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INTEGRATED ENERGY PLAN

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DEVELOPMENT OF THE INTEGARTED ENERGY PLAN

PRESENTATION AT STAKEHOLDER CONSULTATION WORKSHOPS

FEBRUARY 2017

PROBLEM STATEMENT

- Energy is the life blood of the economy which impacts on all sectors as well as individual livelihoods. Integrated energy planning is required to ensure that current and future energy service needs can be met in the most cost effective, efficient and socially beneficial manner while also taking into account environmental impacts.
- A lack of coordinated and integrated national planning for the energy sector has led to underinvestment in much needed energy infrastructure.
  - There is currently inadequate supply in both the electricity and liquid fuel industries due to a lack of timely investments in new capacity.
  - Electricity generation is constrained due to insufficient capacity and inadequate availability of existing infrastructure.
  - There is a high dependence on import of liquid fuels as the current production capacity does not meet national and export demand. No investments have been made in new capacity since the start of the new democracy.
- Planning at individual organisation level is commercially driven and therefore investments which are required in order to ensure that the policy objectives of the country have been left under invested.
- The IEP aims to guide future energy infrastructure investments, identify and recommend policy development to shape the future energy landscape of the country.

ENERGY WHITE PAPER (1998)

- The 1998 White Paper on the Energy Policy of the Republic of South Africa (Energy White Paper) is the primary policy document which guides all subsequent policies, strategies and legislation within the energy sector. It provides specific policy statements on what government intends for the energy system as a whole and sets out five key objectives. These objectives have subsequently formed the foundation and informed the development of energy policy in South Africa and still remain relevant. Various other energy policies have been developed and are in different stages of implementation.
  - Increasing access to affordable energy services
  - Improving energy governance
  - Stimulating economic development
  - Managing energy-related environmental impacts
  - Securing supply through diversity

ENERGY PLANNING WITHIN THE NATIONAL POLICY FRAMEWORK

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NATIONAL DEVELOPMENT PLAN, NEW GROWTH PATH, 9-POINT PLAN

Integrated Energy Plan

Transport Plan

Environmental Policies

Integrated Energy Plan

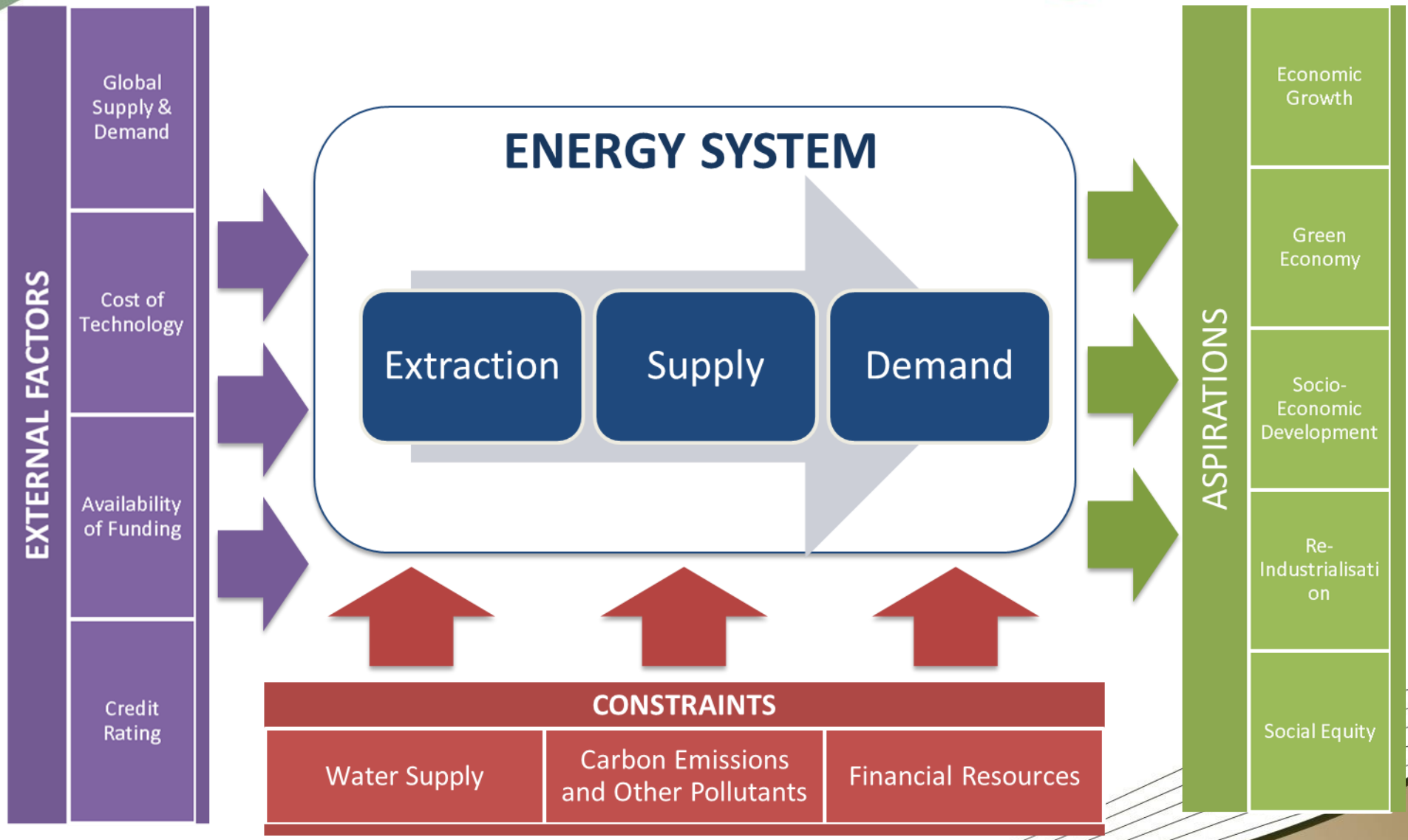
Carbon Tax Policy

Water Policies

Industrialisation Policies

The IEP seeks to quantify and provide feedback on the extent to which policy objectives outside the sector may impact on the attainment of energy sector imperatives and vice versa

ENERGY PLANNING PROCESS



ENERGY PLANNING SCOPE

The Energy Planning Framework considers all energy carriers, all technology options and all key national policy imperatives and proposes an energy mix and policy recommendations which ensures that the energy sector can help achieve these in the most optimal manner.

PRIMARY ENERGY/ RESOURCES	CONVERSION TECHNOLOGIES	SECONDARY ENERGY CARRIERS	END-USE TECHNOLOGIES	DEMAND FOR ENERGY SERVICES
• **RENEWABLES** • Solar • Wind • Biomass • Hydro • **FOSSIL FUELS** • Coal • Crude Oil • Natural Gas • **NUCLEAR FUELS** • Uranium • Resources extraction and sourcing	• **POWER GENERATION** • Conventional Coal Plant • Nuclear • CCGT • OCGT • Solar • Wind • **FUEL PROCESSING** • Oil refineries • GTL • CTL • **REGASIFICATION**	• Electricity • Heat • Refined Petroleum Products	• **INDUSTRY** • Steam boilers • Furnace • Machinery • **COMMERCE** • Air Conditioning • Light Bulbs • **HOUSEHOLDS** • Space Heaters • Refrigerators • Stoves • Geysers • **AGRICULTURE** • Irrigation pumps • **TRANSPORT** • Vehicles • Aircraft • Rail	• **INDUSTRIAL SECTOR** • Process Steam • Motive Power • **COMMERCIAL SECTOR** • Electronic Communication • Cooling • **RESIDENTIAL SECTOR** • Space Heat • Refrigeration • Cooking • Hot water • **AGRICULTURAL SECTOR** • Water supply • **TRANSPORT SECTOR** • Person kms

IEP AND OTHER PLANS

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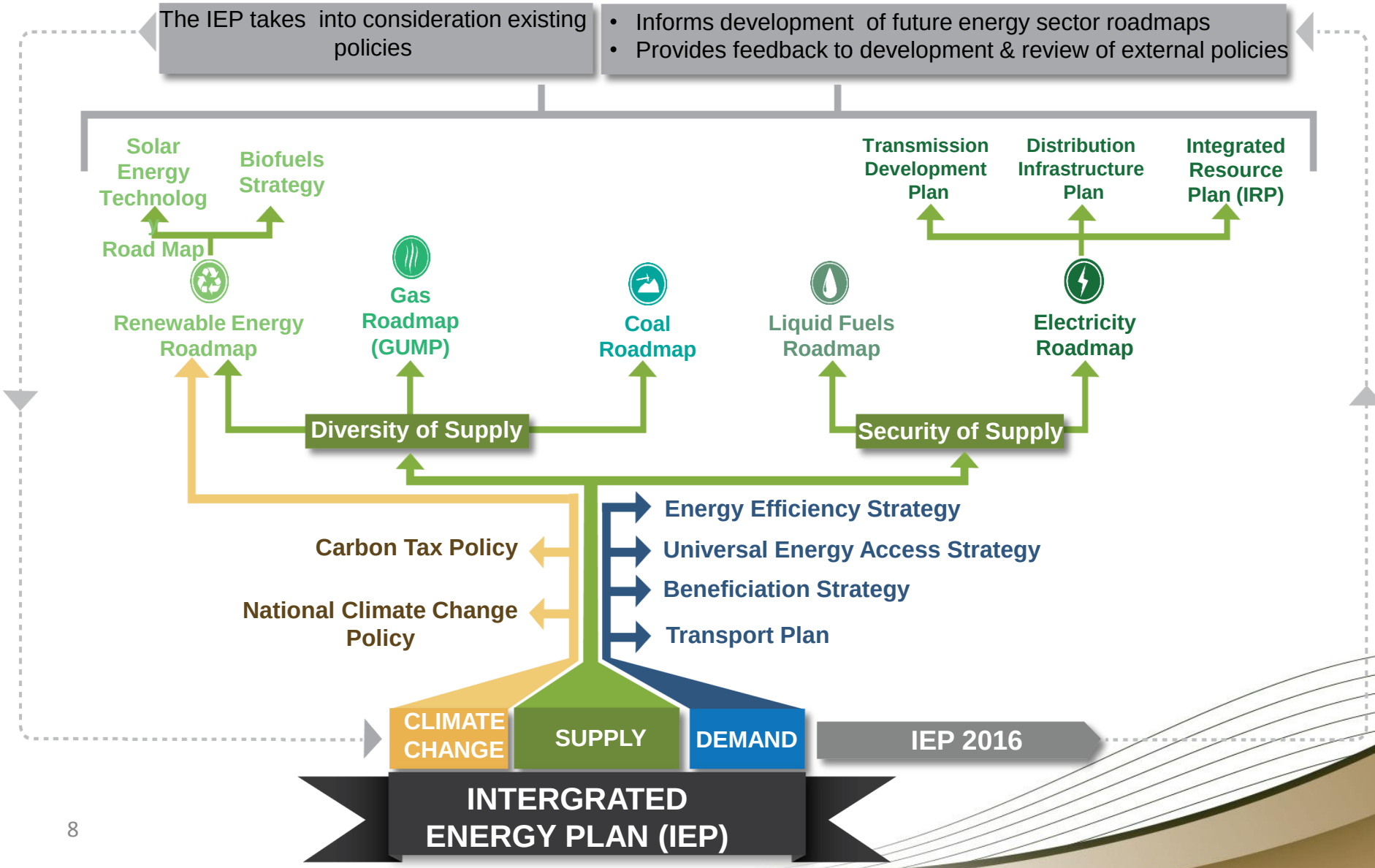

8 KEY ENERGY PLANNING OBJECTIVES

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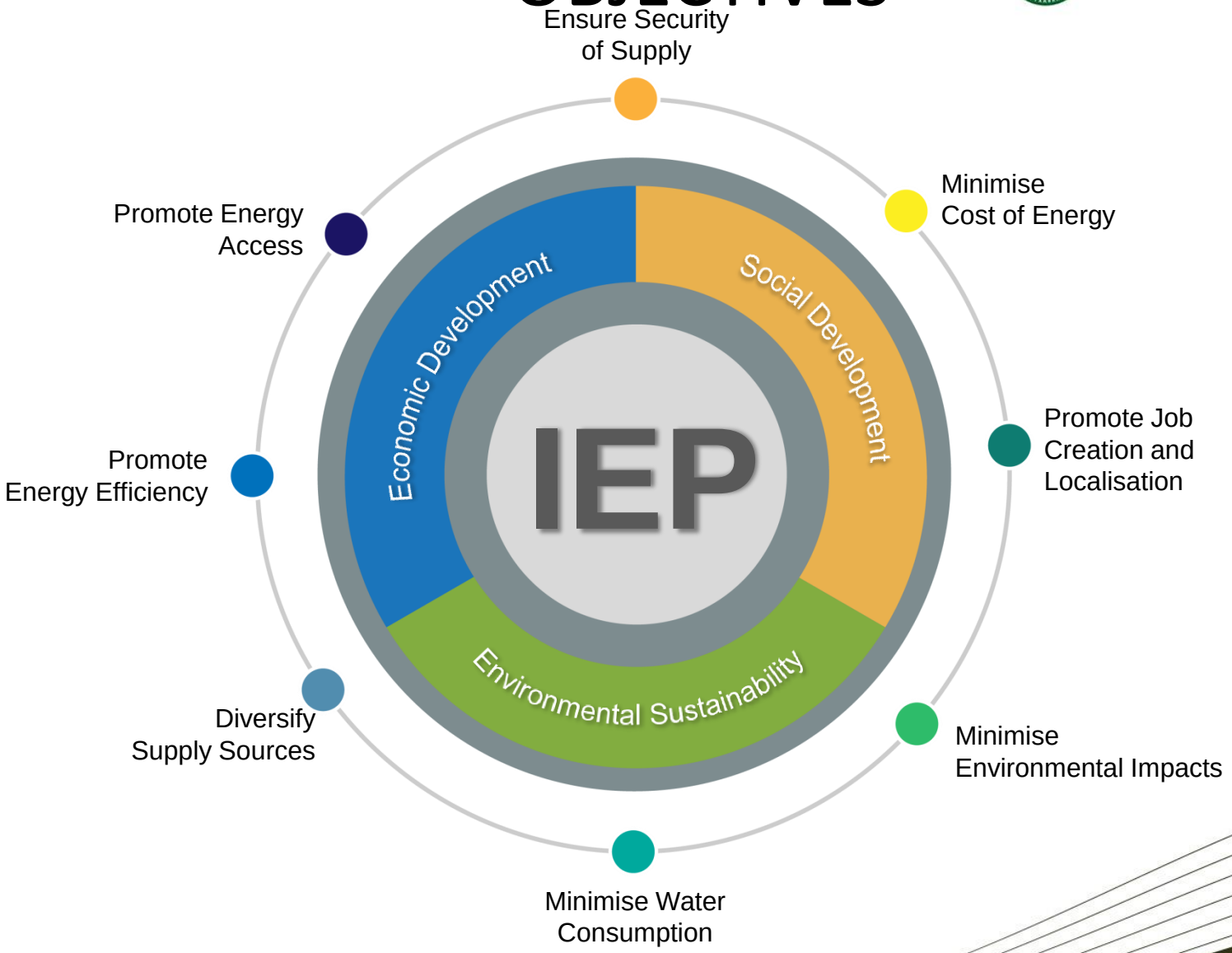
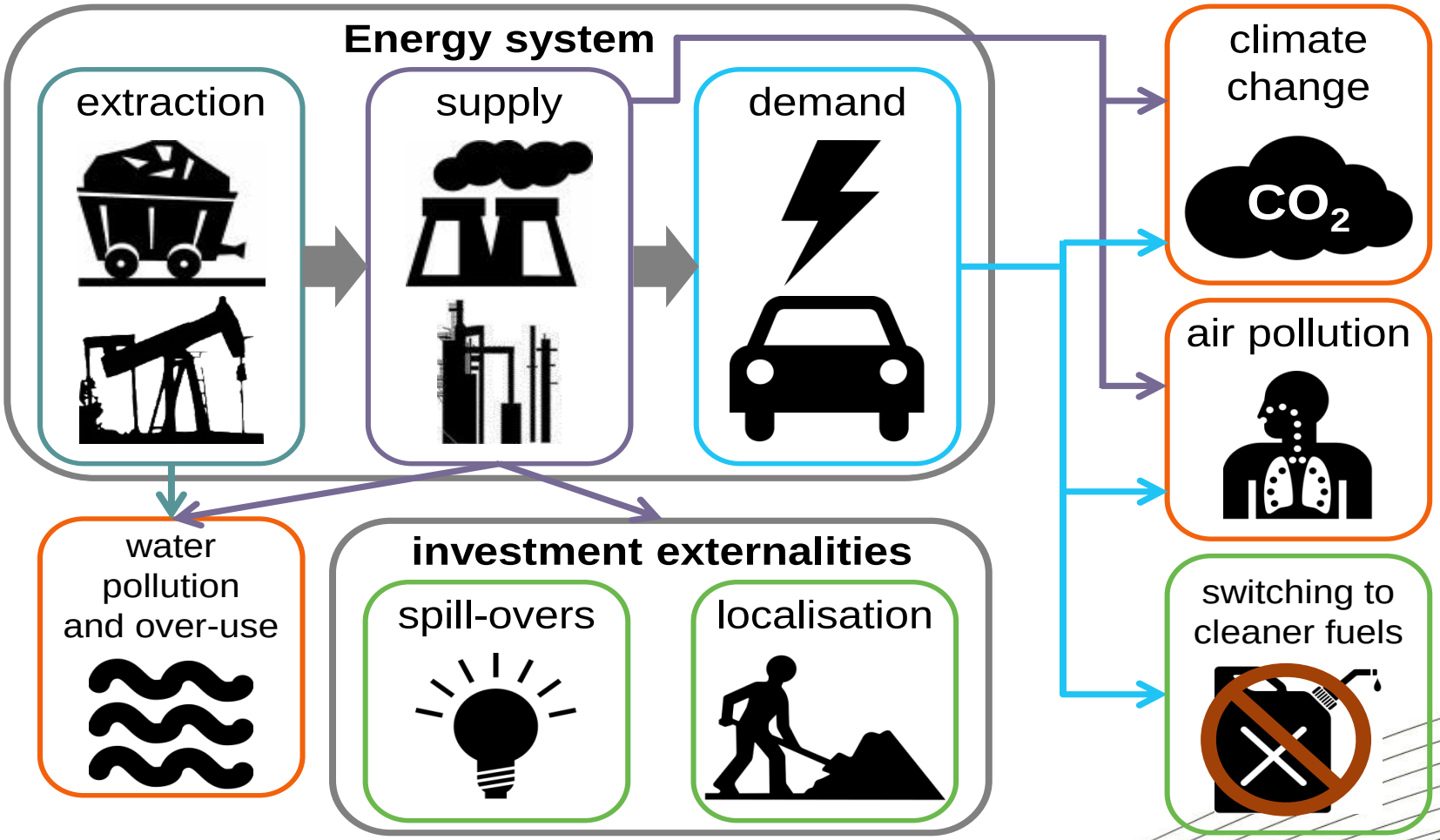


IEP PROGRESS (JUNE 2013 - FEBRUARY 2016)

- **June 2013:** The **Draft IEP Report was approved by Cabinet for publishing** for public consultation .
- **September to November 2013**: Wide consultation through **public stakeholder workshops** in all nine provinces. Substantial input was obtained from stakeholders through the workshops and also through **written comments.**
- **January – September 2014**: An **inter-governmental policy working group** and various **multi-stakeholder sub-committees** were established to deal with more thematic and substantive issues such as policy coherence, macroeconomic impact assessment, review of demand assumptions and externalities studies.
- Representatives from industry, academia, civil society, industry associations participated in these sub-committees.
- **Based on input obtained the following further enhancements were made on the IEP**
  - Internalising of energy systems externalities (Estimation of the externality costs of different energy carriers)
  - Determination of job creation potential for different technology types (with focus on electricity generation technologies)
  - Inclusion of the "Peak-Plateau-Decline" emissions limits constraints as the Base Case
  - Additional scenarios modelled
  - Conduct a macroeconomic impact assessment on all scenarios
  - Incorporate latest assumptions data
    - Technology costs
    - Macroeconomic assumptions
- **August 2015 – February 2016:** Input obtained from the **Ministerial Advisory Committee on Energy (MACE)** and further circulated to other government departments for comments

ENERGY SYSTEM EXTERNALITIES

IEP Internalises Energy System Externalities (both negative and positive)



Source: Vivid Economics 2014

EXTERNALITY COSTS

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An externality cost is a cost imposed on society due to the activities of a third party, resulting in social, health, environmental, degradation or other costs. Externalities may however also be beneficial (e.g. a mine builds a fire break between its operations and the neighbouring farm from which the farmer then directly benefits in terms of safety and security).

In the context of the energy planning framework, negative externalities of different pollutants resulting from the production of energy were considered.

The cost of the externalities were quantified by estimating the 'cost of the damage' to society* caused by such externalities. Examples of such factors that cause damage are: air pollution (caused by pollutants such as nitrogen oxide [NO_x], sulphur oxide [SO_x], particulate matter [PM] and mercury [Hg]), water contamination and soil erosion.

**Overall cost to society is defined as the sum of the imputed monetary value of costs to all parties involved.*

Externality	Description	Value	Unit
SO_2	Sulphur dioxide	7.60	2012 Rand/kg
NO_x	Nitrous oxide	4.50	2012 Rand/kg
Hg	Mercury	41 484.00	2012 Rand/kg
PM	Particulate matter	11.30	2012 Rand/kg
$PM_{Transport}$	Particulates in transport sector	280.70	2012 Rand/kg

JOB CATEGORIES CONSIDERED

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CATEGORY	DEFINITION	EXAMPLE
Direct Jobs	Jobs resulting from construction or operation of the technology	• Construction workers • Brick layers • Plant operators
Supplier Jobs	Jobs resulting from first level suppliers during construction and/or operation	• Turbine manufactures • Cement producers • Steel manufacturers
Indirect Jobs	Jobs resulting further down the value chain during construction and/or operation. i.e. suppliers to suppliers	• Iron ore miners and smelters
Induced Jobs	Jobs resulting from more money in the economy because of the project.	• Restaurants • Transport services • Medical facilities
Permanent Jobs	These are jobs which have a longer duration and are more permanent in nature. Services are usually established in-house within the organisation.	• All operations jobs are considered to be permanent jobs • Estimated per unit of capacity installed
Temporary Jobs	These are jobs which have a relatively short duration. Services are usually contracted.	• All construction jobs are considered to be temporary jobs • Estimated per unit of energy output

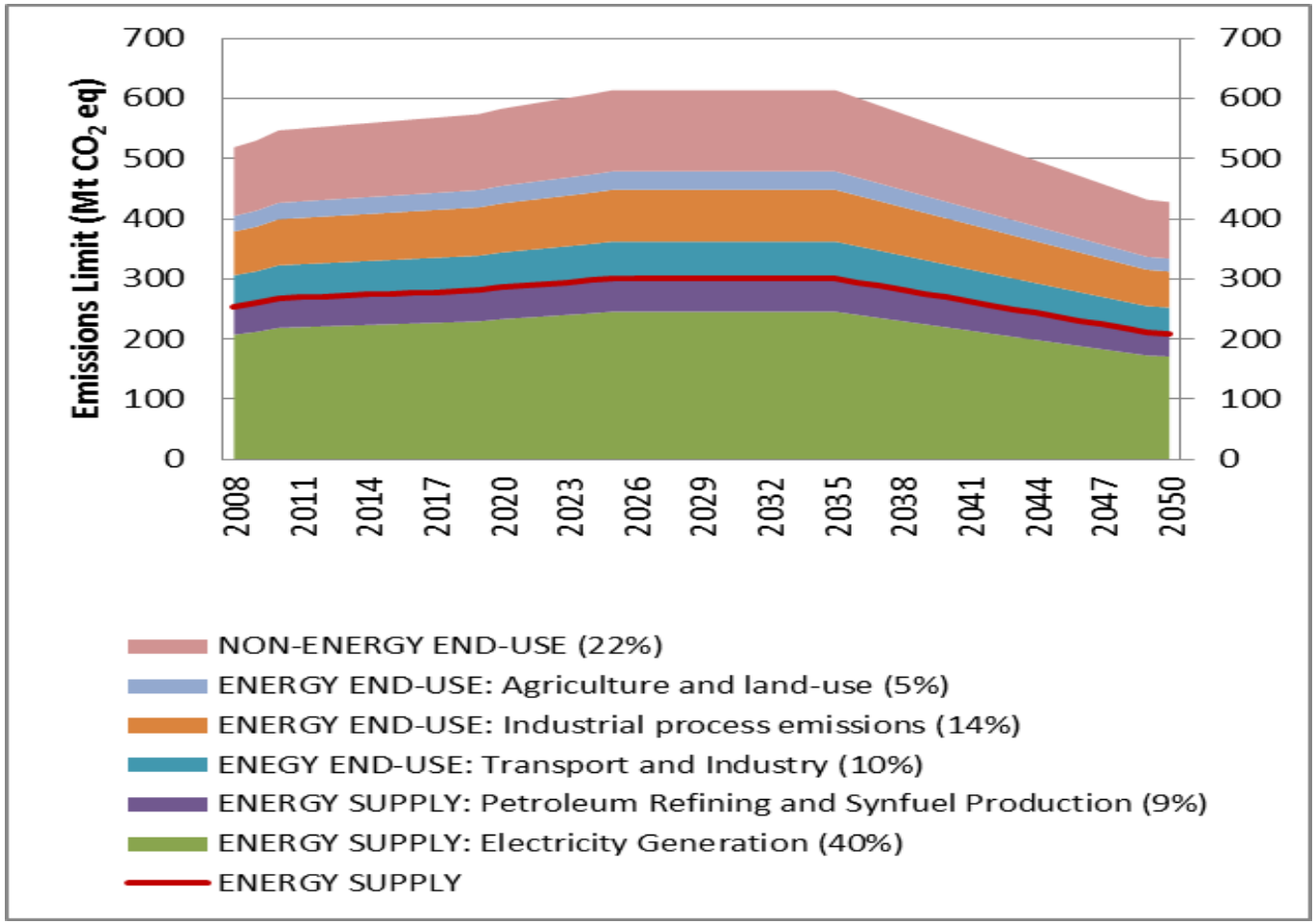
LOCALISATION POTENTIAL

(BASED ON CURRENT POLICIES AND LOCAL CAPABILITY)

Level of difficulty to localise

Localisation Potential	Description
Localisable	The current policy framework is conducive for localisation; local supply of the required skills set is available; and there is sufficient demand for raw material to justify local production
Potentially localisable	The current policy framework exists or could be developed and implemented within a fairly short timeframe (3-5 years)
Collaboration	The current policy and regulatory framework could be developed and implemented within five years and some targeted investments would need to be made
Significant investment required	Regional cooperation and partnerships would need to be developed in order to create demand beyond South Africa's borders
Global demand required	Some of the required technology components can be localised but South Africa would need to be competitive in exporting the technologies and services to the global market

EMISSIONS CONSTRAINTS



The National Climate Change Response White Paper (NCCRWP) sets emission limit targets for all sectors. The energy planning framework considers the impact of the emission limit targets for the energy supply sectors only (electricity generation and the production of petroleum products.

IEP SCENARIOS

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INDICATORS	BASE CASE	RESOURCE CONSTRAINED	ENVIRONMENTAL AWARENESS	GREEN SHOOTS
Technology Constraints	9.6 GW New Nuclear Build enforced			
GDP	Treasury moderate GDP growth			**National Development High GDP Growth**
DEMAND-SIDE INTERVENTIONS				
DSM	1 million SWH		**5 million SWH**	**10 million SWH**
Energy efficiency	Business As Usual	**High Energy Efficiency**		
VEHICLE EFFICIENCY (new vehicle improvement per annum)				
Cars and SUVs	1.1%	**2.50%**		
Trucks and buses	0.8%	**1.00%**		
Electric vehicle penetration	20% annual rate			**40% annual rate**
Prices of Energy Commodities	Moderate	**High**	Moderate	Moderate
CLIMATE CHANGE				
CO_2 emissions limits	Upper bound "Peak-Plateau-Decline" (PPD) emission limit trajectory from the National Climate Change Response White Paper		**PPD lower limit**	PPD upper limit
CO_2 externality costs	• R48-R120/t (2015 - 2019) • R120/t onwards		**• R270/t 2015 - 2050**	• R48-R120/t (2015- 2019) • R120/t onwards
Carbon Tax	Embedded in the externality cost of Carbon			

IEP SCENARIOS

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INDICATORS	BASE CASE	BIG SWH	NUCLEAR RELAXED	NO SHALE GAS
Technology Constraints	9.6 GW New Nuclear Build enforced		None	9.6 GW New Nuclear Build enforced
GDP	Treasury moderate GDP growth			
DEMAND SIDE INTERVENTIONS				
DSM	1 million SWH	10 million SWH	1 million SWH	
Energy efficiency	Business As Usual			
VEHICLE EFFICIENCY (new vehicle improvement per annum)				
Cars and SUVs	1.1%			
Trucks and buses	0.8%			
Electric vehicle penetration	20%			
Prices of Energy Commodities	Moderate			Unavailable shale gas
CLIMATE CHANGE				
CO_2 emissions limits	PPD upper limit			
CO_2 externality costs	• R48-R120/t between 2015 and 2019 • R120/t onwards			
Carbon Tax	Embedded in the externality cost of carbon			

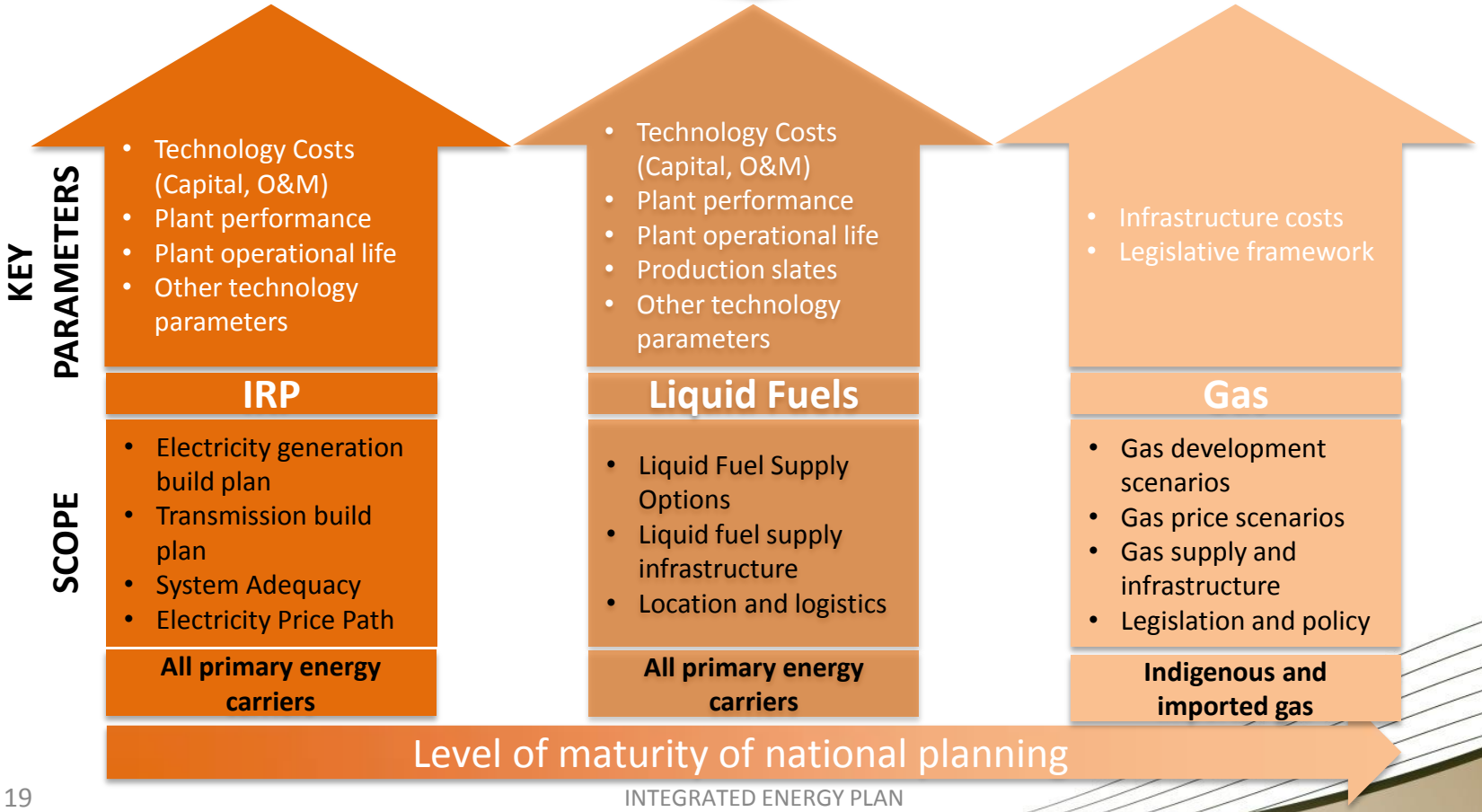
IEP PROGRESS SINCE FEBRUARY 2016

Change in IEP development framework to enable focused approach on the critical energy sub-sectors

Electricity Supply	• Electricity supply is mature and well- established. Planning process is also well-developed • Sector is highly regulated with clear legislation which interlinks development of plans with regulatory activities • Electricity elements of the IEP to be dealt with in detail in the IRP
Liquid Fuel Supply	• Sector is semi-regulated with planning undertaken by individual companies • IEP to focus on more detailed analysis of liquid fuel demand and evaluate different scenarios for supply • Liquid Fuel Roadmap to focus on logistics and specific nodal points
Gas	• Gas industry in South Africa continues to be underdeveloped with significant potential for growth in the future • A detailed framework that explores the options for successfully stimulating the off-take of a gas market in the country is required • Guideline for the foundational elements of this sub-sector taking into account current government programmes (i.e. Operations Phakisa, Gas-to-Power programme) as well as all future considerations (i.e. Shale Gas, Mozambican Gas discoveries)

IEP

Global Parameters (e.g. GDP, Discount rate, Exchange Rate, Fuel Costs)



IEP LIQUID FUEL SUPPLY SCENARIOS

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INDICATORS	BASE CASE	GREEN SHOOTS	CLEANER PASTURES	RESOURCES CONSTRAINED	SECURITY OF SUPPLY
Technology Constraints	• Minimum production constraints on crude oil refineries				**New crude oil refinery enforced (200 000 bbl/day)**
GDP	Moderate GDP Growth	**High GDP Growth**	Same as Base Case		
VEHICLE EFFICIENCY IMPROVEMENT FOR NEW VEHICLES PER ANNUM					
Cars and SUVs	1.1%	**2.50%**			Same as Base Case
Trucks and buses	0.8%	**1.00%**			Same as Base Case
New Electric vehicle penetration	20% annual rate	**40% annual rate**	Same as Base Case		
Prices of Energy Commodities	• Moderate commodity prices • Shale gas available after 2025	Same as Base Case	• **High commodity prices** • **Extraction of shale gas uneconomical**		Same as Base Case
ENVIRONENTAL CONSIDERATIONS					
CO_2 emissions limits	PPD Upper limit	Same as Base Case	**PPD lower limit**	Same as Base Case	
CF2	No CF2 on existing refineries		**CF2 implemented on existing refineries**	Same as Base Case	**CF2 implemented on existing refineries**
Compliance to Clean Fuels 2 (CF2) Standards and Specifications	• All new refineries are CF2 compliant • Total refining yield is marginally reduced as a result of CF2 implementation on existing refineries • Compensation to the Oil Industry in order to upgrade existing refineries to be CF2 complaint has not been factored				
Existing refineries	• All existing crude oil refineries continue to operate throughout the planning horizon (the closure of some of the older refineries are explored in more detailed sensitivity analyses) • The existing GTL plant ceases production after 2030 as a result of depleting gas feedstock • The CTL plant continues to operate until 2040				

PURPOSE OF WORKSHOP

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Share the latest assumptions for Global Parameters (e.g. GDP, Discount rate, Exchange Rate, Fuel Costs)

IRP

- Latest technology parameters
- Presentation of model output for Base Case and first set of scenarios

Liquid Fuels

- Presentation on model output for Base Case and first set of scenarios

Gas

- To be developed in the future

THANK YOU

DEMAND PROJECTIONS

MOTLATSI SEOTSANYANA
(DEMAND MODELLING SPECIALIST)

TRANSPORT DEMAND MODELLING

IEP Transport Model

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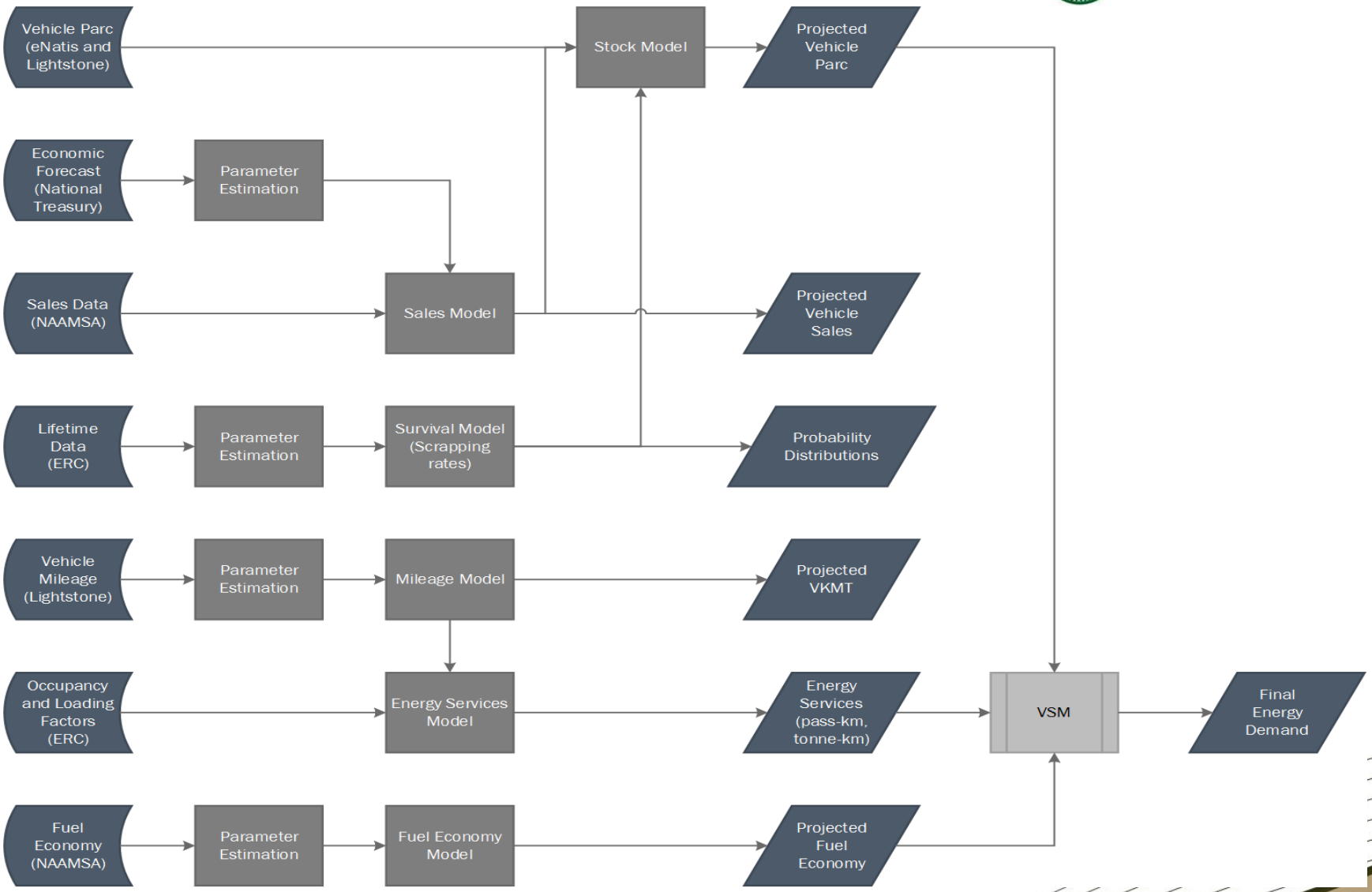

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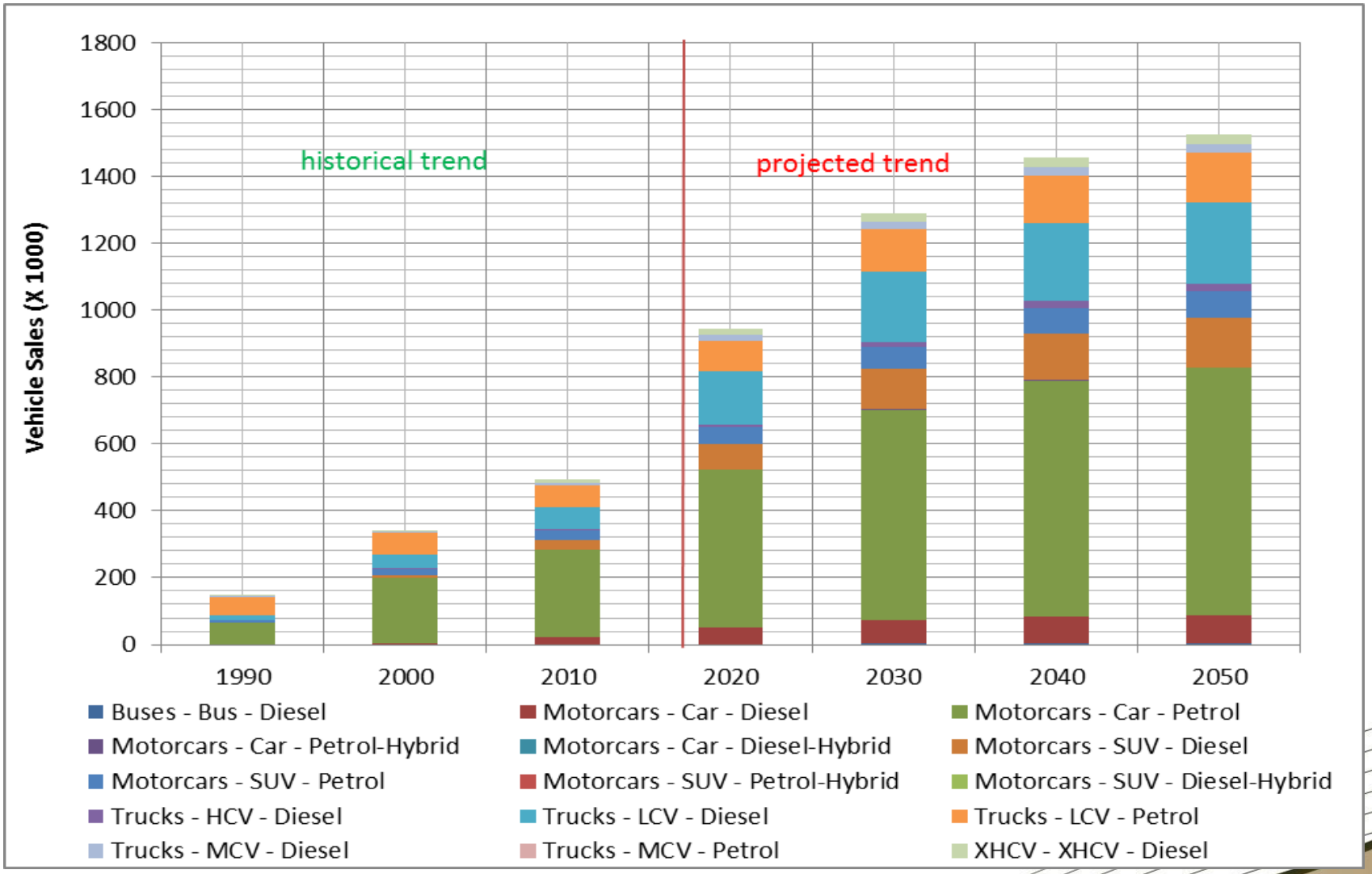
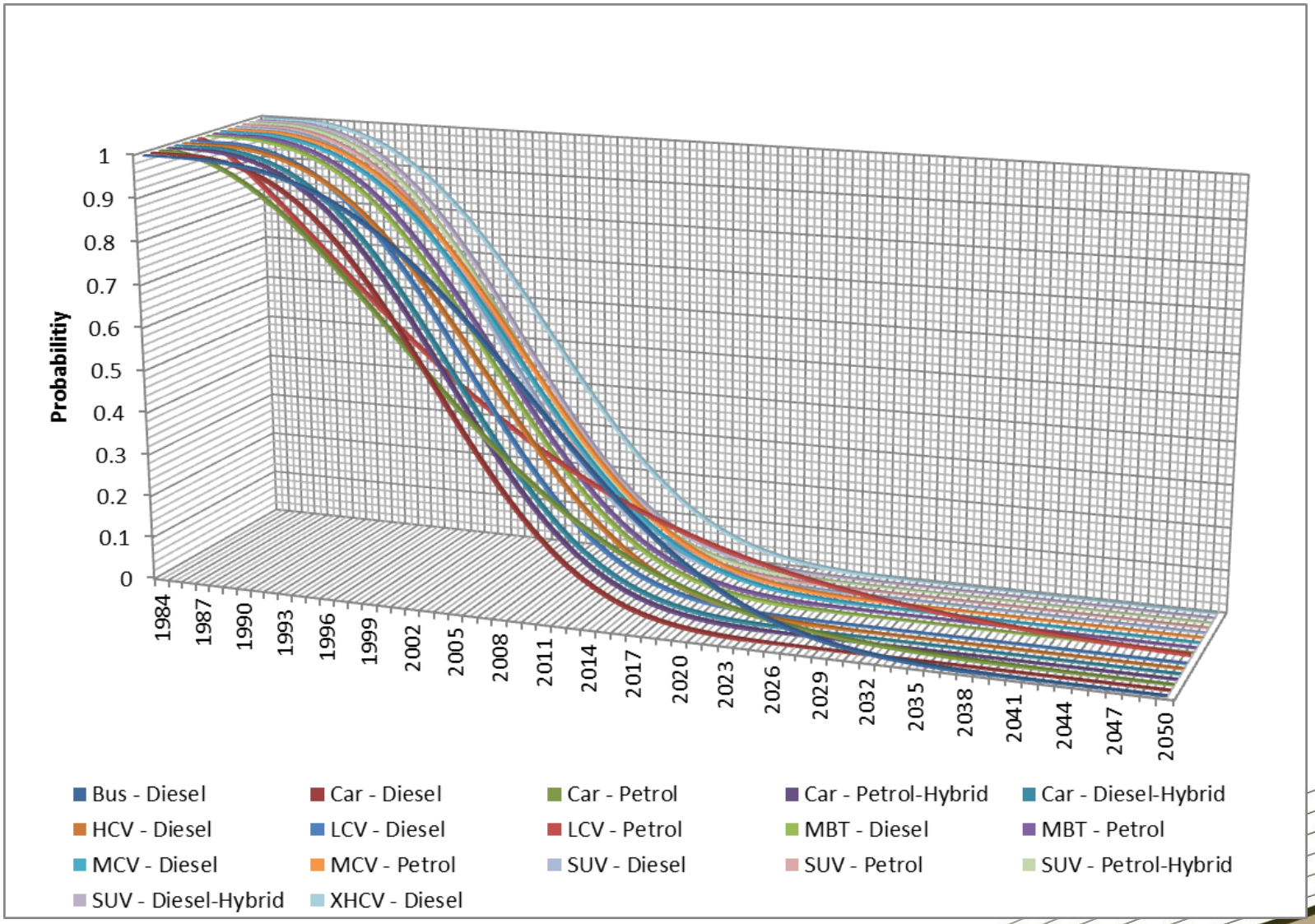
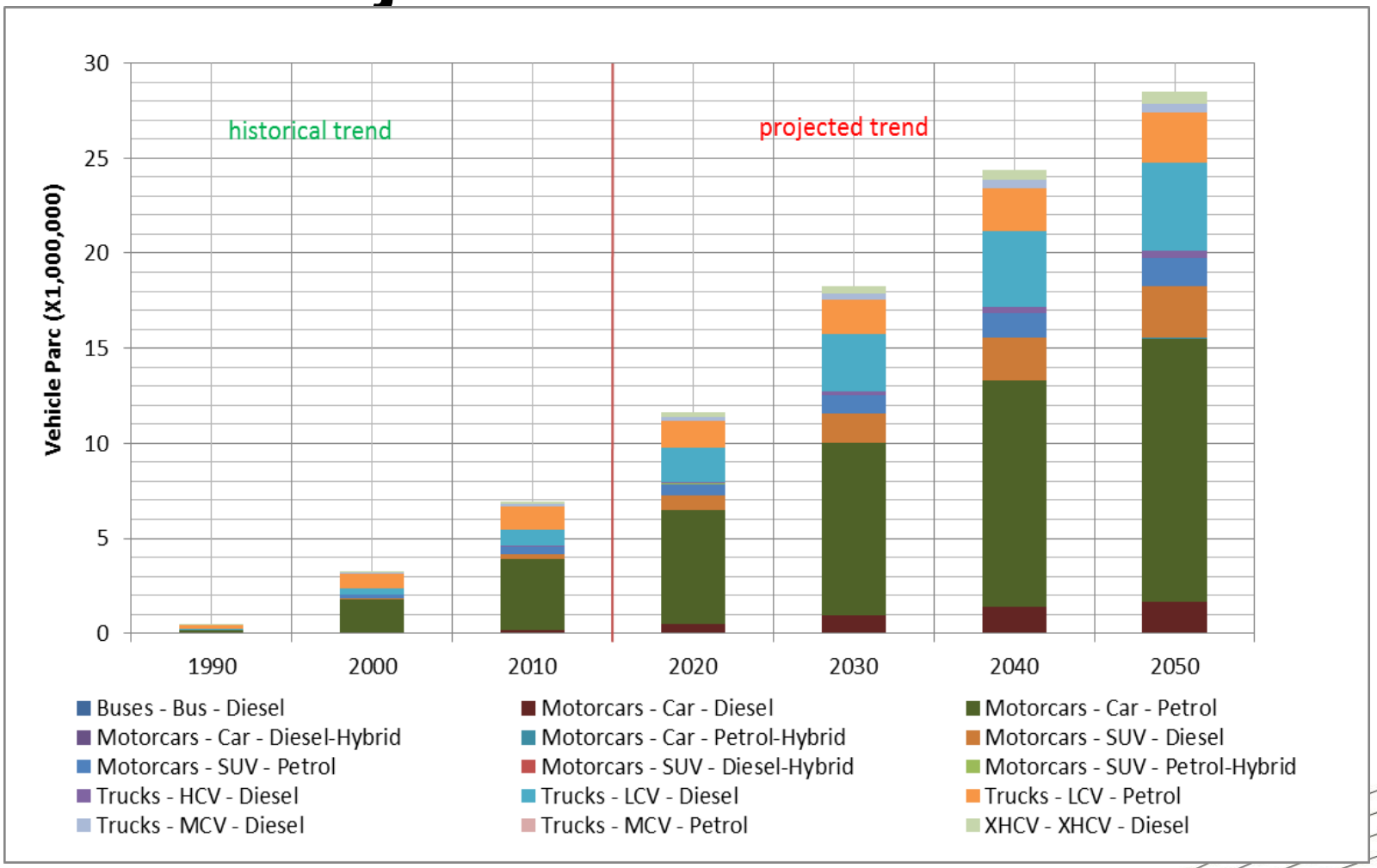
Projected Vehicle Sales



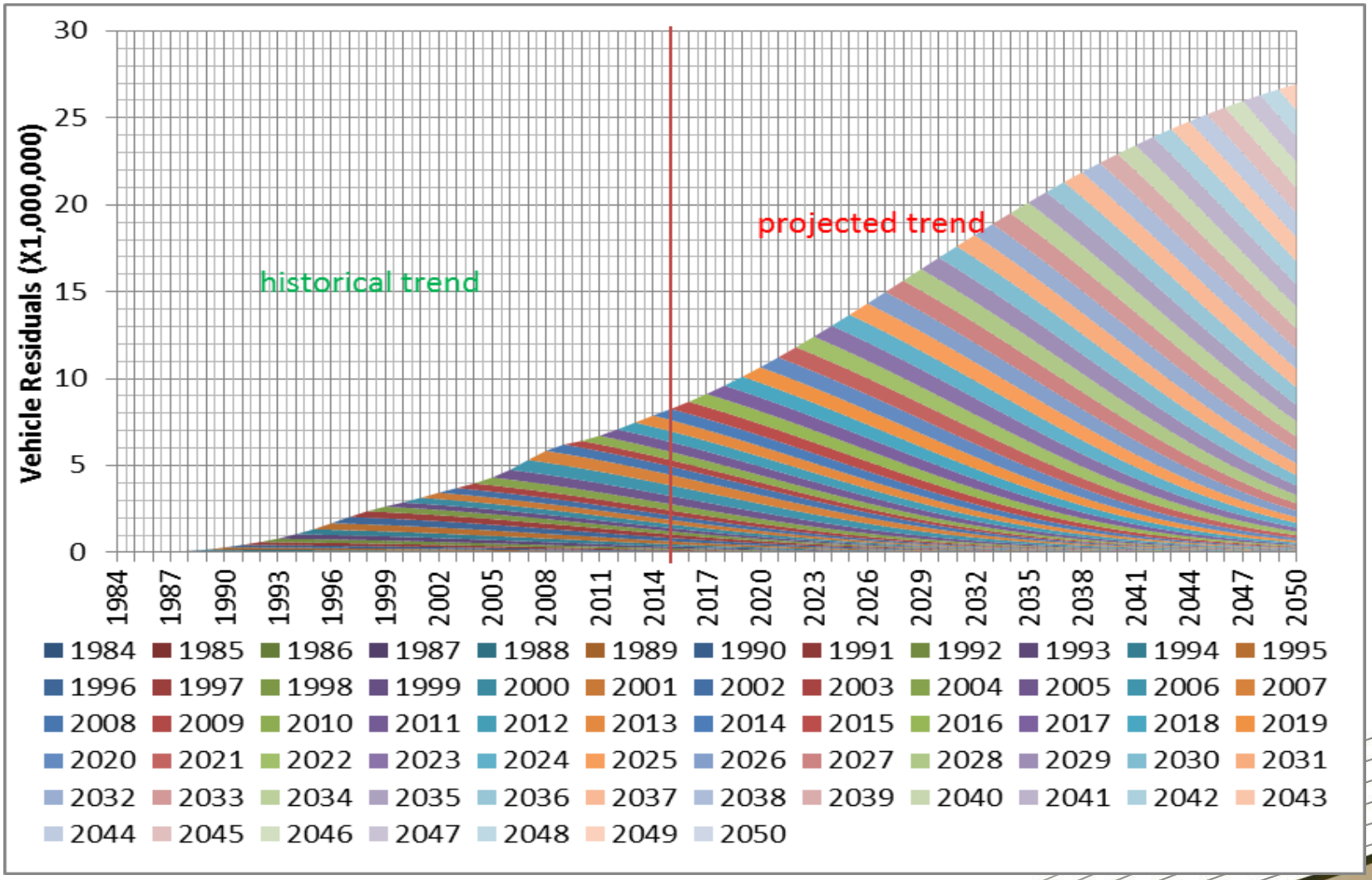
Scrapping Curves for All Technologies



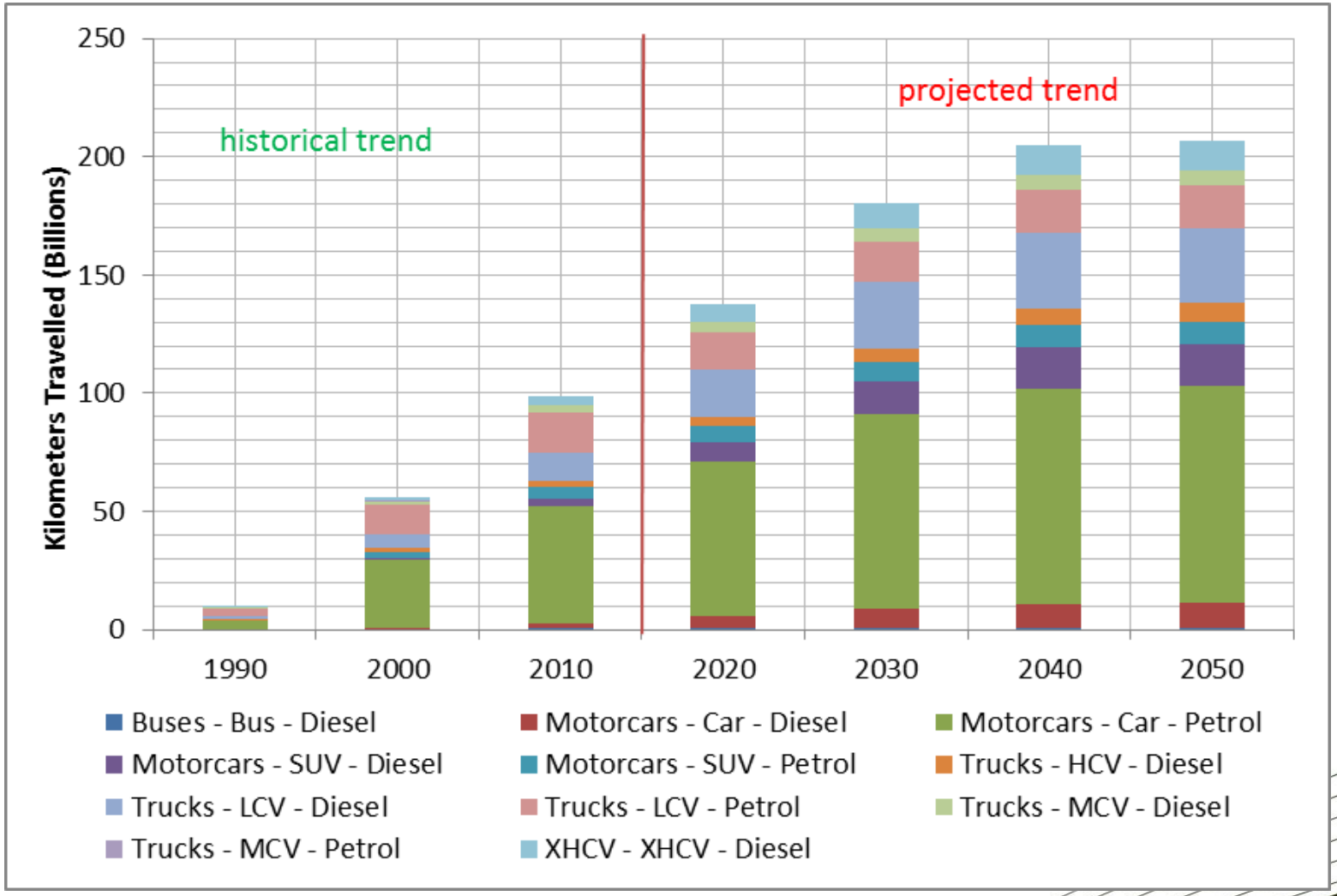
Projected Vehicle Parc



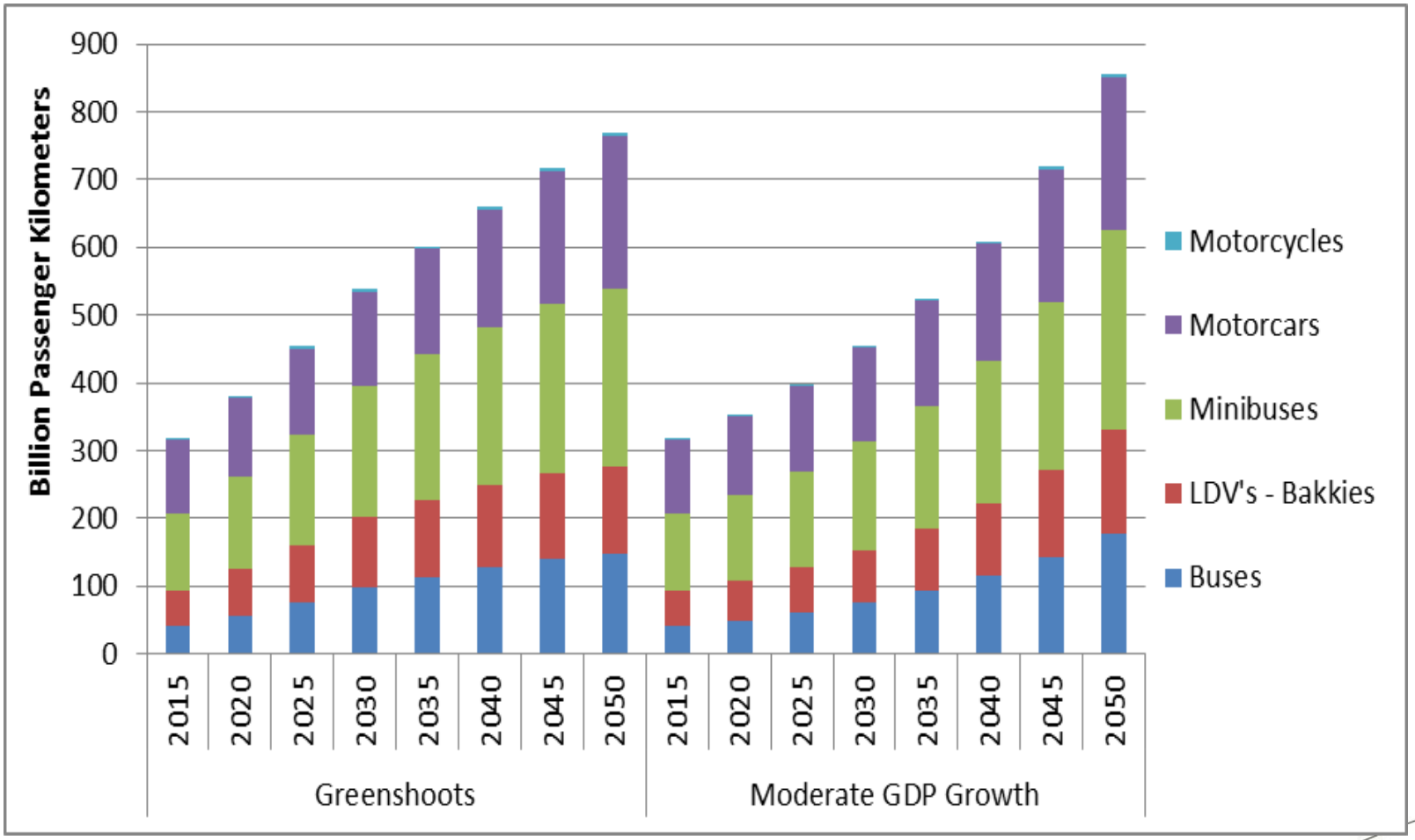
Projected Vehicle Residuals



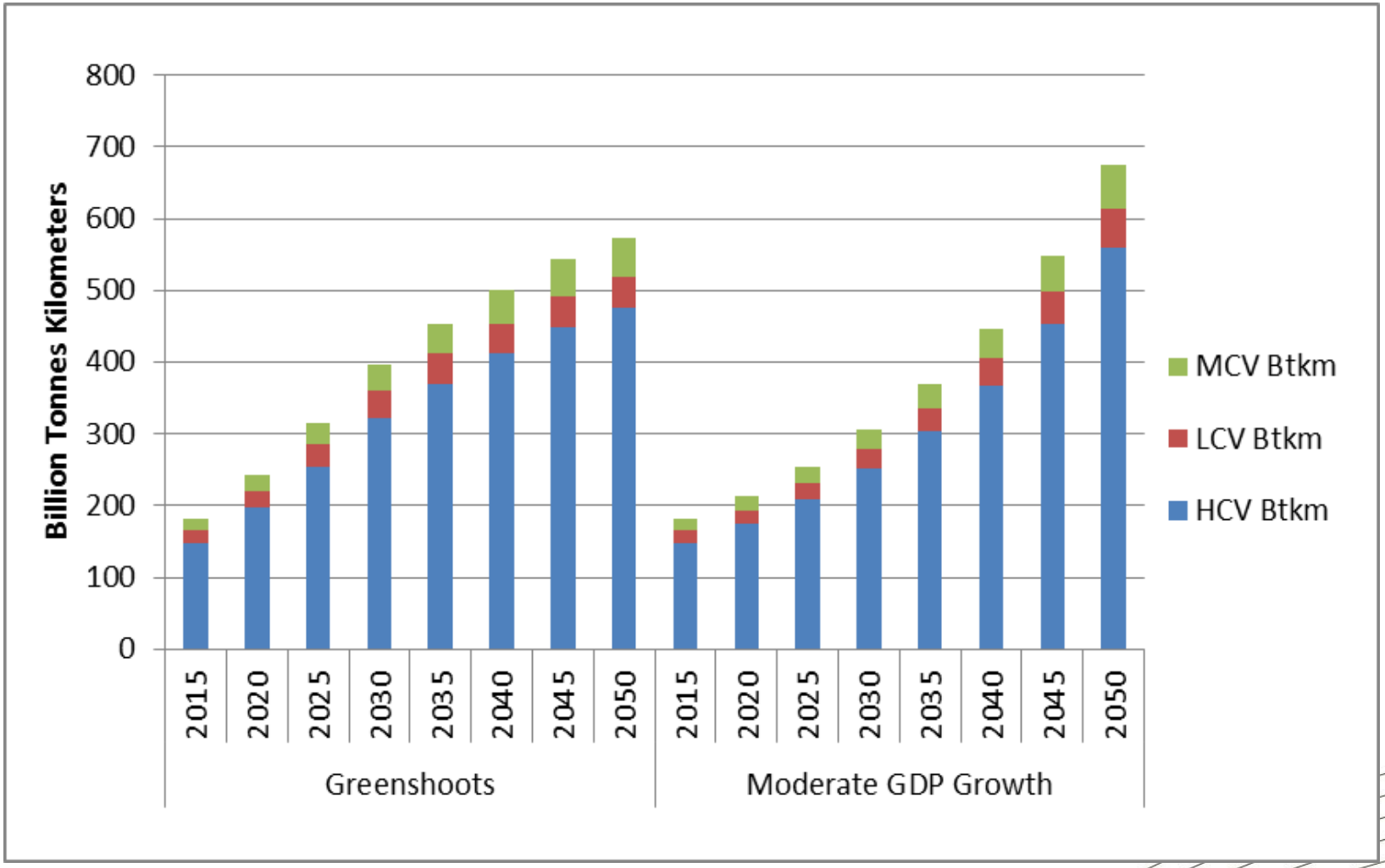
Projected Vehicle Kilometers



Projected Passenger Kilometers



Projected Tonne Kilometers



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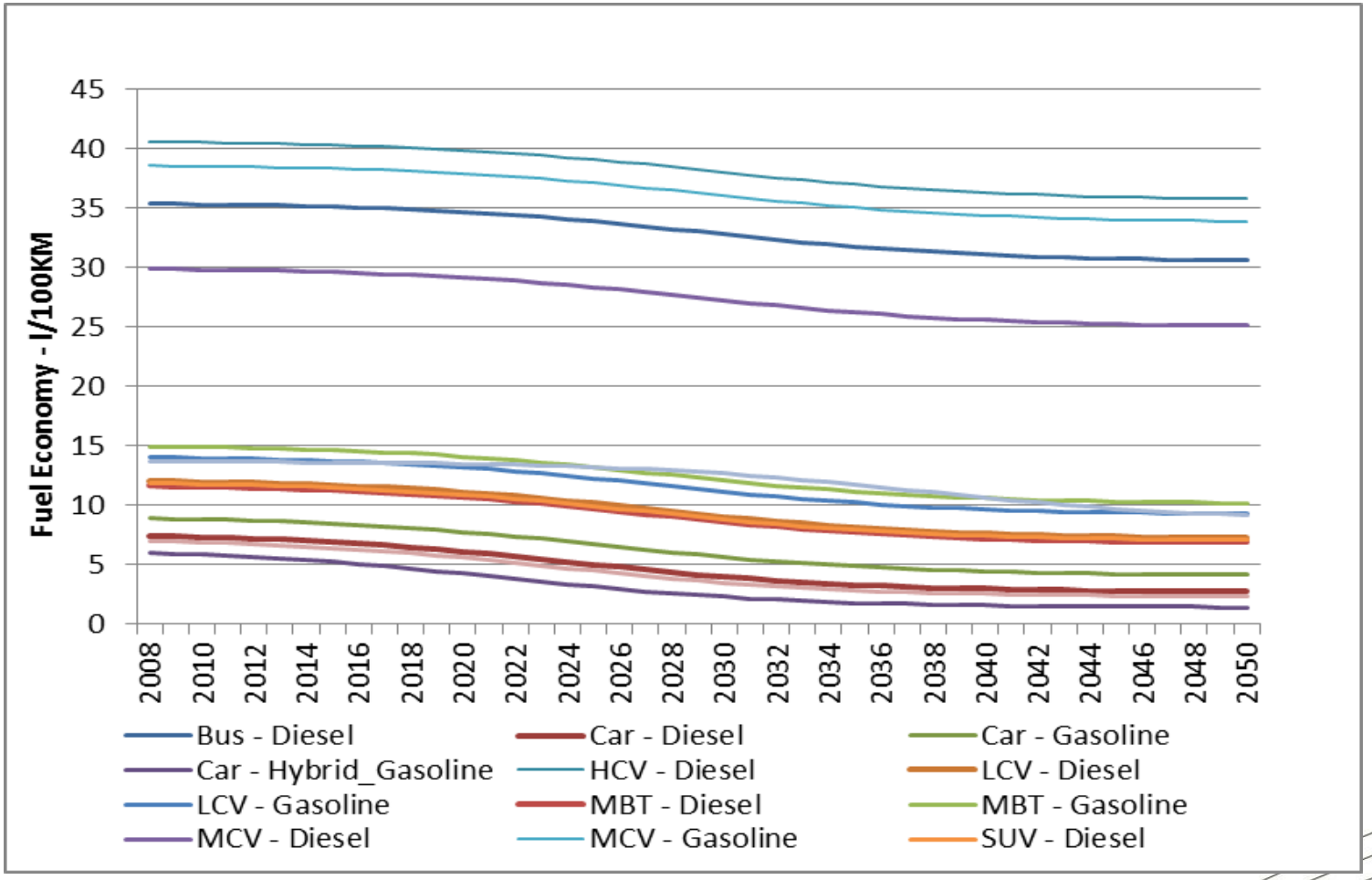
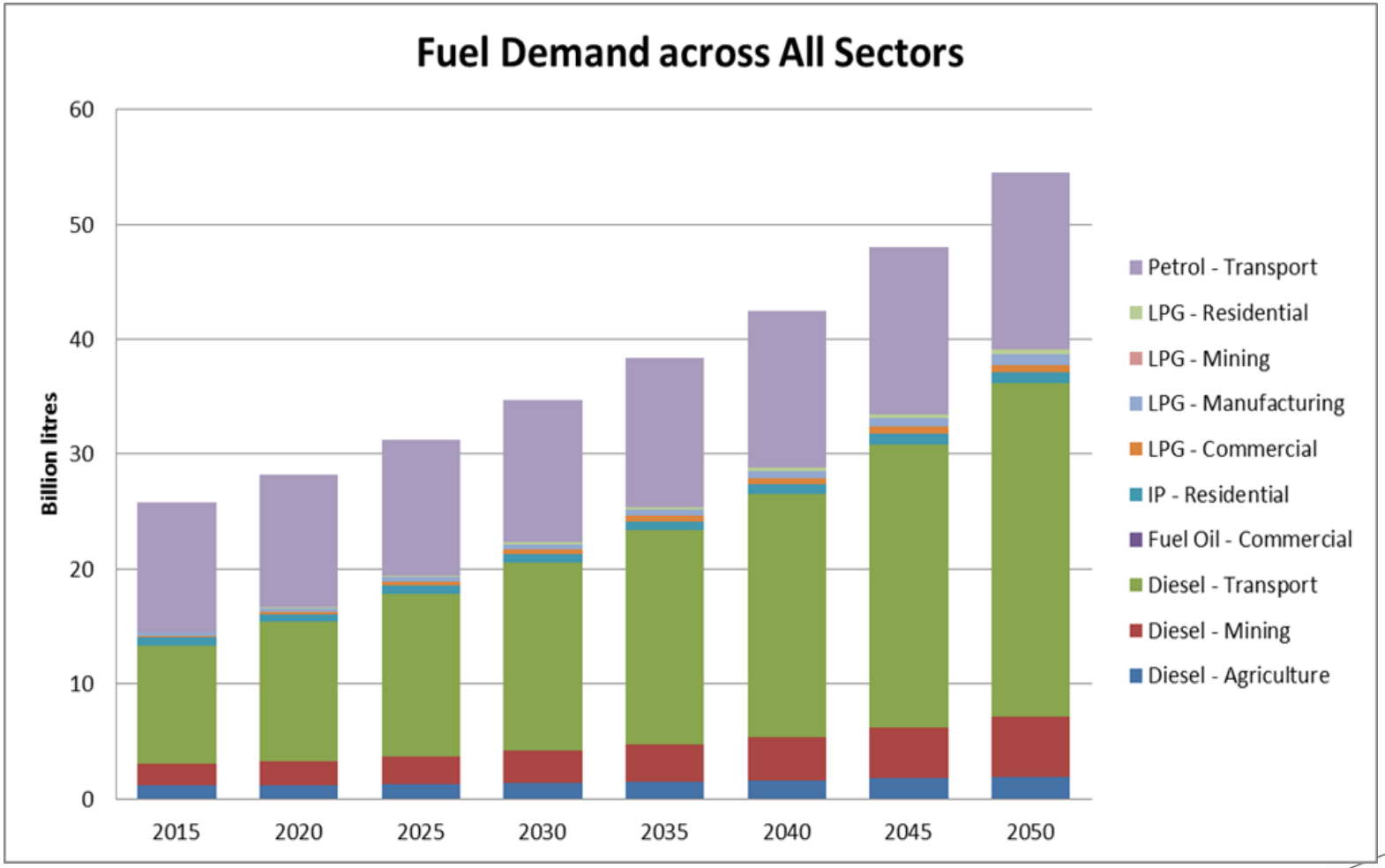
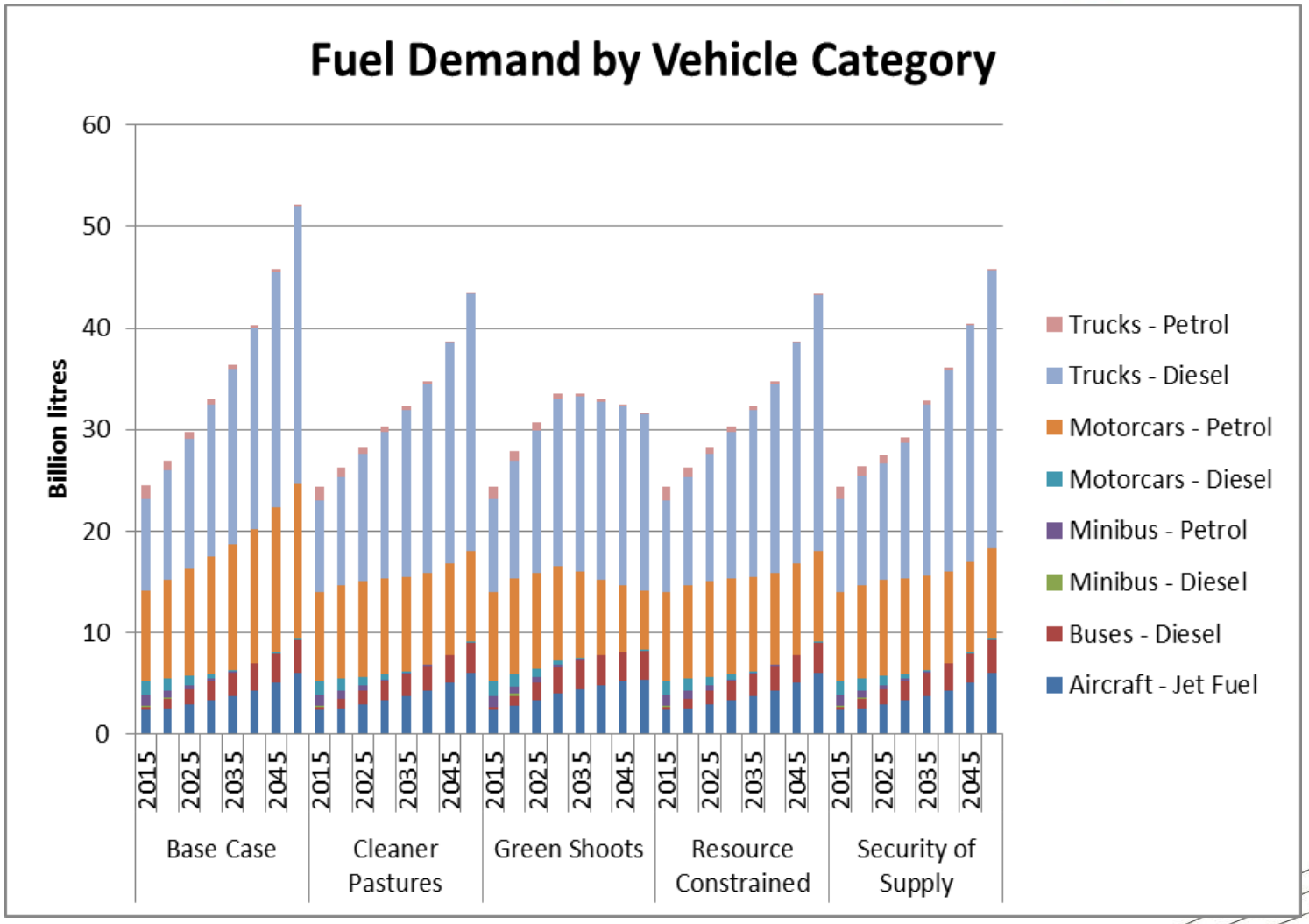
Projected Fuel Economy



FINAL ENERGY DEMAND PROJECTIONS


Fuel Demand across All Sectors
Billion litres
60
50
40
30
20
10
0
2015
2020
2025
2030
2035
2040
2045
2050
Petrol - Transport
LPG - Residential
LPG - Mining
LPG - Manufacturing
LPG - Commercial
IP - Residential
Fuel Oil - Commercial
Diesel - Transport
Diesel - Mining
Diesel - Agriculture


Fuel Demand by Vehicle Category
Billion litres
60
50
40
30
20
10
0
2015
2025
2035
2045
Base Case
Cleaner Pastures
Green Shoots
Resource Constrained
Security of Supply
Trucks - Petrol
Trucks - Diesel
Motorcars - Petrol
Motorcars - Diesel
Minibus - Petrol
Minibus - Diesel
Buses - Diesel
Aircraft - Jet Fuel

THANK YOU

SCENARIOS FOR LIQUID FUELS SUPPLY

Variables Analysed

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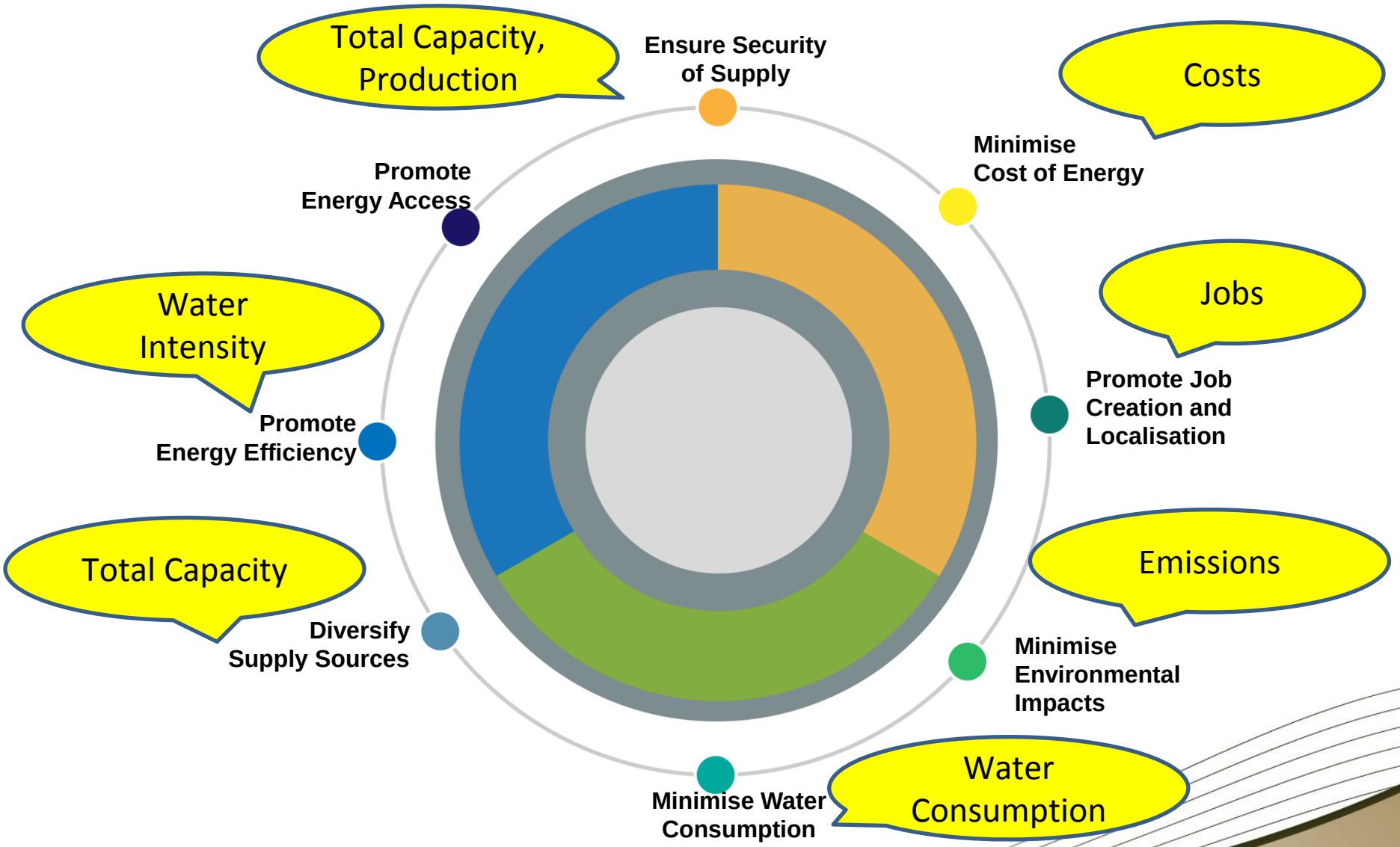
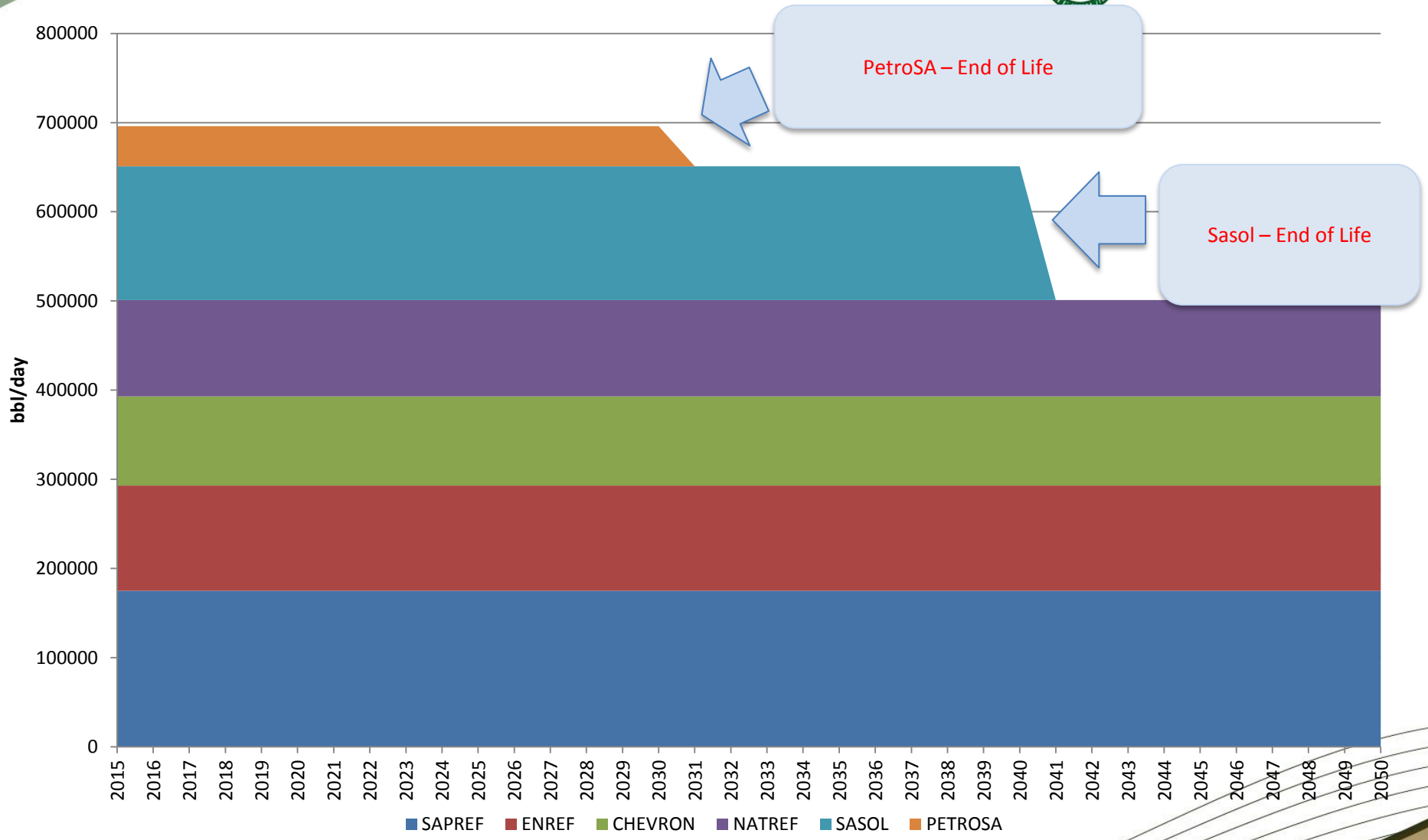
1. Total Capacity
2. Production
3. Emissions
4. Water Consumption
5. Feedstock Consumption
6. Costs
7. Jobs

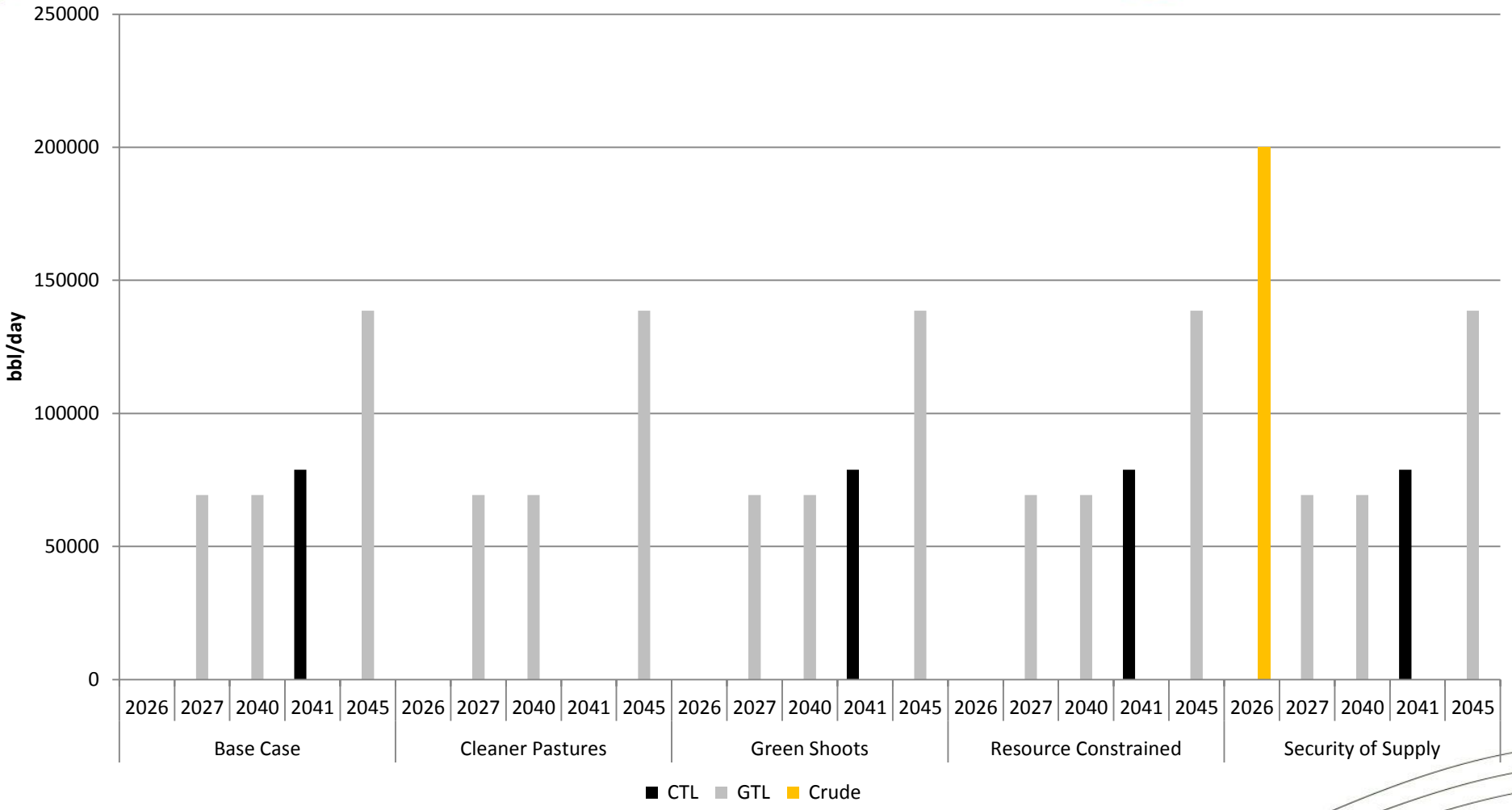
8 KEY OBJECTIVES



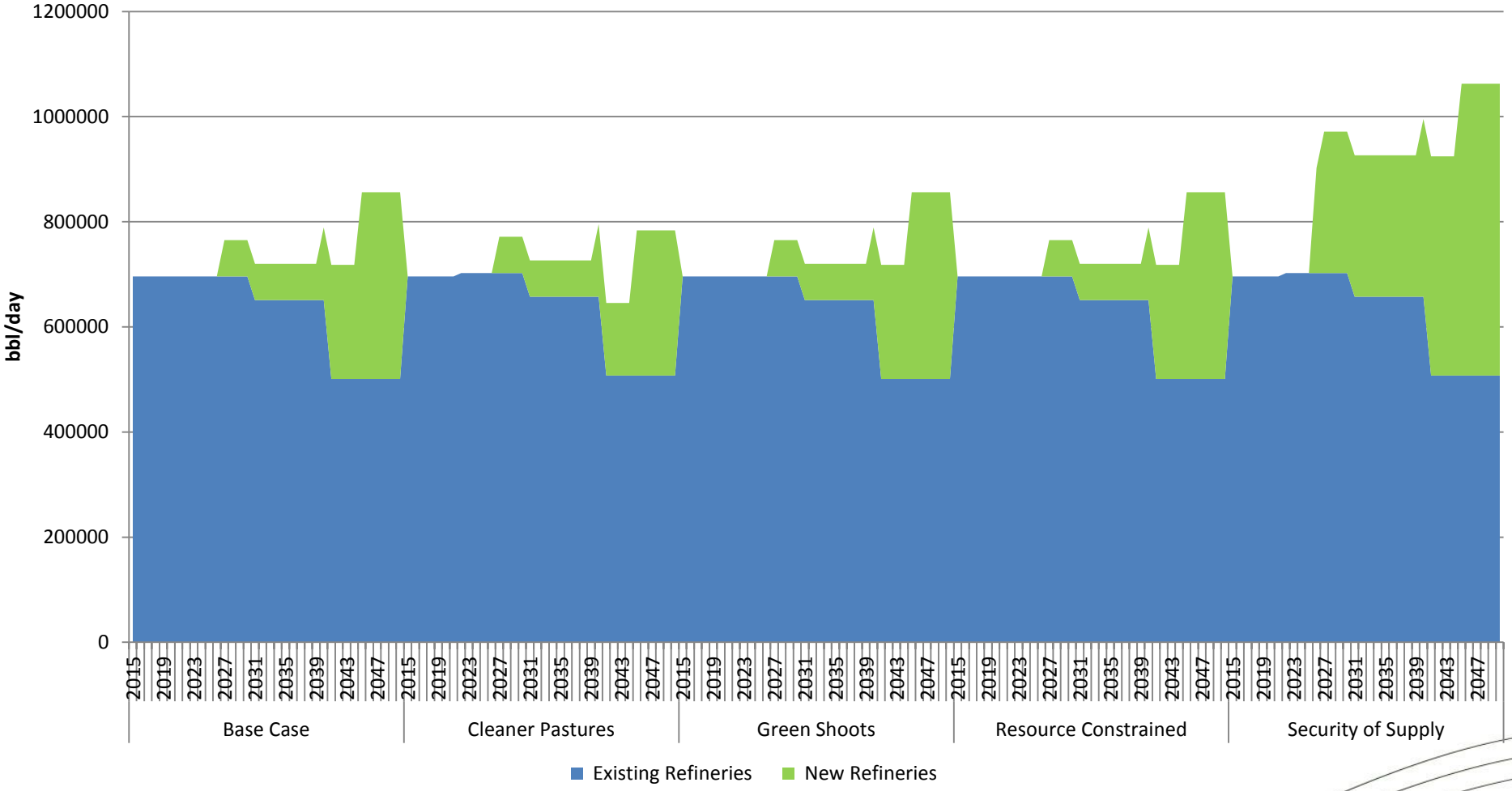
Existing Refining Capacity



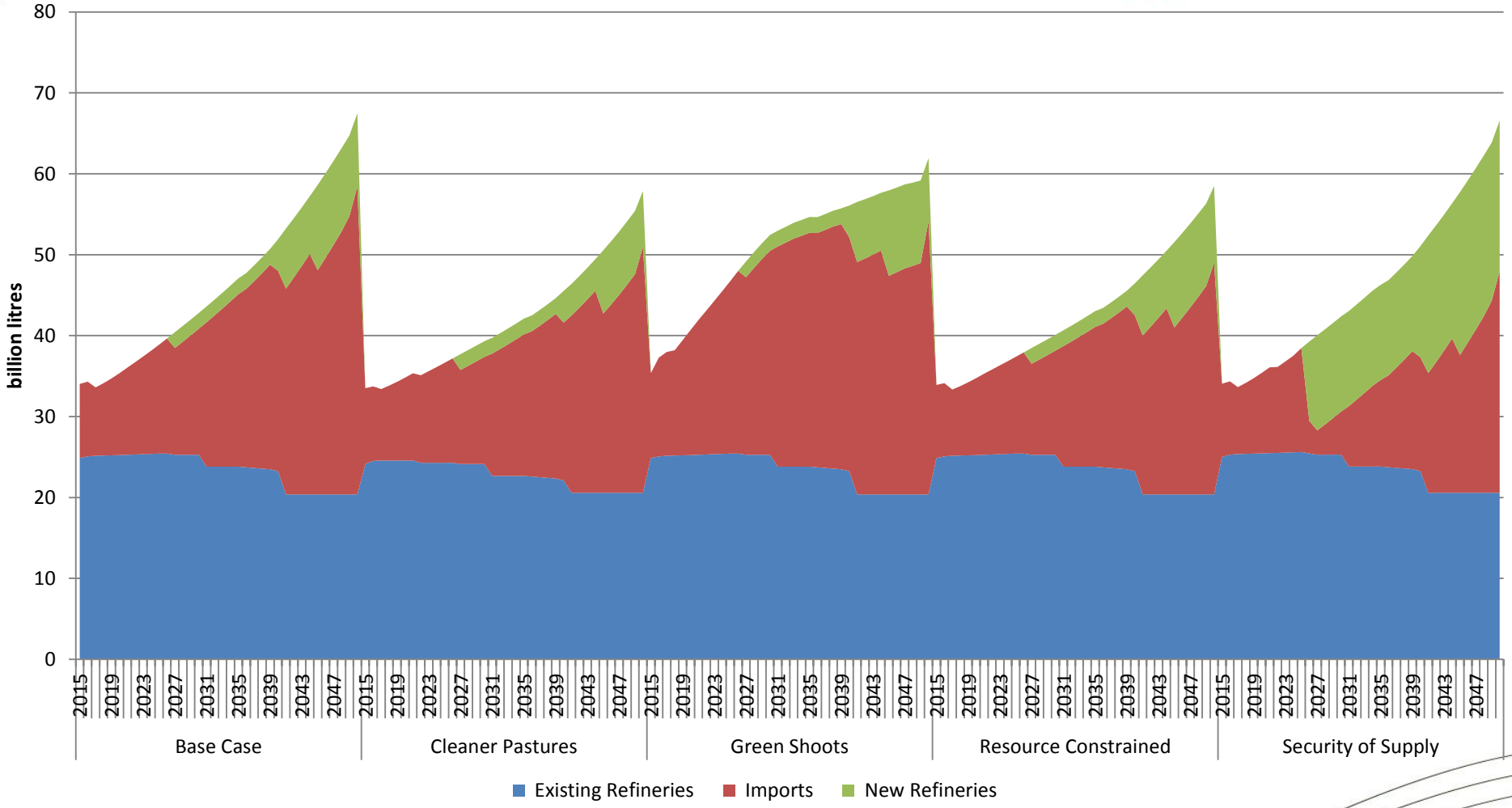
New Refining Capacity



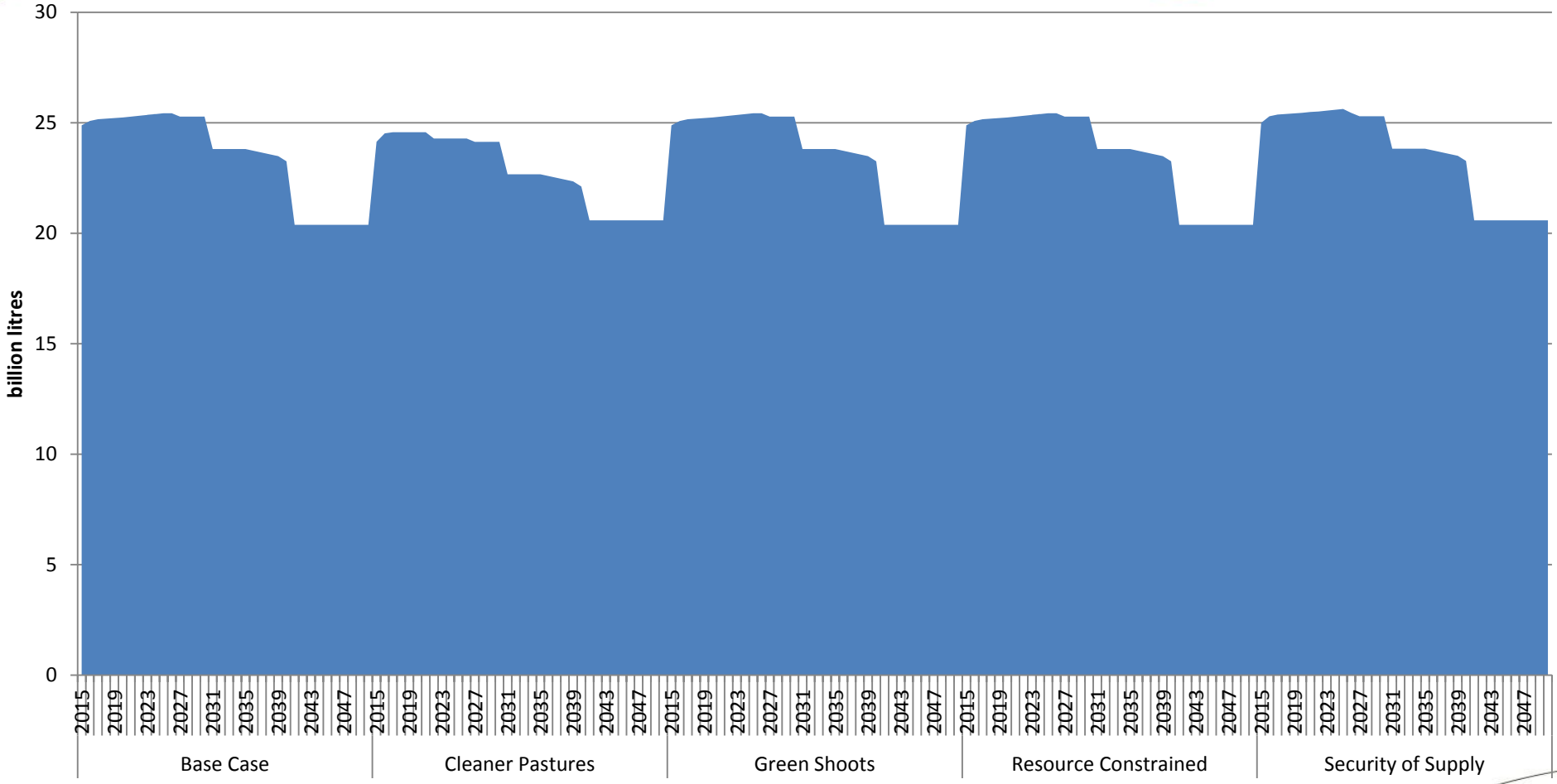
Total Capacity



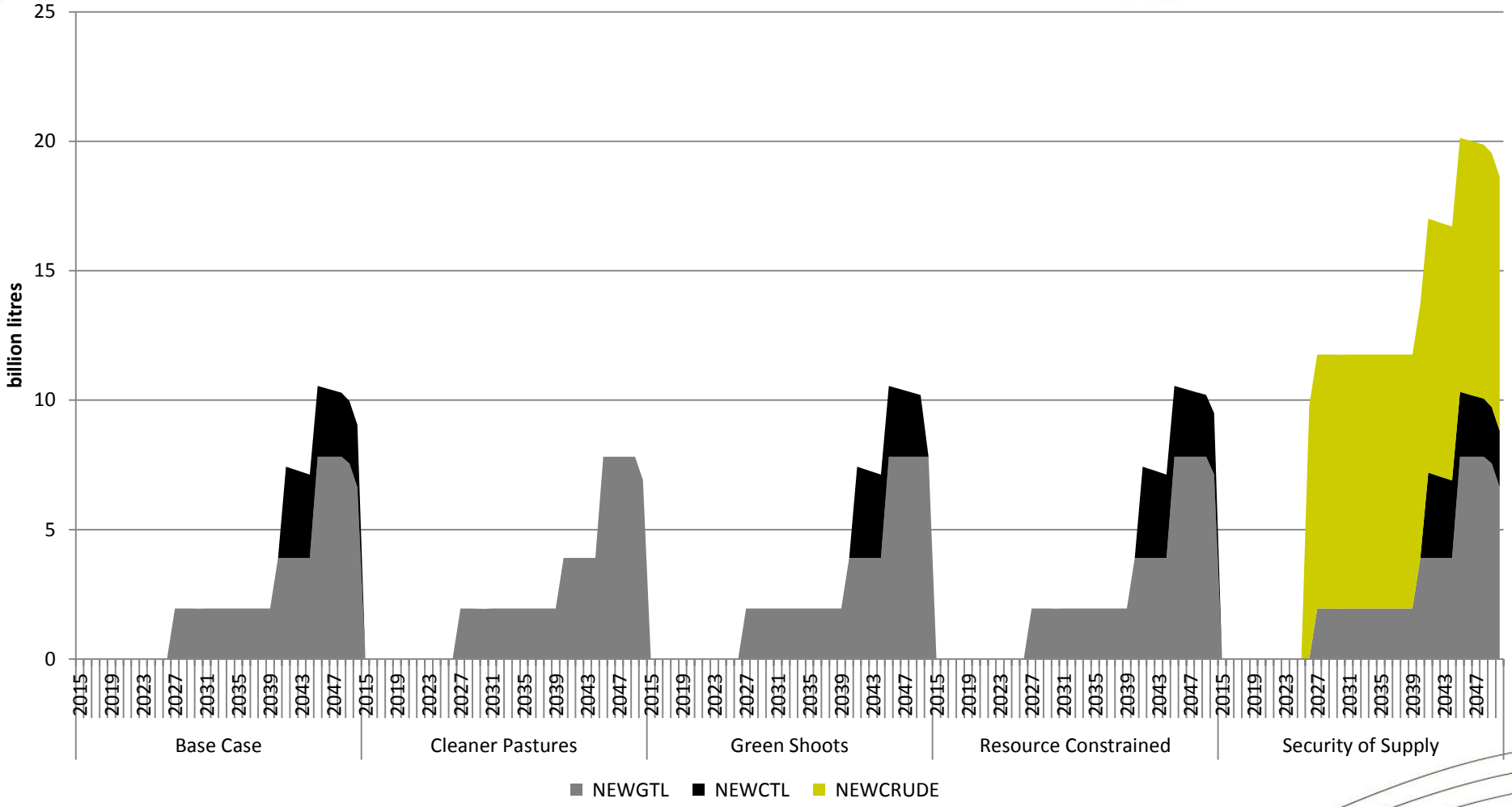
Liquid Fuel Supply



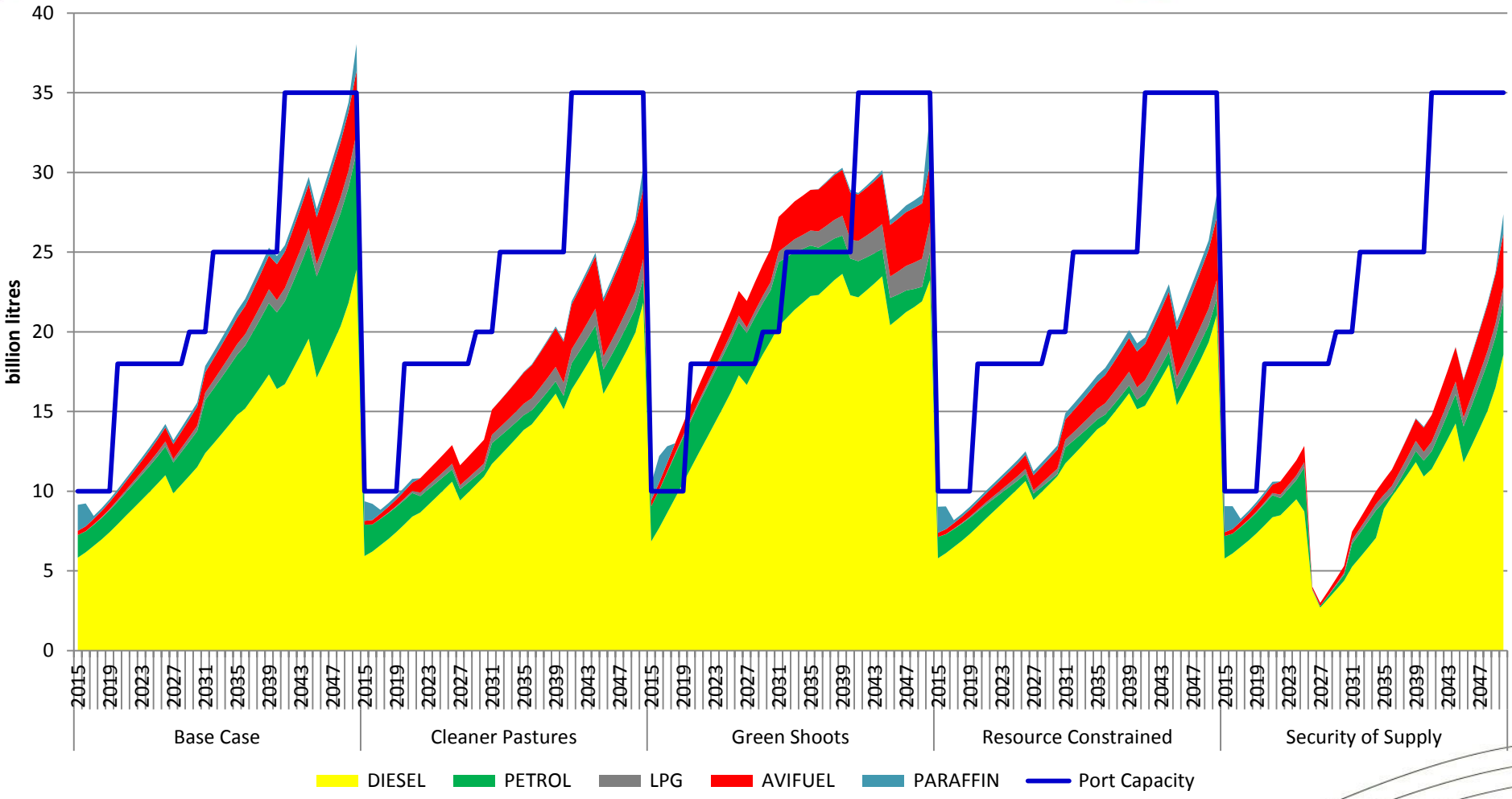
Domestic Production – Existing Refineries



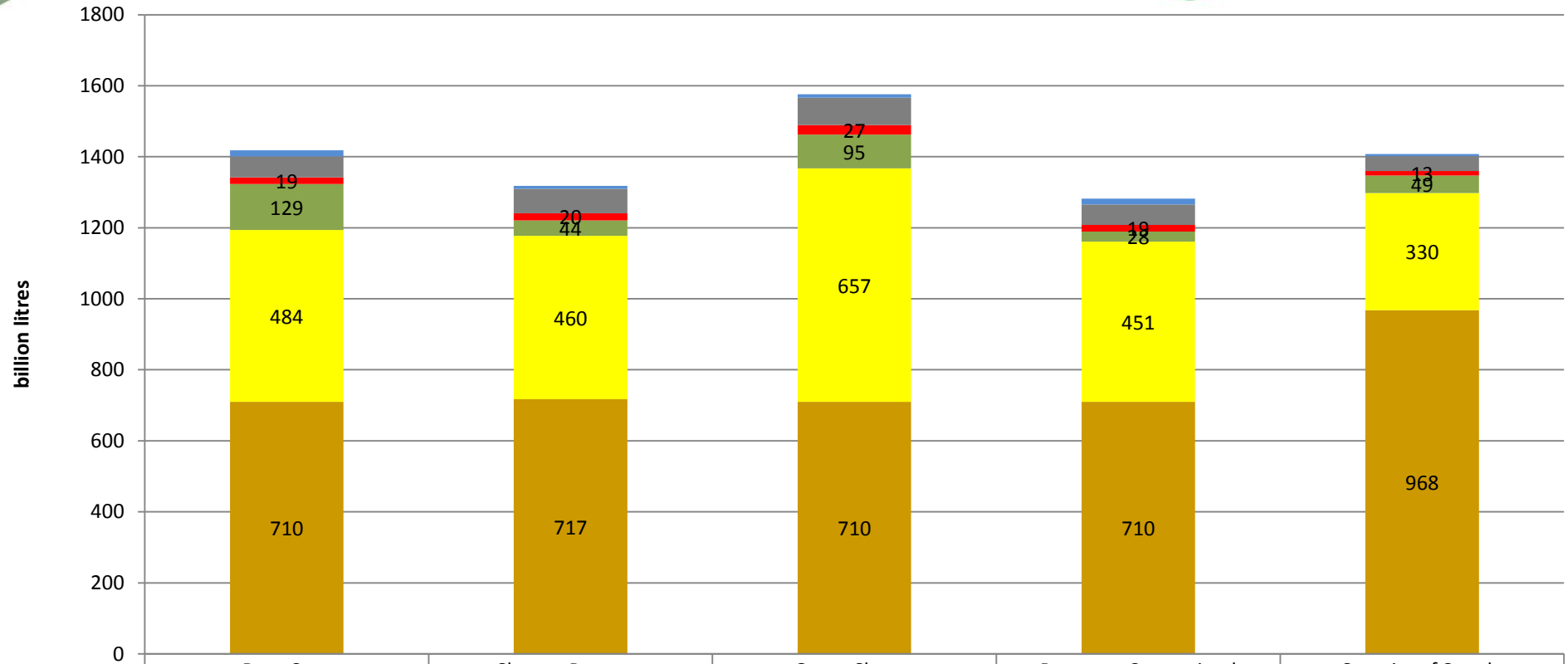
New Refinery Production



Imports and Port Capacity Requirements



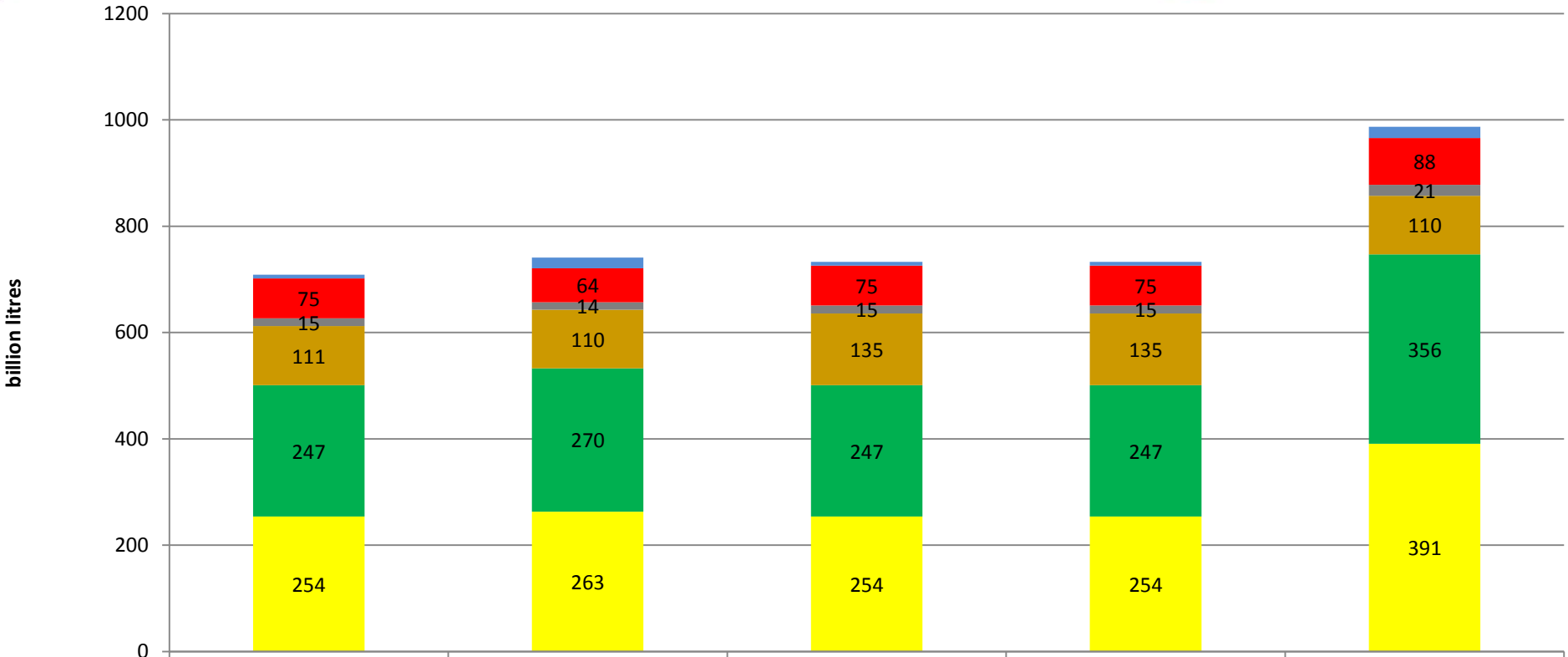
Total Imports



	Base Case	Cleaner Pastures	Green Shoots	Resource Constrained	Security of Supply
Paraffin	17	8	10	16	6
Aviation Fuel	59	69	77	58	42
LPG	19	20	27	19	13
Petrol	129	44	95	28	49
Diesel	484	460	657	451	330
Crude	710	717	710	710	968

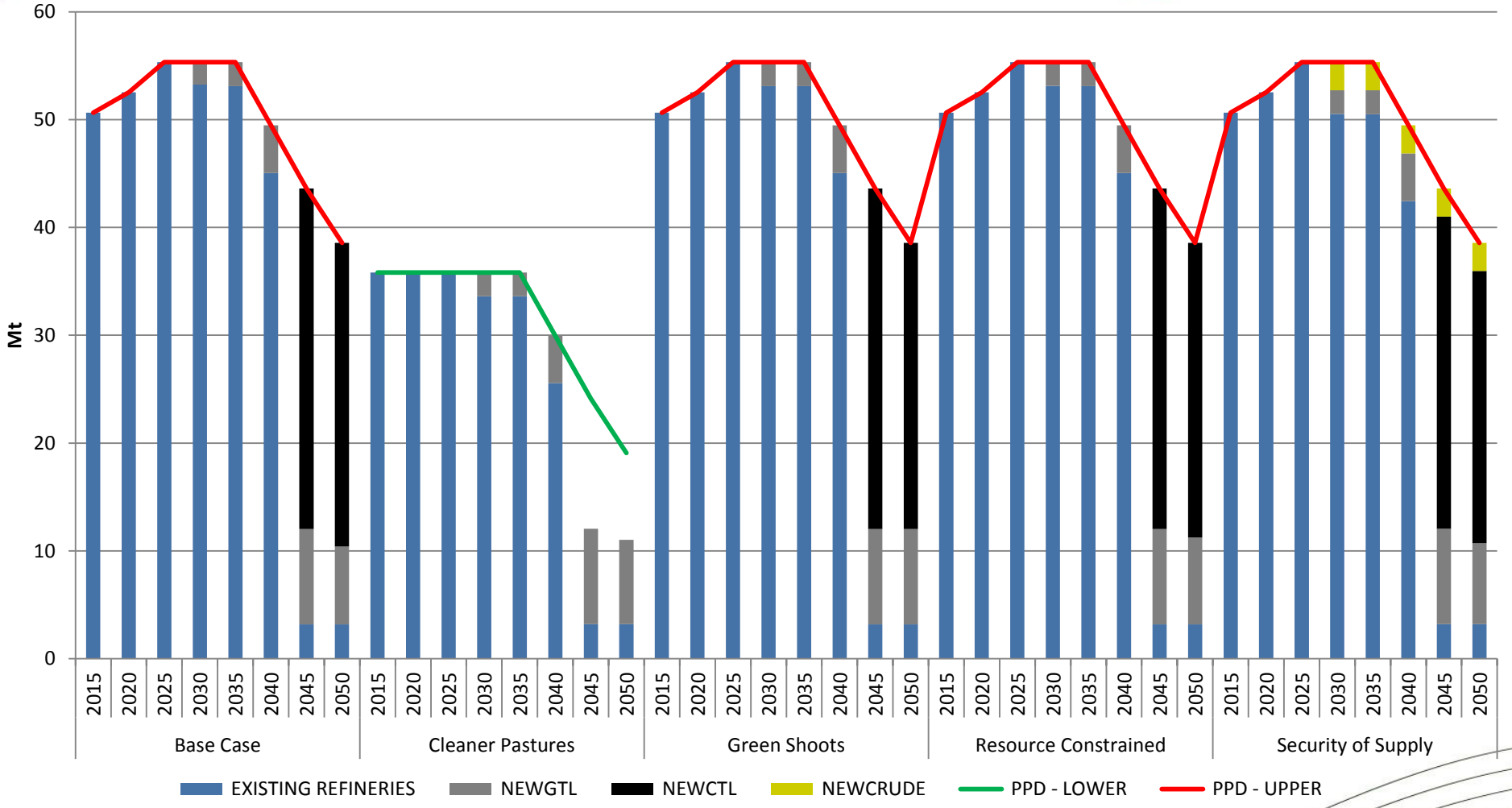
Crude Diesel Petrol LPG Aviation Fuel Paraffin

Total Domestic Production - Crude Oil Refineries

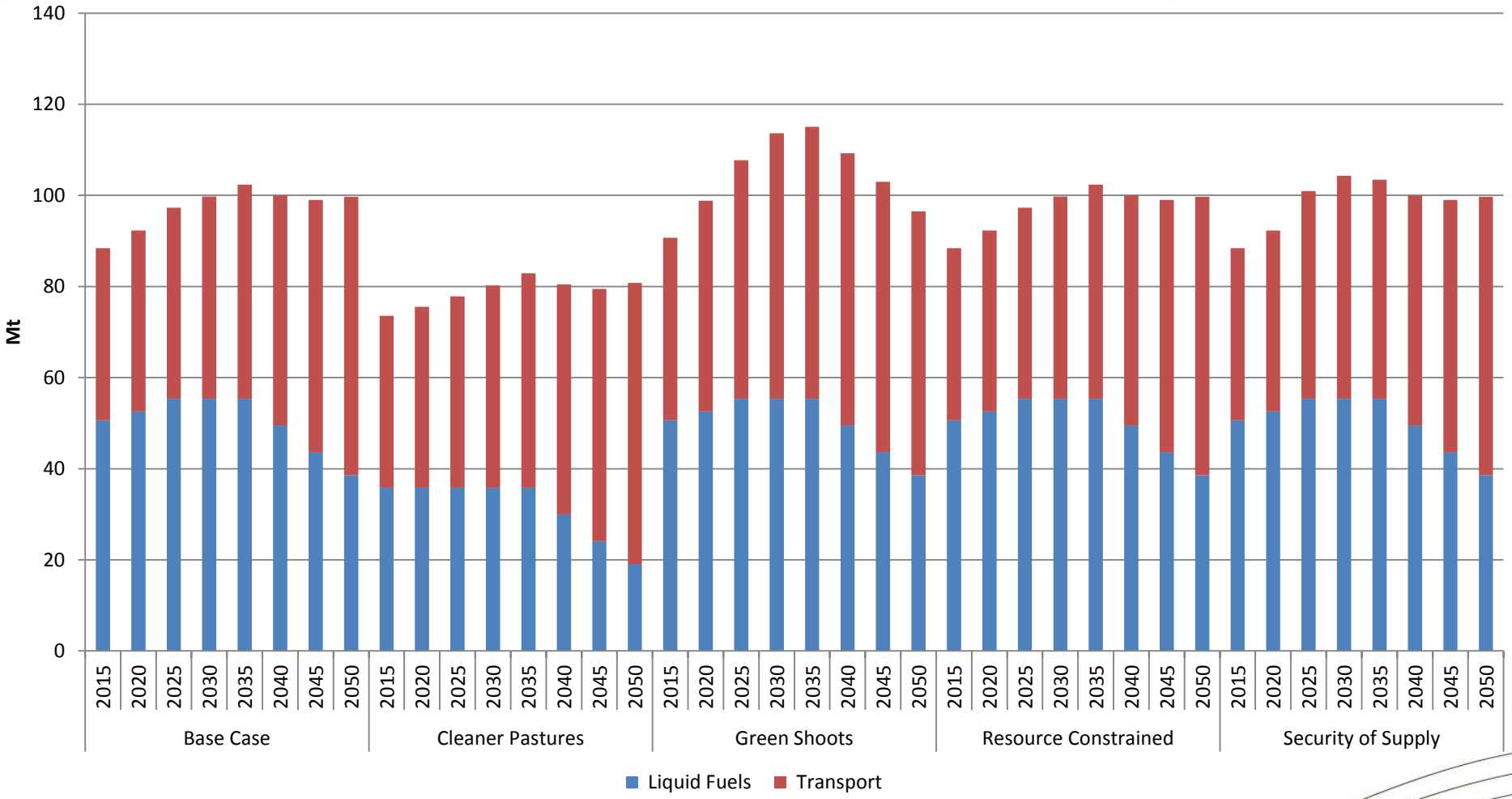


	Base Case	Cleaner Pastures	Green Shoots	Resource Constrained	Security of Supply
Paraffin	7	20	7	7	21
Aviation Fuel	75	64	75	75	88
LPG	15	14	15	15	21
Residuel Fuel Oil	111	110	135	135	110
Petrol	247	270	247	247	356
Diesel	254	263	254	254	391

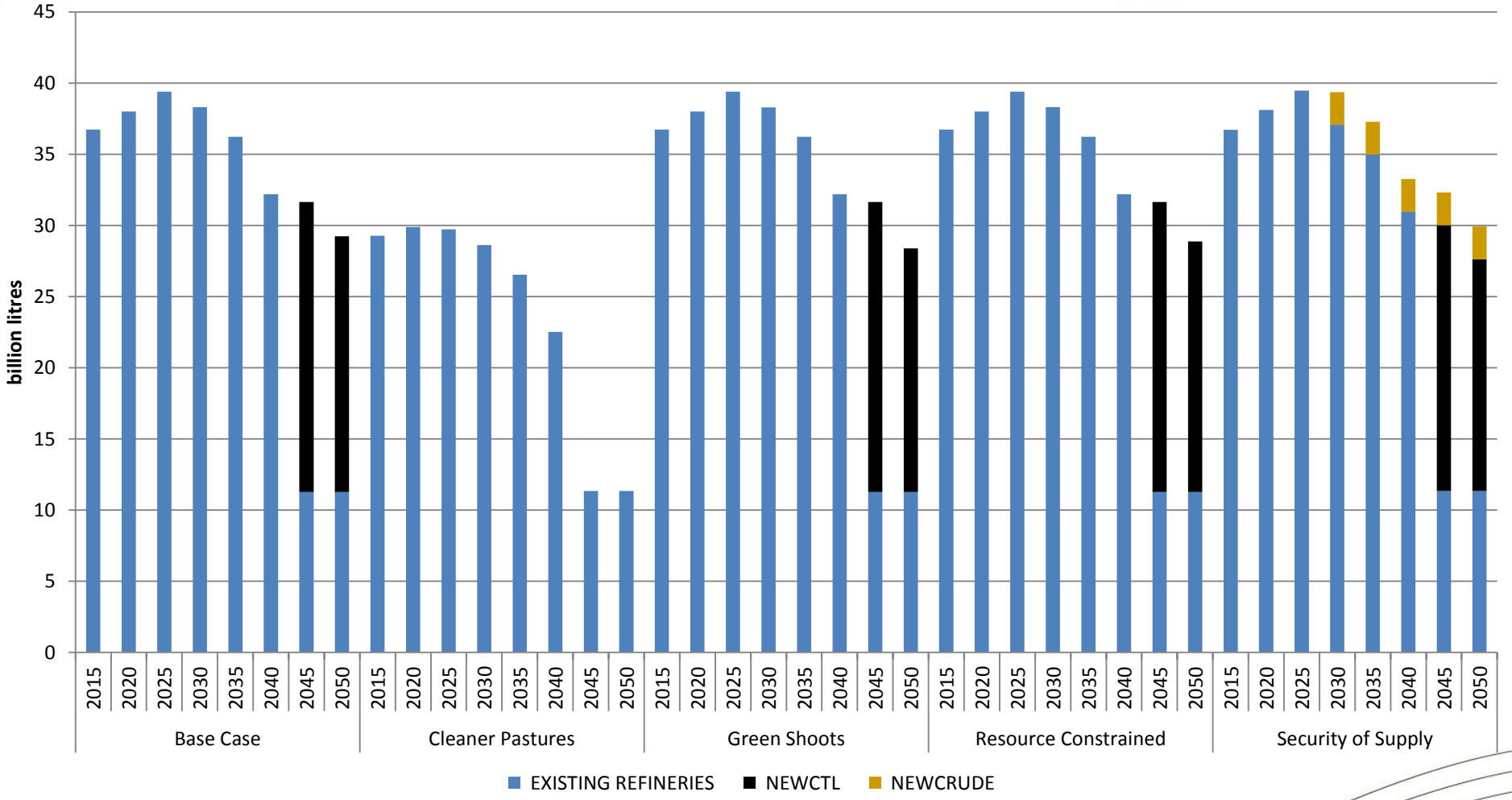
Carbon Dioxide Emissions from Liquid Fuel Production



Total Carbon Dioxide Emissions by Sector



Water Consumption by Refinery Type



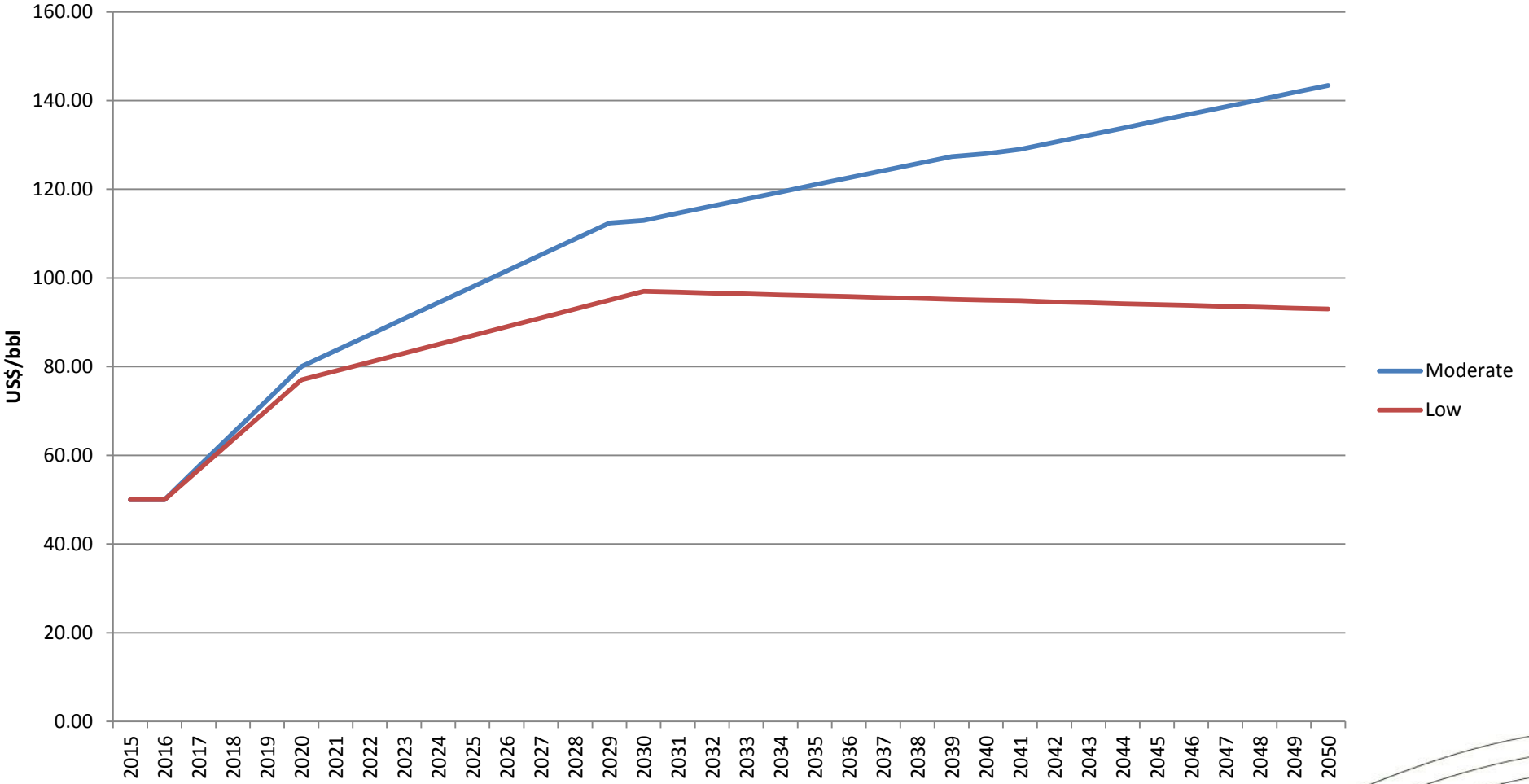
LIQUID FUELS SENSITIVITY SCENARIO ANALYSIS

SENSITIVITY SCENARIOS

energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

	CF2 – No Cost Recovery (CF2_2C)	CF2 – No Cost Recovery (CF2_3C)	Low crude price (LCP)
Key Assumptions	1. CF2 implemented 2. No cost recovery mechanism leading to closure of 2 existing crude refineries 3. No new build commitments	1. CF2 implemented 2. No cost recovery mechanism leading to closure of 3 existing refineries 3. No new build commitments	1. No CF2 implementation. 2. Low global crude oil prices
Reference Scenario	**Base Case**	**Base Case**	**Base Case**

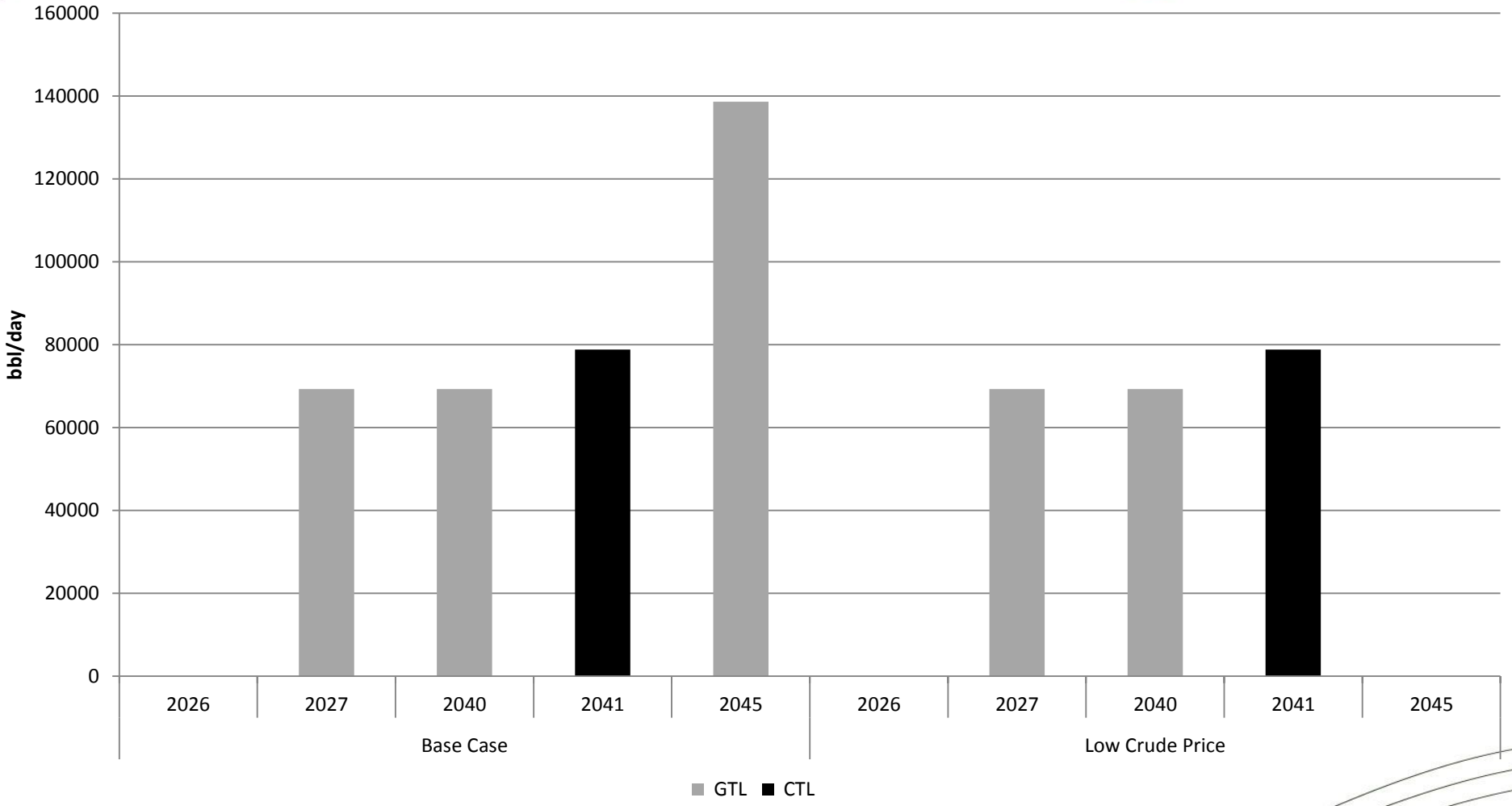
Moderate and Low Crude Prices



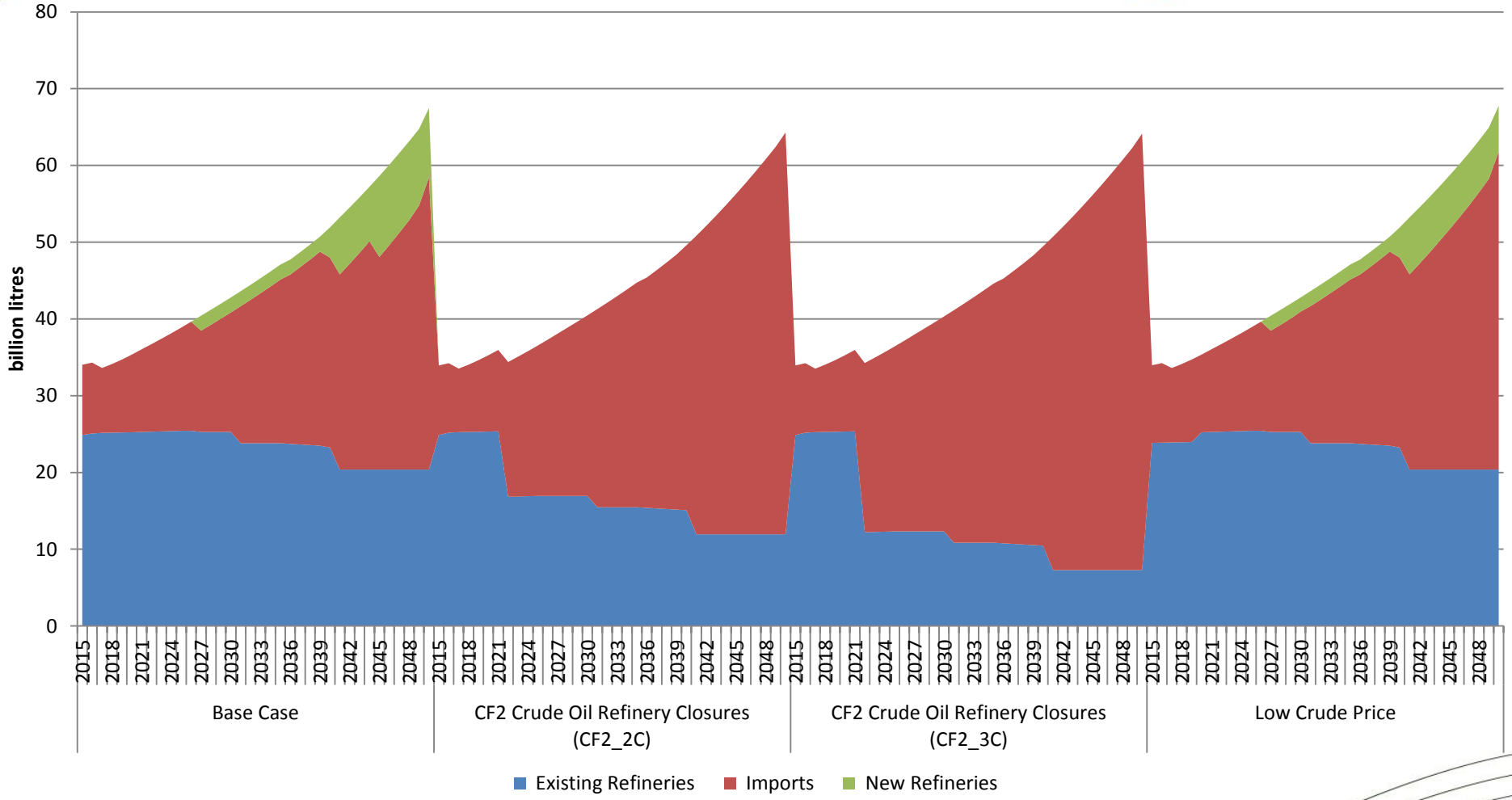
Source: IEA World Energy Outlook 2015

Sensitivity Scenario	Total Capacity	Production	Discounted Costs
Base Case			
Low Crude Price	New Capacity ↓	Imports ↑	Costs ↓
CF2_2C		Imports ↑	Costs ↓
CF2_3C		Imports ↑	Costs ↓

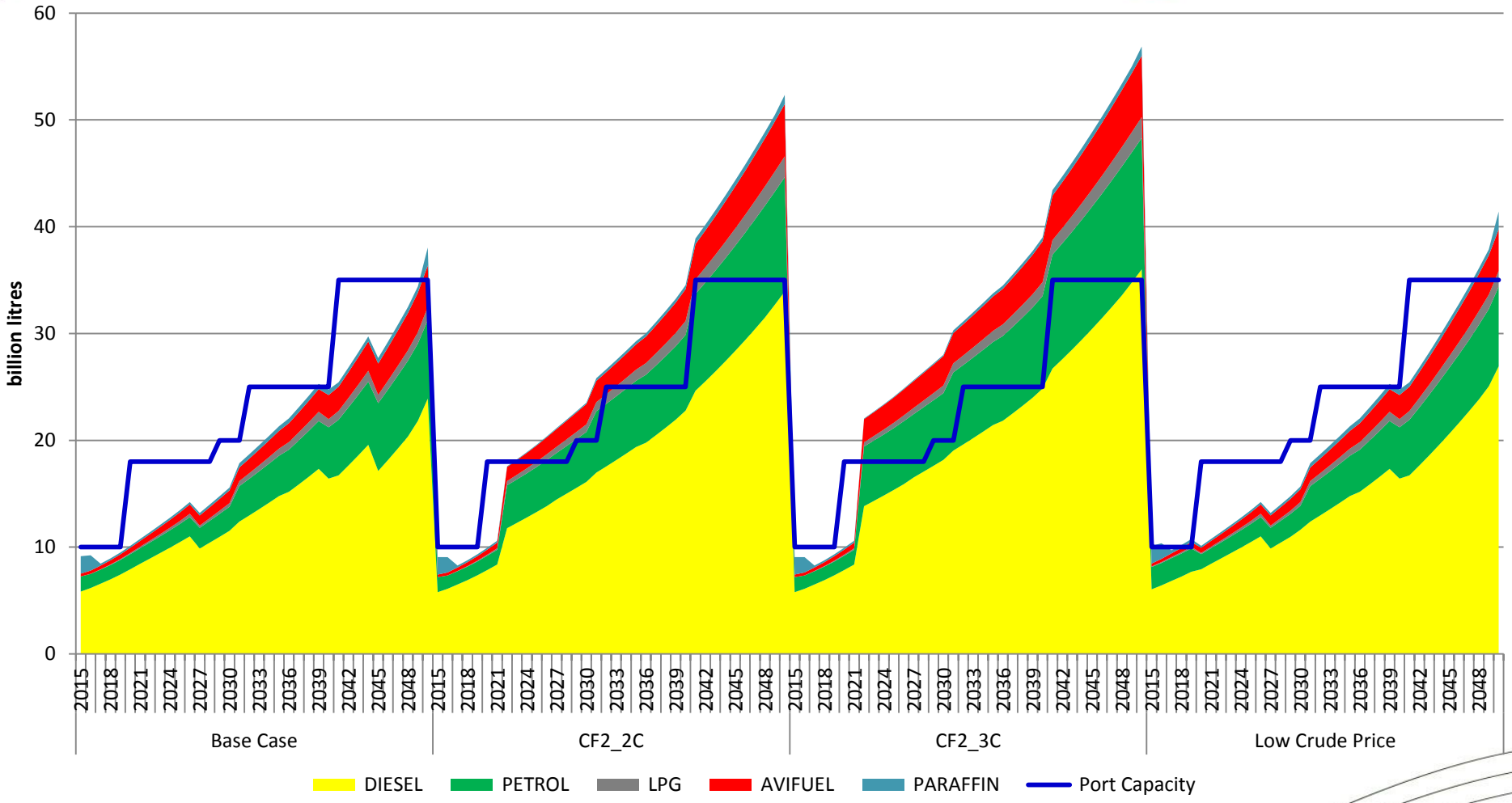
New Refining Capacity



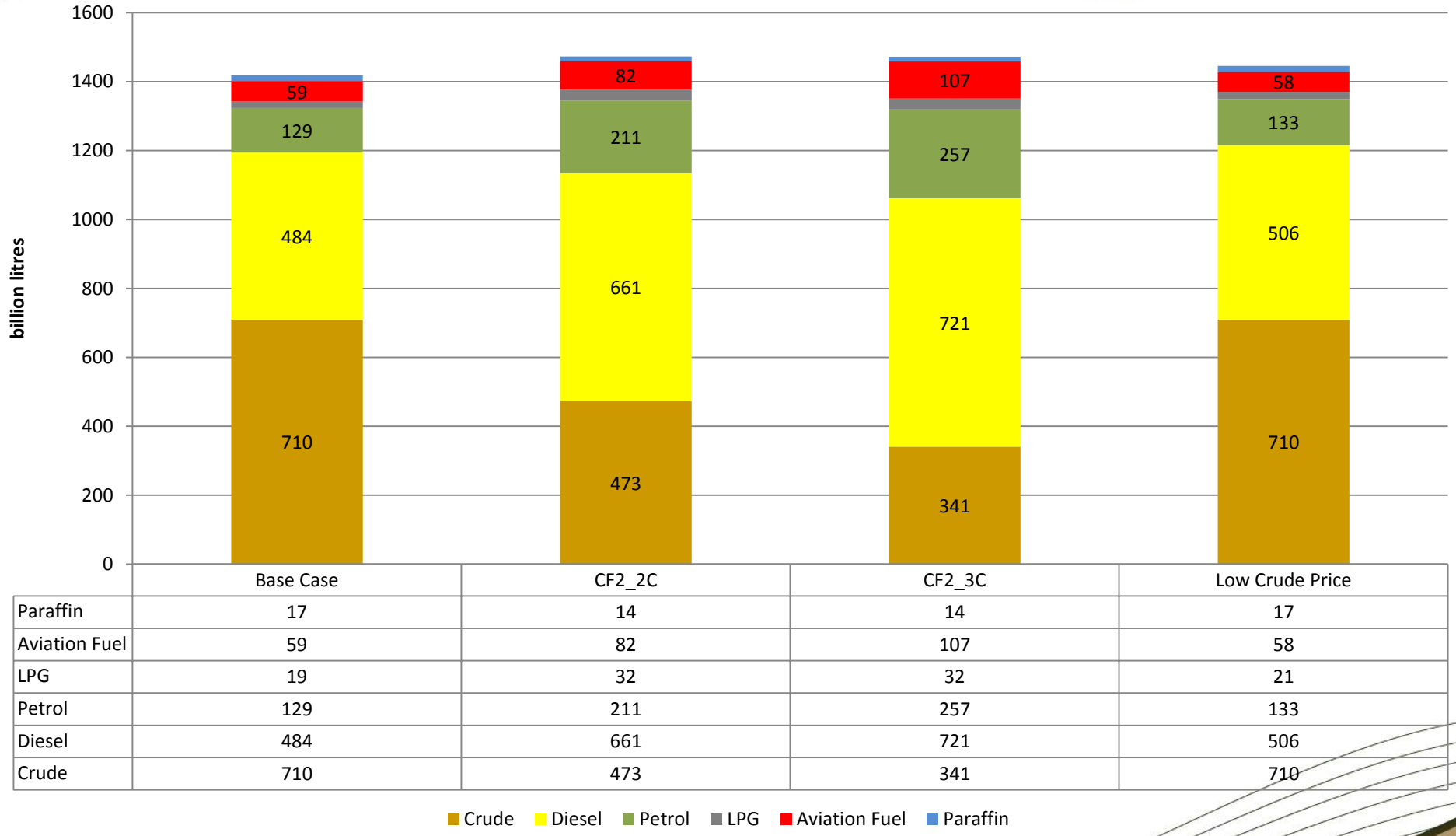
Liquid Fuel Supply



Liquid Fuel Imports



Total Imports



	Base Case	CF2_2C	CF2_3C	Low Crude Price
Paraffin	17	14	14	17
Aviation Fuel	59	82	107	58
LPG	19	32	32	21
Petrol	129	211	257	133
Diesel	484	661	721	506
Crude	710	473	341	710

Sensitivity Scenario	Emissions	Water	Feedstock
Base Case			
Low Crude Price		Consumption ↑	Coal ↑ Gas ↓
CF2_2C	CO_2 ↓ SO_X ↓	Consumption ↓ Intensity ↑	Crude ↓ Coal ↓ Gas ↓
CF2_3C	CO_2 ↓ SO_X ↓	Consumption ↓ Intensity ↑	Crude ↓ Coal ↓ Gas ↓

THANK YOU