Low-Carbon Growth

A Potential Path for Mexico

Mexico City, August 2009

Background to the Mexico Project

Objectives

- Fill gap in existing knowledge base for Mexico
  - Identify a low-carbon path across all sectors using consistent methodology
  - Understand the costs and benefits of abatement both at a micro and macro level
  - Develop a high level implementation strategy laying out barriers to be overcome and timeline for action
- Contribute to the forthcoming Special Programme on Climate Change (PECC)
- Produce a methodology that is repeatable in other countries

Stakeholders

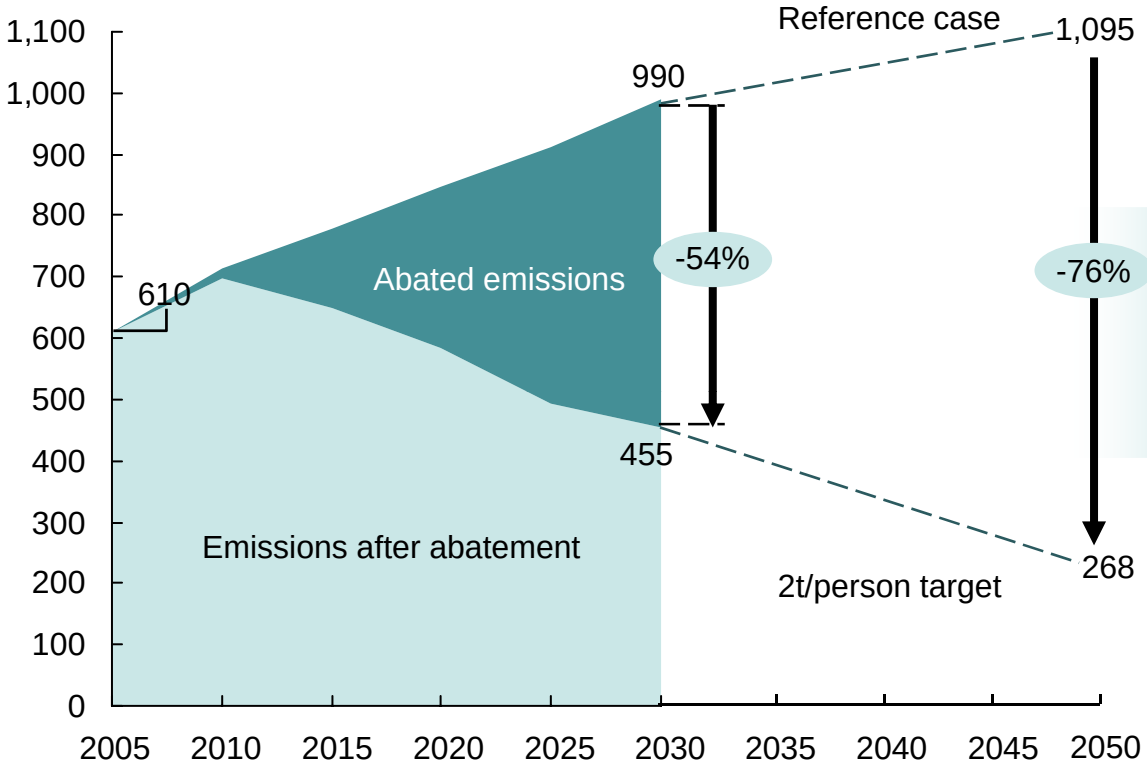
- Project supported by
  - Mario Molina Centre
  - Mexico Office of Climate Change
- Work also syndicated with
  - Regulatory Commission of Energy
  - National Institute of Ecology
  - Ministry of Energy
  - PEMEX (Oil and gas)
  - CFE (Electricity)
- Analytical work conducted by McKinsey

Summary of main findings

- Mexico has the potential to reduce emissions by 535 Mt CO_2e, or 54 percent from reference case level, by 2030
- Reductions can be achieved with action across all major economic sectors, with significant opportunity in power, transport, waste and agriculture
- The incremental investment required is manageable, adding about US$18 billion or 3 percent to total investment in 2030, and the economy can continue to grow at 4 percent annually
- There are significant co-benefits to reducing emissions including energy security, health and welfare, and international leadership status
- Mexico has a window of opportunity to act now – to prevent lock-in of high-carbon infrastructure, to achieve maximum benefit from energy savings, to avoid need of more drastic and costly action later, and to capture competitive advantage in low-carbon technology
- Mexico can pursue a low-carbon strategy across three time horizons: ‘do it now, no regrets’; ‘start now, then accelerate’; and ‘develop now, capture over time’

535 Mt of abatement potential has been identified, which is sufficient to put Mexico on a low-carbon path

Total greenhouse gas emissions,
Mt CO_2e

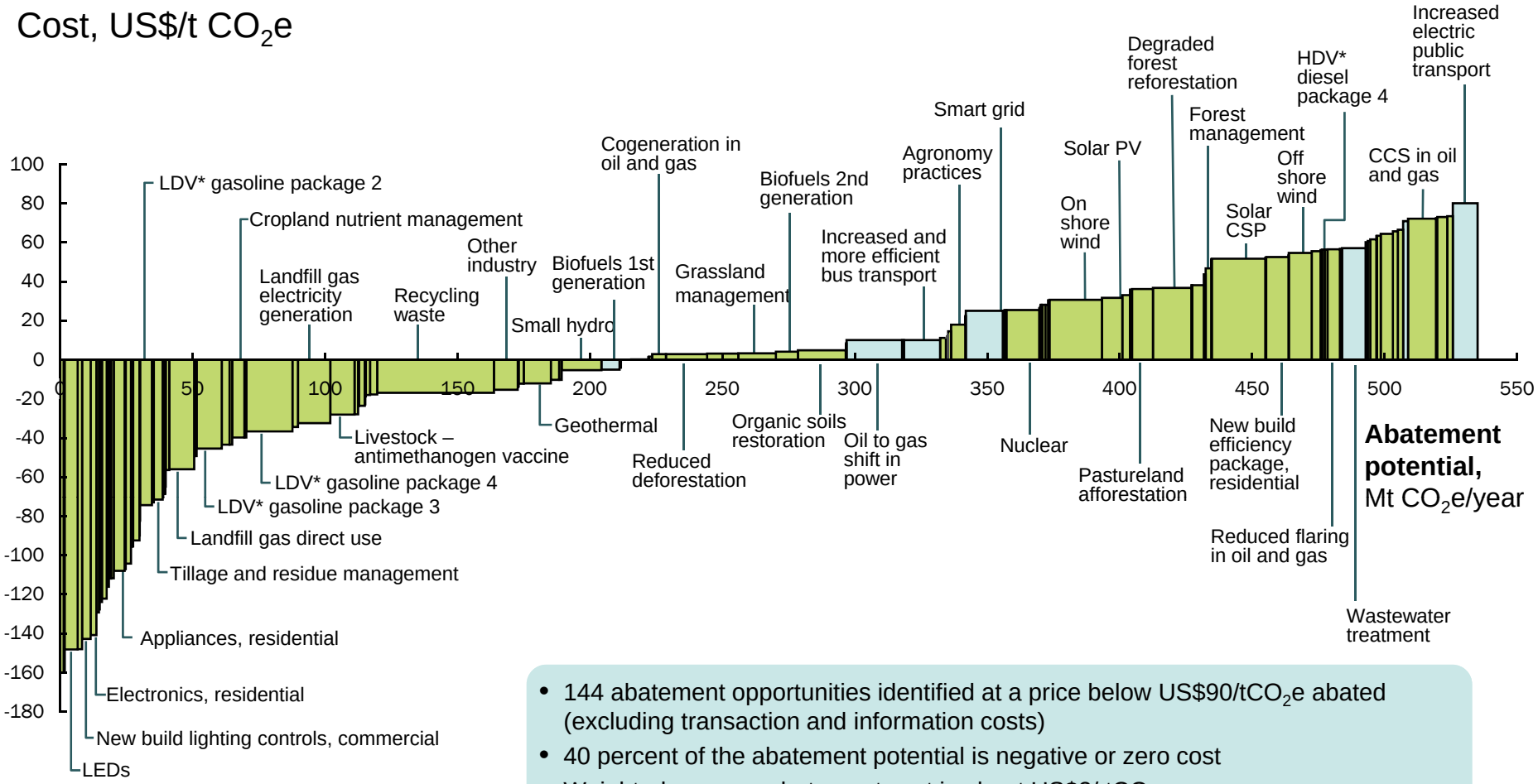


- Under **reference case**, emissions grow from 610 Mt in 2005 (6 tonnes per person) to 990 Mt in 2030 (8 tonnes per person)
  - Based on IEA and other public sources
  - Assumes some efficiency improvements (e.g., cost-motivated engine efficiency) but does not include abatement programs already under way in Mexico
- Against this reference case, **a low-carbon case** identifies 535 Mt of abatement potential in 2030
  - Represents a 54 percent reduction in emissions compared to reference case by 2030
  - This is enough to put Mexico on a path to a sustainable level of emissions of 2 tonnes per person

Source: IEA World Energy Outlook 2007 (unpublished Annex); Houghton unpublished emissions data; EPA and INEGEI non-CO2 emissions database; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

This 535 Mt of abatement potential consists of 144 different opportunities

GHG abatement cost curve for Mexico in 2030
Cost, US$/t CO_2e



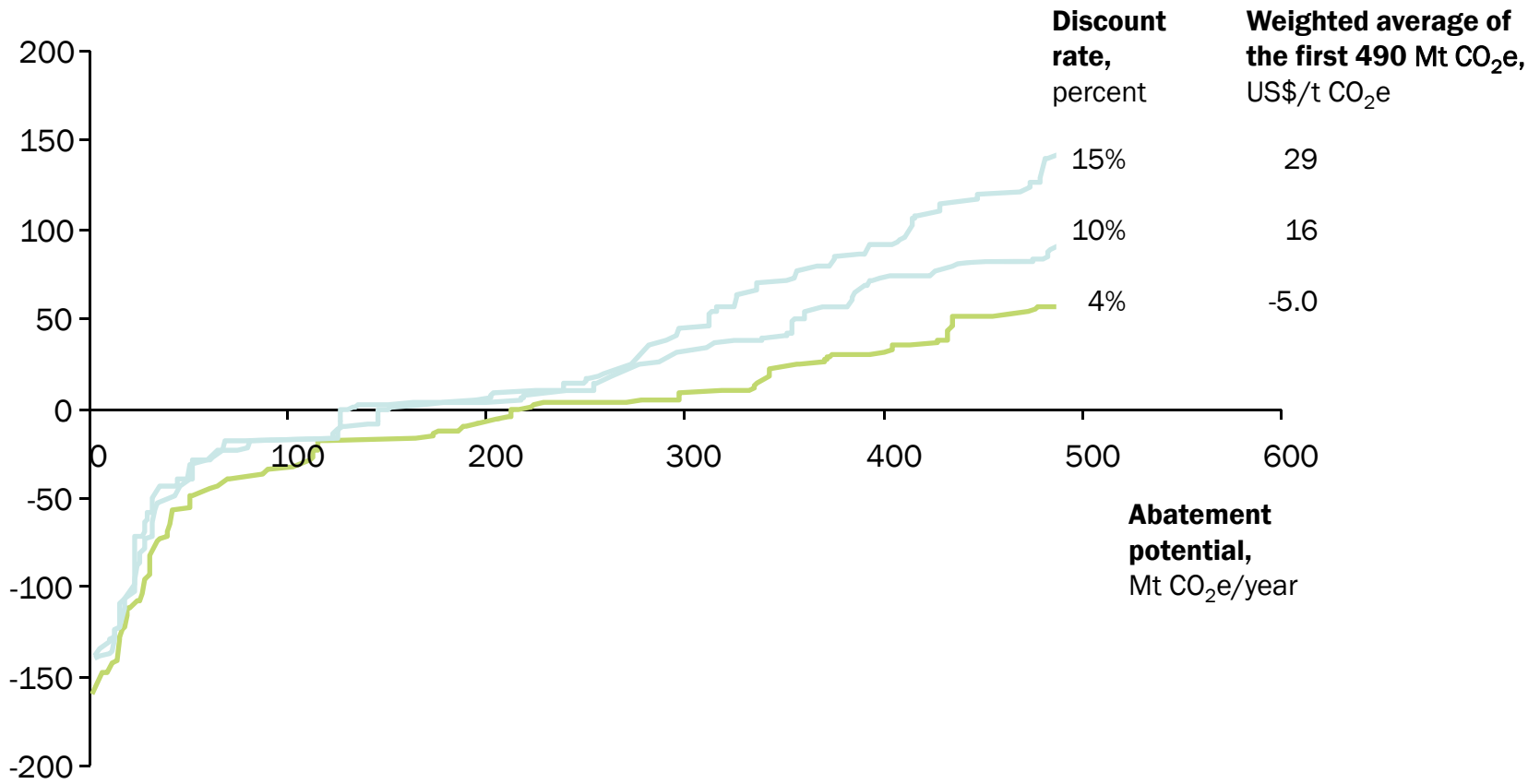
- 144 abatement opportunities identified at a price below US$90/t$CO_2e$ abated (excluding transaction and information costs)
- 40 percent of the abatement potential is negative or zero cost
- Weighted average abatement cost is about US$2/ t$CO_2e$
- No silver bullet to emissions reduction exists – action is required in all sectors
- Many abatement opportunities are fragmented, e.g., energy efficiency and process improvements in industry

* LDVs = light duty vehicles; HDVs = heavy duty vehicles
Note: The cost estimate for the light-colored bars is approximate
Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Cost curve at different discount rates

GHG abatement cost curve for Mexico in 2030 with different discount rates

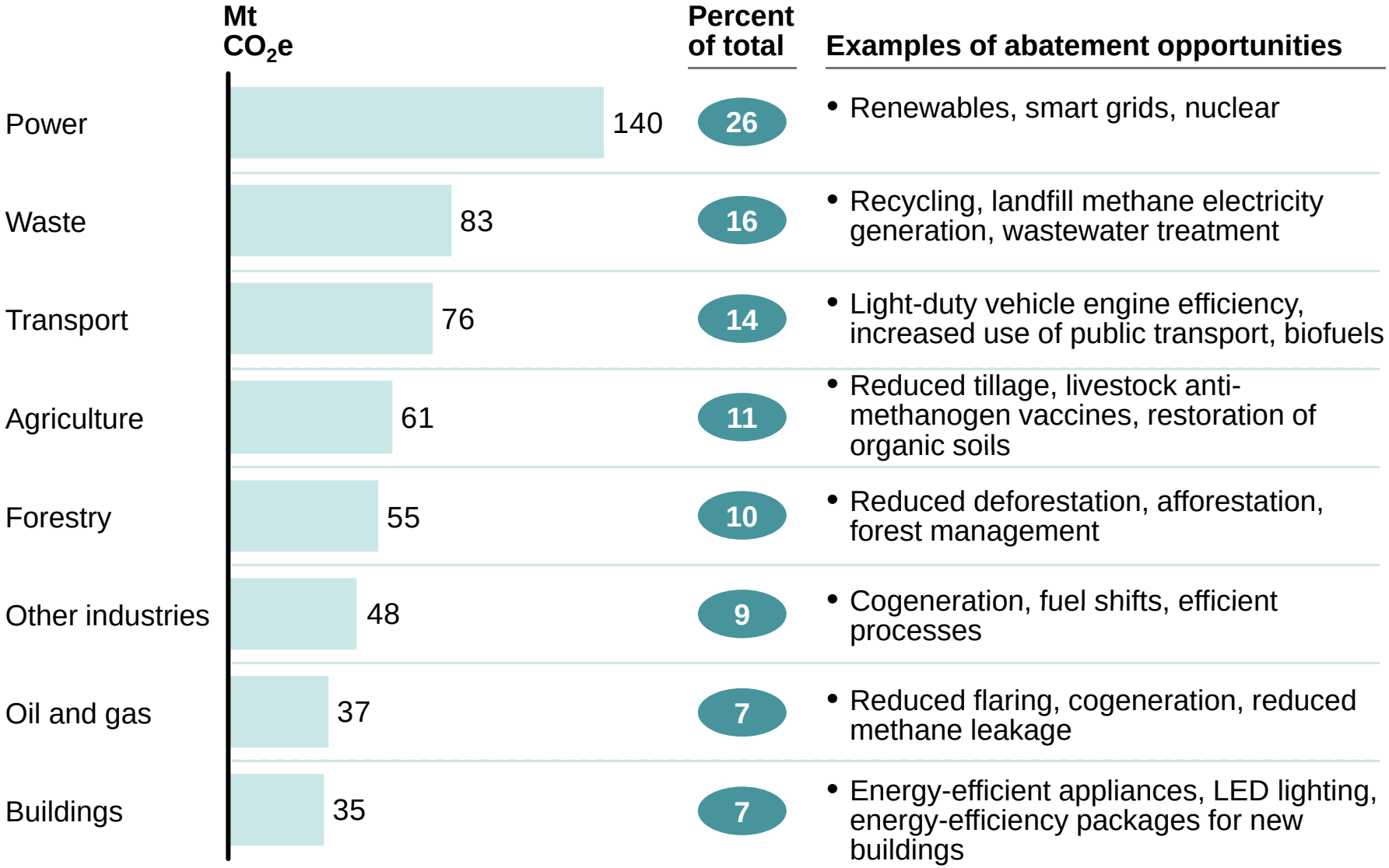
Cost, US$/t CO_2e



Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Abatement opportunities exist in every sector

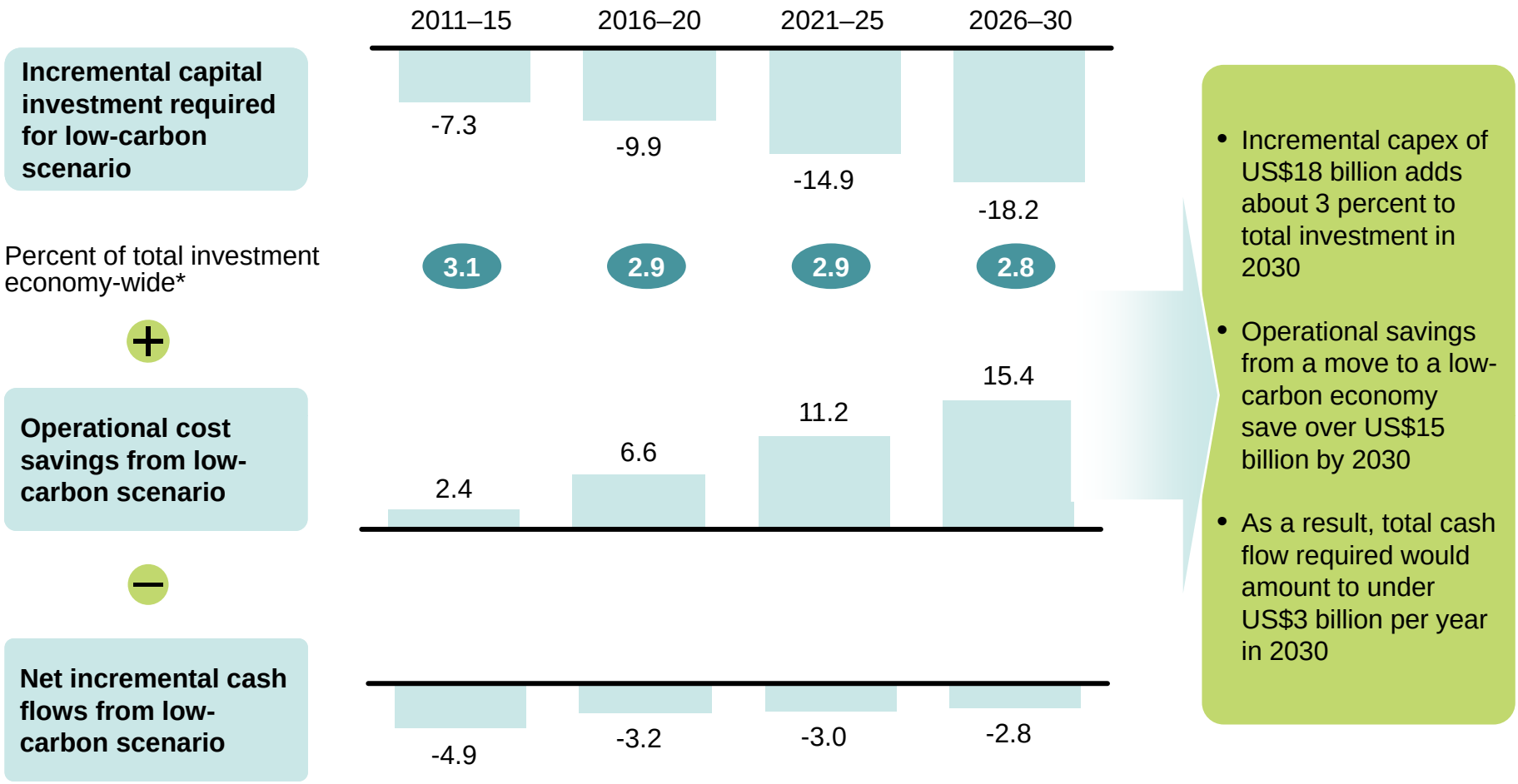
Identified abatement opportunities by sector



Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

From a microeconomic perspective, costs of abatement are moderate, with capital costs largely offset by operational savings

Annual financial flows during each 5-year period,
US$ billion (real 2000)



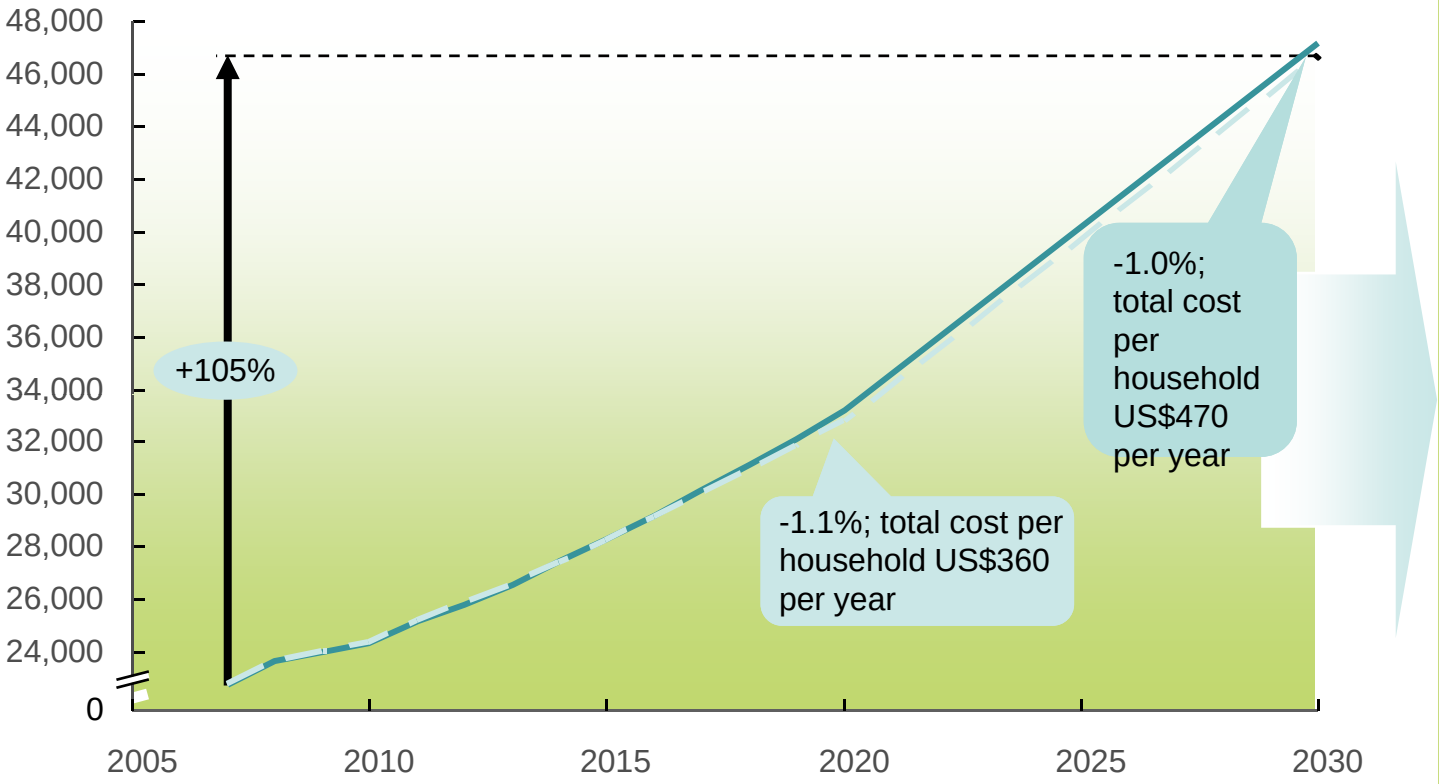
* Represented by gross fixed capital formation

Note: Assumes discount rate 4 percent; oil price US$62/barrel in 2030

Source: Global Insight; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

From macroeconomic perspective, the cost of abatement is around 1 percent of household spending

Household spending,
US$ (real 2000) per household



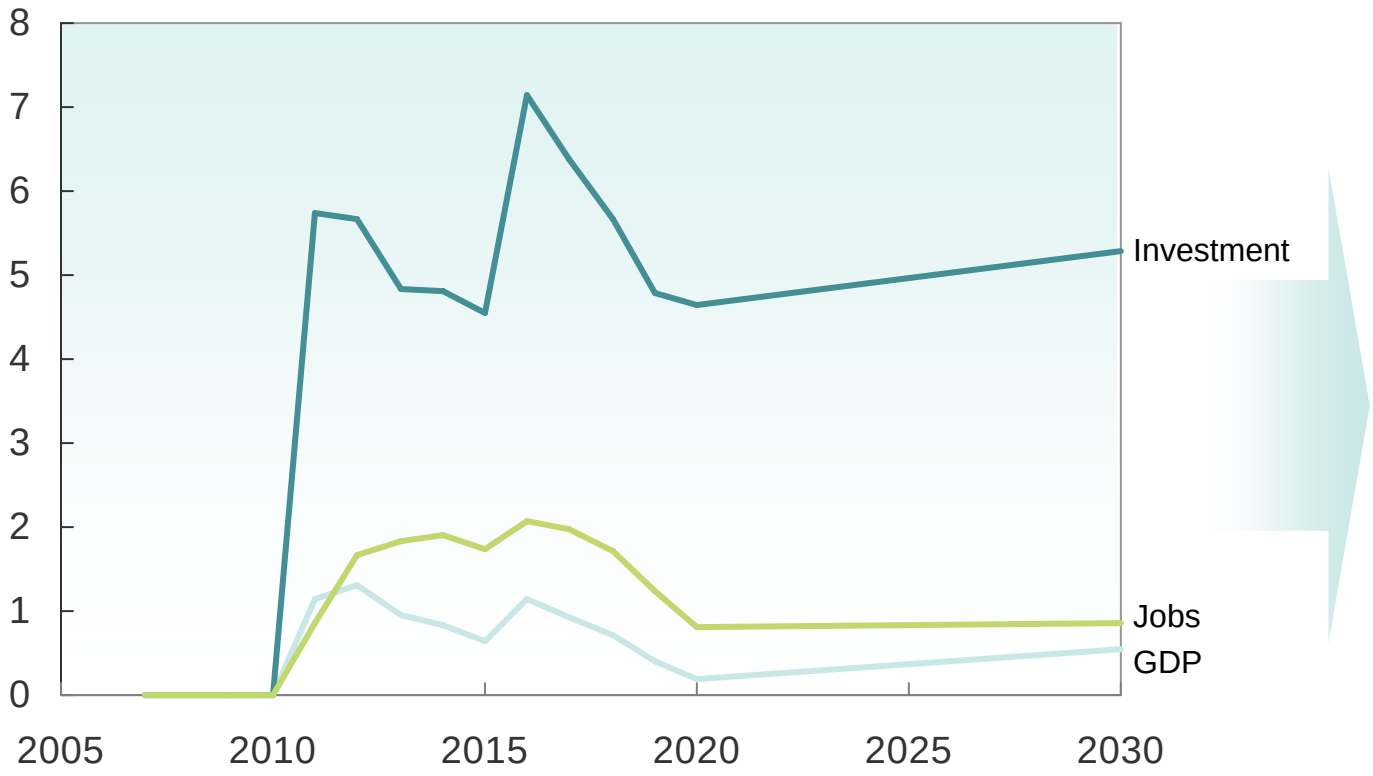
- Cost of going low carbon is less than US$500 per household per year through to 2030
- This cost is incurred gradually over a period when household consumption more than doubles
- Cost is significantly less than the impact of the credit crunch (>2 percent GDP impact forecast for 2009) or 2001 financial crisis (>6 percent drop in GDP)*

* IMF; Global Insight

Source: Cambridge Econometrics E3MG model; Global Insight; McKinsey analysis

At the same time, emissions reduction could drive a low-carbon investment boom that increases GDP and creates jobs

Low carbon case difference from reference case, percent



- Investment in low carbon technology and infrastructure could stimulate the rest of the economy
- This can increase economic growth by up to 1 percent (thereby spurring even more investment across the non-carbon economy)
- While some jobs would be lost e.g., in oil and gas sector, the net impact is estimated as an *addition* of half a million jobs by 2030

Source: Cambridge Econometrics E3MG model; McKinsey analysis

A low-carbon path has many co-benefits

Low-carbon economy

Energy security

- Greater diversity of energy supply
- Protection against oil price shocks
- Greater income through increased availability of oil for exports after domestic demand reduction

Health and welfare

- Greater agricultural productivity, e.g.,
  - +5% yield for dairy and beef from vaccines and feed supplements
  - +11% yield for maize through split fertilization
- Income support for poor people to prevent deforestation
- Better quality of life
  - Less congestion, better air quality from greater use of public transport
  - Cleaner environment through better waste management

Leadership in international climate negotiations

- Increased chances of an effective international climate change agreement
  - Ambitious emissions reduction program by Mexico could help to raise ambition level for other countries
- A leadership role and strengthened negotiating position for Mexico, including improved access to international carbon funds, e.g., CDM

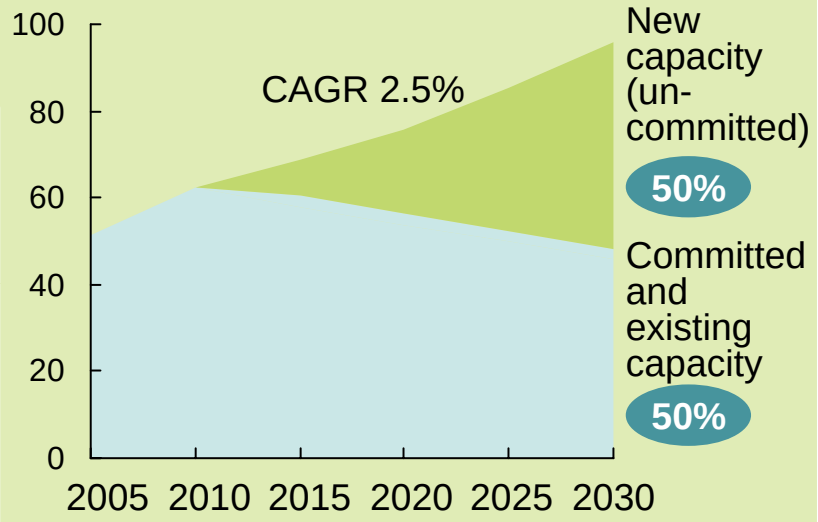
Source: McKinsey analysis

Immediate action to reduce emissions is needed for five reasons

	Description
Capital replacement cycle	• Mexico has an opportunity to prevent lock-in of high-carbon infrastructure for decades to come
Steepening challenge	• Delayed action makes more radical and costly action necessary later
Rising energy prices	• Improving energy efficiency can reduce energy bills and increase income from energy exports, especially as energy prices are likely to rise
Potential for competitive advantage	• A few hubs are likely to emerge globally for new low-carbon technologies • If it acts fast, Mexico could become such a hub in the Americas for, e.g., solar technologies
Global political momentum	• A commitment to ambitious action program would strengthen Mexico's negotiating position for a post-2012 climate agreement and its chances to benefit from carbon financing

Over 50% of Mexico's 2030 power generation capacity is yet to be built

Power generation capacity, GW



Source: CFE; McKinsey analysis

Mexico can pursue the abatement opportunities across three time horizons

X Abatement potential, Mt CO_2e (total 535)

Ease of capture (in near-term)

Cost today	Readily achievable	More challenging	Difficult
Negative	• Appliances and electronics energy efficiency • New build lighting controls • Cropland nutrient mgmt • Energy efficiency, oil & gas • Methane leakage prevention, oil & gas • Fuel shift, industry **35**	• Geothermal, small hydro • Engine efficiency, LDVs[1] • Energy efficiency packages, commercial new build • Retrofit lighting controls • Solid waste (excl. landfill gas flaring) • Cogeneration, other industries **145**	• LED lighting • Tillage and residue mgmt • Chemical process optimization **17**
Modest	• Landfill gas flaring • Increased bus transport • Reduced flaring, oil & gas • Cogeneration, oil & gas • Solar water heaters **36**	• Solar & wind[2]; smart grids • Oil to gas shift, power • Energy efficiency packages, residential new build • Reduced deforestation • Energy efficiency, other industries • Agronomy practices, grassland management • Soil restoration **191**	• Nuclear • Biofuels – 2nd gen. domestic **21**
High	• Afforestation/ reforestation, forest mgmt **27**	• Increased subway transport • Wastewater treatment • Engine efficiency, HDVs[1] **23**	• Carbon capture and storage • Livestock feed supplements and vaccines **41**

1 ‘Do it now, no regrets’

2 ‘Start now, then accelerate’

3 ‘Develop now, capture over time’

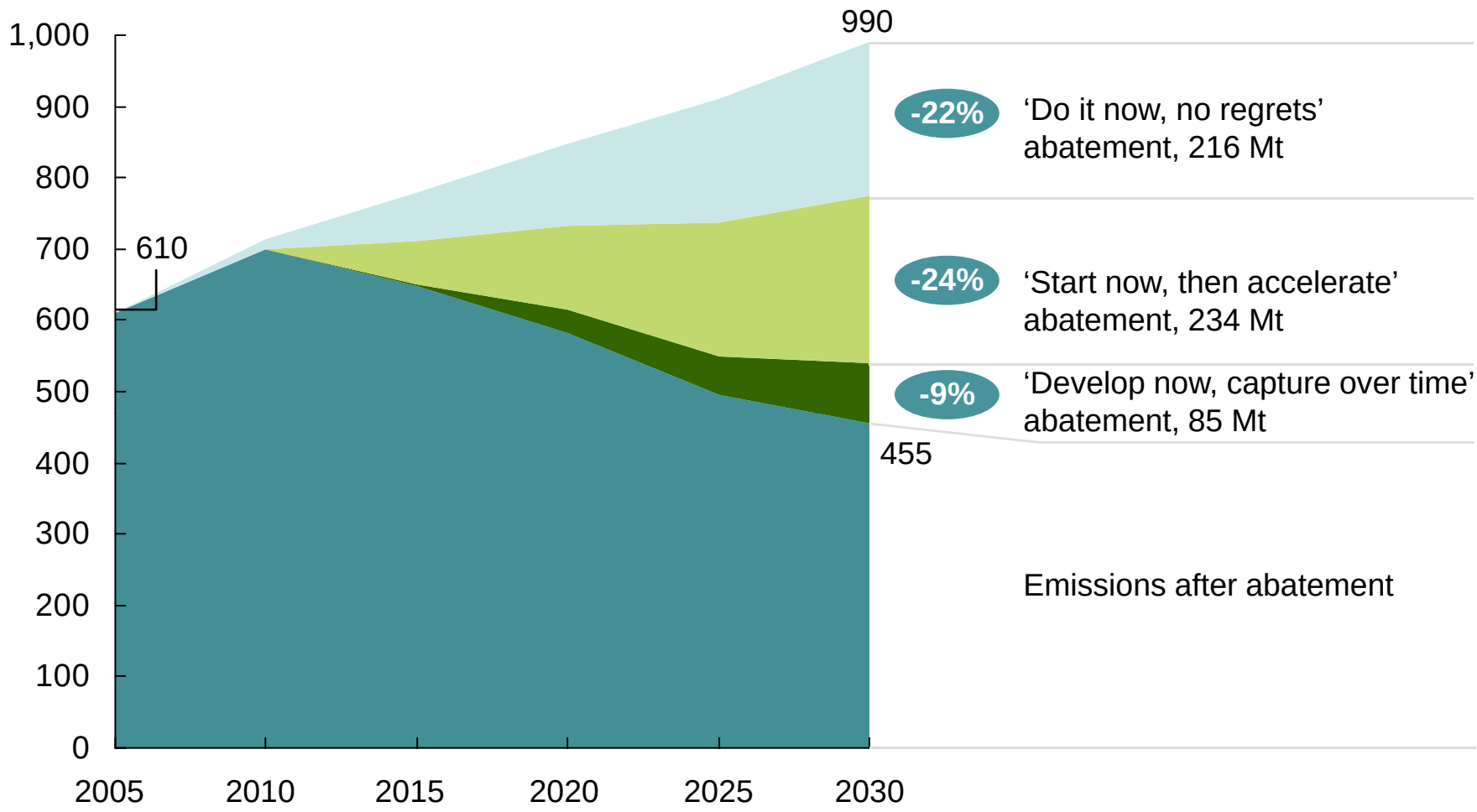
1 LDVs = light duty vehicles; HDVs = heavy duty vehicles

2 Though costs of these technologies are high, from an implementation perspective they belong to category 2 as early action is needed to support learning and to make wide implementation possible

Note: Only a selection of largest opportunities are listed here, but abatement figures include all opportunities

Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Most of the opportunity is available now, or ready to be started immediately and scaled up later



Source: IEA and Houghton unpublished emissions data; EPA non-CO2 emissions database; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Potential sources of funding

	Description
Private Sector	• Given right incentives and a stable regulatory framework, Mexico's businesses could begin directing capital investment • Other studies have shown that in most sectors, most of the incremental costs could eventually be passed on to consumers.
Public Sector	• Government funding will play an important role in several ways: – Kick-start private sector investment (e.g. providing low interest loans for energy efficiency investments – Public sector will need to invest in public goods that support the low carbon transition (e.g. upgrades to the national electricity grid to better support renewables)
Carbon Markets	• Through CDM, developed countries can contribute to their domestic abatement goals by funding abatement in developed countries where the cost is potentially lower • Other mechanisms like Global Environmental Fund (e.g. Green Fund)
International Institutions	• Agencies such as the World Bank and IADB have increasingly directed funds to invest in emissions reduction in developing economies. This can be in the form of grants or low interest loans
Foreign direct investments	• Mexico received around US$25 billion in private sector foreign direct investment in 2007. • If Mexico became a leading emerging market for low-carbon products and services, it would likely attract a growing share of the rapidly growing amounts being invested in 'clean tech' (estimated at US$150 billion this year).

Backup

Mexico is already making progress toward becoming a low-carbon economy

Two comprehensive policy documents under way

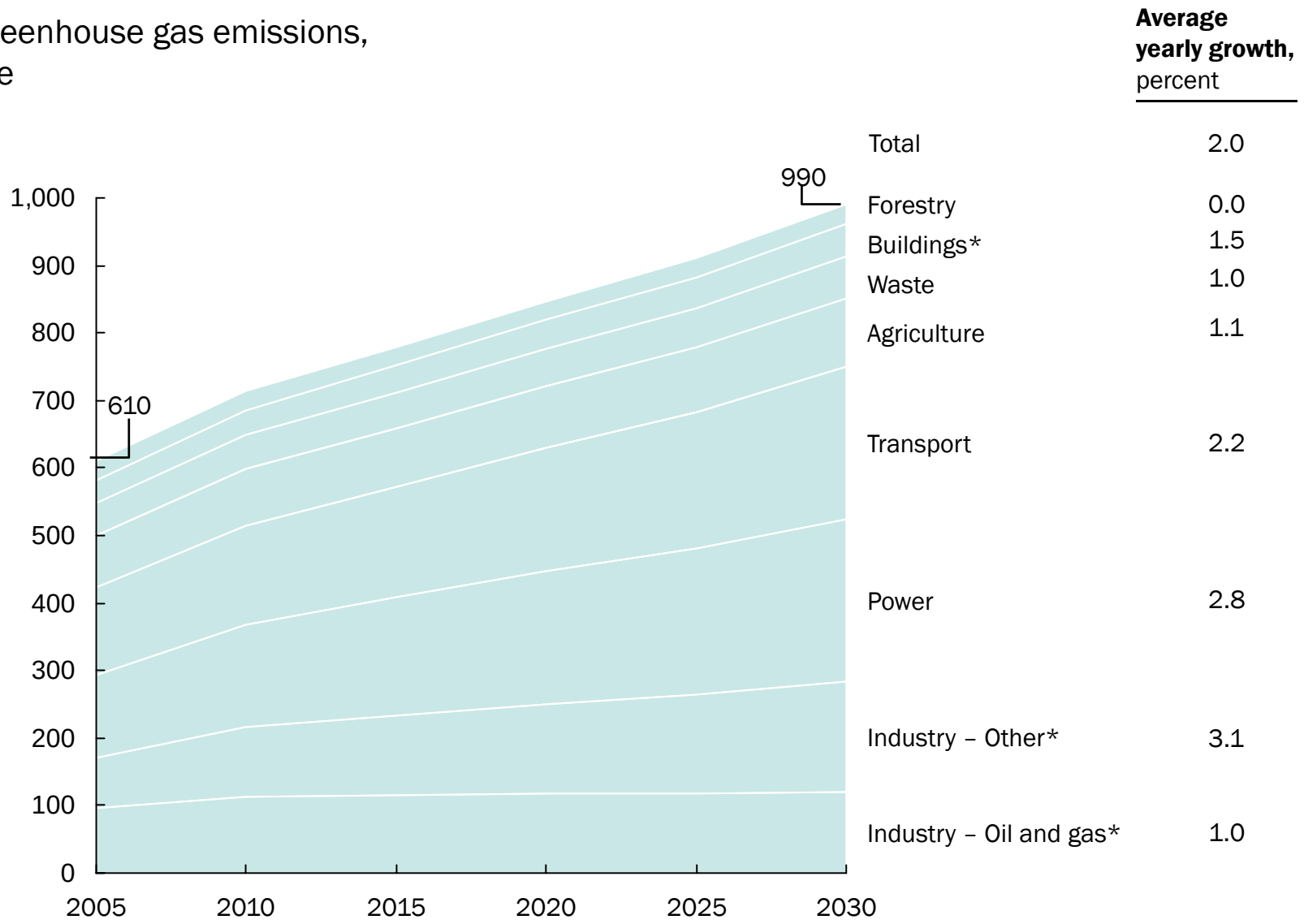
- National Strategy on Climate Change (ENACC) 2007
- Special Program on Climate Change (PECC)

Specific projects are underway in all sectors – sample of initiatives

Power	• Pilot for small-scale, distributed solar power
Transport	• Strict efficiency standards under revision • "Eco-vehicles" web portal to educate consumers
Buildings	• Substitution program for inefficient home appliances • Guidelines for energy-efficient new buildings
Industry	• Cogeneration potential assessment and projects across industries • Pemex plan for gas injection into mature fields to reduce flaring
Agriculture	• Project for sustainable rural development and resource efficiency in agriculture
Waste	• Local waste management programs
Forestry	• Program for conservation and sustainable management of forests

Source: ENACC; Prospectiva del Sector Electrico, SENER; interviews; McKinsey analysis

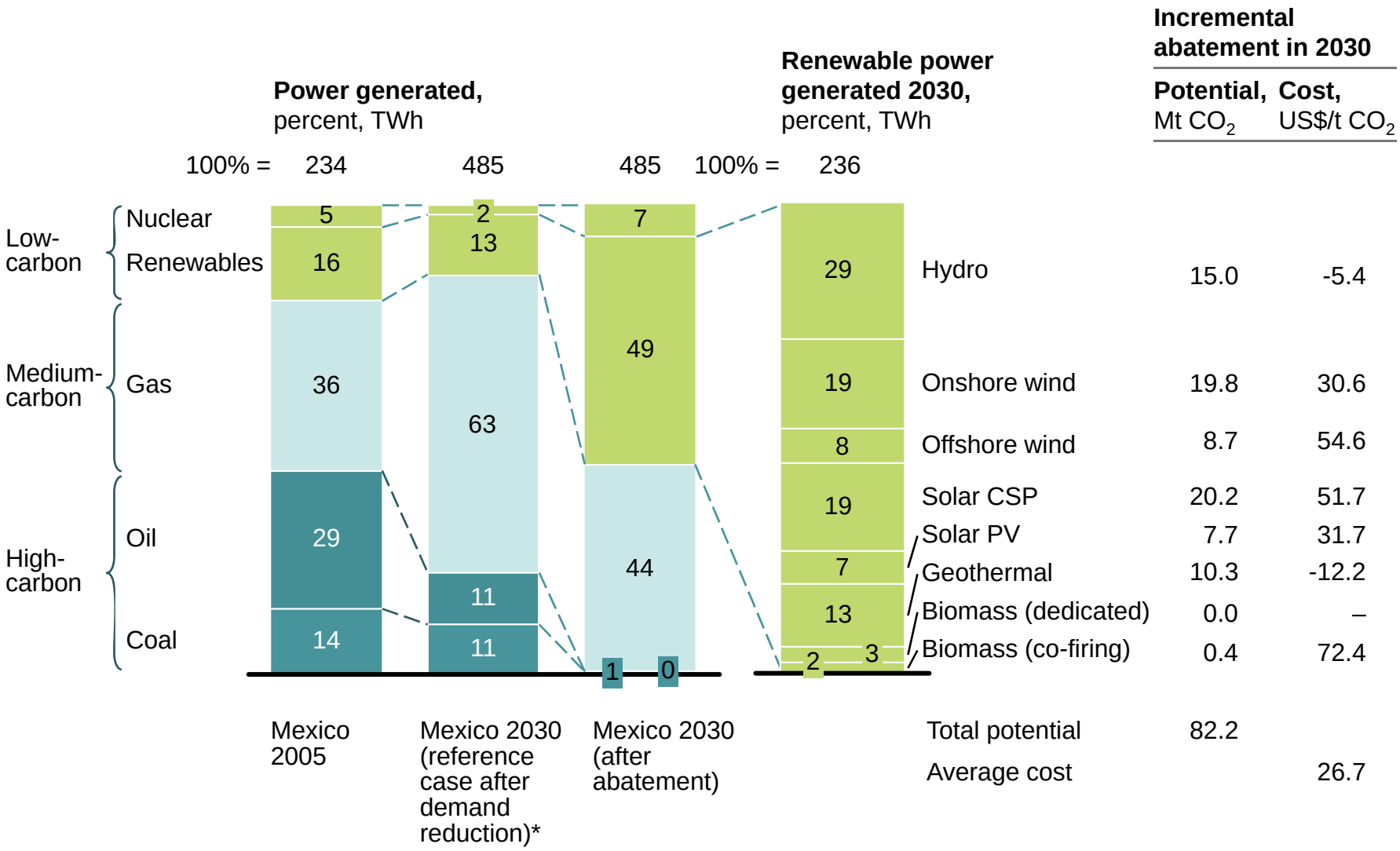
Under reference case, emissions grow from 610 Mt in 2005 to 990 Mt in 2030



* Direct emissions only; indirect emissions included in power

Source: IEA WEO 2007; Houghton; EPA; INEGEI; McKinsey analysis

In the power sector, some 50 percent of future generation requirements could come from renewables

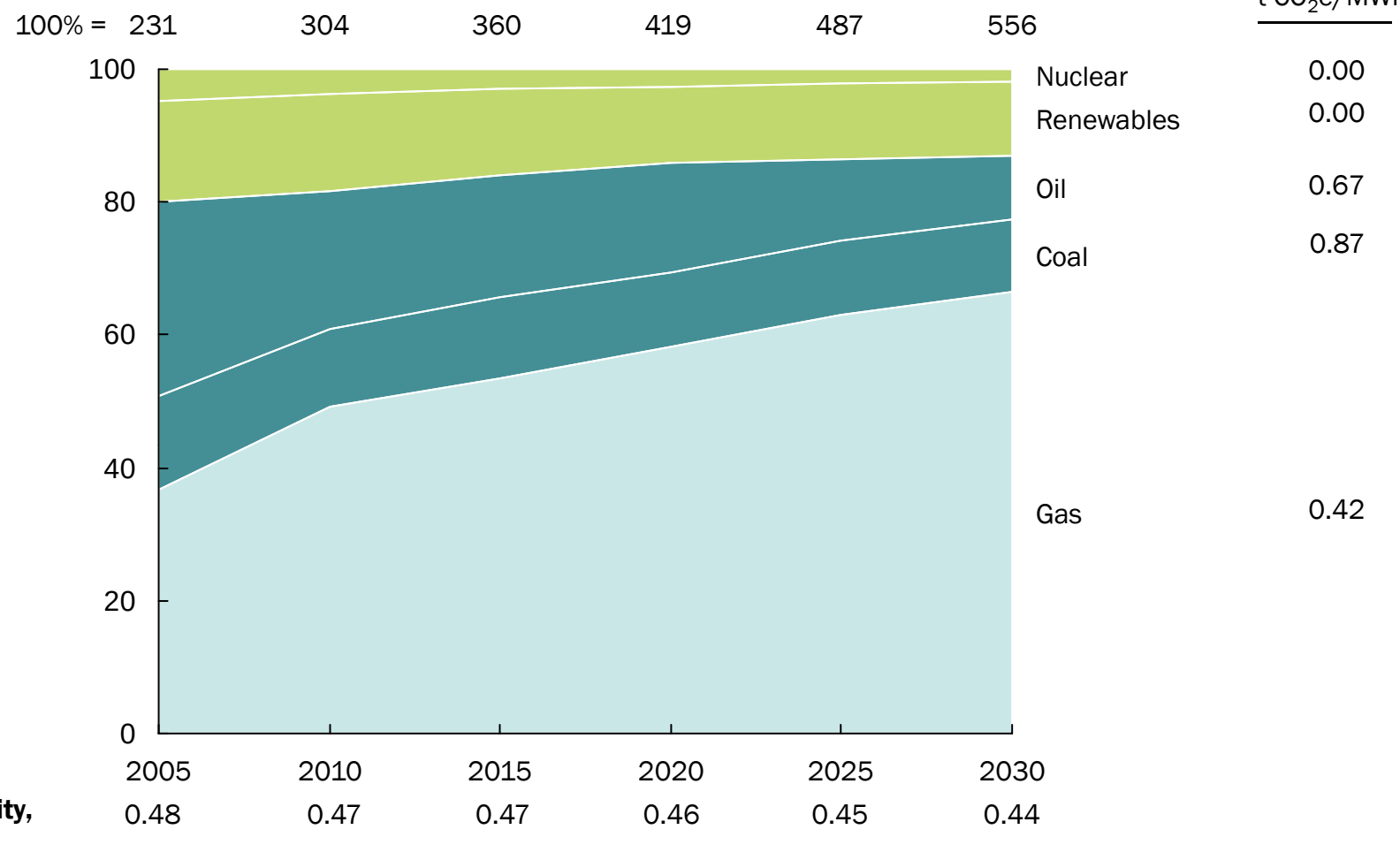


* Mexico's current policy prevents a share of more than 50 percent gas in the power mix

Source: IEA WEO 2007 (unpublished Annex); McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 2. Power generation mix in reference case

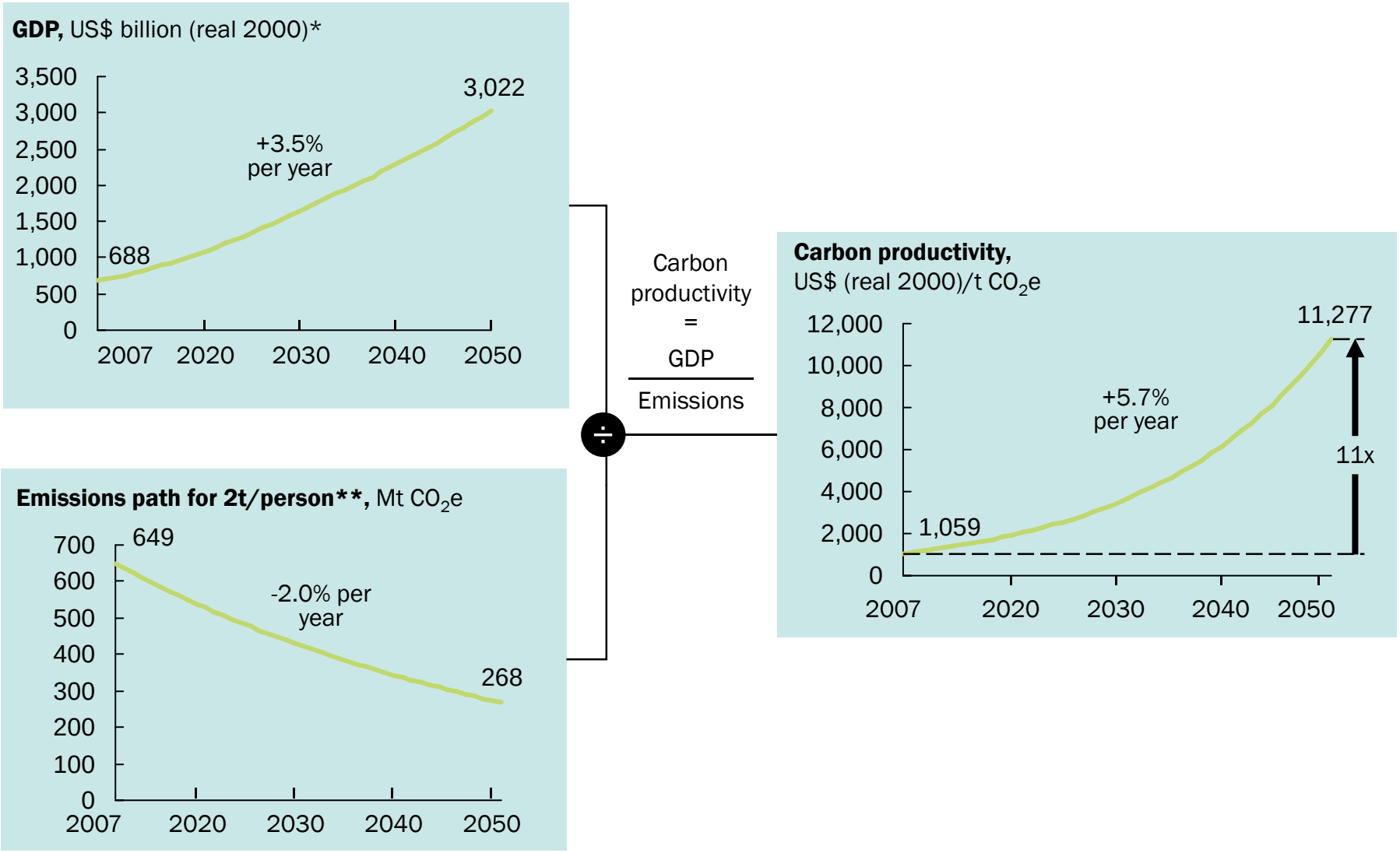
Power generation,
percent, TWh



* Based on 2030 forecasts

Source: IEA reference scenario

Exhibit 3. Carbon productivity improvement required



* Extrapolated from 2039 onwards based on CAGR 2033-2038

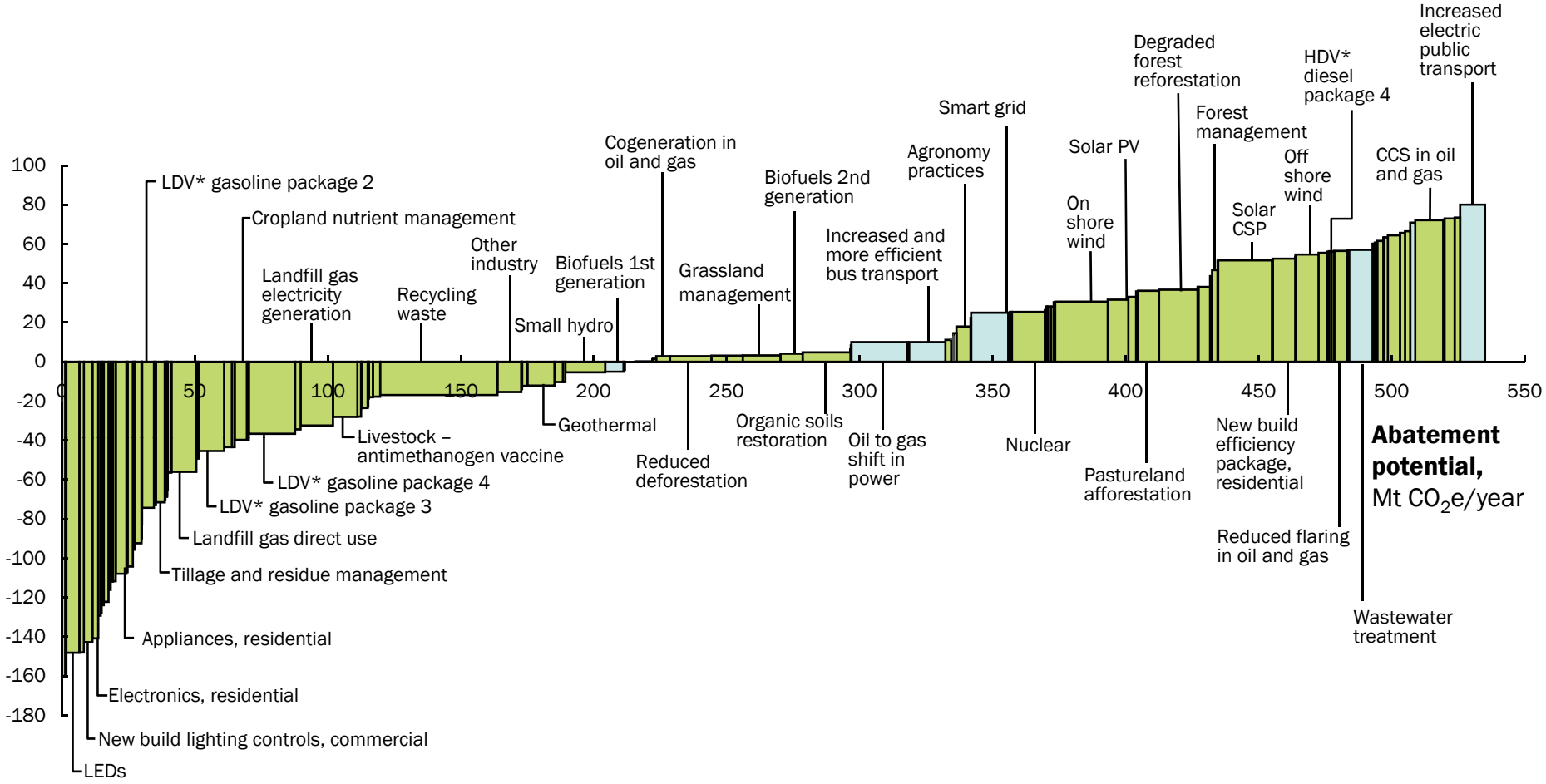
** Based on G8+5 target of 20 $GtCO_2e$ global emissions by 2050 and population of ~9 billion, emissions per person is roughly 2 tonnes

Source: Global Insight; UN population database; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 4. National carbon abatement cost curve for Mexico

GHG abatement cost curve for Mexico in 2030

Cost, US$/t CO_2e



* LDVs = light duty vehicles; HDVs = heavy duty vehicles

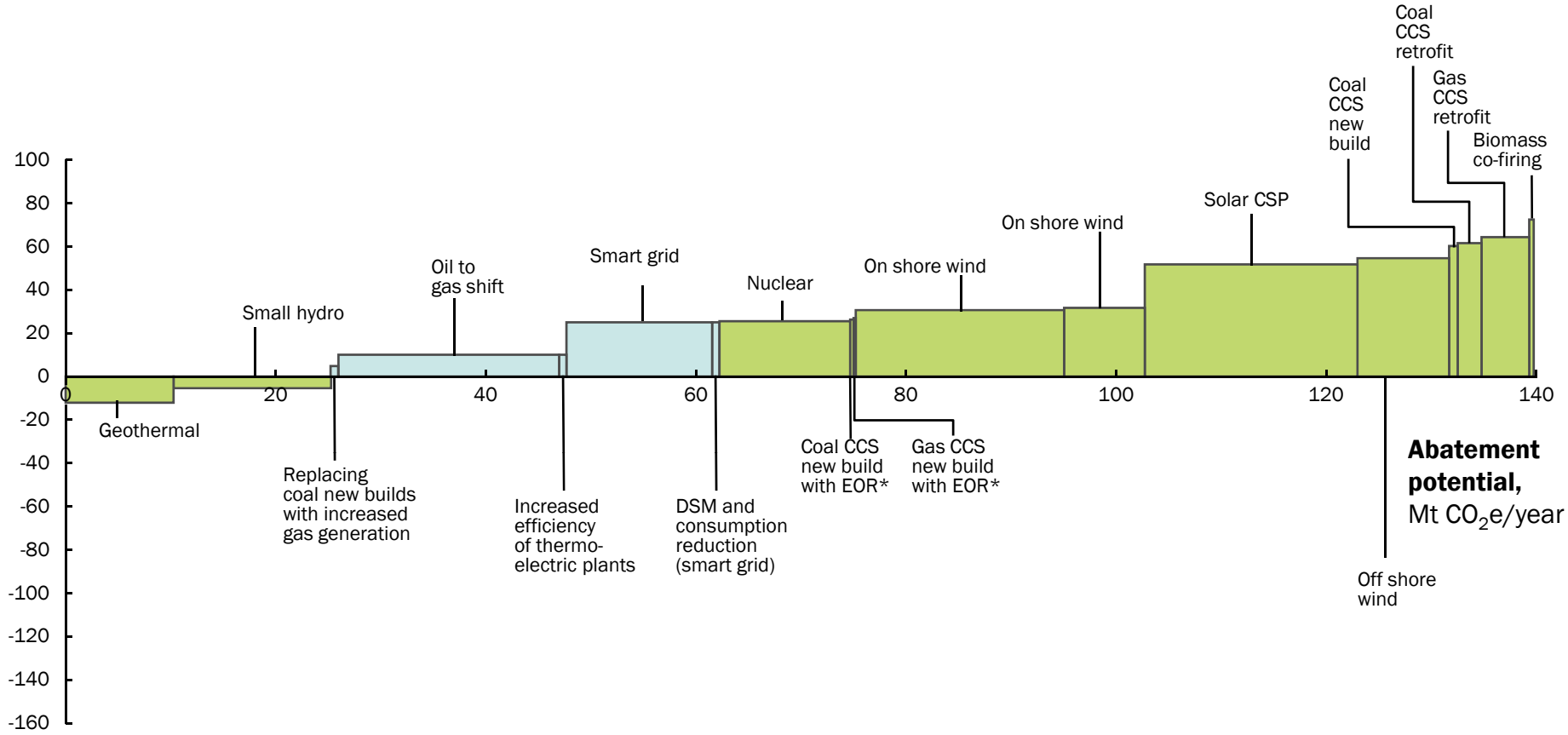
Note: The cost estimate for the light-colored bars is approximate

Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 5. Power sector cost curve

GHG abatement cost curve for power in Mexico, 2030

Cost, US$/$tCO_2e$

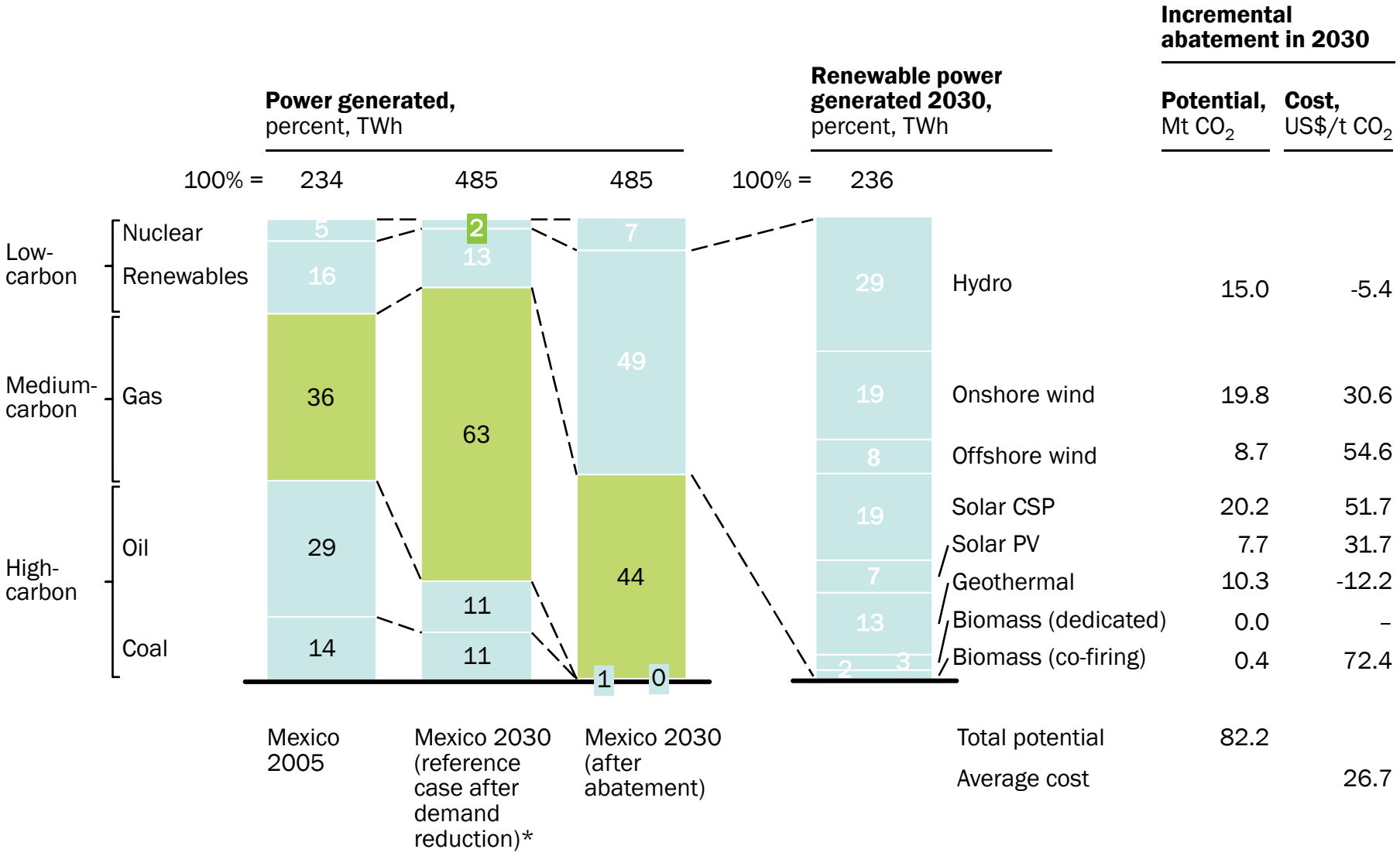


* Enhanced oil recovery

Note: The cost estimate for the light-colored bars is approximate

Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

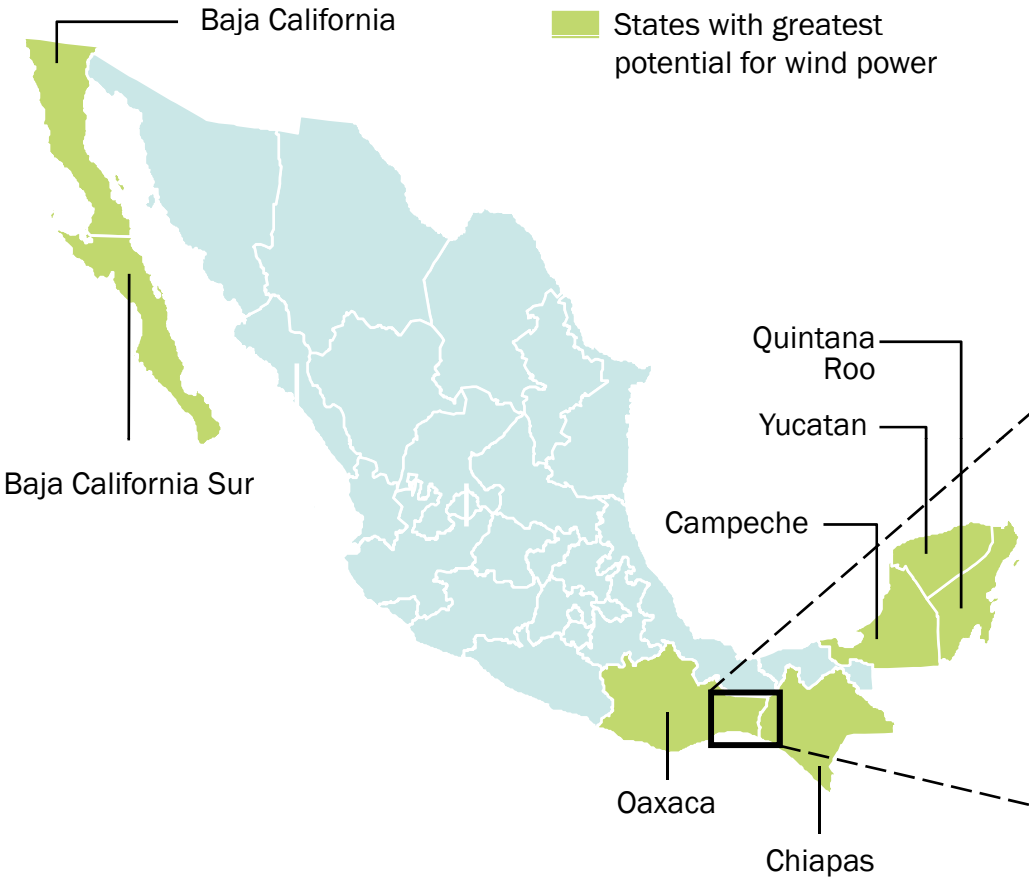
Exhibit 6. A low-carbon scenario for power generation



* Mexico's current policy prevents an over 50% share of gas in the power mix

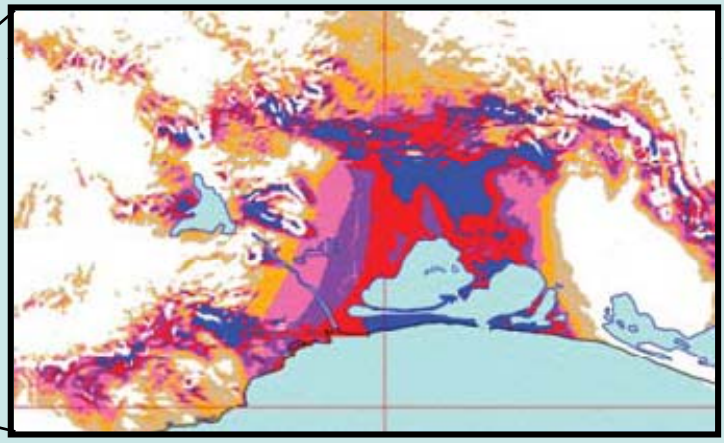
Source: IEA WEO 2007 (unpublished Annex); McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 7. Wind potential in Mexico



Wind conditions in the Tehuantepec Isthmus are among the best in the world

Wind Power Class		Resource Potential	Wind Power Density at 50m (W/m^2)	Wind Speed at 50 m (m/s)
	1	Poor	0-200	0-5.3
	2	Marginal	200-300	5.3-6.1
	3	Moderate	300-400	6.1-6.7
	4	Good	400-500	6.7-7.3
	5	Excellent	500-600	7.3-7.7
	6		600-800	7.7-8.5
	7		>800	>8.5

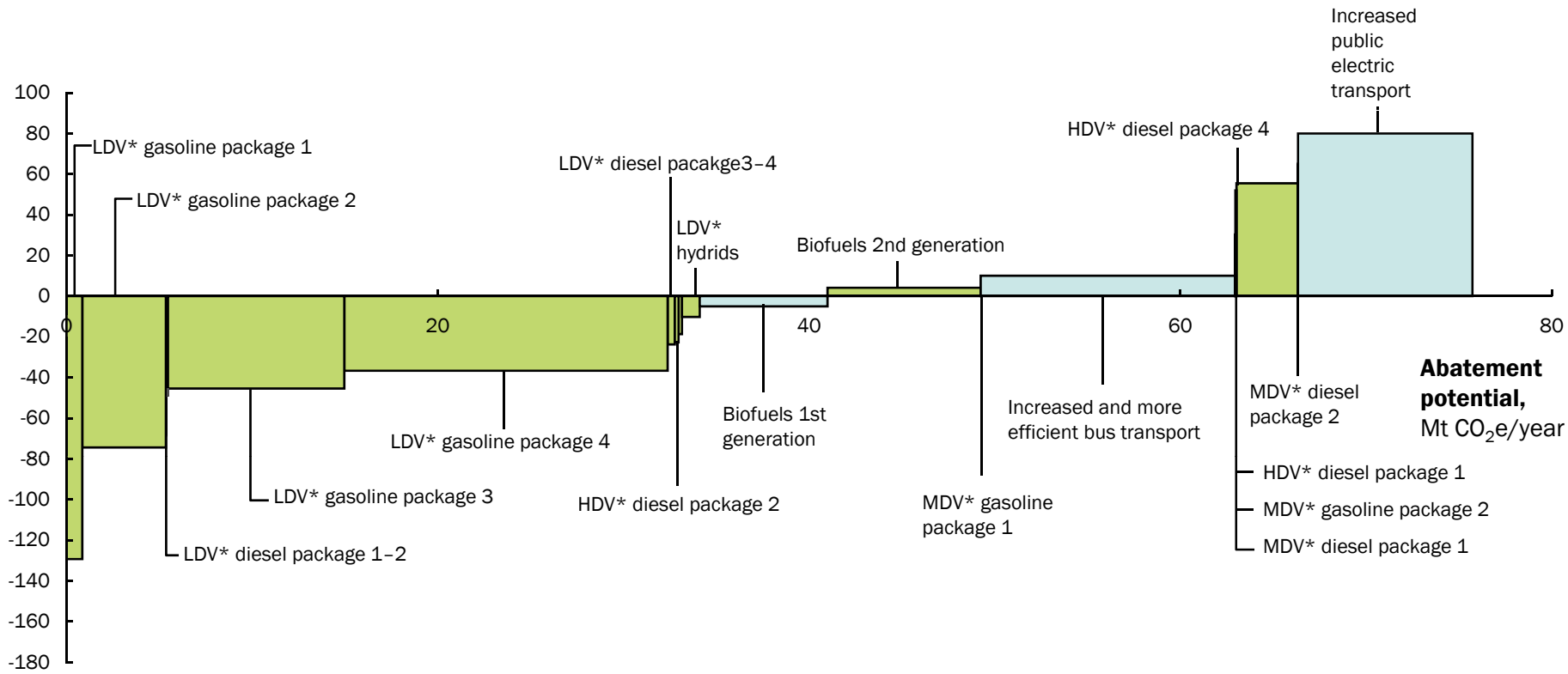


Source: SENER; NEREL; ANES; AMDEE; IEE; IEA; McKinsey analysis

Exhibit 8. Transport sector cost curve

GHG abatement cost curve for transport in Mexico, 2030

Cost, US$/t CO_2e



* LDVs = light duty vehicles; MDVs= medium duty vehicles; HDVs = heavy duty vehicles

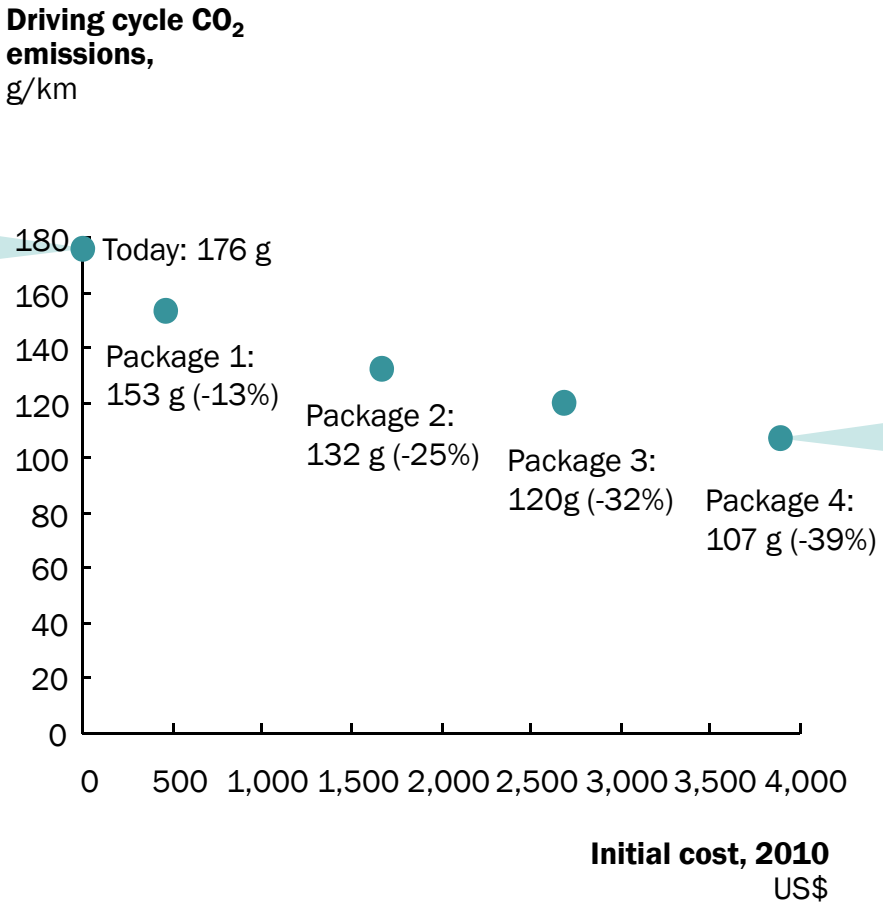
Note: The cost estimate for the light-colored bars is approximate

Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 9. Auto engine efficiency improvement potential

Design today – standard car

- Engine
  - Intake: Naturally aspirated
  - Displacement: 1,600 cc
  - Cylinders: 4
  - Valve control: Traditional
  - Max power: 75 kW
- Transmission: Manual, 5 gears
- Weight: 1,100 kg
- CO_2 emissions (combined cycle): 176 g/km
- Fuel consumption (combined cycle): 7.2 l/100 km
- Cost: US$17,700



Design after improvements with currently available technologies

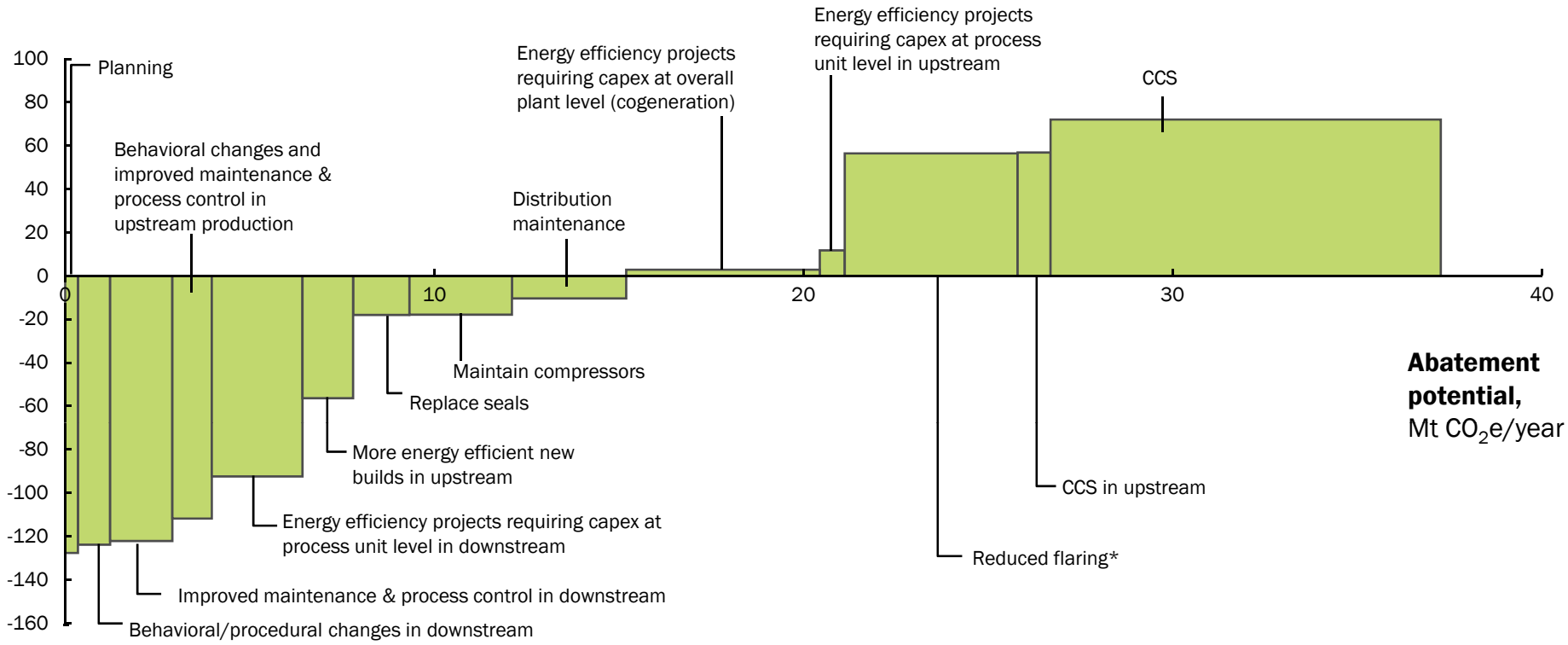
- Engine
  - Intake: Turbocharged
  - Displacement: 800 cc
  - Cylinders: 4
  - Valve control: Variable
  - Max power: 75 kW
- Transmission: Manual, 5 years, optimized gear box
- Weight: 1,000 kg
- CO_2 emissions (combined cycle): 107 g/km
- Fuel consumption (combined cycle): 4.4 l/100 km
- Cost: ~US$21,600 (2010); ~US$20,100 (2030)

Source:McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 10. Oil and gas sector cost curve

GHG abatement cost curve for oil and gas industry in Mexico, 2030

Cost, US$/t CO_2e

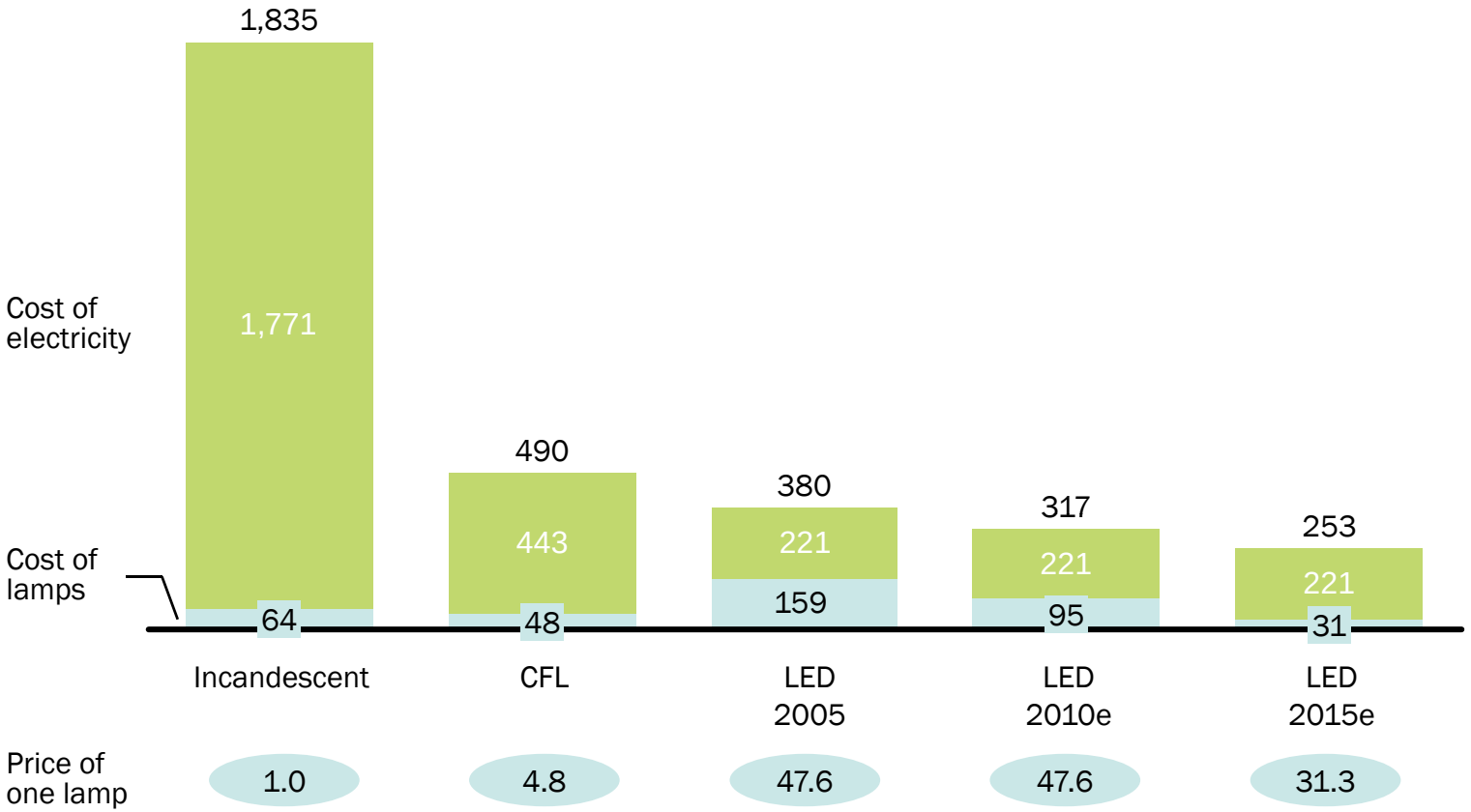


* Costs depend on location-specific factors and on whether the gas is sold on the market or injected into depleting oil fields

Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 11. Lifetime costs for lighting types

Total cost of ownership for 90 million lumen hours, US$*

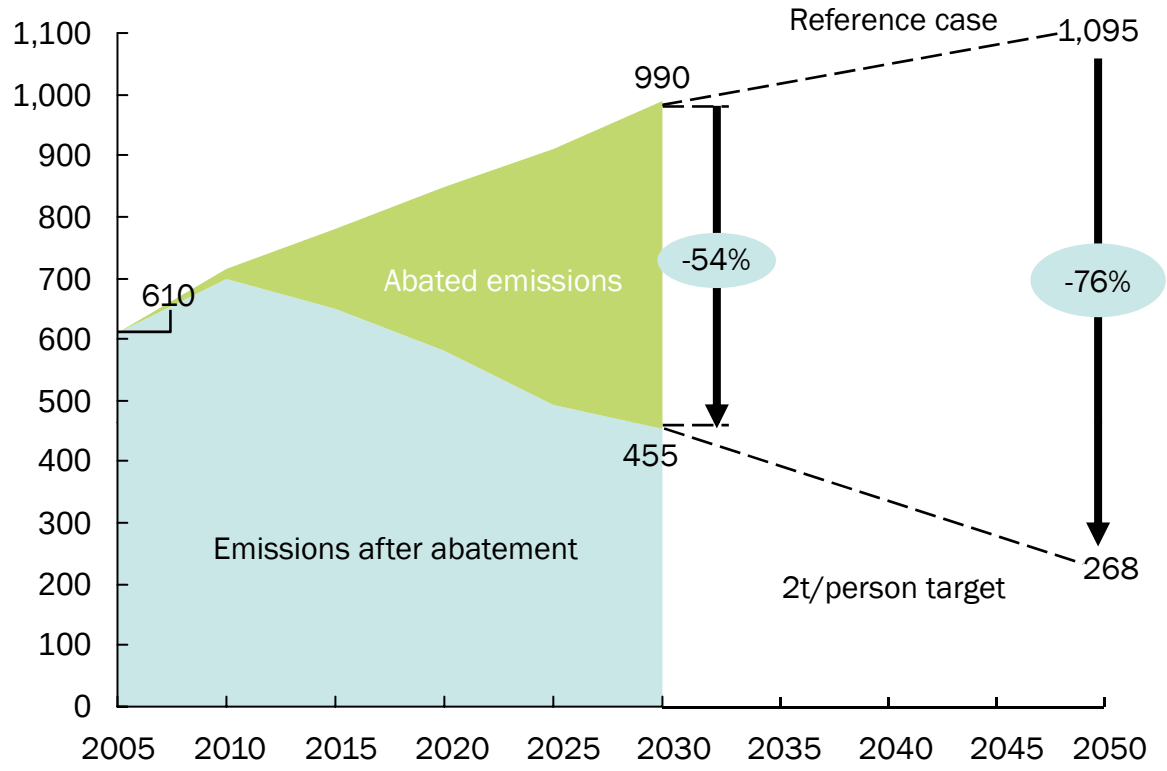


* Assumes electricity price US$0.246/kWh (CFE tariff for highest-consuming households)

Source: Daiwa (Mar 2007) "LED Sector: The future's bright, the future's green"; IEA (2006) "Light's Labour's Lost"; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 12. Potential low carbon pathway for Mexico

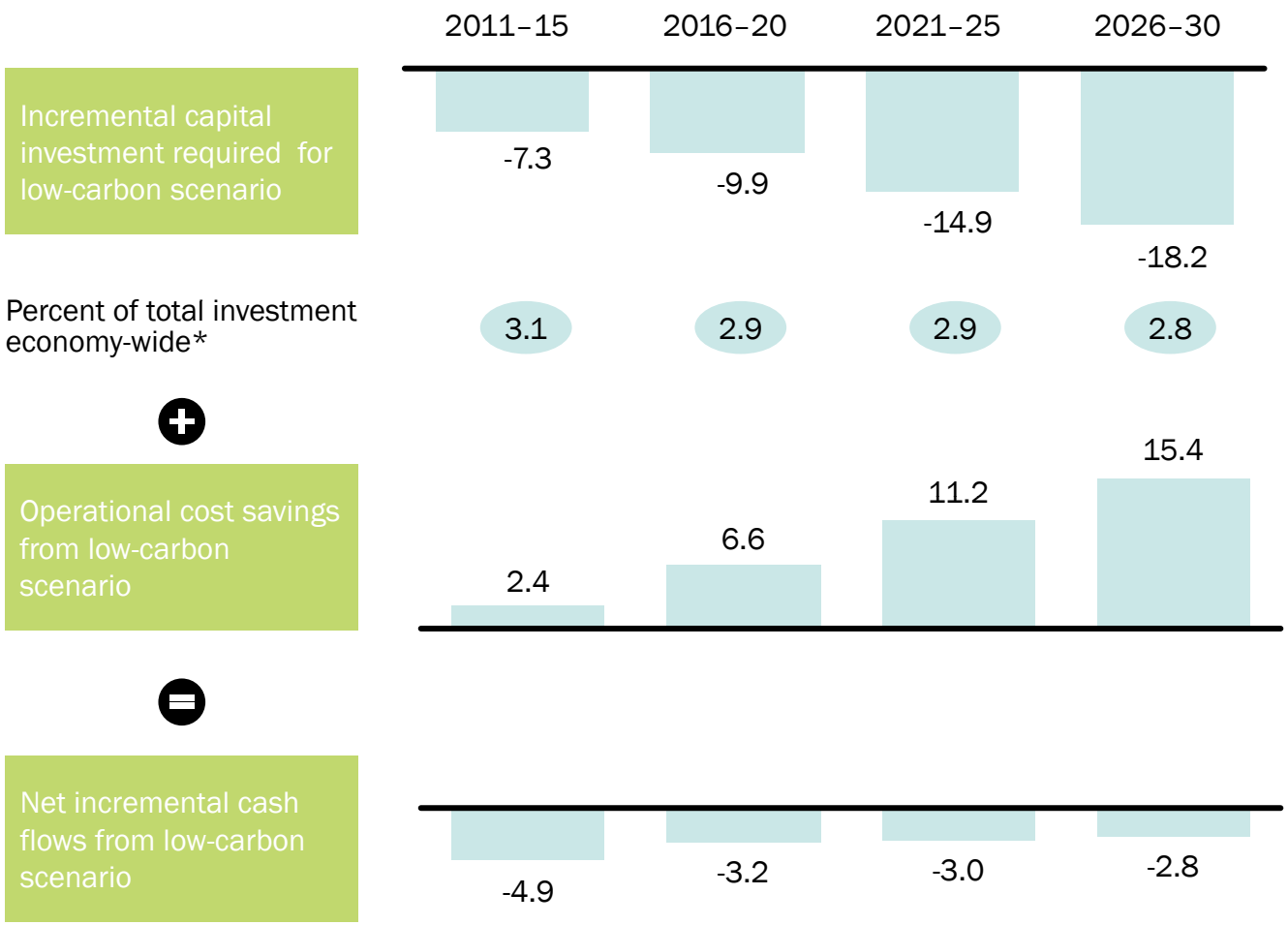
Total greenhouse gas emissions,
Mt CO_2e



Source: IEA World Energy Outlook 2007 (unpublished Annex); Houghton unpublished emissions data; EPA and INIGEI non-CO_2 emissions database; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 13. Incremental investment and operational costs of abatement

Annual financial flows during each 5-year period,
US$ billion (real 2000)



* Represented by gross fixed capital formation

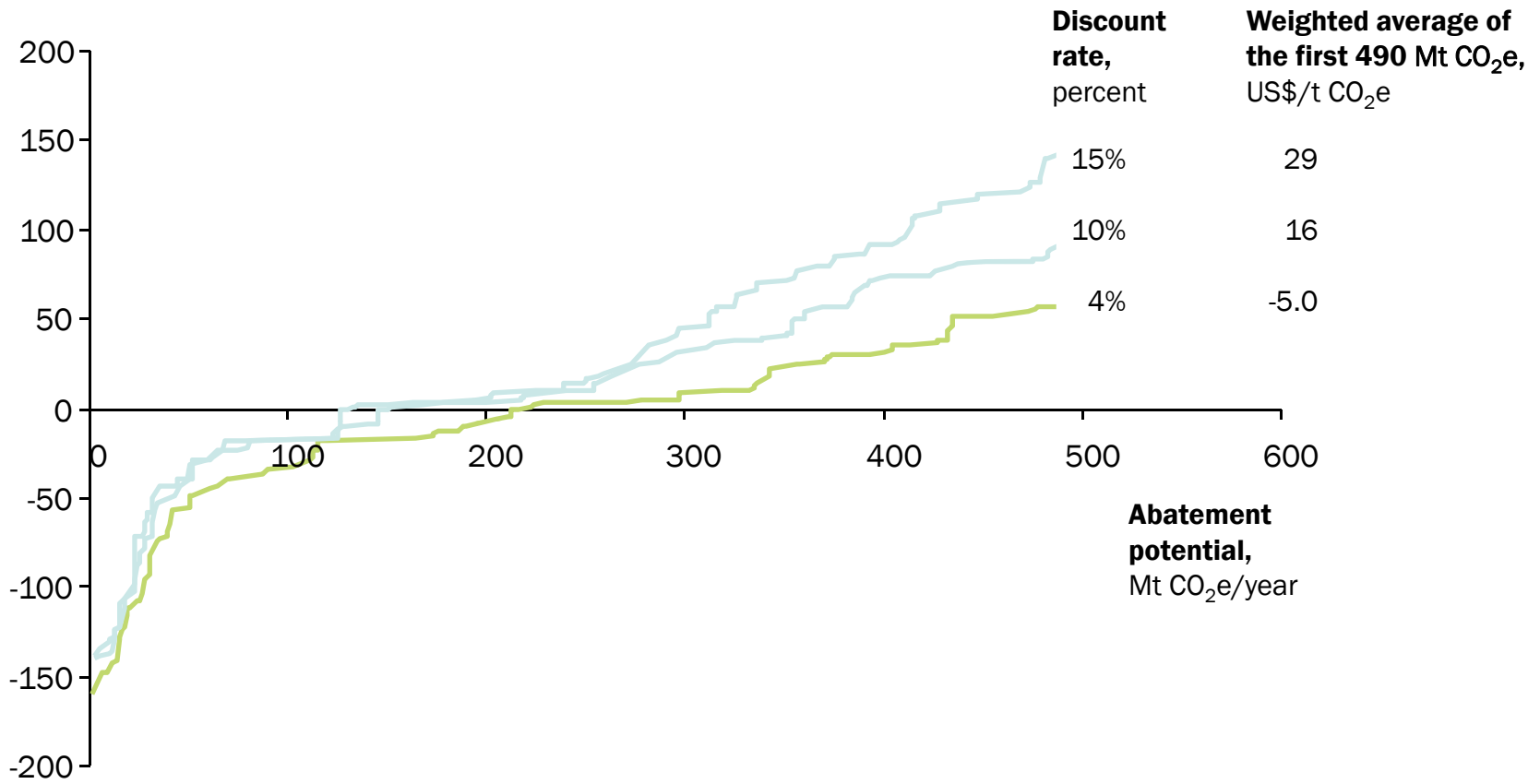
Note: General assumptions: discount rate 4 percent; oil price US$62/barrel in 2030

Source: Global Insight; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 14. Cost curve at different discount rates

GHG abatement cost curve for Mexico in 2030 with different discount rates

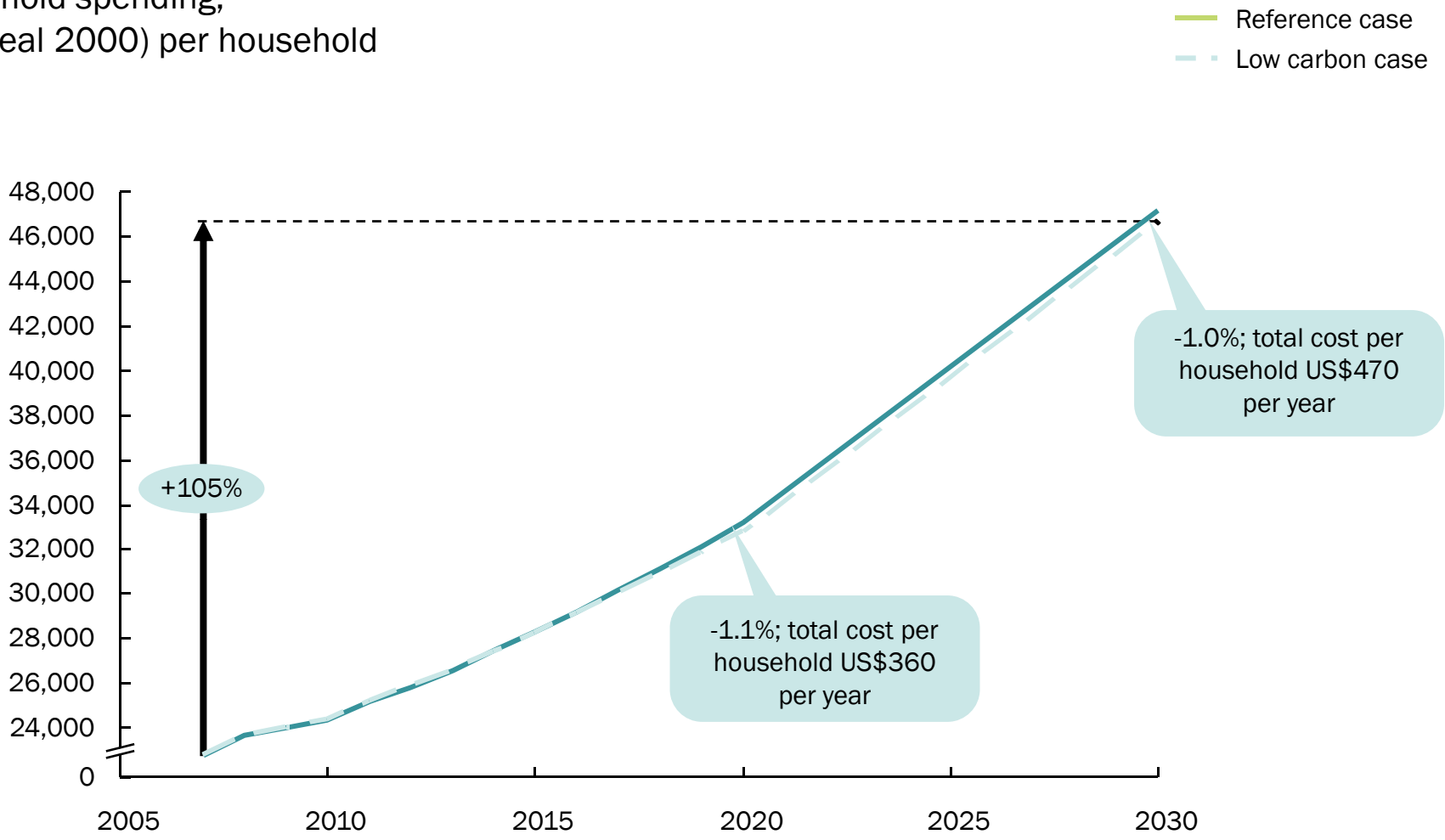
Cost, US$/t CO_2e



Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 15. Household spending impact of going low-carbon

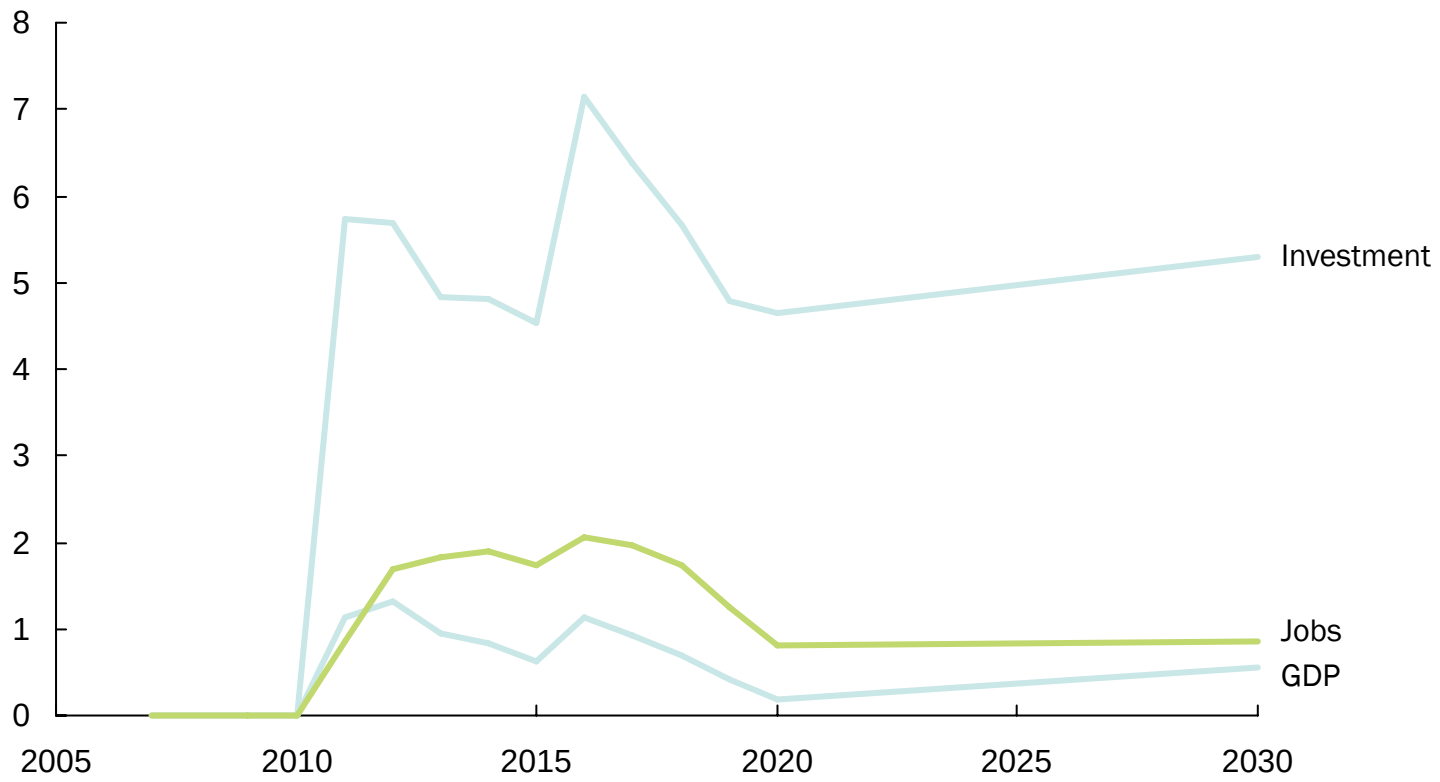
Household spending,
US$ (real 2000) per household



Source: Cambridge Econometrics E3MG model; Global Insight; McKinsey analysis

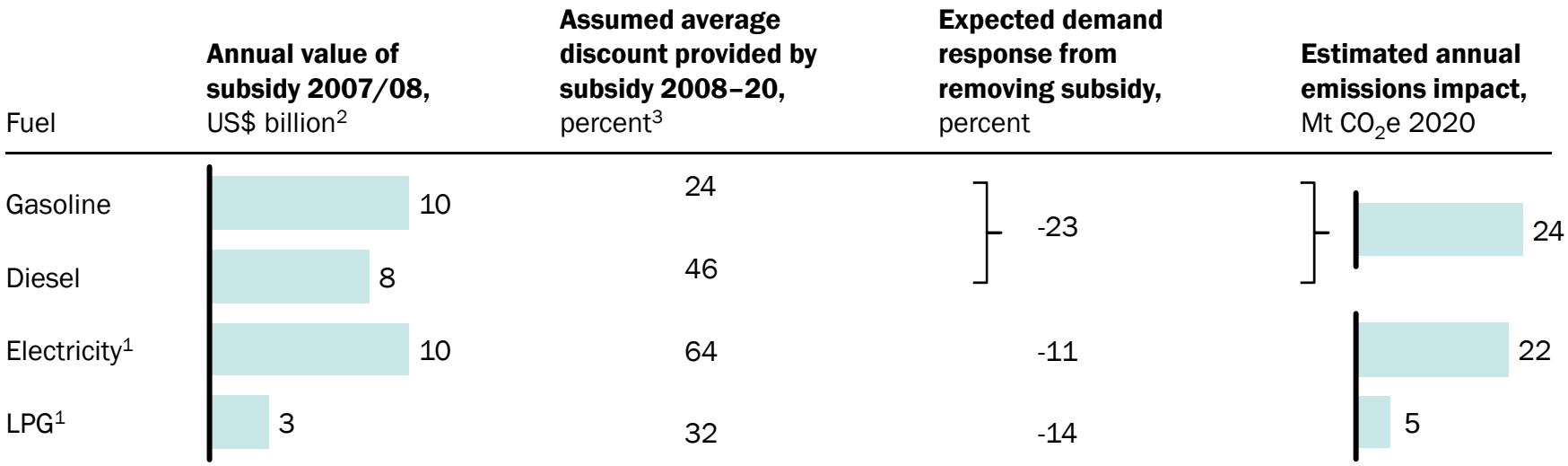
Exhibit 16. Impact of low-carbon investments on GDP and jobs

Low carbon case difference from reference case,
percent



Source: Cambridge Econometrics E3MG model; McKinsey analysis

Exhibit 17. Carbon impact of removing fuel subsidies



1 Domestic consumption only

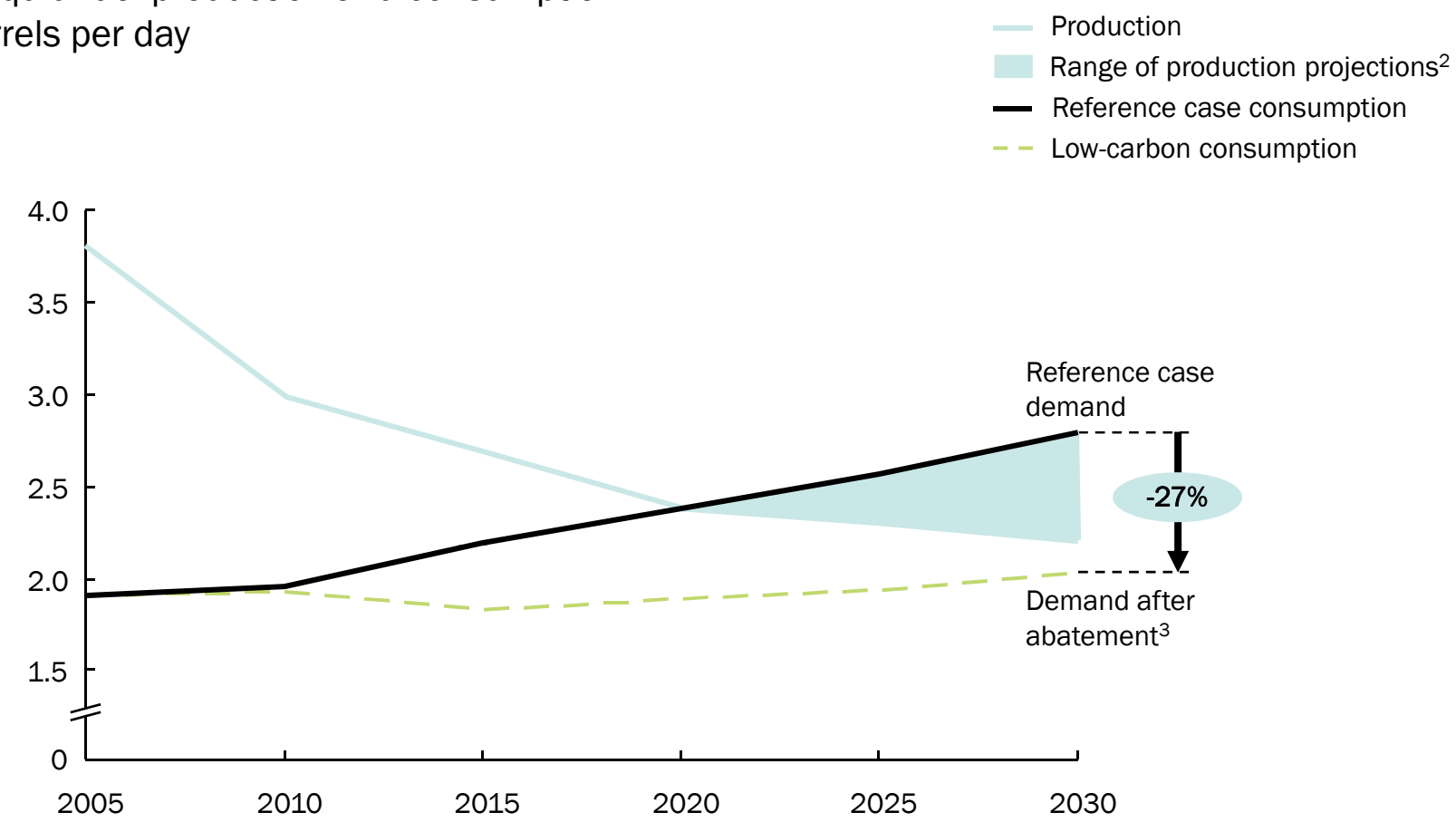
2 McKinsey Global Institute (June 2008) (gasoline and diesel); 2007 budget for energy subsidies, as reported in El Economista (7 December 2006) (electricity); Energy Regulatory Commission of Mexico (LPG)

3 Electricity subsidy does not apply to the highest consuming households

Source: Cambridge Econometrics E3MG model; McKinsey analysis

Exhibit 18. Impact of low-carbon scenario on domestic oil consumption

Mexico's liquid fuel production and consumption[1],
million barrels per day



1 Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains

2 Production forecasts depend on levels of investment achieved, regulatory reform and participation of International Oil Companies

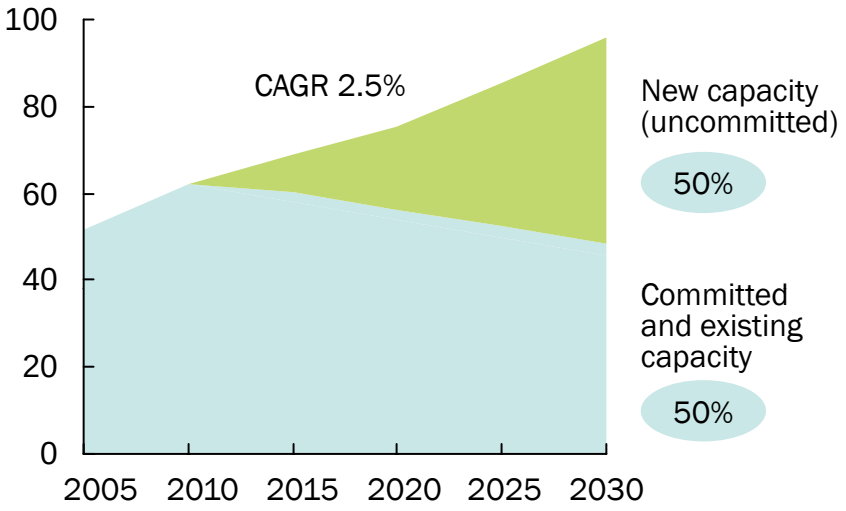
3 Transport abatements and oil-to-gas shift in power

Source: Energy Information Administration (US) International Energy Outlook 2008; Mexico Ministry of Energy; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 19. Mexico's capital replacement cycle

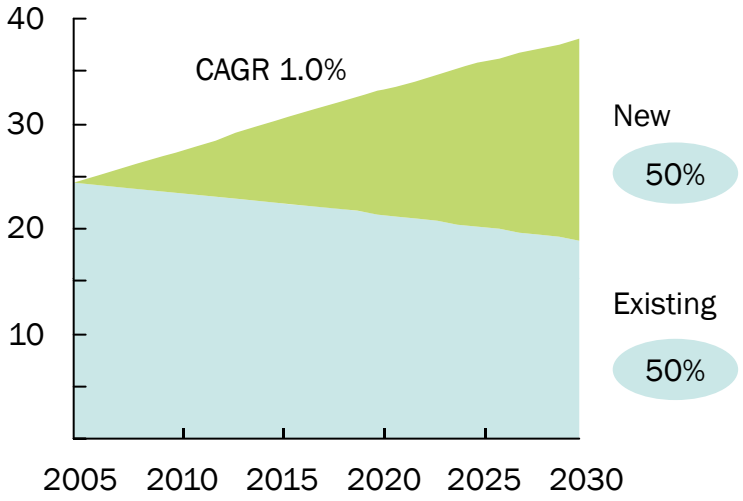
Over 50% of Mexico's 2030 power generation capacity is yet to be built

Power generation capacity, GW



Energy-efficiency technology could be applied to 19 million new houses by 2030

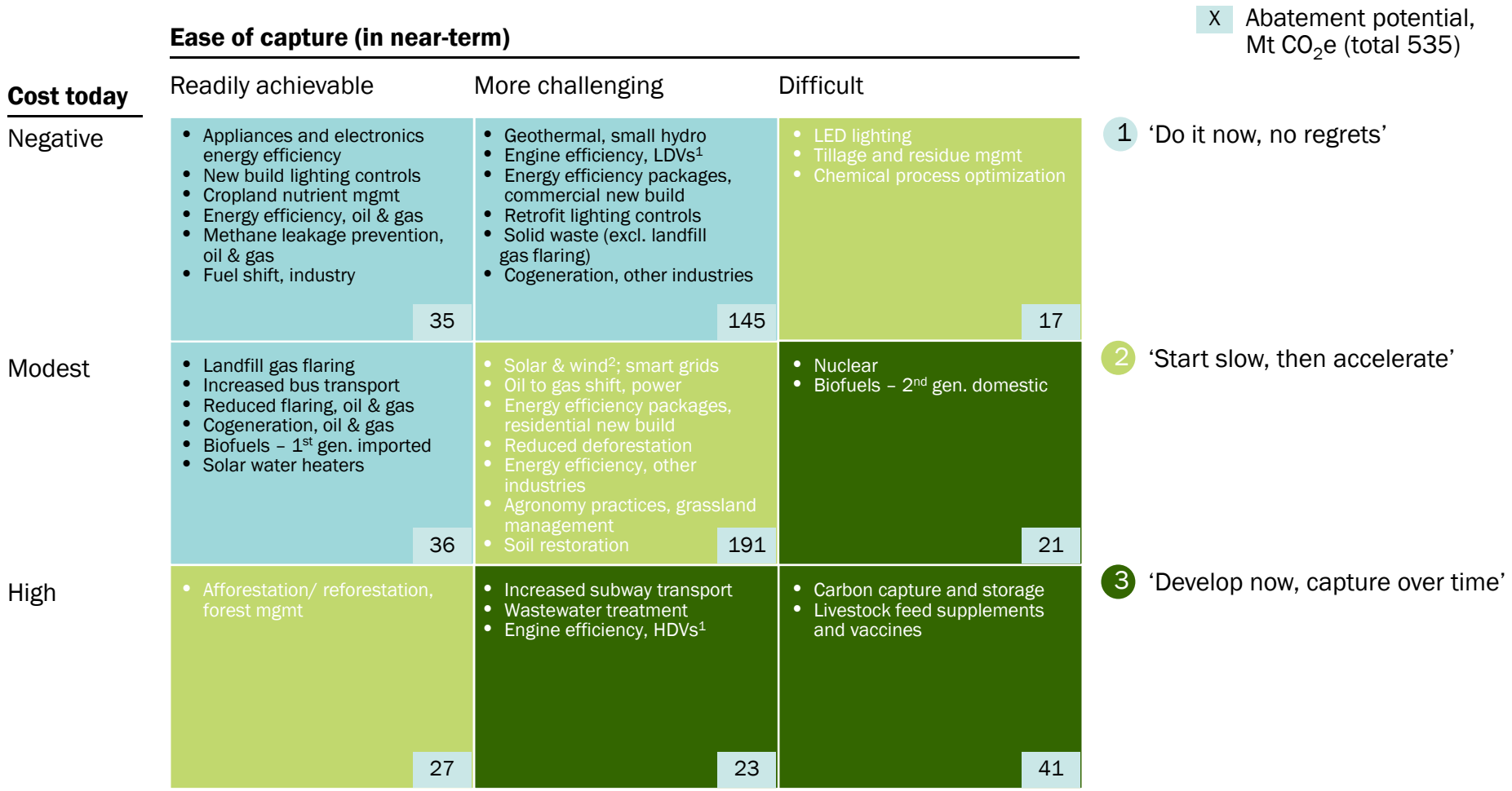
Houses in Mexico, million*



* CONAPO estimate for number of houses in Mexico and assuming a yearly retirement rate of 0.7 percent

Source: CFE POISE 2008-2017; CONAPO; McKinsey analysis

Exhibit 20. Three horizons for implementation



1 LDVs = light duty vehicles; HDVs = heavy duty vehicles

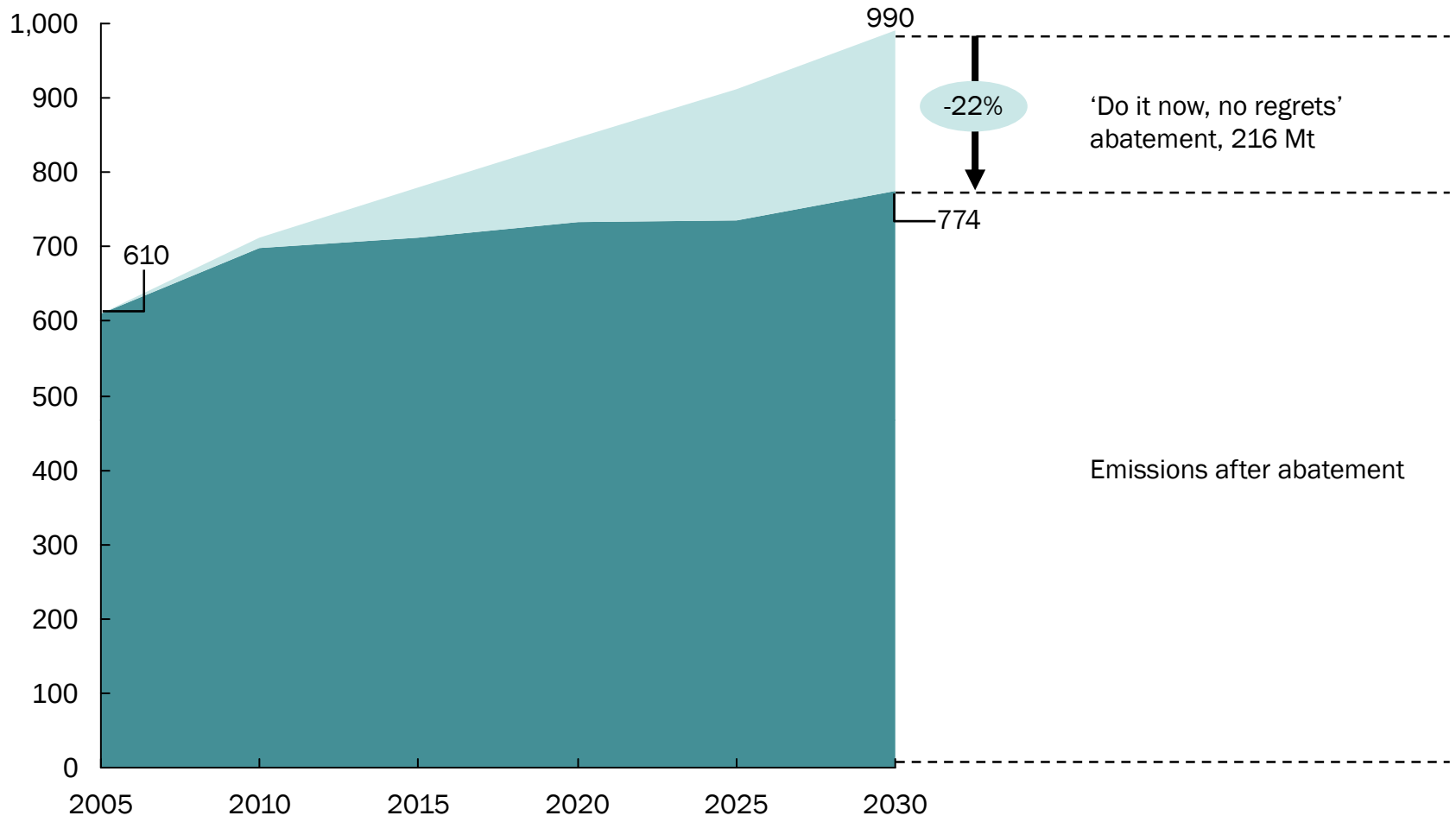
2 Though costs of these technologies are high, from an implementation perspective they belong to category 2 as early action is needed to support learning and to make wide implementation possible

Note: Only opportunities of 1 Mt or more are listed here, but abatement figures include all opportunities

Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 21. Horizon 1 pathway

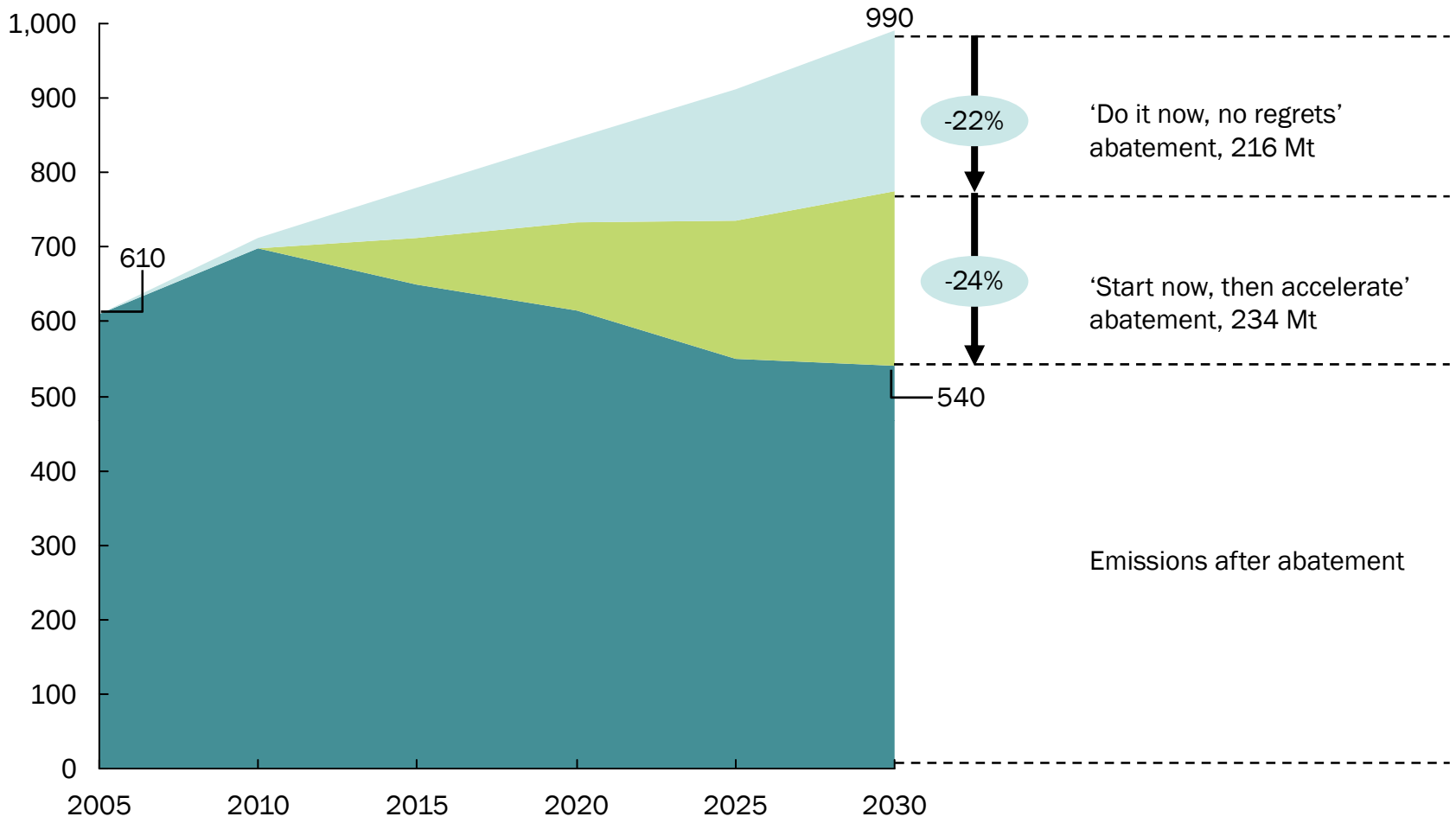
Total emissions,
Mt CO_2e



Source: IEA and Houghton unpublished emissions data; EPA non-CO_2 emissions database; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 22. Horizon 2 pathway

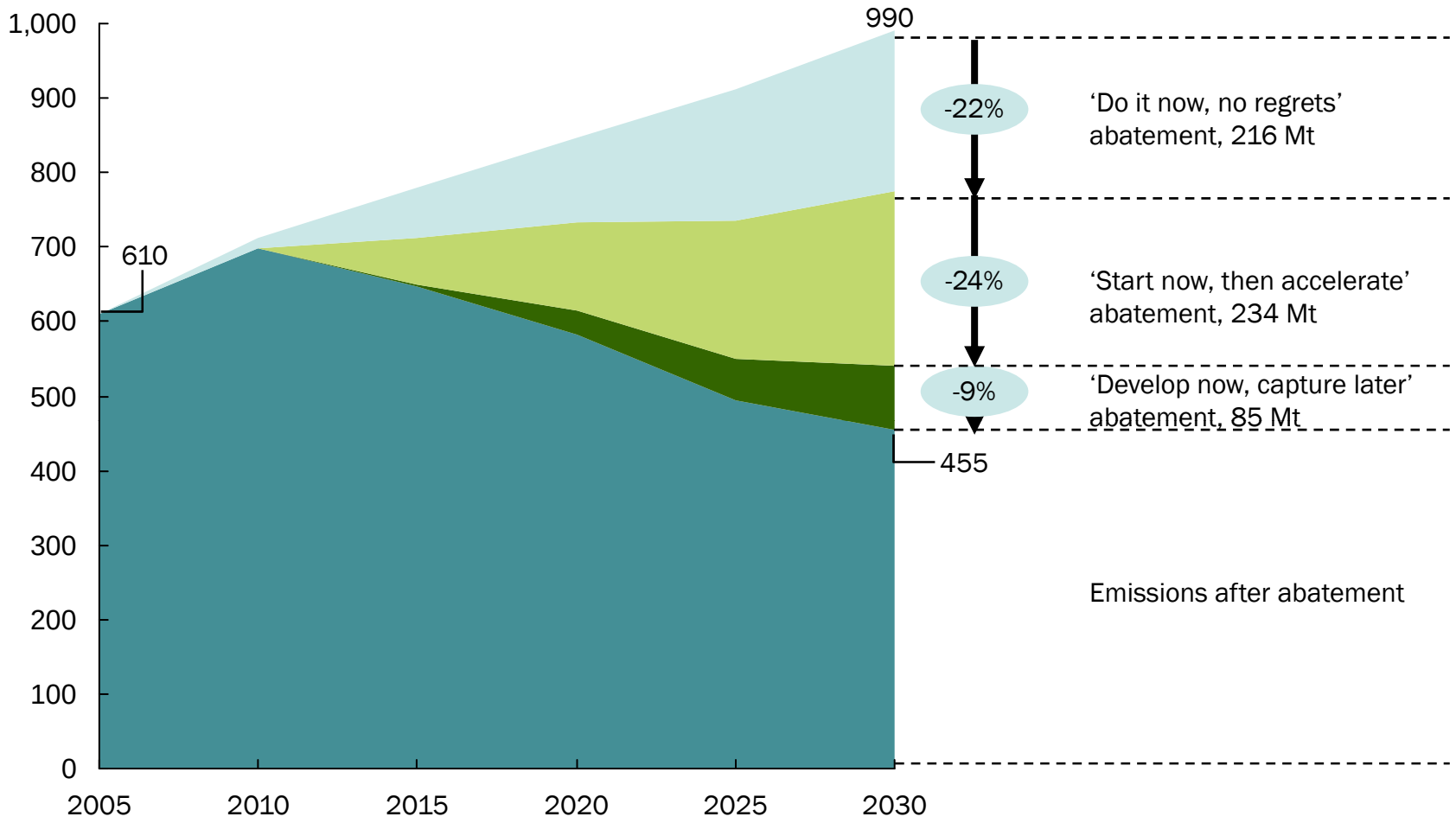
Total emissions,
Mt CO_2e



Source: IEA and Houghton unpublished emissions data; EPA non-CO_2 emissions database; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

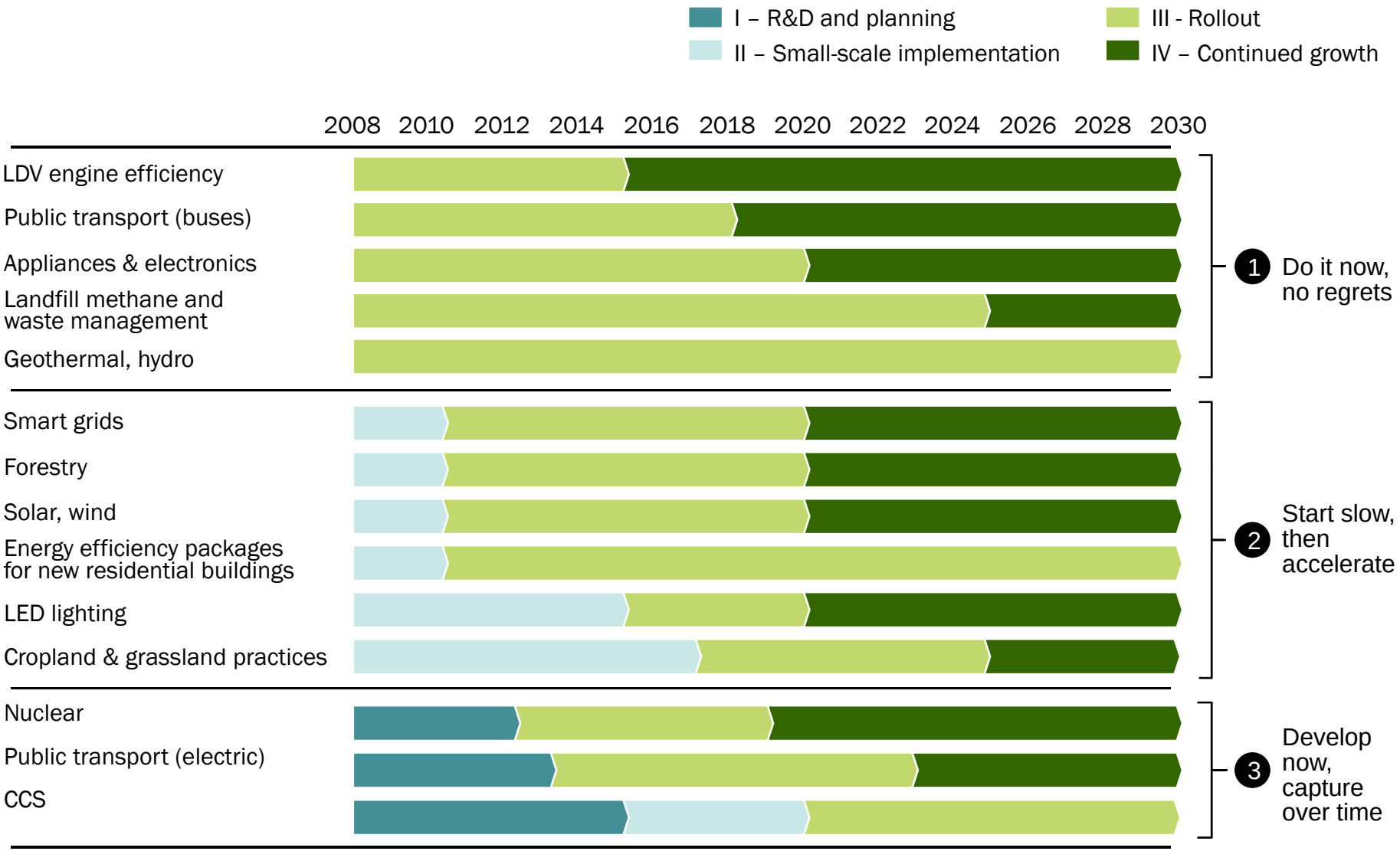
Exhibit 23. Horizon 3 pathway

Total emissions,
Mt CO_2e



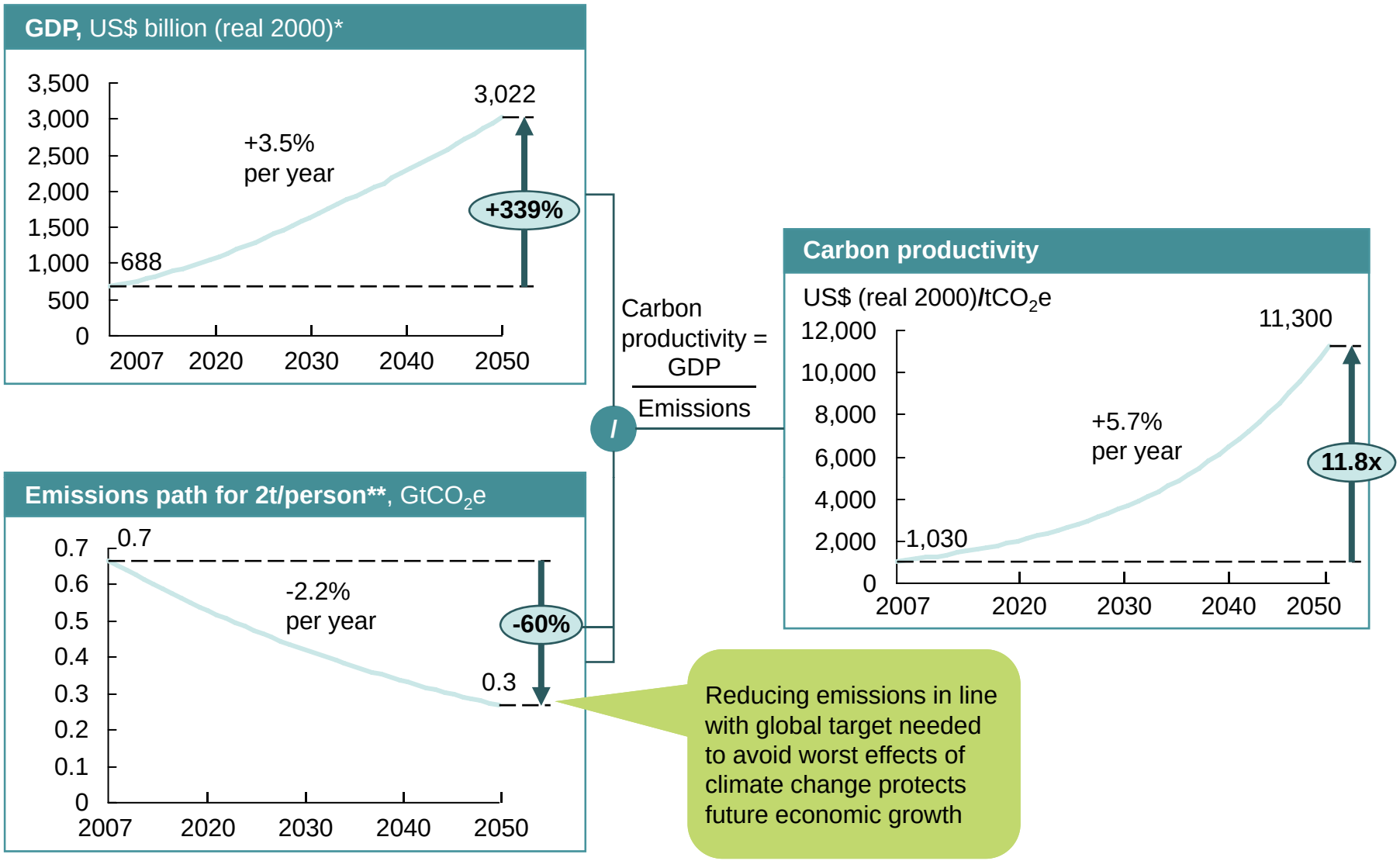
Source: IEA and Houghton unpublished emissions data; EPA non-CO_2 emissions database; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Exhibit 24. Implementation paths over time



Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

But to get onto a sustainable path, Mexico's emissions need to go down by 60 percent and carbon productivity to increase 12-fold by 2050



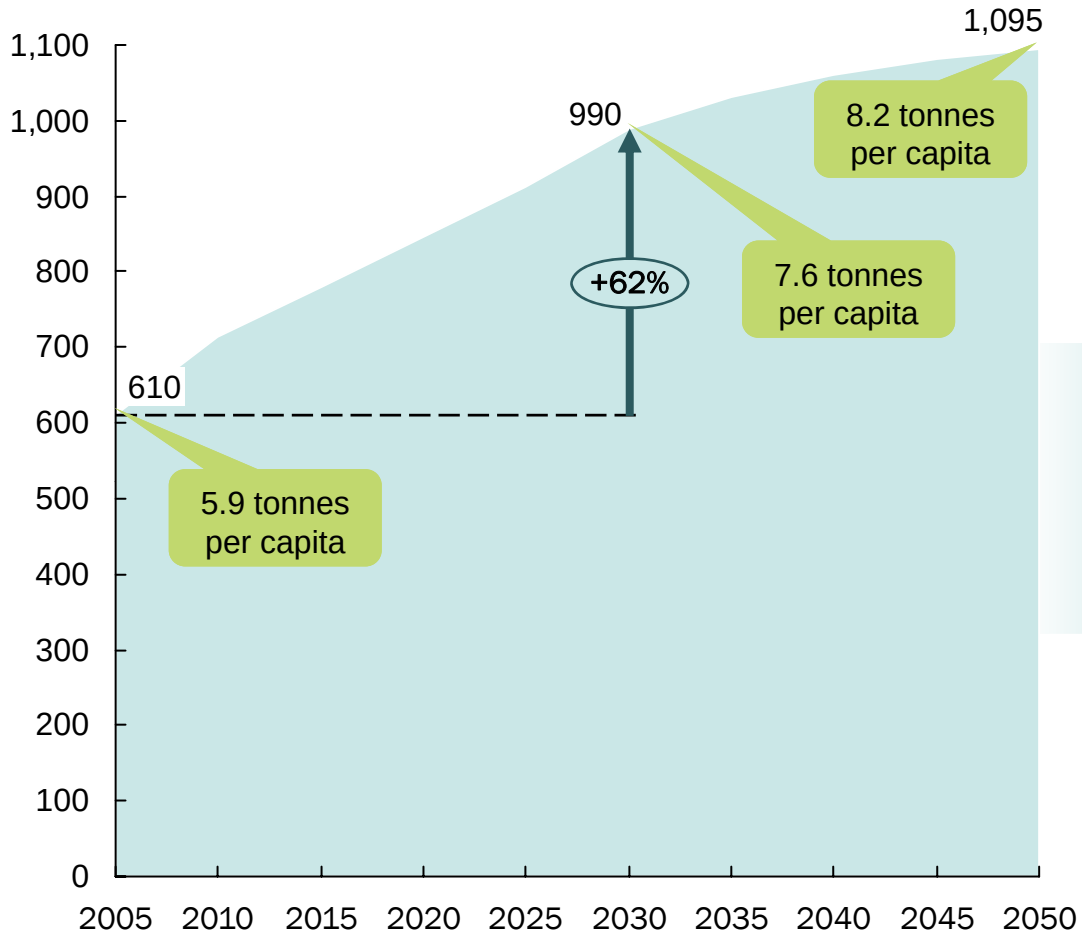
* Extrapolated from 2038 onwards

** Based on G8 target of 20 GtCO2e global emissions by 2050 and population of ~9bn, emissions per person is approximately 2 tonnes

Source: Global Insight; UN population database; McKinsey global GHG abatement cost curve v2.0; McKinsey analysis

Under the reference case, Mexico's greenhouse gas emissions are forecast to grow by 62 percent by 2030

Total greenhouse gas emissions,
Mt CO_2e



- Reference case based on, e.g., IEA (CO2 combustion); US EPA (non- CO2), R. A. Houghton (forestry
- Emissions grow as a result of GDP and population growth, without major breakthroughs in clean technology
- Based on alternative estimates for energy demand growth, such as those by Mexico's Energy Regulatory Commissions, emissions growth would be even higher

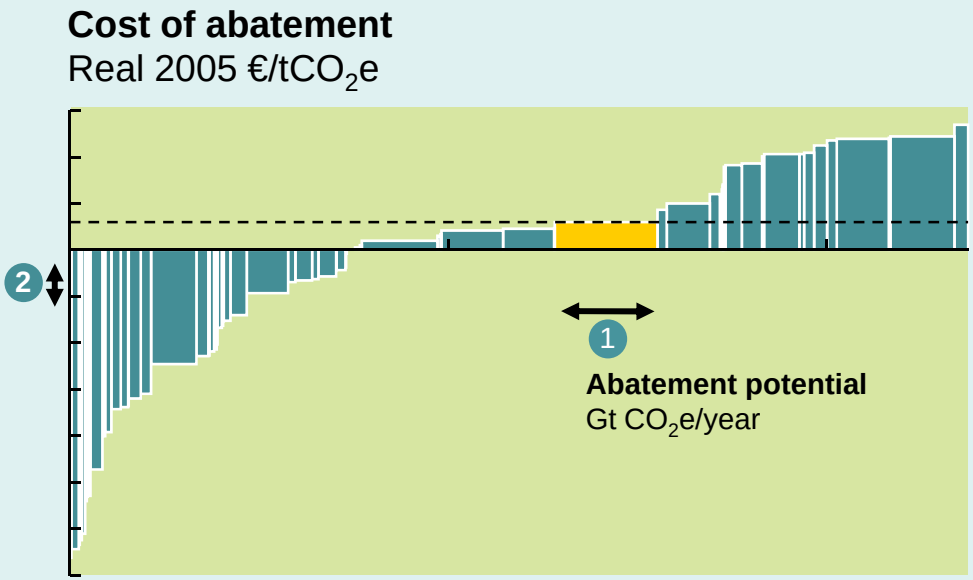
Source: IEA WEO 2007; Houghton; EPA; INEGEI; McKinsey analysis

How to read a GHG abatement cost curve

Two dimensions
Each bar represents one opportunity to reduce greenhouse gas emissions

1. *Volume dimension (width)*
   - Amount of CO_2e that can be reduced in a specific year by this lever, irrespective of the year when the opportunity was implemented

2. *Cost dimension (height)*
   - Average cost of avoiding 1 ton CO_2e with this opportunity, relative to the activities that would otherwise occur in the reference case
     - Cost is averaged across sub-opportunities, regions, years
     - Excludes taxes, subsidies, transaction and program costs
     - Uses a "societal" interest rate equivalent to the rate of long term government bonds.



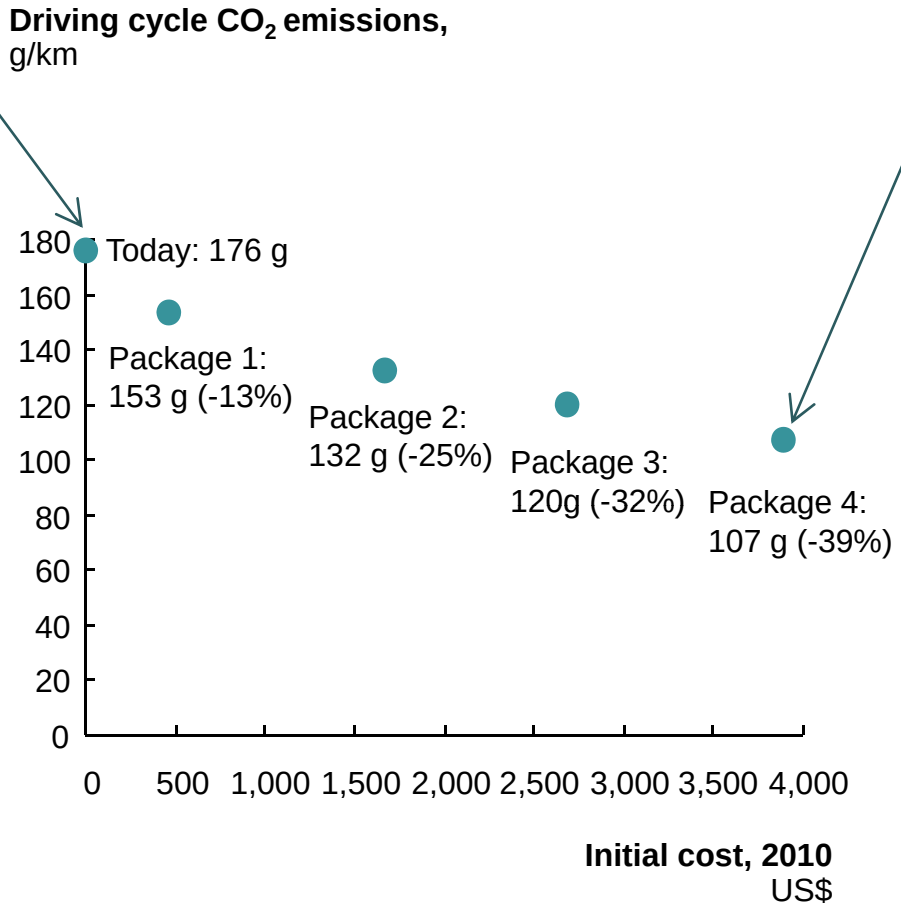
The abatement cost curve is a useful tool for:
- Creating an integrated perspective on abatement potential and opportunities.
- Evaluating orders of magnitude and prioritizing abatement measures within and across sectors.
- Providing a fact base to support the assessment of possible regulatory arrangements.

It is NOT useful for
- Forecasting CO_2 prices or potential climate regulation
- Predicting development of individual technologies

Transport: Engine efficiency could improve 39 percent against today's standards

Design today – standard car

- Engine
  - Intake: Naturally aspirated
  - Displacement: 1,600 cc
  - Cylinders: 4
  - Valve control: Traditional
  - Max power: 75 kW
- Transmission: Manual, 5 gears
- Weight: 1,100 kg
- CO_2 emissions (combined cycle): 176 g/km
- Fuel consumption (combined cycle): 7.2 l/100 km
- Cost: US$17,700



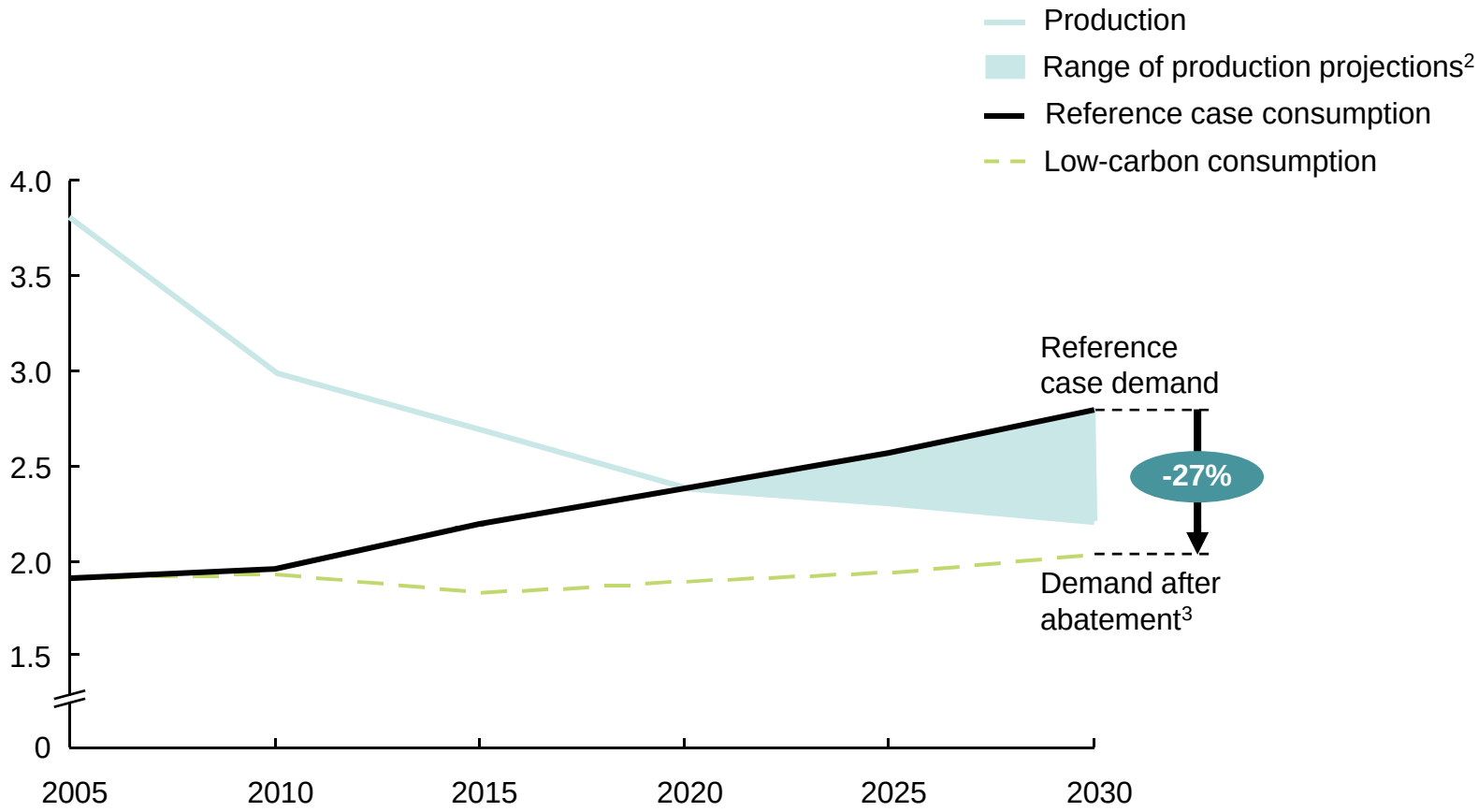
Design after improvements with currently available technologies

- Engine
  - Intake: Turbocharged
  - Displacement: 800 cc
  - Cylinders: 4
  - Valve control: Variable
  - Max power: 75 kW
- Transmission: Manual, 5 years, optimized gear box
- Weight: 1,000 kg
- CO_2 emissions (combined cycle): 107 g/km
- Fuel consumption (combined cycle): 4.4 l/100 km
- Cost: ~US$21,600 (2010); ~US$20,100 (2030)

Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Impact of low-carbon scenario on domestic oil consumption

Mexico's liquid fuel production and consumption 1, million barrels per day



1 Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains

2 Production forecasts depend on levels of investment achieved, regulatory reform and participation of International Oil Companies

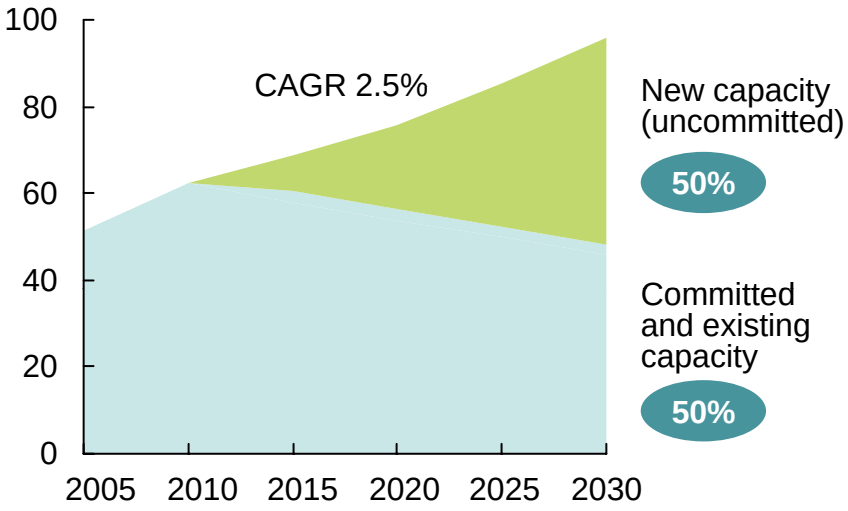
3 Transport abatements and oil-to-gas shift in power

Source: Energy Information Administration (US) International Energy Outlook 2008; Mexico Ministry of Energy; McKinsey GHG abatement cost curve v2.0; McKinsey analysis

Mexico will replace half its infrastructure in power and buildings by 2030

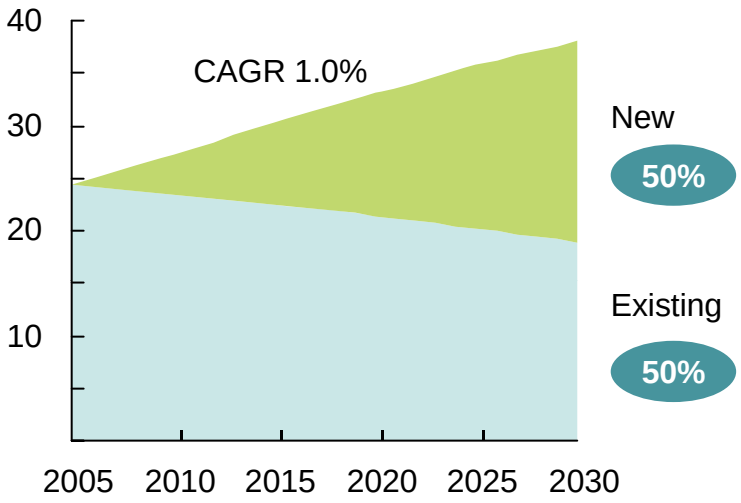
Over 50% of Mexico's 2030 power generation capacity is yet to be built

Power generation capacity, GW



Energy-efficiency technology could be applied to 19 million new houses by 2030

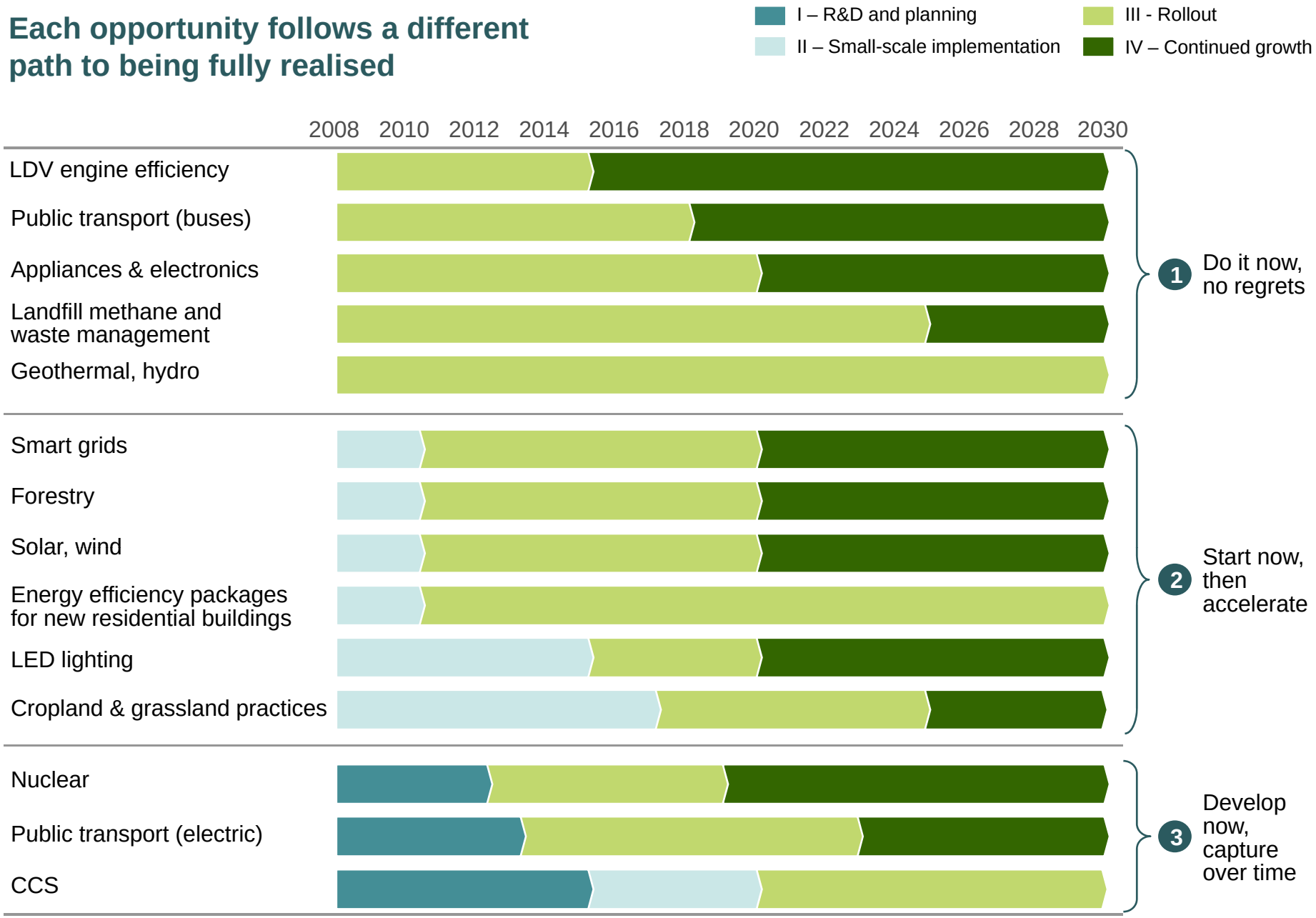
Houses in Mexico, million*



* CONAPO estimate for number of houses in Mexico and assuming a yearly retirement rate of 0.7 percent

Source: CFE POISE 2008-2017; CONAPO; McKinsey analysis

Each opportunity follows a different path to being fully realised



Source: McKinsey GHG abatement cost curve v2.0; McKinsey analysis