

The Accelerating Energy Transition

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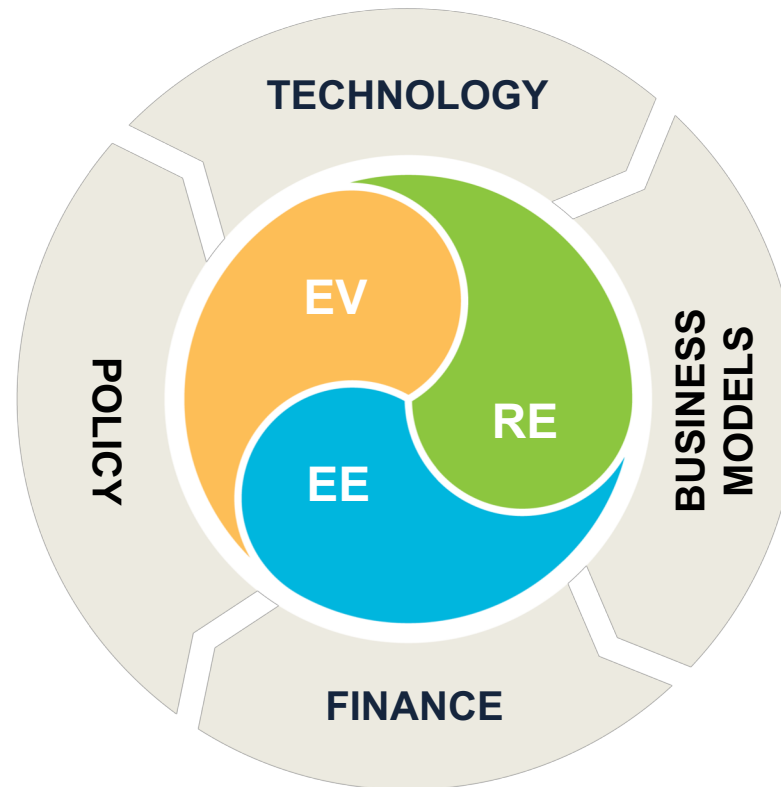
Australian Alliance for Energy Productivity

Innovation X-Change



Transforming global energy use to create a clean, prosperous, and secure low-carbon future.

An energy revolution is afoot, towards a low carbon future



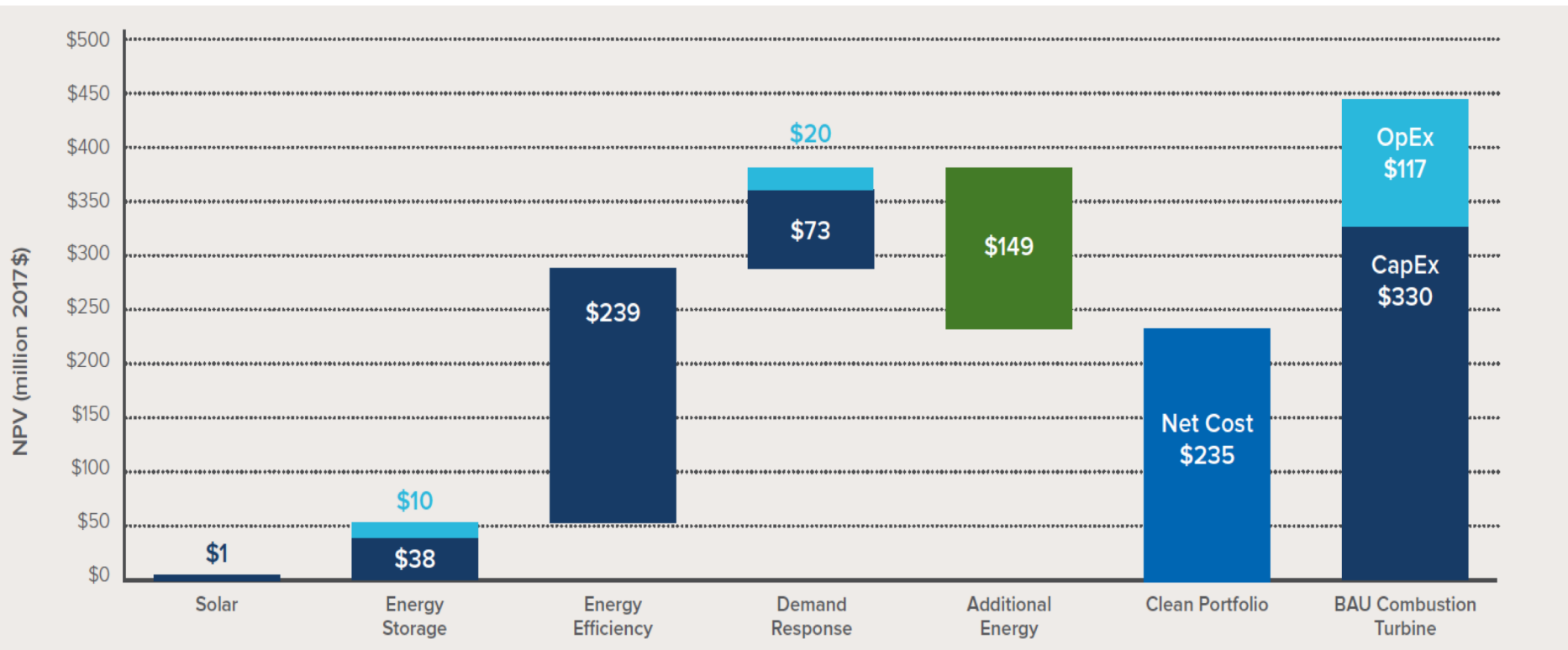
With technology combinations providing most or all network stability services

		Synchronous					Inverter-Based					Demand Response		
		Coal	Gas-Simple Cycle	Gas-CCGT	Nuclear	Hydro	Synchronous Condenser	Wind	Centralized PV	Distributed PV	Centralized Storage	Distributed Storage	Industrial	Small / Aggregated
Volt/Var		●	●	●	●	●	●	●	●	◐	◑	◑	○	○
Short Circuit Contribution		●	●	●	●	●	◑	○	○	○	○	○	○	○
Frequency Support	Inertial Response	●	◐	●	●	●	●	◑	◑	○	●	●	○	○
	Primary Frequency Response	◐	◐	◐	○	●	○	◑	◑	◑	●	●	◑	◑
	Regulation	◐	●	●	○	●	○	◑	◑	◑	●	●	◑	◑
	Load Following	◐	●	●	○	◐	○	◑	◑	◑	◑	◑	◑	◑
	Spinning Reserve	◐	●	●	○	●	○	◑	◑	○	◑	◑	●	●
Short-term availability		●	◐	◐	●	◐	●	◑	◑	◑	◑	◑	◑	◑
Long-term availability		◐	◐	◐	●	●	◑	◑	◑	◑	◑	◑	◑	◑
Black Start		◐	◐	◐	○	●	○	○	○	○	●	○	○	○



Soon, clean energy portfolios will even put gas at risk

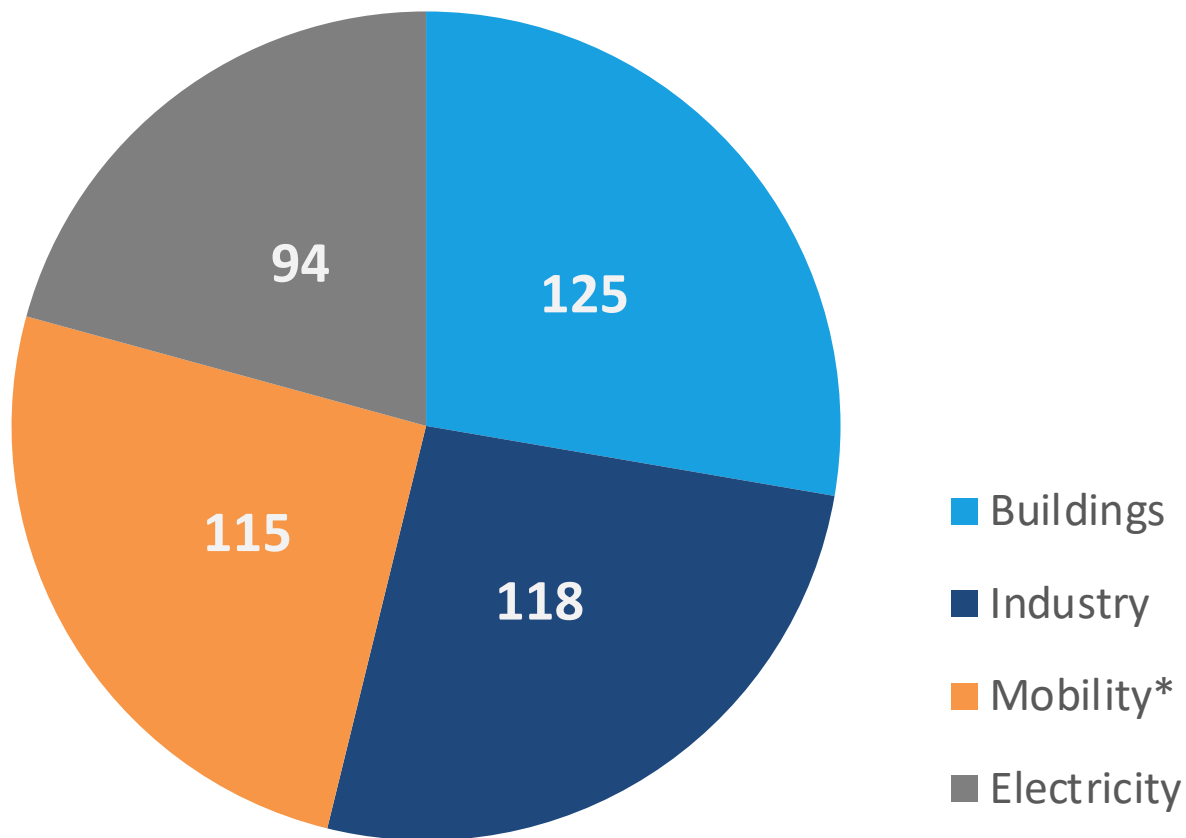
COST BREAKDOWN OF CLEAN ENERGY PORTFOLIO VERSUS GAS-FIRED POWER PLANT – TEXAS



Source: RMI, 2018. *The Economics of Clean Energy Portfolios*.

But energy transition is more than renewables

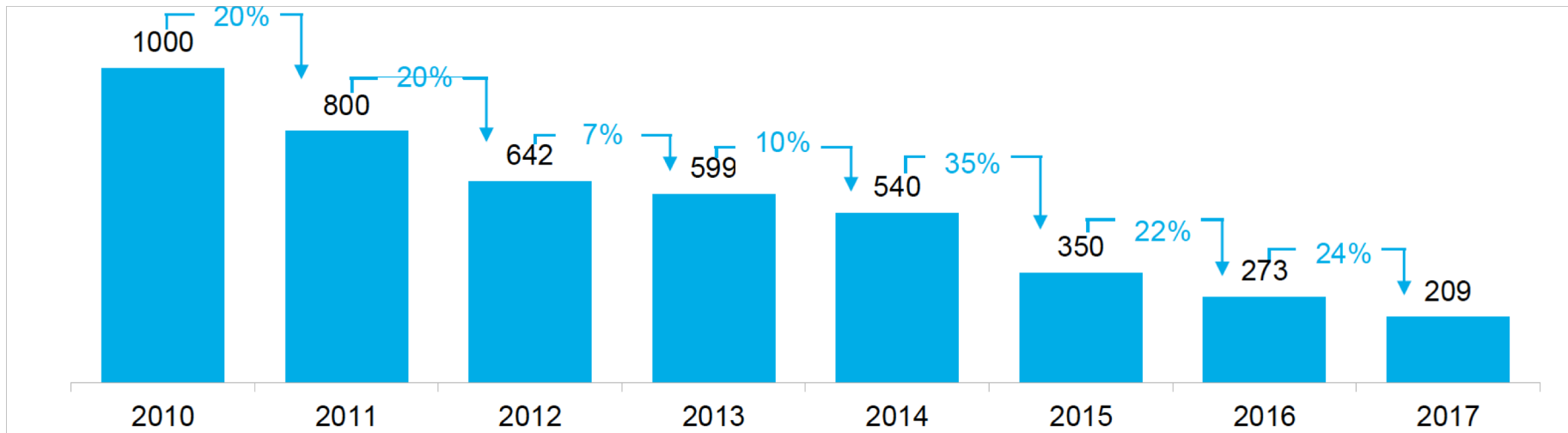
Total global final energy consumption by end-use sector, 2016
Exajoules



*Includes both passenger and freight transport. Electricity does not include that used in other end-use sectors.

20% learning rate in Li-ion storage is a game changer

Lithium-ion battery pack prices \$/kWh



Source: BNEF 2018

Li-ion gains are shifting the game in (electric) mobility

Electric vehicles



NEWS

Volvo Cars Aiming For 50% Of Sales To Be EVs By 2025

Daimler Is Buying a Massive \$23 Billion Worth of Battery Cells to Power Its Future EV Lineup

Volkswagen to spend \$50 billion by 2023 on electric car 'offensive'

100 electric buses by Yutong delivered to Santiago de Chile

GM Restructuring Reveals a 'Disconnect' Between SUV Sales Today and an EV Future

San Francisco Commits To All-Electric Bus Fleet By 2035

In this way, smart buildings are becoming an energy asset



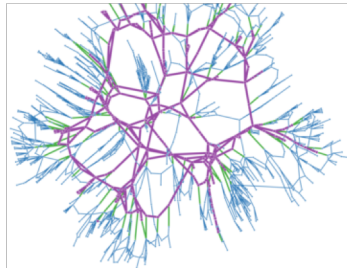
IT solutions will be key to tie together clean resources to improve grid functions with high penetration renewables

FIVE EXAMPLES

DEMAND RESPONSE 2.0, WHICH ENABLES DEMAND TO SEAMLESSLY FOLLOW SUPPLY



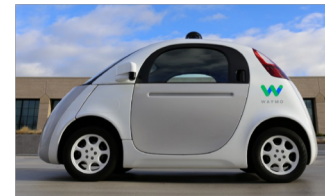
AUTOMATING NETWORK STABILITY, ENABLING MORE ASSETS TO BE INTEGRATED INTO A MORE FLEXIBLE LOWER CARBON ELECTRICITY SYSTEM



REAL TIME GRID DATA AS A CRITICAL INGREDIENT TO MANAGE THE GRID, INCLUDING ON CARBON INTENSITY



MOBILITY TRANSFORMATION ENABLED BY AUTONOMOUS ELECTRIC VEHICLES



BLOCKCHAIN AS THE KEY ENABLING TECHNOLOGY FOR THE TRANSACTIVE GRID...OR AS MASSIVE **DISRUPTOR** OF THE CURRENT POWER SYSTEM



The ETC has focused our lens industry & transport solutions

MISSION

REACHING NET-ZERO CARBON EMISSIONS FROM
HARDER-TO-ABATE SECTORS BY MID-CENTURY

POSSIBLE



These parts of the economy are harder to decarbonize

THE BIGGEST CHALLENGE IN MEETING THE PARIS AGREEMENT LIES IN THE MAJOR HARDER-TO-ABATE SECTORS

HEAVY
INDUSTRY



CEMENT



STEEL



PLASTICS

HEAVY-DUTY
TRANSPORT



HEAVY ROAD TRANSPORT



SHIPPING



AVIATION

10GtCO₂

of total
annual
carbon
emissions
from
energy
and
industry...

30%

...and their share of remaining emissions will
grow as other sectors, like power, buildings
and light-duty transport get decarbonized.

REACHING NET-ZERO CO₂ EMISSIONS FROM HARDER-TO-ABATE SECTORS BY MID-CENTURY IS POSSIBLE

TECHNICALLY



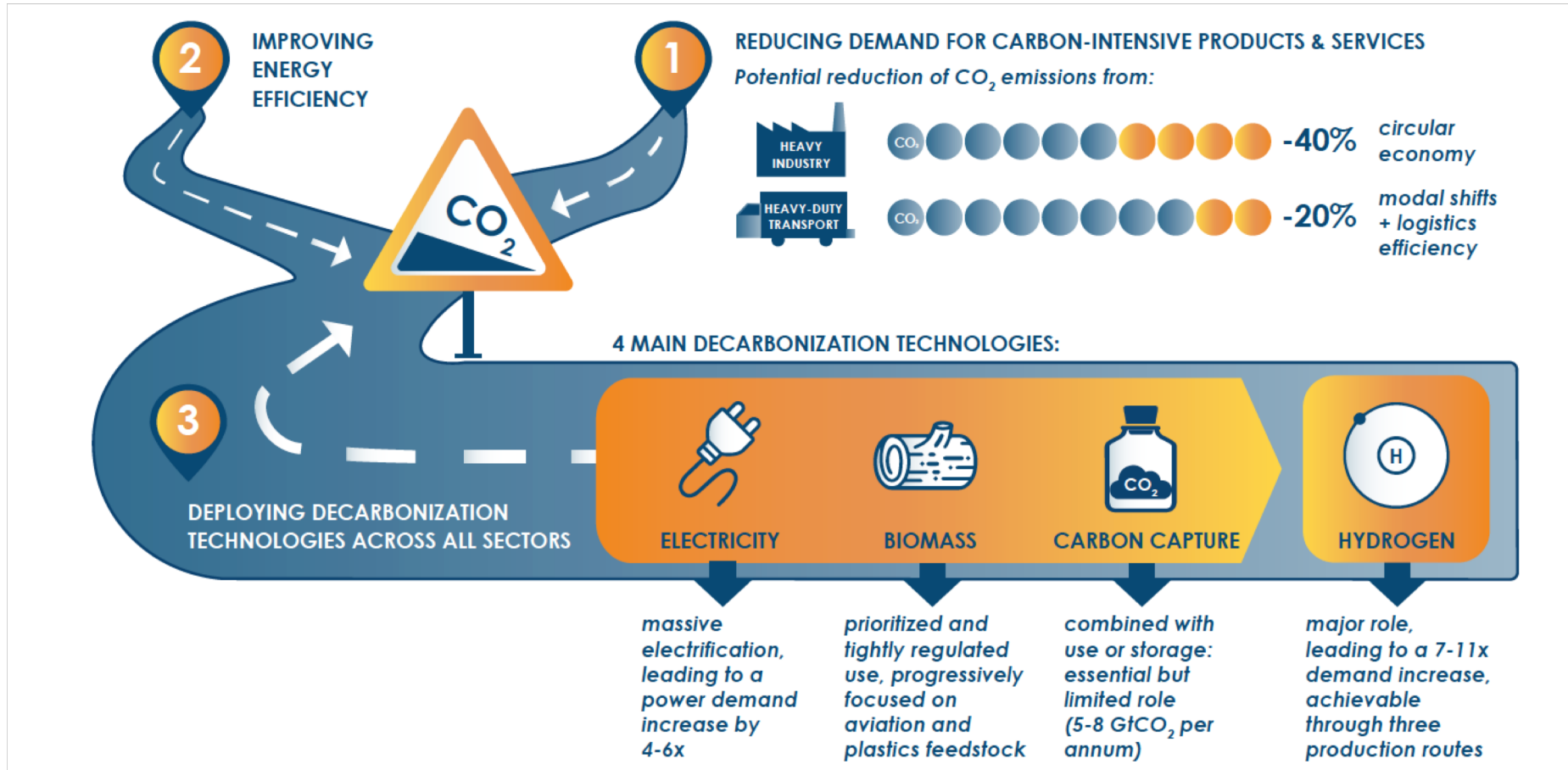
Technologies are
commercially ready
or at research phase.



ECONOMICALLY

It will cost less than
0.5% of global GDP.

Three central pathways to decarbonization of industry



How a “circular economy” drives emissions reductions

1

MATERIALS RECIRCULATION

GHG

MATERIALS

High-value recycling and less new material

High-value recycling

- Increased collection rates
- Design for disassembly and improved materials separation
- Less contamination and downgrading of materials

2

PRODUCT MATERIAL EFFICIENCY

MATERIALS

PRODUCT

Less material input for each car, building etc.

Improved production

- Less production waste
- Avoid over-specification

Reuse of components

Improved design

- High-strength materials
- New design principles
- Variation in size

3

CIRCULAR BUSINESS MODELS

PRODUCT

USEFUL SERVICE

Fewer products to achieve the same benefit

Higher utilisation

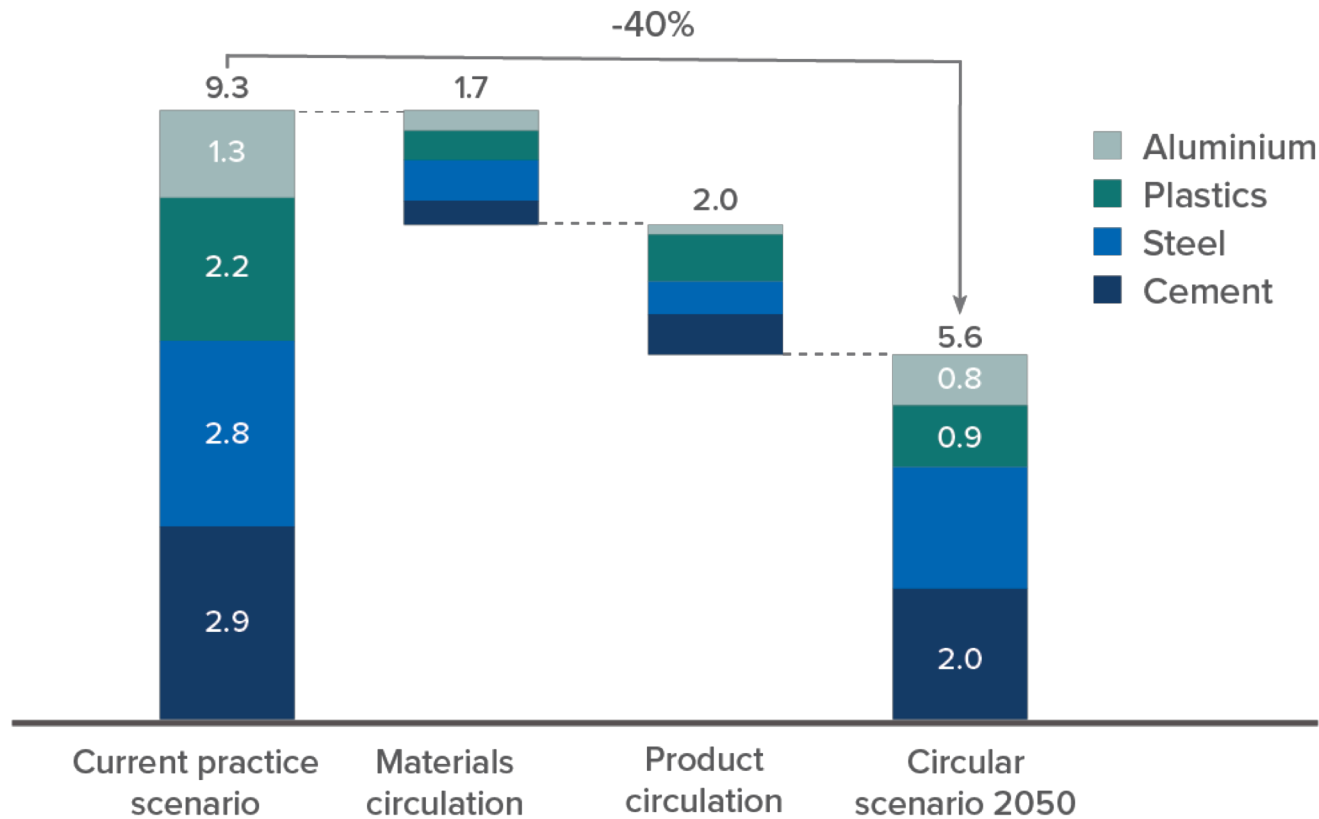
- Sharing of products
- Product as service

Longer lifetime

- Design for durability and disassembly
- Long lasting materials
- Improved maintenance
- Remanufacturing

A more circular economy can cut emissions by 40%

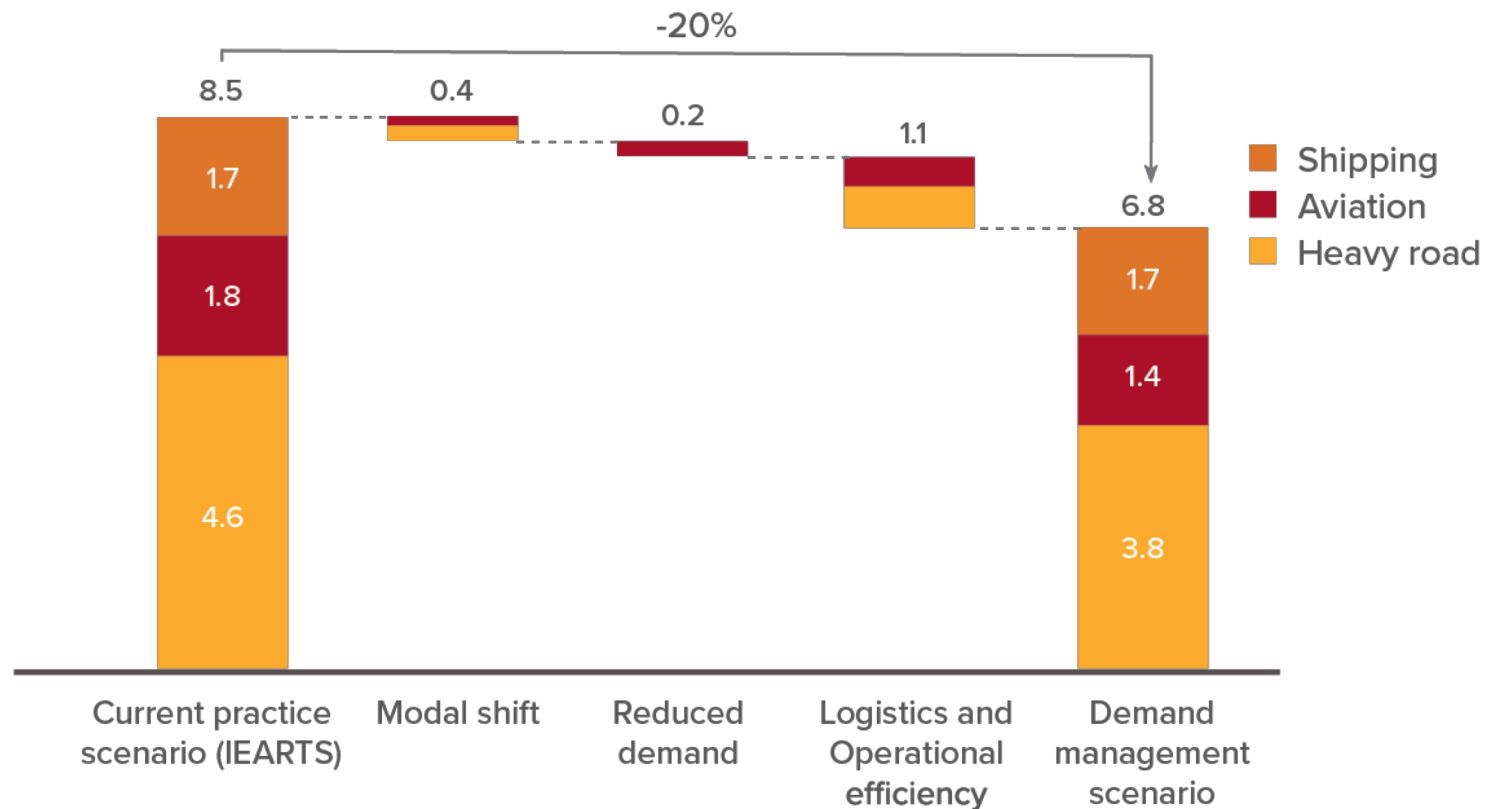
Global emissions reductions potential from a more circular economy
Gt CO₂ per year



Source: Material Economics analysis for the energy Transitions Commission (2018)

Demand management can cut heavy transport emissions by 20% by 2050

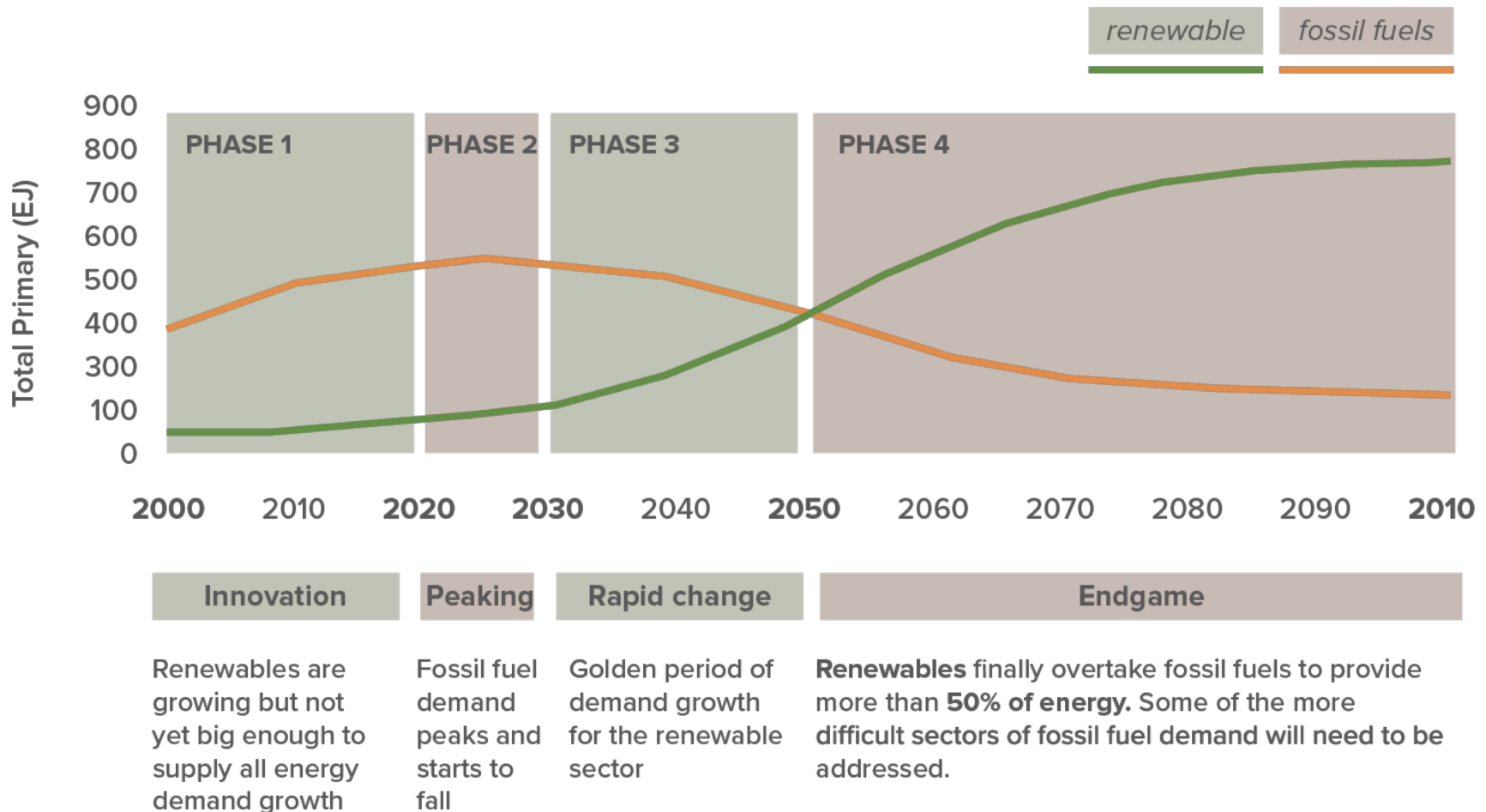
Global emissions reductions potential from demand management
Gt CO₂ per year, 2050



Source: SYSTEMIQ analysis for the Energy Transitions Commission (2018)

The transition may appear slow moving, but is speeding up

Phases of the energy transition



Source: Shell Sky scenario, CTI

But for climate change, capital stock is the major challenge

