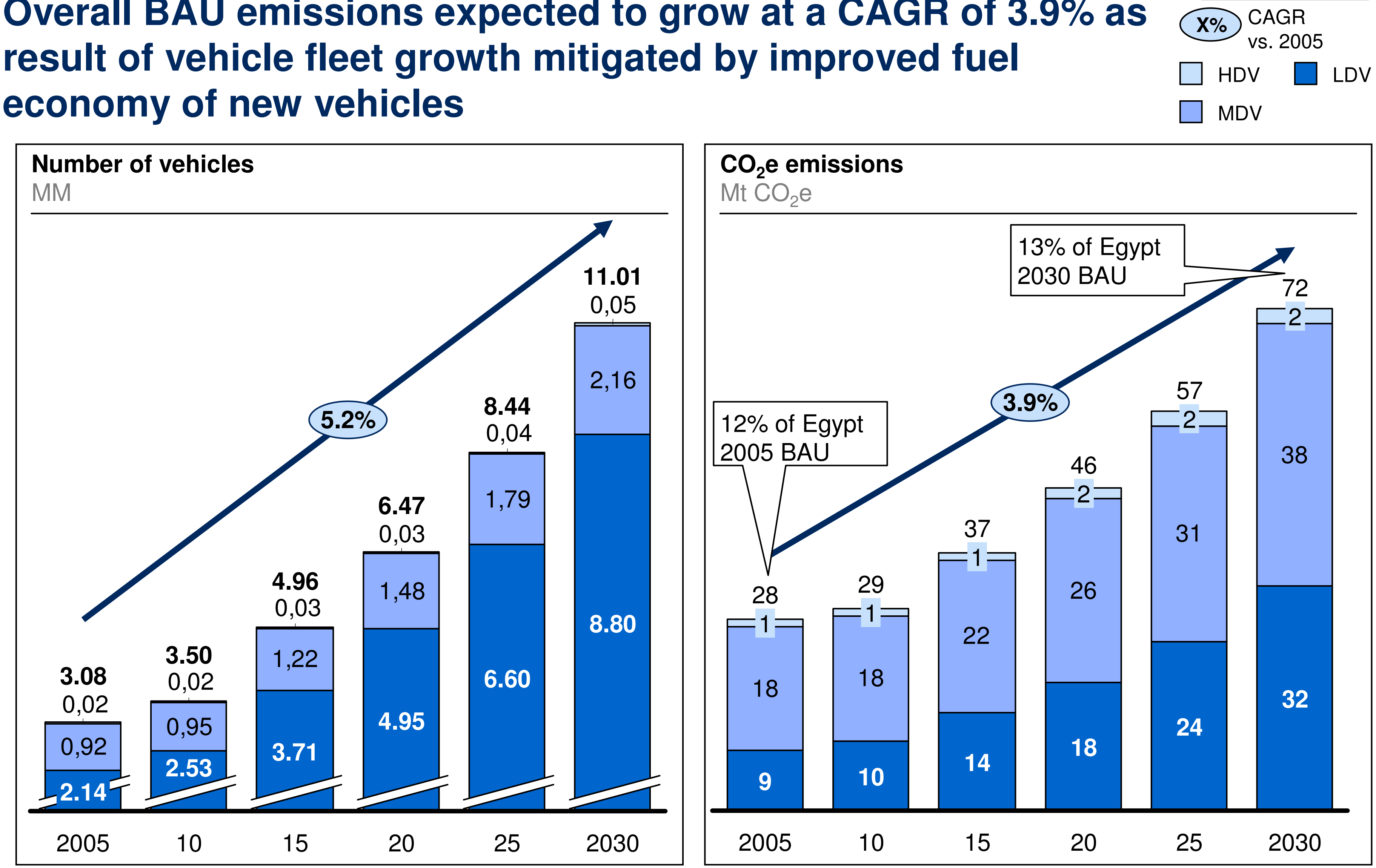
- Abatement potential in 2030 of ~21 Mt CO_2e, (~29% of BAU) was identified
- Key abatement levers are
  - LDV vehicle fuel efficiency technology (~13 Mt CO_2e)
  - Biofuel usage (1st and 2nd generation) (~5 Mt CO_2e)
- Total incremental investment required to implement abatement levers is in the range of ~ EUR 24 billion (Capex 2011-2030) is partially offset by ~20 billion EUR opex savings for the same period
- Nevertheless ~80% of levers can be implemented with economic benefits:
  - LDV internal combustion engine (ICE) improvements, compressed natural gas (CNG) and hybrid abatement levers, accounting for ~12.5 Mt CO_2e abatement, can be implemented at significant savings, with incremental annualized Capex for improved vehicles offset by Opex savings due to lower fuel consumption
  - Similarly biofuel abatement lever can generate Opex savings more than offsetting required Capex

1 In road transport BAU emissions, only combustion emissions of fossil fuels are included; refining emissions of fossil fuels are covered in the petroleum sector. Road transport sector emissions excludes emissions from 2–3 wheelers which are insignificant.

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; McKinsey Global Insights

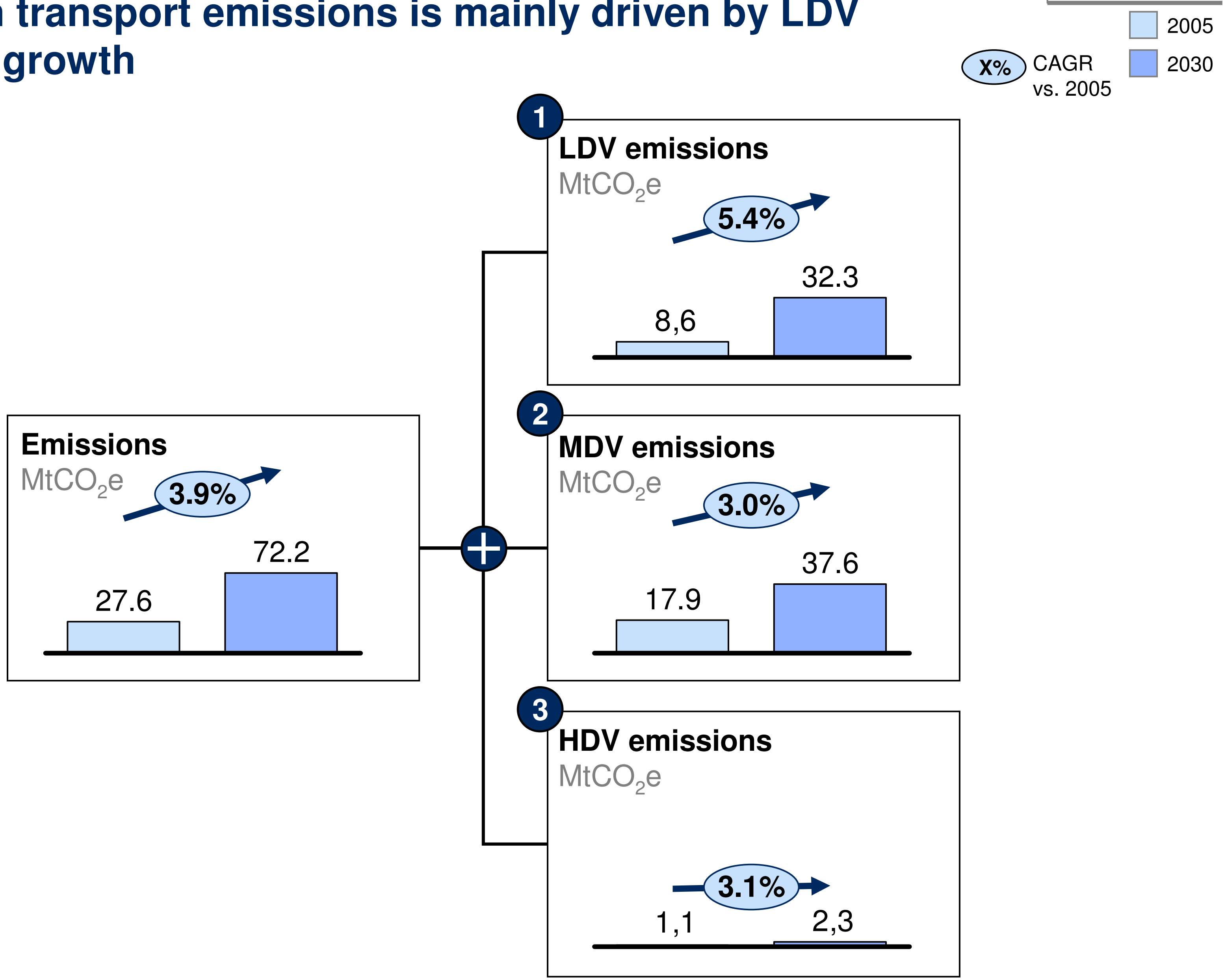
PRELIMINARY

Overall BAU emissions expected to grow at a CAGR of 3.9% as result of vehicle fleet growth mitigated by improved fuel economy of new vehicles



PRELIMINARY

Increase in transport emissions is mainly driven by LDV emissions growth

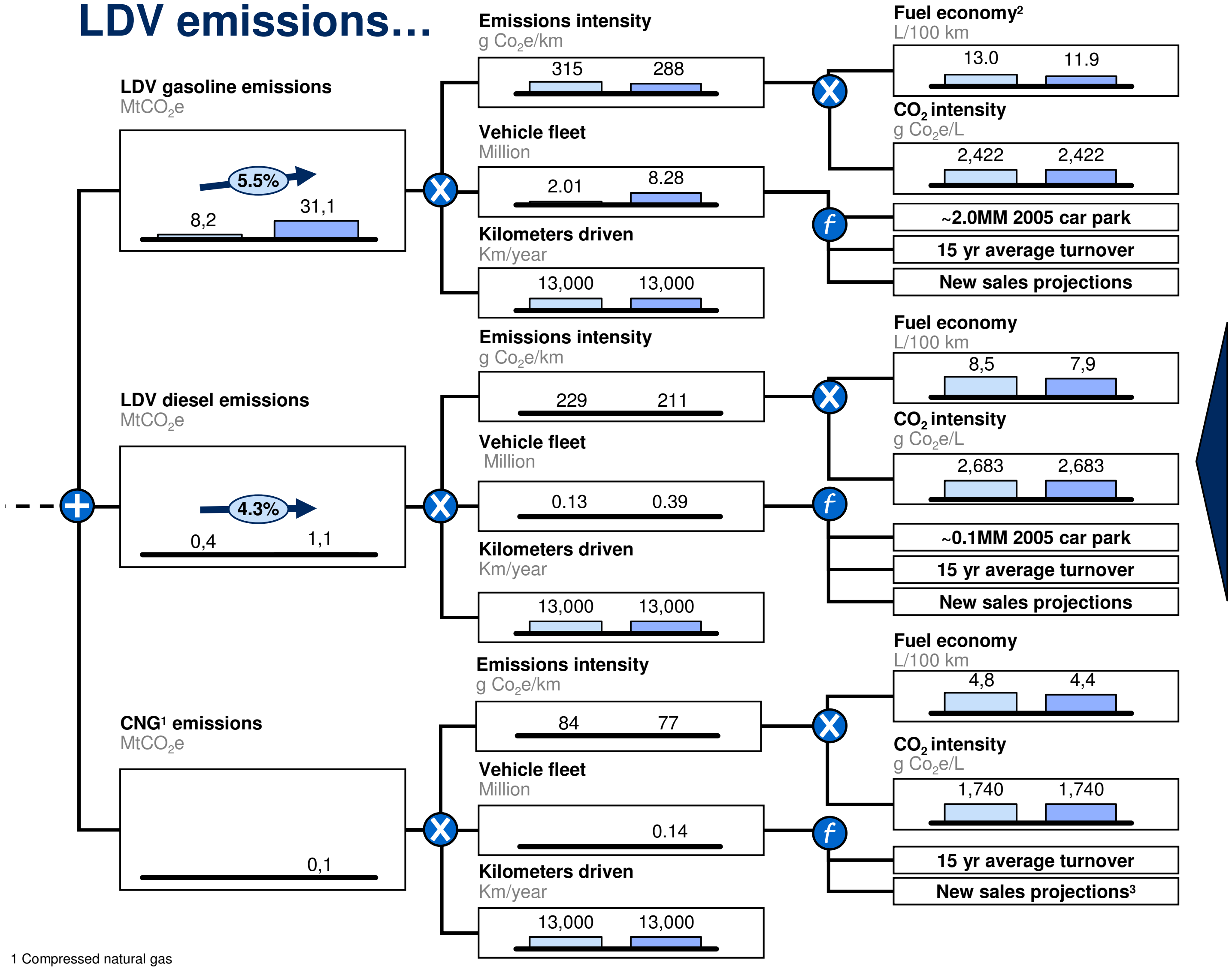


SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

PRELIMINARY

1 Gasoline powered LDVs are the major contributor to total LDV emissions…

2005 | 2030 | X% CAGR vs. 2005



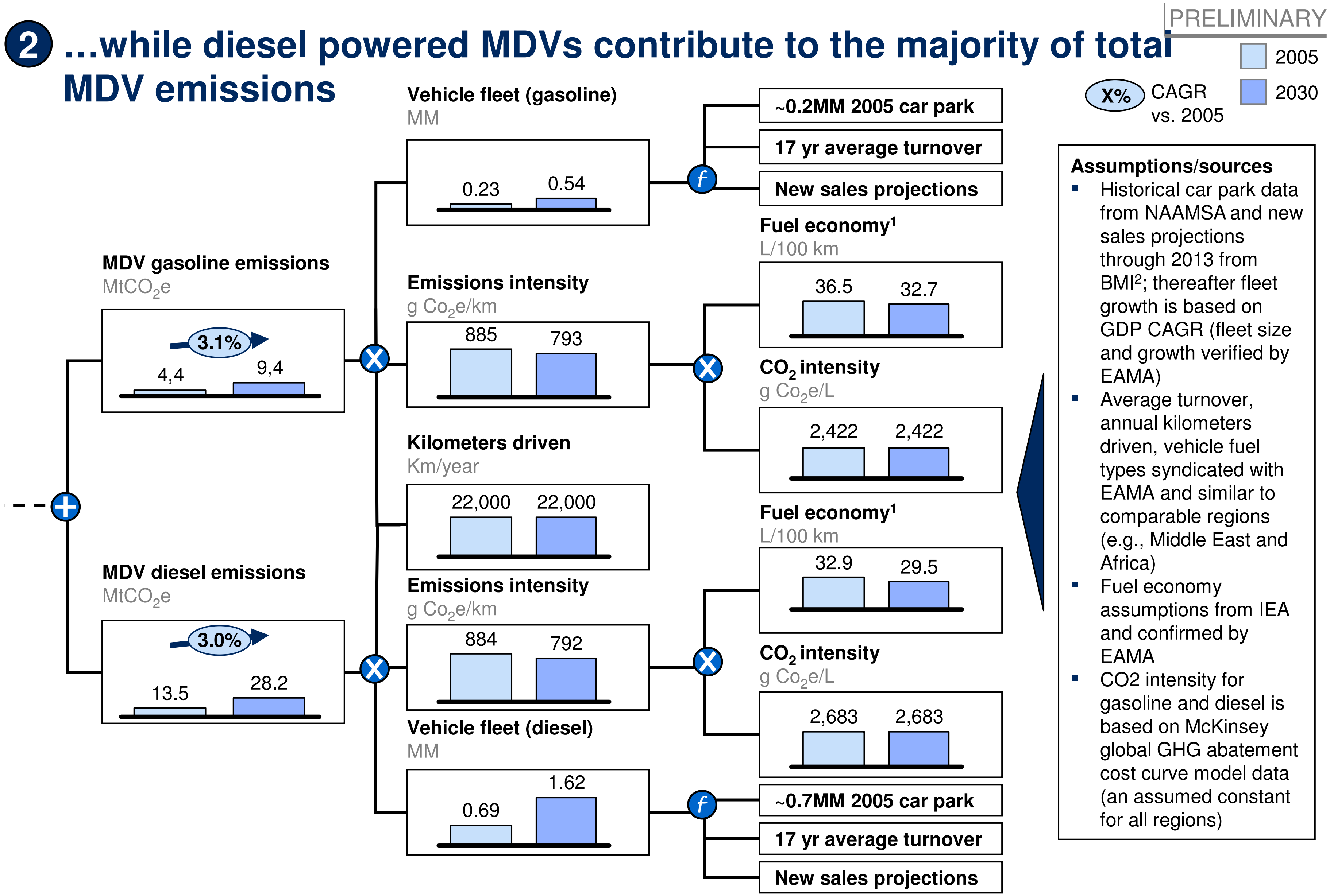
Assumptions/sources

- Historical car park data from NAAMSA[4]; new sales projections through 2013 from BMI[5]; thereafter assume LDV per capita CAGR of ~4.5%, aligned with input from Egyptian Automobile Manufacturer Association (EAMA)
- Average turnover, annual kilometers driven, vehicle fuel types syndicated with EAMA and similar to comparable regions (e.g., Middle East and Africa)
- Fuel economy assumptions from IEA[6] and confirmed by EAMA
- CO2 intensity for gasoline, diesel and CNG is based on McKinsey global GHG abatement cost curve model data (an assumed constant for all regions)

1 Compressed natural gas
2 LDV gasoline fuel economy assumes ~2% penetration of full hybrids by 2030
3 Assumes CNG penetration reaches 0.5% of LDV sales around 2011-15 period and increases to 2.0% of total LDV sales by 2030
4 National Association of Automobile Manufacturers of South Africa
4 Business Monitor International, Egypt Autos Report, 2009
6 International Energy Agency

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; McKinsey Global Insight

2 …while diesel powered MDVs contribute to the majority of total MDV emissions

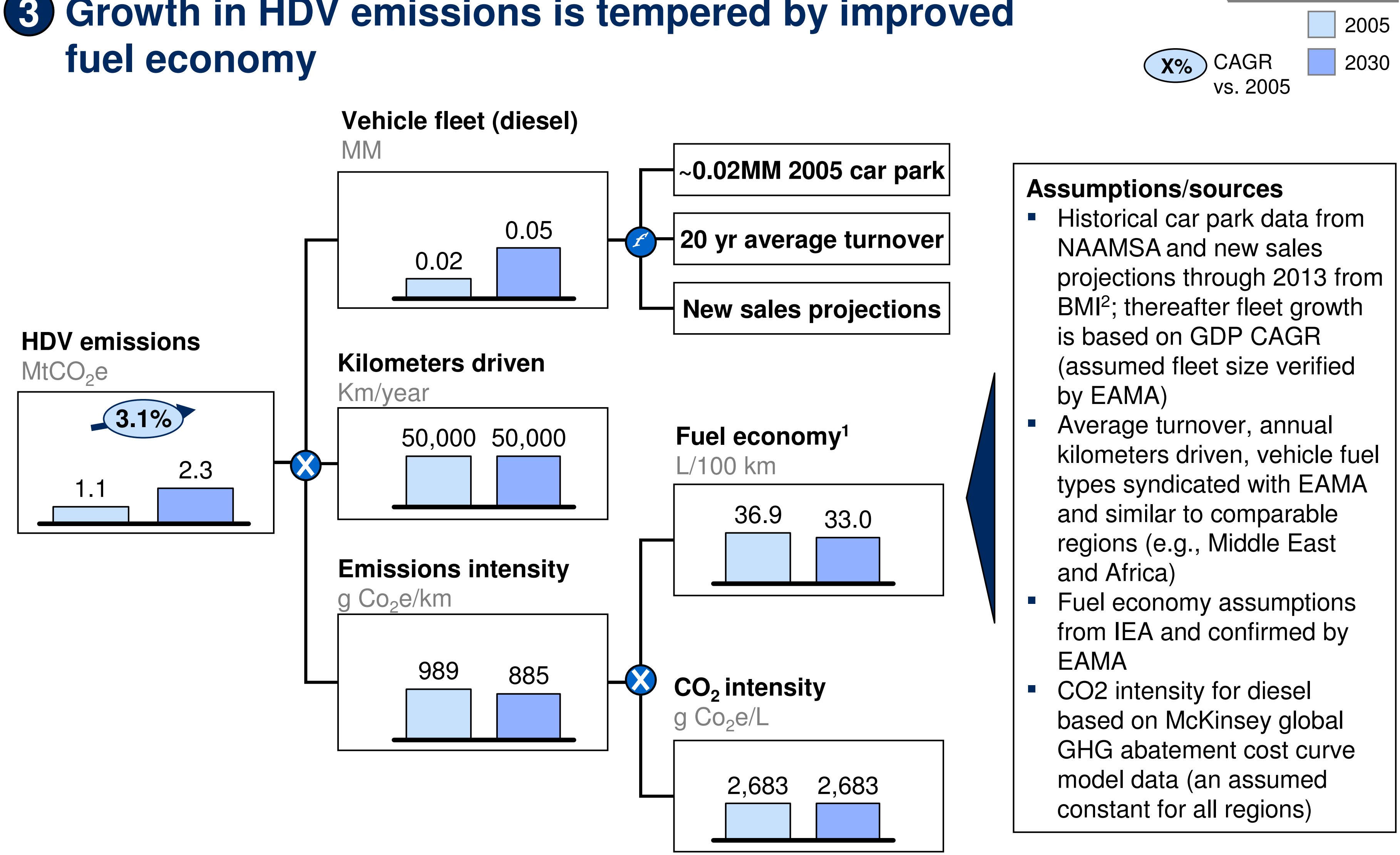


1 Includes weighted average of bundle 0 and bundle 1 fuel economies
2 Based on 2005 HDV and MDV commercial vehicle share and assumes share remains constant until 2030

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; McKinsey Global Insights

PRELIMINARY

3 Growth in HDV emissions is tempered by improved fuel economy



Assumptions/sources

- Historical car park data from NAAMSA and new sales projections through 2013 from BMI[2]; thereafter fleet growth is based on GDP CAGR (assumed fleet size verified by EAMA)
- Average turnover, annual kilometers driven, vehicle fuel types syndicated with EAMA and similar to comparable regions (e.g., Middle East and Africa)
- Fuel economy assumptions from IEA and confirmed by EAMA
- CO2 intensity for diesel based on McKinsey global GHG abatement cost curve model data (an assumed constant for all regions)

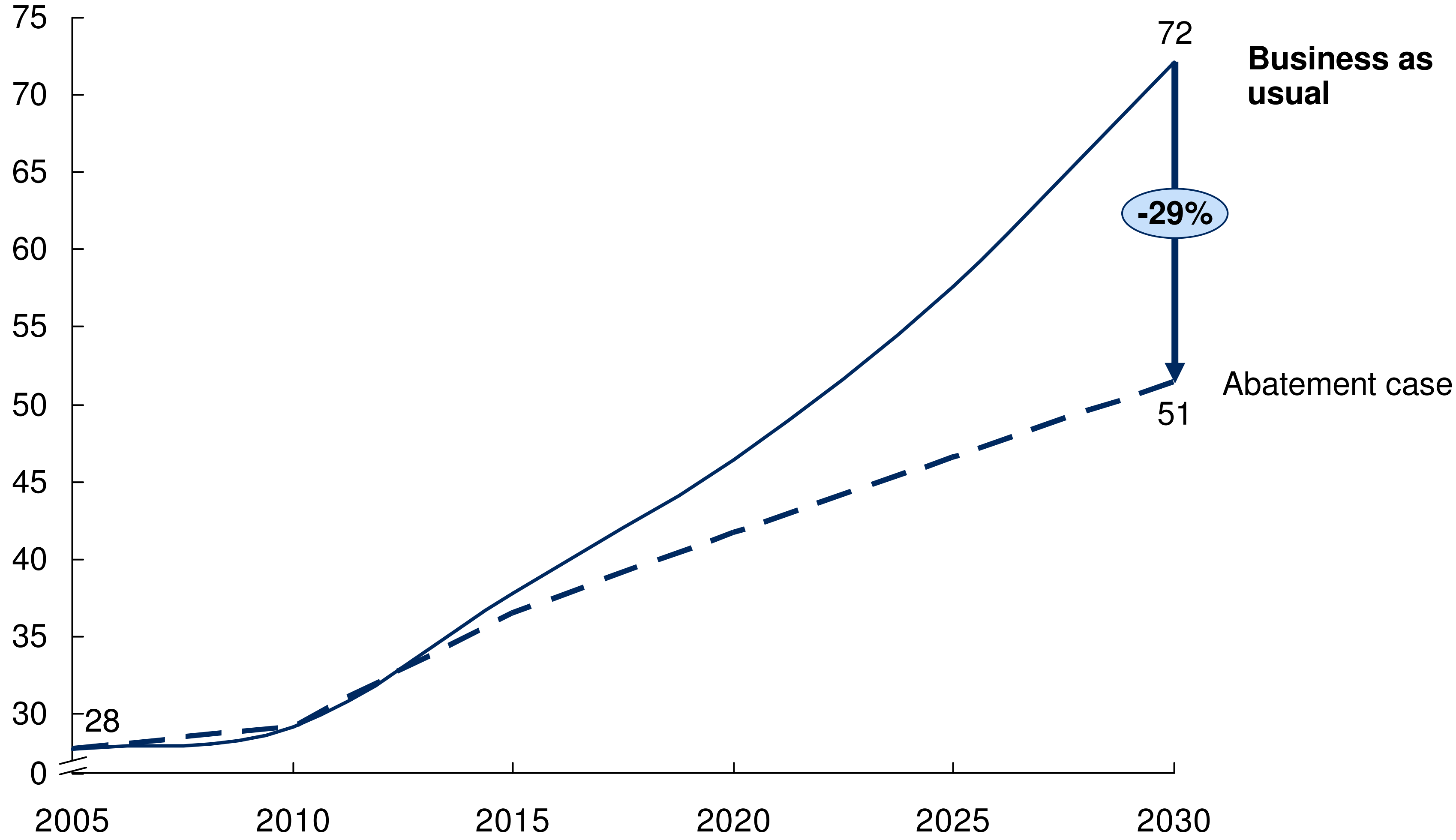
1 Includes weighted average of bundle 0 and bundle 1 fuel economies
2 Based on 2005 HDV and MDV commercial vehicle share and assumes share remains constant until 2030

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0; McKinsey Global Insights

Applicable abatement levers can reduce 2030 emissions by ~29%

MtCO2e per year

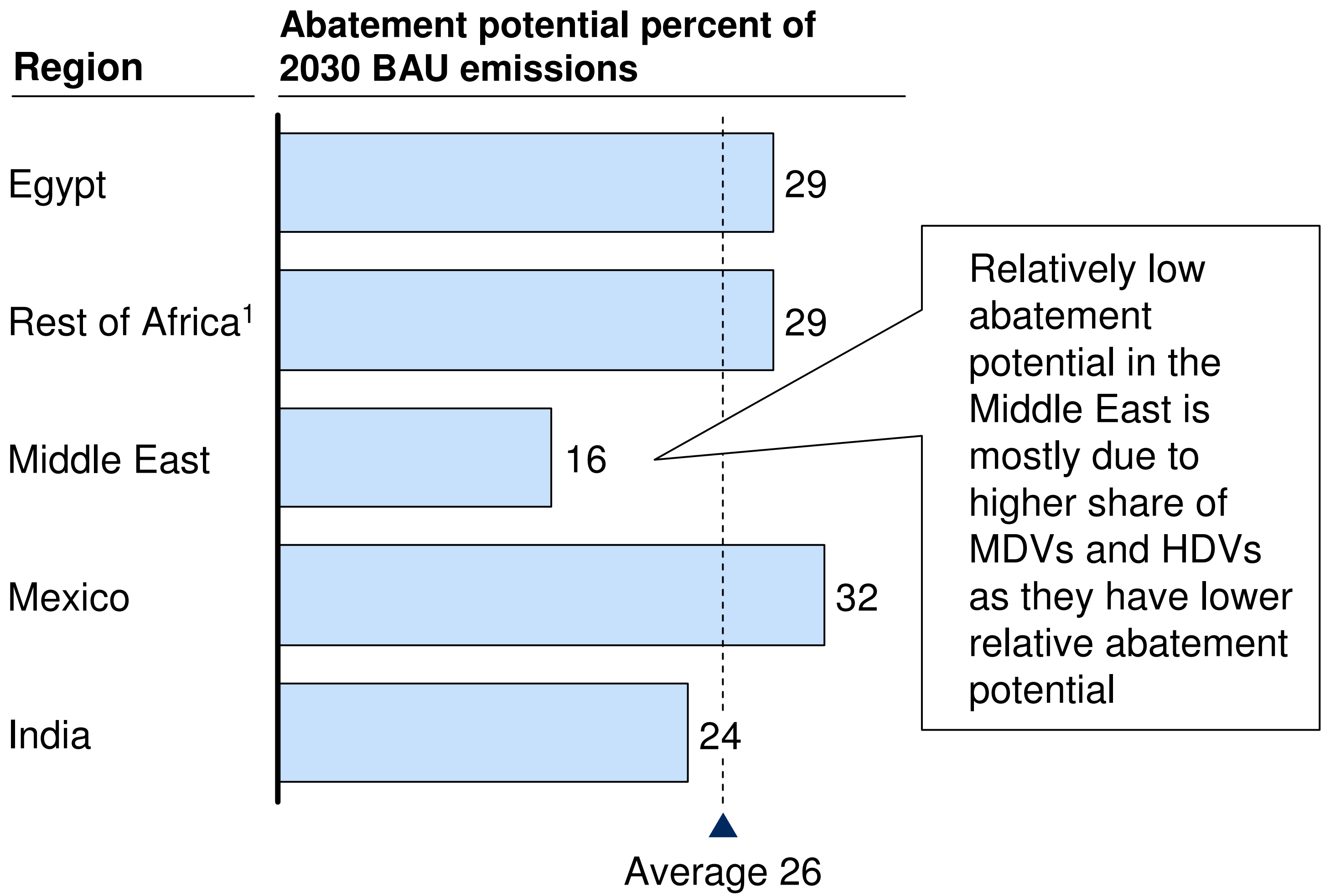
PRELIMINARY



SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

… which is in line with abatement potential of selected comparable regions

PRELIMINARY



1 Africa excluding South Africa

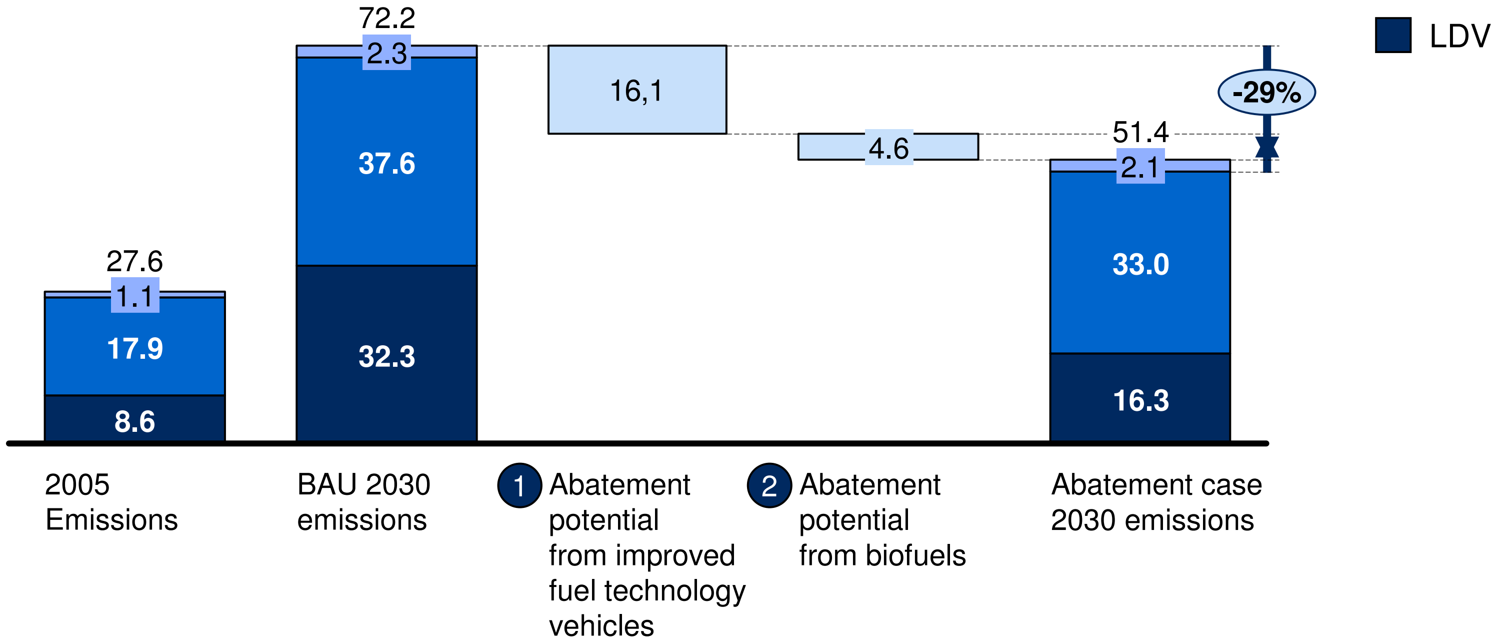
SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

Potential abatement is mostly driven by sales of improved fuel technology vehicles …

PRELIMINARY

Annual emissions and abatement potential

Mt CO_2e per year



	2005 Emissions	BAU 2030 emissions	Abatement potential from improved fuel technology vehicles	Abatement potential from biofuels	Abatement case 2030 emissions
CAGR 2005-2030		4.0%			2.4%
Comments		Driven by growing vehicle fleet, especially LDVs[1]	Dependent on penetration of improved ICE[2], hybrid, electric and CNG	Dependent on penetration of biofuels	Abatement levers have greatest impact on LDVs

1 Includes BAU emissions reduction from improved fuel economy of bundle 0 for all vehicle types; sales penetration of full hybrid and CNG LDVs, bundle 1 for MDVs and bundles 1 and 2 for HDVs

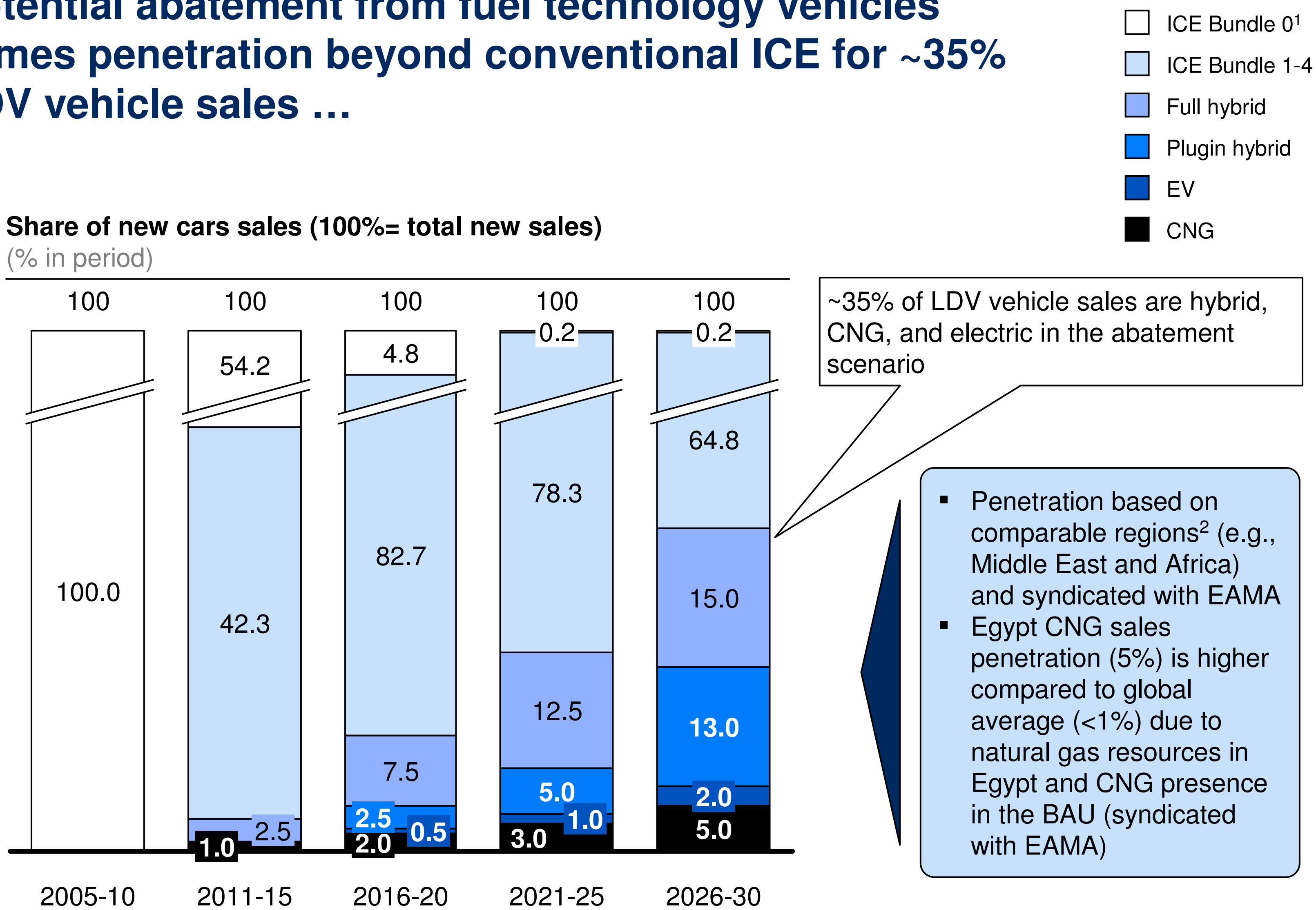
2 Internal combustion engines

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

PRELIMINARY

1 … potential abatement from fuel technology vehicles assumes penetration beyond conventional ICE for ~35% of LDV vehicle sales …

Share of new cars sales (100%= total new sales)
(% in period)



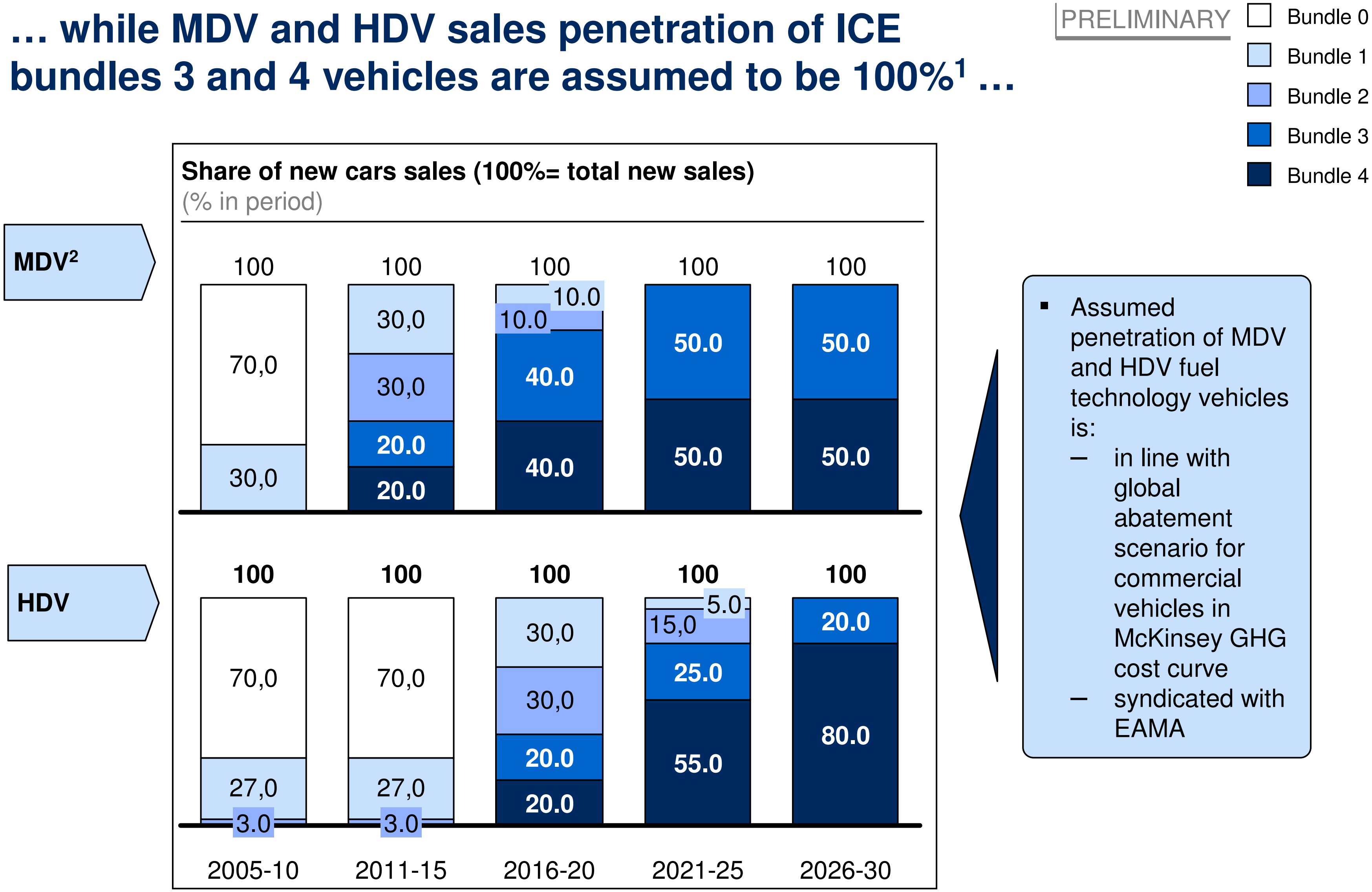
- Penetration based on comparable regions[2] (e.g., Middle East and Africa) and syndicated with EAMA
- Egypt CNG sales penetration (5%) is higher compared to global average (<1%) due to natural gas resources in Egypt and CNG presence in the BAU (syndicated with EAMA)

1 Internal combustion engine (includes gasoline and diesel and excludes CNG)
2 Global penetration assumptions based on analysis with multinational original equipment manufacturers (OEMs)

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

1 … while MDV and HDV sales penetration of ICE bundles 3 and 4 vehicles are assumed to be 100%[1] …

PRELIMINARY



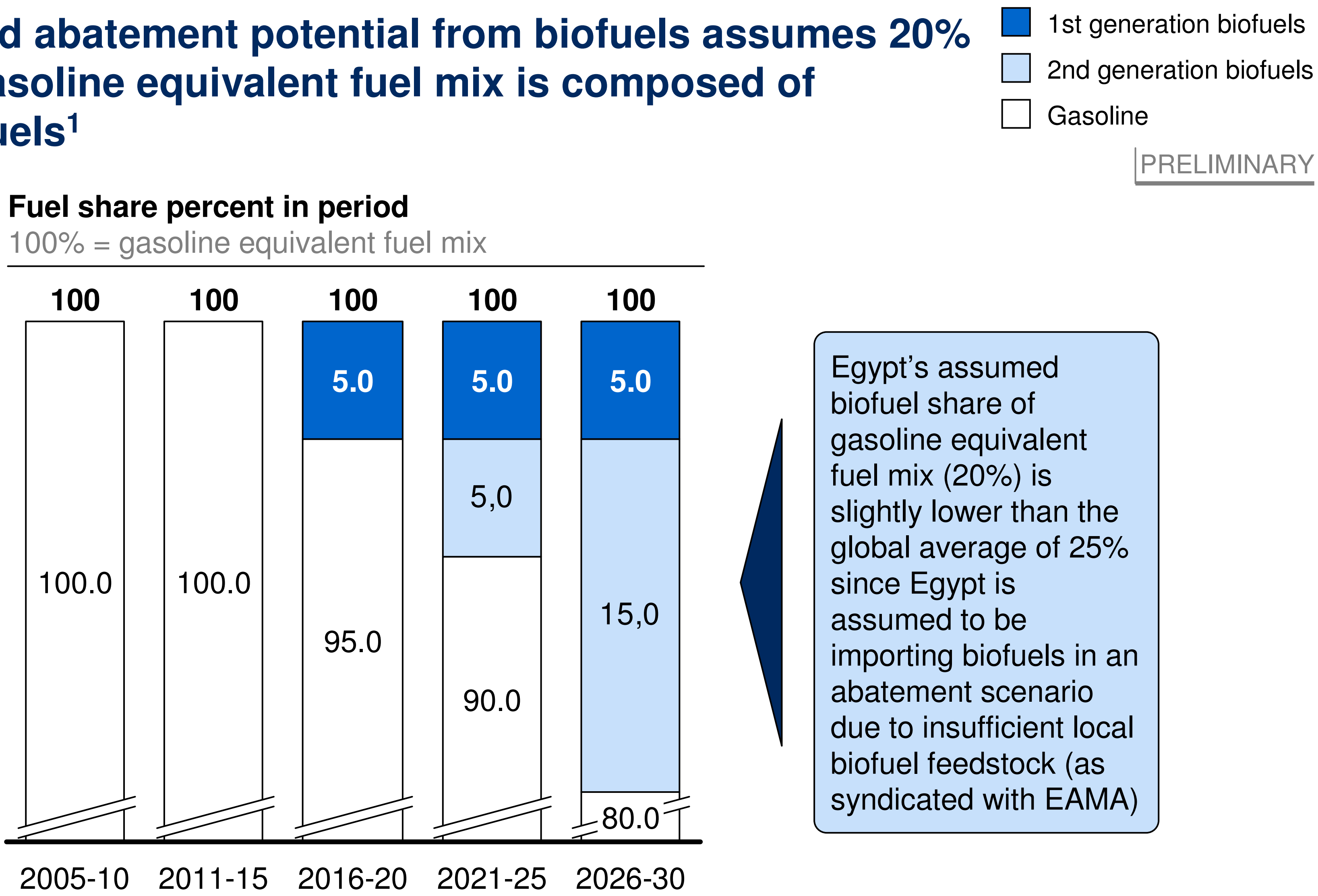
- Assumed penetration of MDV and HDV fuel technology vehicles is:
  - in line with global abatement scenario for commercial vehicles in McKinsey GHG cost curve
  - syndicated with EAMA

1 Global penetration based on analysis with OEMs of bundle introduction; assumes hybrid EV/CNG abatement levers for MDVs and HDVs are not implemented due to cost >EUR 100 per tCO_2e
2 Assumes penetration of bundles are the same for gasoline and diesel

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

2 …and abatement potential from biofuels assumes 20% of gasoline equivalent fuel mix is composed of biofuels[1]

PRELIMINARY



Egypt's assumed biofuel share of gasoline equivalent fuel mix (20%) is slightly lower than the global average of 25% since Egypt is assumed to be importing biofuels in an abatement scenario due to insufficient local biofuel feedstock (as syndicated with EAMA)

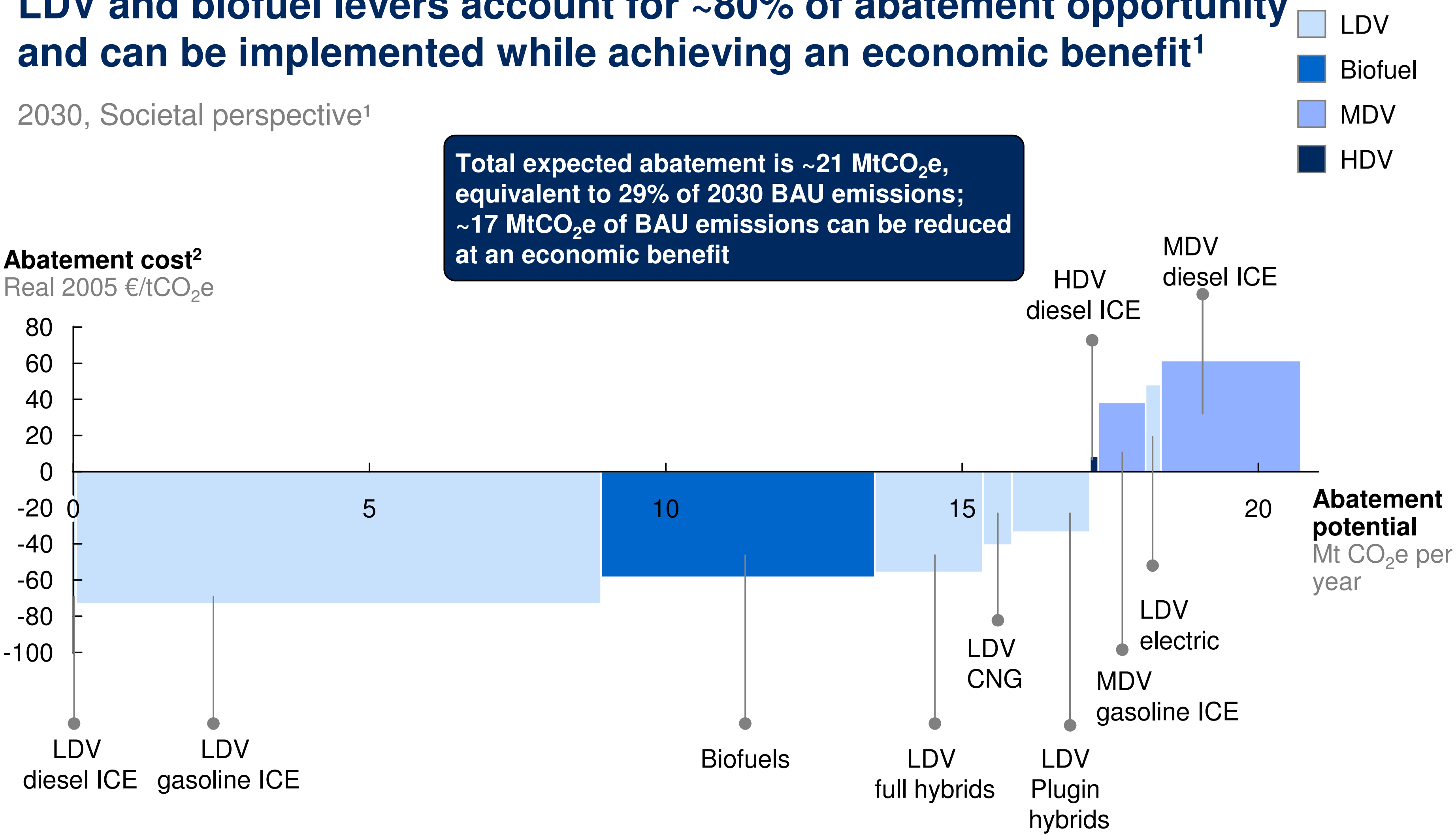
1 Biofuels include sugarcane (1st generation) and ligno-cellulosic bioethanol (2nd generation) to replace gasoline in the gasoline equivalent fuel mix; does not include biodiesel as currently there is no known feedstock with proven abatement potential when including land-use-change emissions

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

LDV and biofuel levers account for ~80% of abatement opportunity and can be implemented while achieving an economic benefit[1]

2030, Societal perspective[1]

Total expected abatement is ~21 $MtCO_2e$, equivalent to 29% of 2030 BAU emissions; ~17 $MtCO_2e$ of BAU emissions can be reduced at an economic benefit



1 Societal perspective (i.e., excluding taxes, subsidies, and with a capital cost similar to government bond rates)

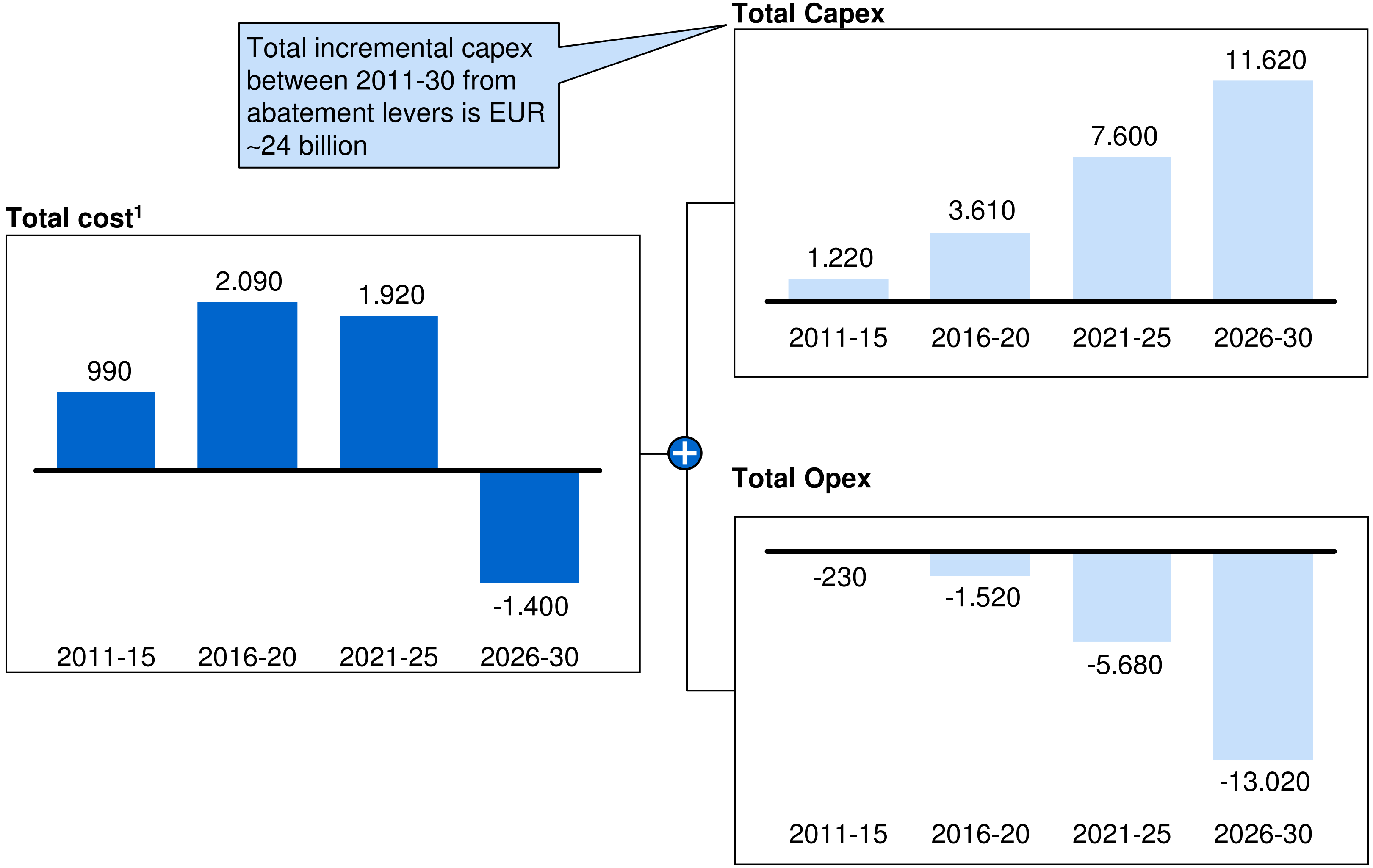
2 The curve represents an estimate of the maximum potential of all technical GHG abatement measures. Cost includes incremental annualized Capex (based on vehicle average lifetime and Egypt government interest rate of 10%) and Opex (including fuel savings; oil price is considered to be ~$100/barrel in 2030)

SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

Road transport sector will need an overall capital outflow until 2026-30 period, when incremental Opex savings offset Capex

PRELIMINARY

Real EUR, millions



1 Cash flow form capex and opex cost/savings

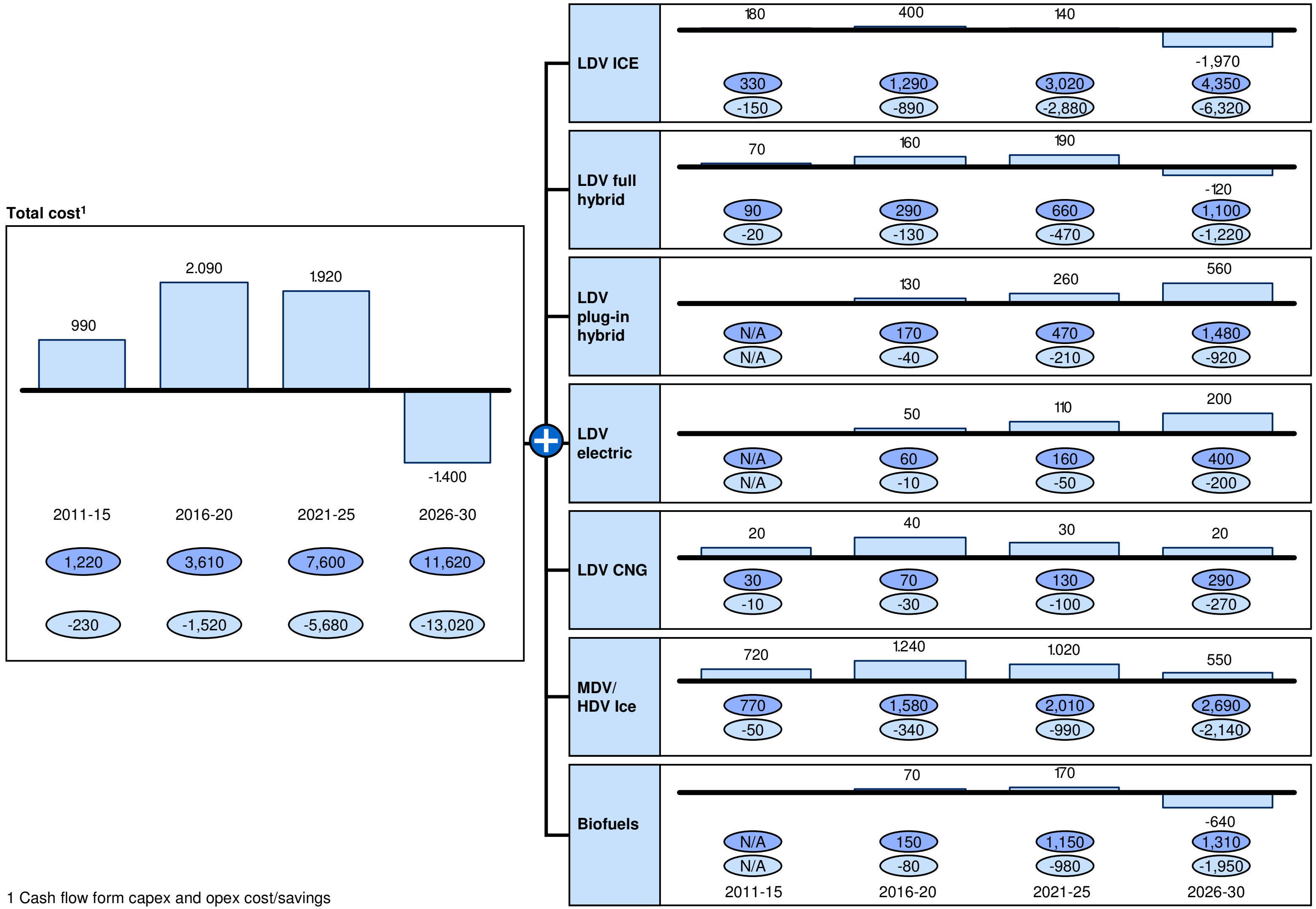
SOURCE: McKinsey Global GHG Abatement Cost Curve v2.0

BACK UP

LDV ICE and biofuel levers will provide greatest Opex savings relative to incremental Capex

Real EUR, millions

Capex
Opex



1 Cash flow form capex and opex cost/savings

Comments

- Incremental capex is driven by investment in fuel technology vehicles
  - Greater sales penetration over time
  - Reduced vehicle unit capex due to expected cost and technology evolution
- Opex is driven by
  - Reduction in fuel consumption
  - Expected higher fuel prices

Deep dive - Selected sectors

- Power
- Buildings
- Cement
- Road Transport
- **Agriculture**

Sector summary

BAU

- Agriculture emissions totalled ~27 Mt CO_2e in 2005
- Under a business as usual (BAU) scenario, emissions are expected to grow to ~42 Mt CO_2e by 2030
- The increase in the BAU is driven by the soil emissions due to the increase of land and the growth of the emission per land due to the large use of fertilizer

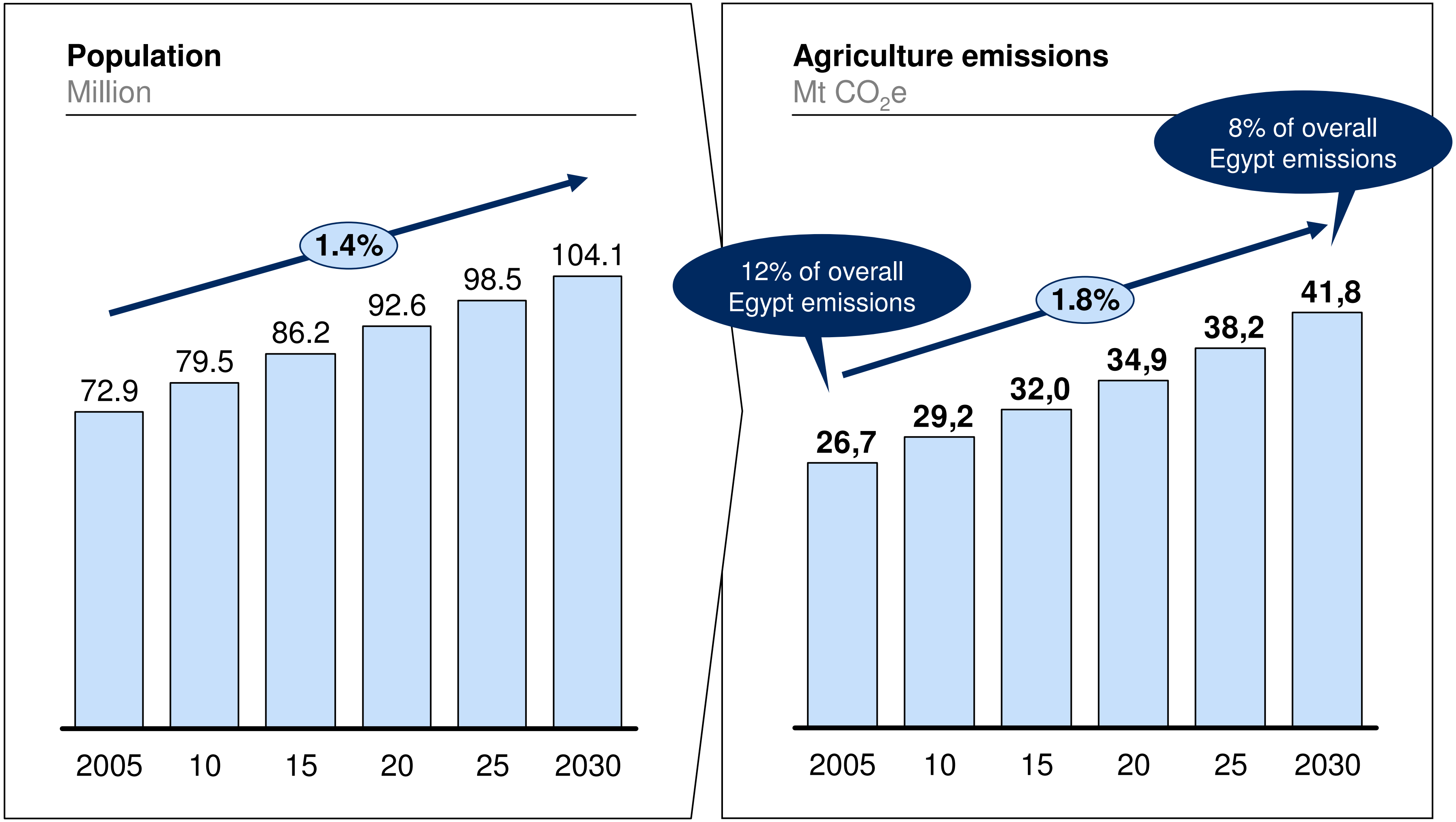
Abatement potential

- Overall abatement potential is in the range of ~16 Mt CO2e, equivalent to ~37% of total BAU emissions in 2030
- 95% of the overall abatement potential comes from the implementation of 4 main levers:
  - ~40% of the potential (~6.5 Mt CO2e) is captured through reduction of burning agricultural residue
  - ~20% of the potential (~3 Mt CO2e) is captured through rationalizing the use of synthetic fertilizer on crop land
  - ~20% of the potential (~3 Mt CO2e) is captured by extending organic farming on the land reclaimed in the next years
  - ~15% of the potential (~2 Mt CO2e) is captured by rice water management
- Majority of the levers can be implemented with economic benefit

SOURCE: CAIT, Egypt GHG Abatement Cost Curve

Agriculture emissions are expected to increase in line with the population growth

PRELIMINARY

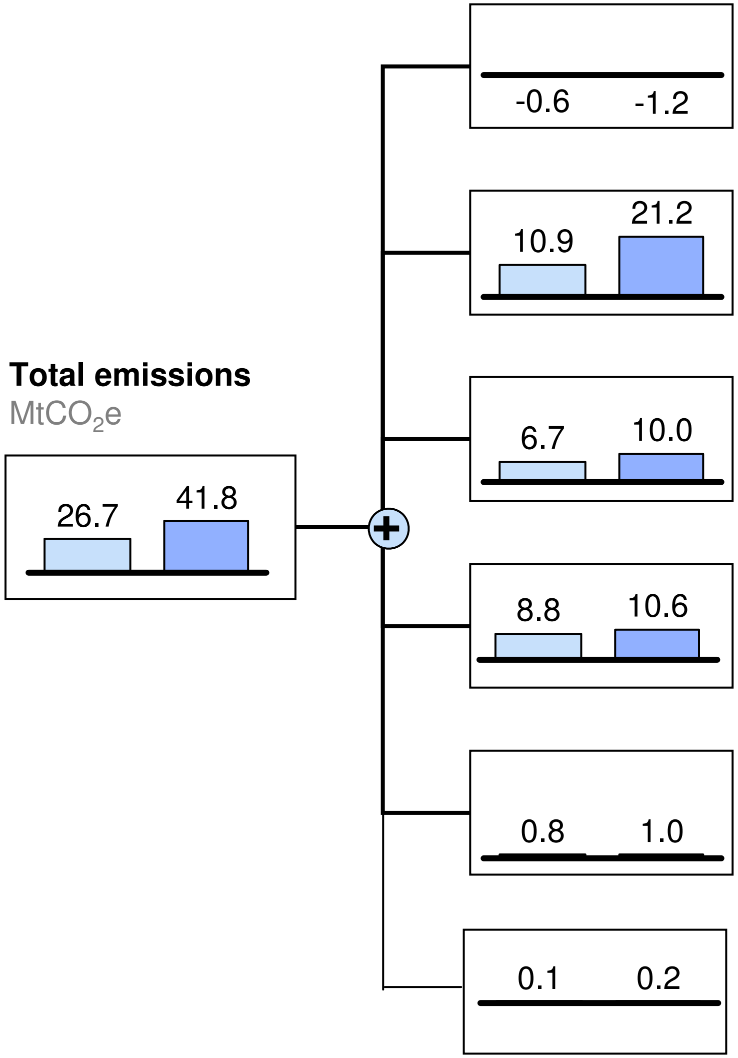


SOURCE: Global GHG Abatement Cost Curve v2.0, EPA

Increase in Agriculture emissions is driven by growth in emissions from rice and crop cultivations

PRELIMINARY

2005
2030



Carbon sequestration[1]
MtCO$_2$e
- Soil carbon sequestration from already pulled levers, such as organic farming, crop rotations and covered crops

Crop soil emissions (N_2O)
MtCO$_2$e
- N_2O emissions from crop lands excluding rice (e.g., fertilizers, nitrification)

Rice (CH_4)
MtCO$_2$e
- CH4 methane emissions from cultivated rice wetland

Livestock Enteric (CH_4)
MtCO$_2$e
- CH4 emissions from enteric fermentation in livestock, predominantly ruminants such as cattle and sheep

Livestock manure (CH_4, N_2O)
MtCO$_2$e
- CH4 emissions from collection, handling and storage of manure

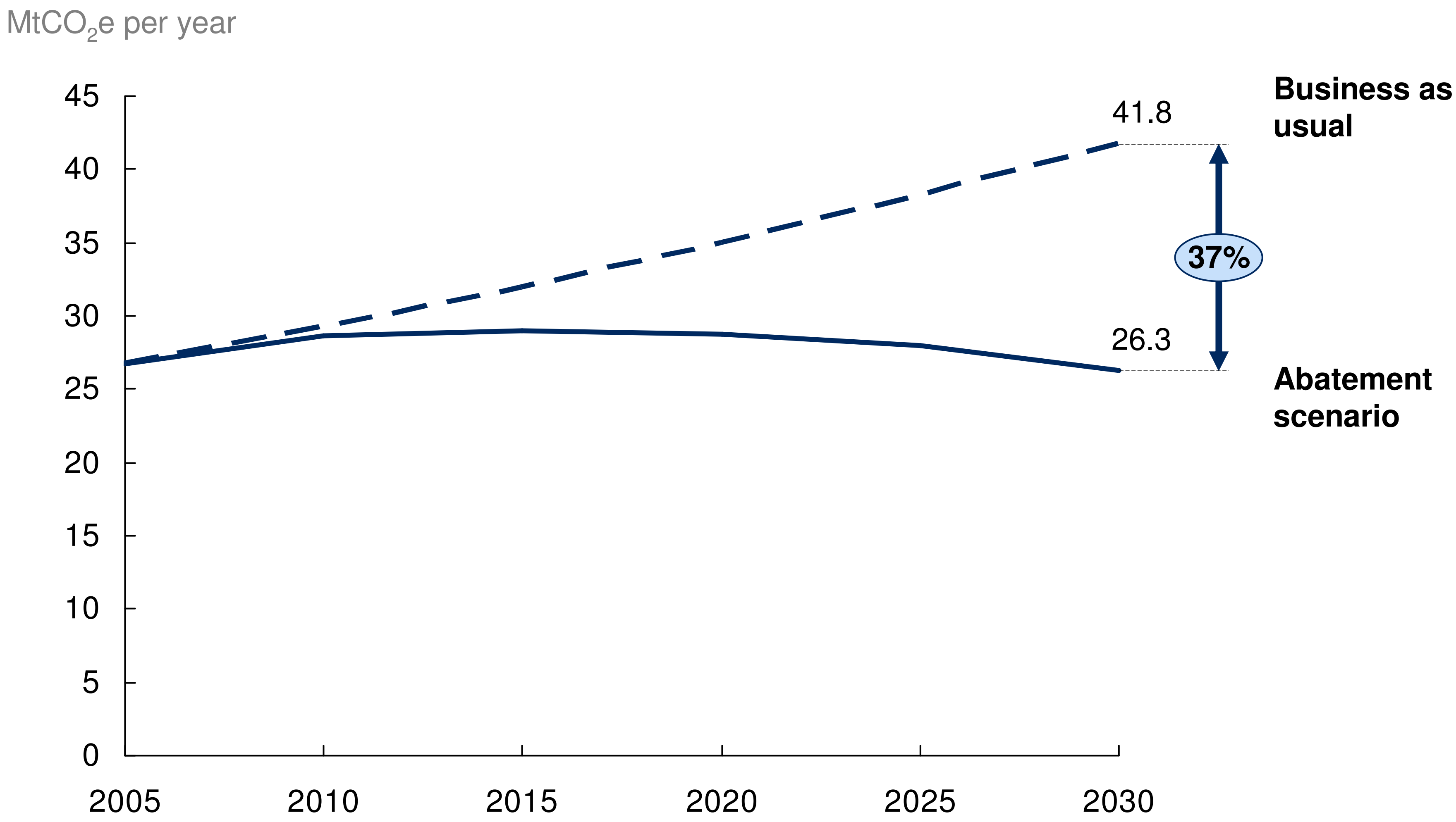
Residue insufficient burning (CH_4)
MtCO$_2$e
- CH4 emissions from insufficient burning of agricultural residue (e.g., rice straw)

1 In the Agriculture sector BAU case, carbon sequestration provides a natural abatement (negative CO2e)

SOURCE: EPA, CAIT

Applicable abatement levers can reduce 2030 emissions by ~37% of the BAU scenario

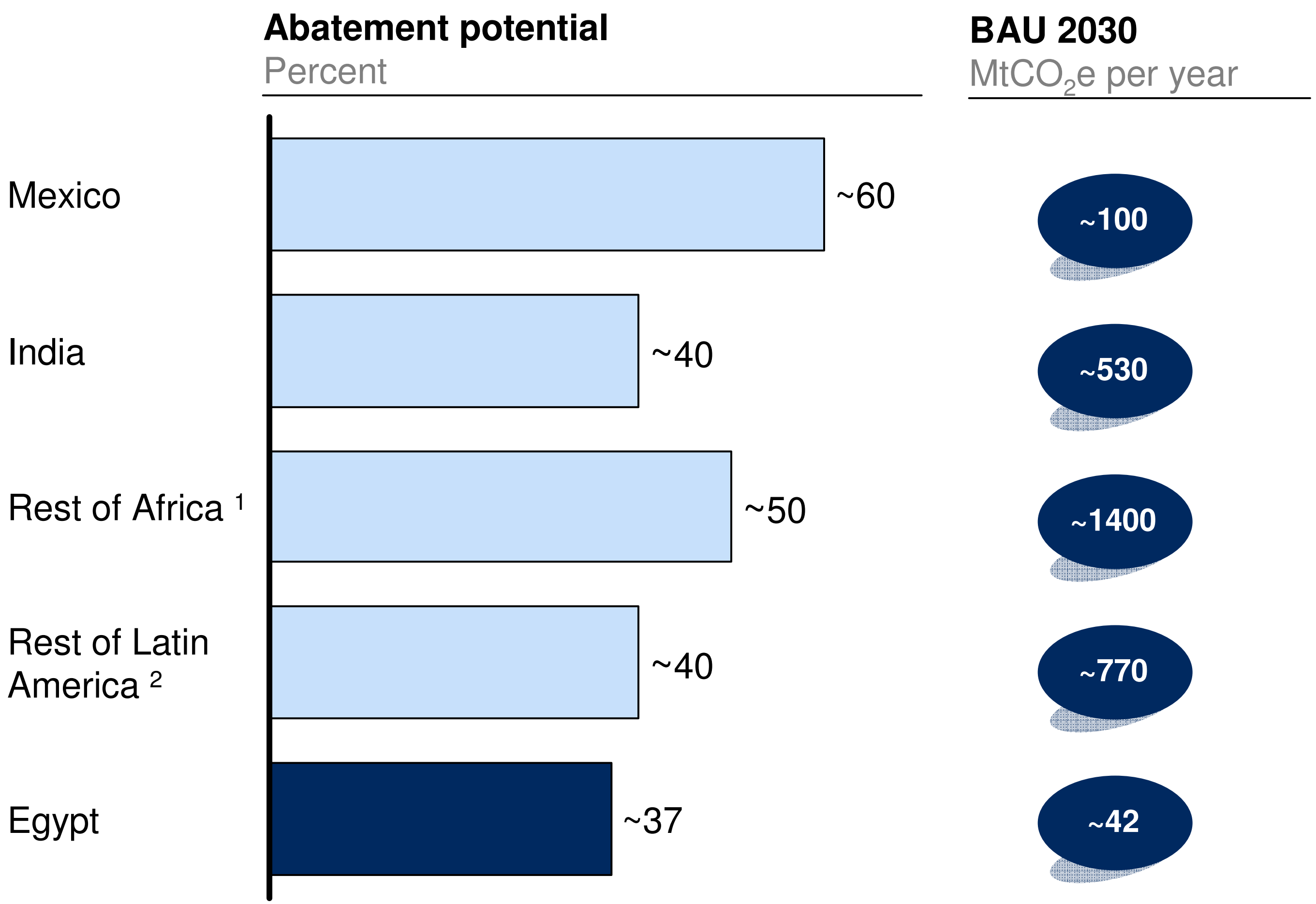
PRELIMINARY



SOURCE: Global GHG Abatement Cost Curve v2.0, Team Analysis

…slightly lower than comparable developing geographies

PRELIMINARY



1 Rest of Africa excluding South Africa
2 Rest of Latin America excluding Brazil

SOURCE: Global GHG Abatement Cost Curve v2.0. Includes direct and indirect emissions; excludes emissions from forestry

Abatement potential based on assessment of local feasibility of levers (1/2)

PRELIMINARY

✓ Applicable ✗ Not applicable

	Levers	High-level description of levers	Applicability in Egypt	Comments
Arable land management	Residue management	▪ Avoid burning of agriculture residue (e.g., mechanizing harvesting); use of residue for animal feeding, biotech fermentation, composting production or biochar production	✓	▪ Large potential in Egypt where most of the residue (e.g., rice straws, corn stover) are burnt after harvesting
	Organic farming	▪ Cultivate the reclaimed land with organic fertilizer as manures and biosolid to increase carbon sequestration	✓	▪ Significant potential in Egypt where a large part of the arable land has been or will be reclaimed from the desert (reclaimed land is ~32% of arable land in 2005, ~55% in 2030)
	Crop conser-vation tillage	▪ Advances in weed control methods and farm machinery allows crops to be grown with minimal tillage	✓	▪ Applicable as scenario similar to comparable developing countries
	Crop nutrient management	▪ Improve management of fertilizers: use of slow-release fertilizer forms; precise farming; improve timing in fertilizer application	✓	▪ Applicable on most of the crops (e.g., most of the crops are treated with nitrogen based fertilizer, mainly urea)
	Advanced agronomy practices	▪ Use improved crop varieties; extend crop rotations (e.g., legume crops); extend covered crops	✗	▪ Already in place in Egypt (e.g., ~90% crop adopts crop rotations, 300,000 feddans covered crops)

Source: IPCC; Global V2.0 team

Abatement potential based on assessment of local feasibility of levers (2/2)

PRELIMINARY

✓ Applicable ✗ Not applicable

	Levers	High-level description of levers	Applicability in Egypt	Comments
Rice management	Rice water management	▪ During growing season, keep rice paddies marginally covered by 5-10 cm of flood water and drain water once or multiple times	✓	▪ Applicable in Egypt where water level varies across rice paddies depending on the water availability
Rice management	Rice nutrient management	▪ Use of sulfate fertilizer instead of traditional nitrogen fertilizer	✓	▪ Sulfate fertilizer applicable on Egypt rice paddies, as they are mostly located on alkaline land in the north
Livestock	Feed supplements	▪ Feed livestock with dietary additives such as propionate precursors	✗	▪ Not applicable as methane emissions used as sign of animal good health (syndicated with expert)
Livestock	Vaccines	▪ Administer to livestock anti methanogen vaccine against methanogenic bacteria	✗	▪ Not applicable as methane emissions used as sign of animal good health (syndicated with expert)
Others	Degraded soil restoration	▪ Introduce re-vegetation; improve fertility by nutrient amendments; apply organic substrates	✗	▪ Not applicable as share of completely degraded land negligible in Egypt (partially degraded land in the north of the country)
Others	Grassland management	▪ Increase grazing intensity; improve fire management; introduce species	✗	▪ Not applicable as share of grassland negligible in Egypt

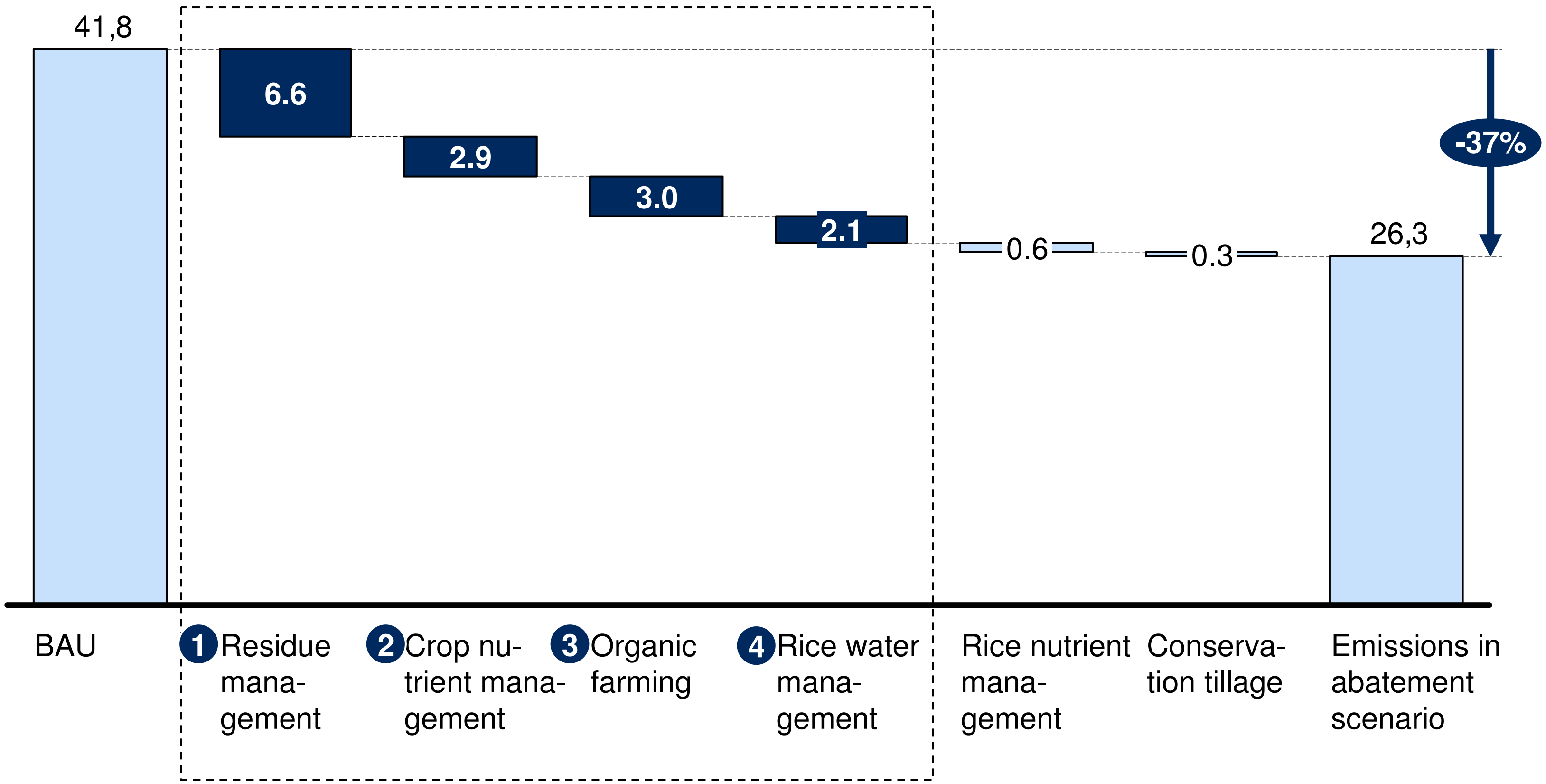
Source: IPCC; Global V2.0 team

About 95% of the abatement potential is captured by implementation of four major levers

PRELIMINARY

Details follow

Emission abatement
MtCO2e per year, 2030



Source: IPCC; Global V2.0 team; Team Analysis

1 Residue management offers the opportunity for potential abatement of carbon level in the atmosphere

ILLUSTRATIVE

PRELIMINARY

From…. **…to**

Residue burning: carbon cycle and methane emissions

High carbon level in atmosphere

Carbon absorption ***Carbon emission*** ***Methane emission***

Growing season ***Harvesting season***

Land

Residue management: pure carbon absorption

Low carbon level in atmosphere

Carbon absorption

Growing season ***Harvesting season***

Land

Possible techniques for residue management: biotech fermentation industry, animal feeding, composting production or biochar production

SOURCE: Expert interview; EPA; Egypt’s Agriculture Sector Transformation Strategy; Team Analysis

1 Residue management – avoid burning of rise, corn and sugarcane straw can eliminate ~6.5 MtCO2e

PRELIMINARY

Segments	Tons per year Million, 2006	Tons per year[1] Million, 2030	Share burnt[2] Percent	Emission/ ton[3] tCO_2e/ ton	Total emissions[3] $MtCO_2e$, 2030
Rice straw	2.3	2.4	~80	1.35	2.7
Corn stover	3.2	4.3	~10[4]	1.79	0.7
Sugarcane	6.6	9.0	~25	1.42	3.2
Total	12.1	15.7			6.6

1 Estimated from increase of land and increase of productivity with CAGR 0.7%; data from Egypt's Agriculture Sector Transformation Strategy
2 Some residues are not burnt but used for animal feeding (e.g., 20% rice straw), brick production (e.g., wheat stover), composting (e.g., potatoes leaves)
3 It accounts both for carbon emissions and methane emissions from rice straw insufficient burning, data from Chinese Scientific Bulletin "Estimation of emissions from field burning of crop straw in China"
4 90% of corn stover used for animal feeding or domestic heating

SOURCE: Expert interview; Chinese Scientific Bulletin; Egypt's Agriculture Sector Transformation Strategy Team Analysis

2 Optimizing of fertilizer management potentially driving a reduction of ~3 MtCo2e emissions

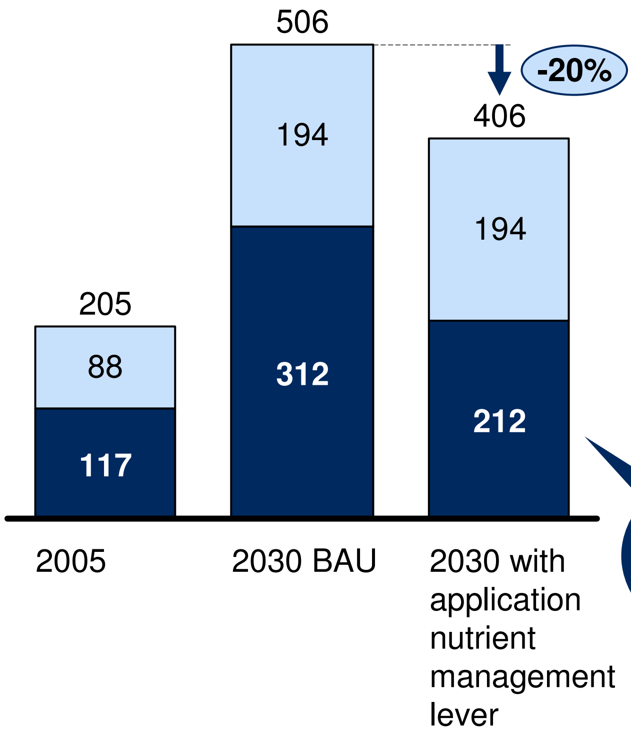
PRELIMINARY

Assumed possible reduction in the usage of mineral fertilizer (N,P,K) by 20%:

- **Egypt use of synthetic fertilizer in 2005 fairly higher tan world average**
- **Egypt use of organic fertilizer is increasing according with growth in livestock**
- **Recent increase in consumption of fertilizers (18%) not balanced by land productivity increase (0.7%)**

Synthetic fertilizer
Organic fertilizer

N,P,K fertilizer (synthetic and organic)
Kg/ feddan



Delta emission per feddans tC02eq/ land feddan	**Arable land** Million feddans	**Potential abatement** MtCo2e, 2030
~0.32[1]	x ~9.0	= ~2.9

Saving of 100 kg (e.g., from 312 to 212) fertilizer could allow to reduce the emission by 0.32 tCo2e per arable land feddan

1 Calculated from fertilizer saving (100 kg), share of nitrogen in N,P,K (82%), emissions of N20 from nitrogen application using urea reference (1.25%) from A.F. Bouwman, "Direct emission of nitrous oxide from agricultural soil" and "Global estimates of gaseous emissions of NH3, NO and N2O from agricultural land", National Institute of Public Health and Environment, Netherlands

SOURCE: Expert interview; Agriculture Sector Transformation Strategy; Press, FAO; Team Analysis

3 Use of organic fertilizer on land future reclaimed can reduce emissions by ~3 MtCo2e

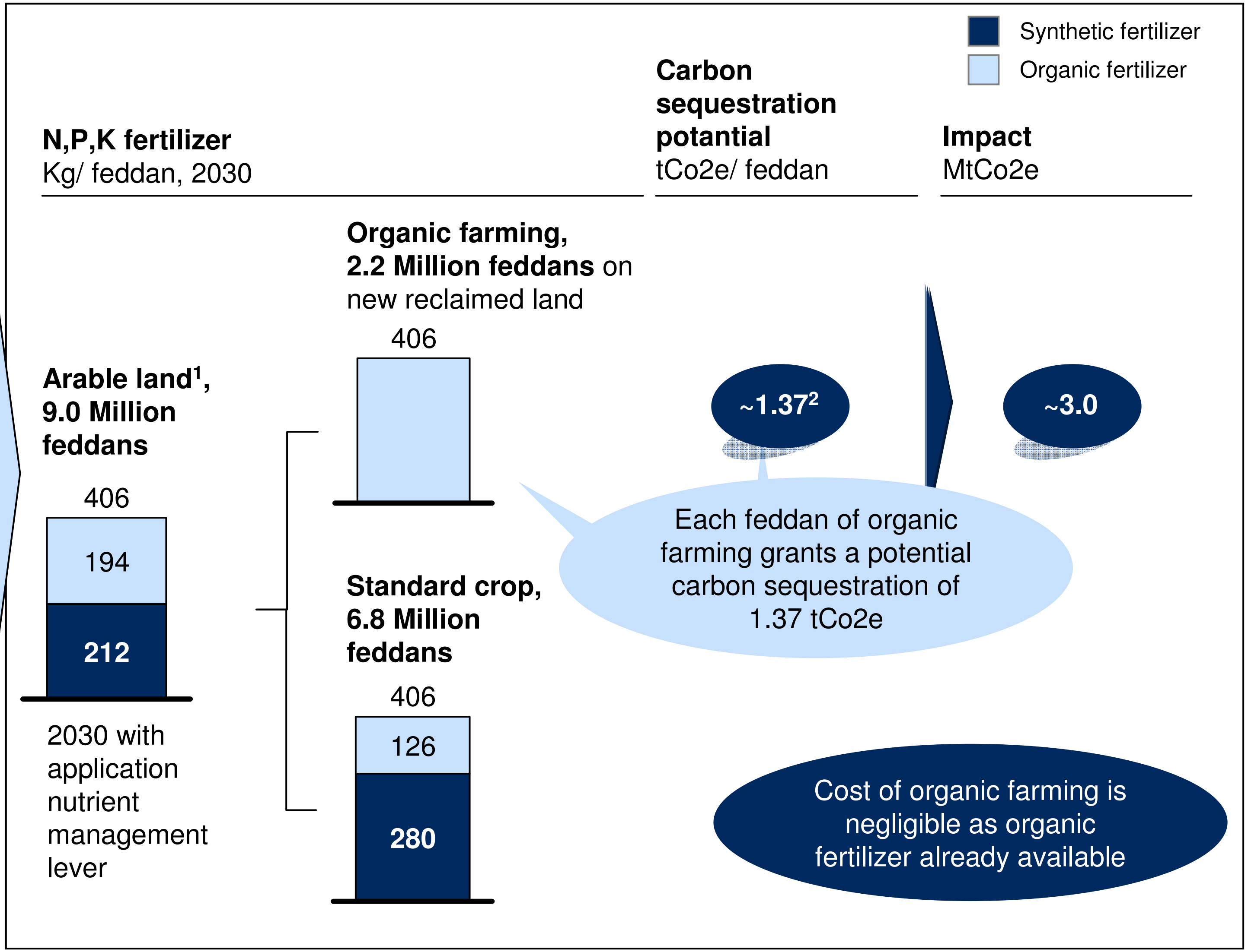
PRELIMINARY

Land assumptions:

- **In BAU scenario use of organic farming accounts for 0.5 million feddans**
- **In abatement scenario use of organic farming extended to the land to be reclaimed from 2005 up to 2030 (additional 2.2 million feddans)**

Fertilizer assumptions:

- **Organic farming uses manures and compost from internal production (~50% of manures supply and ~75% of composts supply are used in organic farming in 2030)**



1 It does not include the 0.5 Million feddans of organic farming already considered in BAU
2 Soil & More, "Carbon sequestration potential of reclaimed desert soils in Egypt"
SOURCE: Expert interview; Soil & More; Egypt's Agriculture Sector Transformation Strategy; Press; Team Analysis

4 Water management on rice paddies can unlock a potential of ~2 MtCo2e in 2030

PRELIMINARY

Segments	**Rice land Egypt** Million feddans, 2009	**Rice land Egypt**[1]**,** Million feddans, 2030	**Flooded land** Pecent	**Abatement ratio** tCO2e/ feddan	**Total abatement** MtCO2e, 2030
Moist warm	0	0	90	1.6	0
Moist cool	0	0	90	1.6	0
Dry warm	1.8	1.1	90	2.1	2.1
Dry cool	0	0	90	2.1	0

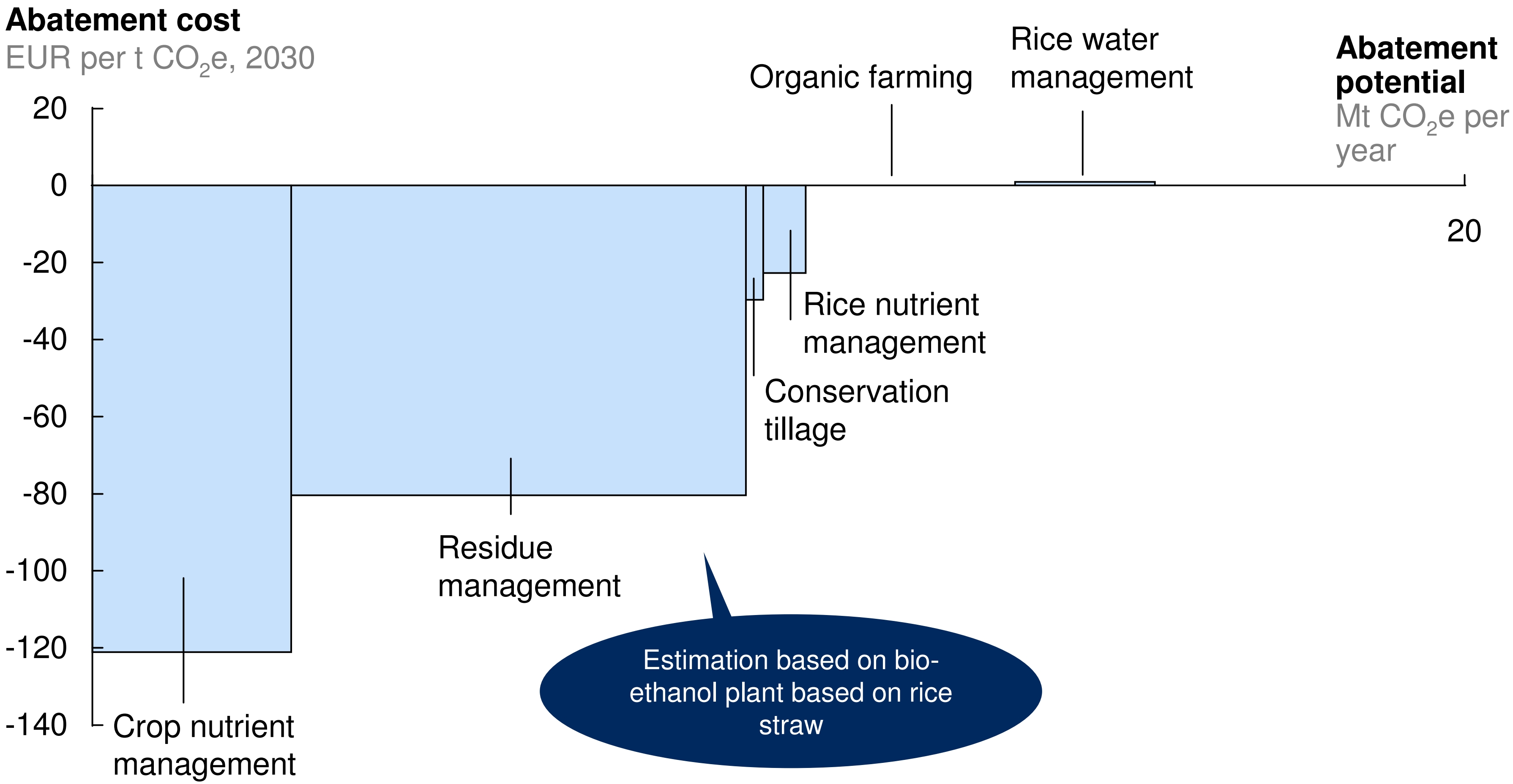
1 According to the law, rice land will be reduced to 1.1 million feddans to limit water consumption

Source: IPCC; Global V2.0 team; Team Analysis

Majority of the levers can be implemented with economic benefit

PRELIMINARY

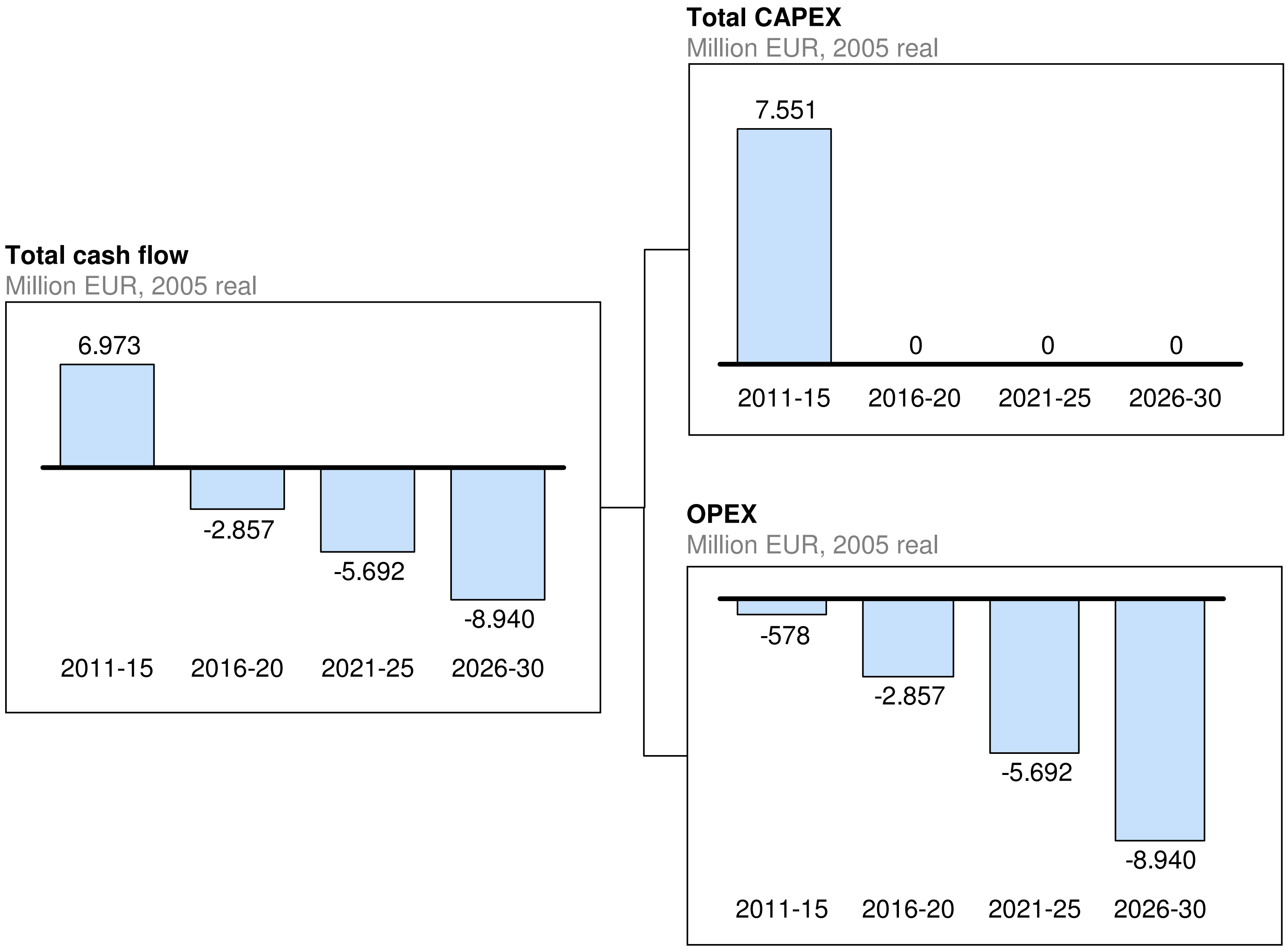
2030, Societal perspective[1]



1 Societal perspective (i.e., excluding taxes, subsidies, and with a capital cost similar to government bond rates)

SOURCE: Global GHG Abatement Cost Curve v2.0; “White Biotechnology Industries development strategy” project ; expert Interview

Incremental Capex required is fully offset by Opex savings



SOURCE: Global GHG Abatement Cost Curve v2.0; “White Biotechnology Industries development strategy” project ; expert Interview