PHILIPPINE ENERGY PLAN 2023-2050

VOLUME I

Transitioning to Reliable, Clean, and Resilient Energy

Republic of the Philippines
DEPARTMENT OF ENERGY

Message from the President

I am one with the Department of Energy in presenting to the Filipino people the updated Philippine Energy Plan (PEP) 2023-2050. This blueprint embodies our collective goal for a more assertive, efficient, and clean energy transition, ensuring that every Filipino will enjoy a more sufficient, reliable, and equitable energy ecosystem.

In our relentless pursuit of energy security, the PEP outlines several key strategic initiatives, which include increasing the share of renewable energy in the power generation mix, developing alternative fuels and emerging energy applications, adopting advanced smart grid technologies, and establishing a resilient, green, and climate-proof energy infrastructure.

In addition to this, the PEP aims to cultivate a deep awareness of our energy usage and promote sustainable practices across every sector. We endeavor to lead by example and inspire broad shifts towards responsible and efficient consumption.

Mindful of the complexities of the energy transition, we are committed to prioritizing comprehensive transition finance strategies, quality job creation, human resource upskilling, and infrastructure enhancements. These efforts are aligned with our mandate to unlock significant opportunities for economic growth and with our global commitment to avert climate crisis.

Our journey towards sustainable development calls for greater cooperation to establish the foundations for strengthening our energy prospects. Therefore, let us unite and make the PEP one of the pillars in realizing our shared vision for a "Bagong Pilipinas" - a nation powered by resilience, sustainability, and inclusive progress.

Ferdinand R. Marcos Jr.

Message from the Secretary

The Philippine Energy Plan (PEP) 2023-2050 serves as a guiding framework for the country's energy transformation over the next decades. This updated PEP takes an encompassing approach by exploring a wide range of energy scenarios and setting ambitious clean energy targets. These are strategic decisions rooted in our nation's developmental requirements for a secure energy supply in support of inclusive economic growth and societal advancement. The PEP underscores the pressing energy needs of our people while being cognizant of the global call for climate actions and rapid advancements in new energy technologies, with implications for cost and efficiency.

Under the leadership of President Ferdinand R. Marcos, Jr., the PEP is a priority energy blueprint meant to provide guidance to all energy stakeholders. As it complements and builds upon the Philippine Development Plan 2023-2028 and Ambisyon Natin 2040, the PEP aspires to shape the present with a vision of the country's self-reliant energy future and paves the path for the longer-term energy benefits that can be enjoyed by future generations.

Diversification of energy sources, with an emphasis on indigenous ones, as well as transforming how we produce, deliver, and consume energy are critical aspects of our energy transition. Therefore, our government stands resolute in its commitment to adopting clean technologies and propelling green energy development for a sustainable and more efficient energy system.

Renewable energy plays a crucial role in achieving our goals, and we continue to formulate and implement policies that incentivize innovation and facilitate investments. As a result, we have accelerated the development and utilization of various RE sources which now cover 22.3 percent of our 2023 power generation mix. To maximize energy supply, we have prioritized energy efficiency and conservation initiatives through the adoption of advanced technologies and the promotion of sustainable energy practices across all sectors. We also aim to improve the efficiency of the transport system through the deployment of electric vehicles. Moreover, the DOE is studying the feasibility of using emerging cleaner fuels and technologies. We have also reassessed the potential role of nuclear energy in diversifying the energy mix to meet emission reduction targets and enhance energy security.

In expanding electricity access and promoting local development, we are championing initiatives such as small island interconnections, microgrid systems development, off-grid hybridization programs, and distributed energy resources. Achieving total electrification is expected to significantly increase household incomes and expenditures, resulting in an estimated total net economic benefit of PhP 315 billion, or approximately 1.8 percent of GDP.

Our energy transition path is guided by the principles of equity and inclusivity, ensuring the uplift of all Filipinos. We aim to create opportunities for employment and investments that will alleviate poverty and future-proof our communities.

While the PEP provides a comprehensive roadmap for our energy transition, the targets are indicative to ensure adaptability and flexibility in response to the dynamic nature of the energy sector, both domestically and globally. As such, the PEP is a continuing plan, subject to periodic updates to remain attuned and responsive to policy and regulatory reforms, technological changes, shifts in socioeconomic structure, and the availability of transition financing.

Looking toward 2050, we envision a Bagong Pilipinas that is energy self-sufficient, prosperous, inclusive, and resilient. With shared optimism, we call on our equally committed stakeholders to embark with us on our energy transformation journey.

Raphael P. M. Lotilla

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Abbreviations and Acronyms

4Ps	Pantawid Pamilyang Pilipino Program
AAGR	Average Annual Growth Rate
ADB	Asian Development Bank
AF	Adaptation Fund
AFF	Agriculture, Fishery, and Forestry
AI	Artificial Intelligence
APAEC	ASEAN Plan of Action for Energy Cooperation
APEC	Asia Pacific Economic Cooperation
ARC	Achieving access to affordable energy, Reliability and resiliency, and Clean and sustainable energy
AS	Ancillary Service
ASEAN	Association of Southeast Asian Nations
ASF	African Swine Fever
BARMM	Bangsamoro Autonomous Region of Muslim Mindanao
BAU	Business-As-Usual
BBB	Build, Build, Build
BBL	Barrel
BBM	Build Better More
BESS	Battery Energy Storage System
BOL	Bangsamoro Organic Law
BOT	Build-Operate-Transfer
BPD	Barrel per day
BSCF	Billion Standard Cubic Feet
BSP	Bangko Sentral ng Pilipinas
CAB	Civil Aeronautics Board
CAAP	Civil Aviation Authority of the Philippines
CEFI	Clean Energy Finance and Investment
CEFIM	Clean Energy Finance and Investment Mobilisation
CEM	Capacity Expansion Model
CES	Clean Energy Scenario
CFPP	Coal Fired Power Plant
CLUP	Comprehensive Land Use Plan
CO_2	Carbon Dioxide
COC	Coal Operating Contract
COP28	28th Conference of Parties
CREVI	Comprehensive Roadmap on Electric Vehicle Industry
CREZ	Competitive Renewable Energy Zones
CSP	Competitive Selection Process
CTCN	Climate Technology Center and Network
DBCC	Development Budget Coordinating Council
DC	Department Circular
DE	Designated Establishment
DES	Distributed Energy System
DOE	Department of Energy
DOG	Downstream Oil and Gas
DOLE	Department of Labor and Employment
DOST	Department of Science and Technology
DOTr	Department of Transportation
DP	Development Partner
DRFI	Disaster Risk Financing and Insurance
DSWD	Department of Social Welfare and Development
DTI	Department of Trade and Industry
DU	Distribution Utilities
E10	10 percent Bioethanol
E20	20 percent Bioethanol
EBT	Energy Balance Table
EC	Electric Cooperatives
ECA	Economic Consulting Associates
ECP	Energy Consuming Product
EEC	Energy Efficiency and Conservation
EF	Emission Factor
EIRP	Energy Investment Regulations and Processes
EO	Executive Order
EP	Energy Planning
EPIRA	Electric Power Industry Reform Act
ER	Energy Regulations
ERC	Energy Regulatory Commission
ESCO	Energy Service Company
ESS	Energy Storage System
ETC	Energy Transition Council
ETM	Energy Transition Mechanism
ETP	Energy Transition Program
EV	Electric Vehicle
EVCS	Electric Vehicle Charging Station
EVIDA	Electric Vehicle Industry Development Act
EVOSS	Energy Virtual One Stop Shop
FIES	Family Income and Expenditure Survey
FIRe	Fourth Industrial Revolution
FIT-ALL	Feed-In-Tariff Allowance
FSF	Financial Sector Forum
FSRU	Floating Storage and Regasification Unit
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEAP	Green Energy Auction Program
GEF	Global Environment Facility
GEMP	Government Energy Management Program
GEOP	Green Energy Option Program
GHG	Greenhouse Gas
GOMP	Grid Operating and Maintenance Program
GRDP	Gross Regional Domestic Expenditure
GSIS	Government Service Insurance System
GSPA	Gas Sales and Purchase Agreement
GVA	Gross Value Added
GW	Gigawatt
GWP	Global Warming Potential
ha	Hectare
HECS	Households Energy Consumption Survey
HFCE	Household Final Consumption Expenditure
hp	Horsepower
ICC	Indigenous Cultural Community
ICT	Information and Communication Technology
IEA	International Energy Agency
IEB	Intergovernmental Energy Board
IEC	Information, Education, and Communication
IEEJ	Institute of Energy Economics, Japan
IFP	Infrastructure Flagship Projects
IGRB	Intergovernmental Relations Body
IMF	International Monetary Fund
IO	International Organization
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IP	Indigenous People
IPP	Independent Power Producers
IRENA	International Renewable Energy Agency
IRR	Implementing Rules and Regulations
JDC	Joint Department Circular
kTOE	Thousand Tons of Oil Equivalent
kWh	Kilowatt-hour
LBP	Land Bank of the Philippines
LCOE	Levelized Cost of Energy
LDF	Loss and Damage Fund
LEAP	Long Range Energy Alternatives Planning System

LFRO	Liquid Fuel Retail Outlet
LGU	Local Government Unit
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LPP	Liquified Petroleum Product
LRT	Light Rail Transit
MARINA	Maritime Industry Authority
MENRE	Ministry of Environment and Natural Resources and Energy
MERALCO	Manila Electric Railroad and Light Company
MGSA	Microgrid Systems Act
MISSI	Monthly Integrated Survey of Selected Industries
ML	Million Liters
MLPY	Million Liters per Year
MMB	Million Barrels
MMT	Million Metric Tons
MOPS	Mean of Platts Singapore
MPhP	Million Pesos
MRT	Metro Rail Transit
$MtCO_2e$	Million Tons of Carbon Dioxide Equivalent
MTOE	Million Tons of Oil Equivalent
MTPA	Million Tons per Annum
MVIP	Mindanao-Visayas Interconnection Project
MW	Megawatt
MWh	Megawatt-hour
NAFMIP	National Agricultural and Fisheries Modernization and Industrialization Plan
NAP	National Accounts of the Philippines
NDC	Nationally Determined Contribution
NEA	National Electrification Administration
NEDA	National Economic Development Authority
NGCP	National Grid Corporation of the Philippines
NMP	Net Metering Program
NREL	National Renewable Energy Laboratory
NREP	National Renewable Energy Program
NTER	National Total Electrification Roadmap
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Square
OPEC	Organization of Petroleum Exporting Countries
OSW	Offshore Wind
PCECP	Philippine Conventional Energy Contracting Program
PCG	Philippine Coast Guard
PCIP	Provincial Commodity Investment Plans
PD	Presidential Decree
PDNGR	Philippine Downstream Natural Gas Regulation
PDP	Philippine Development Plan
PE	Power and Electrification
PELP	Philippine Energy Labeling Program
PEP	Philippine Energy Plan
PETP	Philippine Energy Transition Program
PEU	Philippines Economic Update
PHILGUARANTEE	Philippine Guarantee Corporation
PHILMech	Philippine Center for Postharvest Development and Mechanization
PLEXOS	Power System Planning and Market Simulation Software
PNR	Philippine National Railways
PNS	Philippine National Standards
POPCEN	Census of Population
PPA	Philippine Ports Authority
PPP	Public Private Partnership
PSA	Philippine Statistics Authority
PSA	Power Supply Agreement
PSC	Petroleum Service Contract
PV	Photovoltaic
QME	Qualified Marginalized End-User
QR	Quick Response
R&D	Research and Development
RA	Republic Act
RbM	Results Based Management
RCEP	Regional Comprehensive Economic Partnership
RE	Renewable Energy
REC	Review and Evaluation Committee
REDU	Renewable Energy Development and Utilization
REF	Reference Scenario
RES	Reference Energy System
RESC	Renewable Energy Service Contract
RM	Results Matrix
RPS	Renewable Portfolio Standards
RR	Reserve Requirements
SBL	Single Borrower's Limit
SC	Service Contract
SDG	Sustainable Development Goals
SEC	Securities and Exchange Commission
SEGF	Sustainable Energy Facility
SEI	Stockholm Environment Institute
SFTG	Sustainable Finance Taxonomy Guidelines
SGGP	Smart and Green Grid Plan
SIS	System Impact Study
SMR	Small Modular Reactor
SONA	State of the Nation Address
SP	System Performance
SSCMI	Small Scale Coal Mining Resource Development
TCF	Trillion Cubic Feet
tCO_2e	Tons of Carbon Dioxide Equivalent
TDP	Transmission Development Plan
TFEC	Total Final Energy Consumption
TOE	Tons of Oil Equivalent
TOR	Terms of Reference
TPA	Third Party Auctioneer
TPES	Total Primary Energy Supply
TWG	Technical Working Group
TWh	Terawatt-hour
UCERD	Upstream Conventional Energy Resource Development
UC-ME	Universal Charge for Missionary Electrification
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UP	University of the Philippines
USD	United States Dollar
VFELP	Vehicles Fuel Economy Labelling Program
VRE	Variable Renewable Energy
WB	World Bank
WEF	World Economic Forum
WESM	Wholesale Electricity Spot Market
WFH	Work from Home
Wh/PhP	Watt-hour per peso
WOO	World Oil Outlook

Overview

Under the leadership of President Ferdinand Marcos Jr., the government is boldly charting a course to a more dynamic and sustainable energy future that benefits communities, drives economic growth, and improves the well-being of Filipino people. Guided by this vision, the government's top priority is to achieve inclusive and sustainable development propelled by modern and clean energy technologies. Driven by a commitment to sustainable progress, the Department of Energy (DOE) stands with the nation at the forefront of this transformative journey, carrying out strategic plans and programs that support equitable growth, prioritize energy security, and facilitate the transition to clean energy sources.

At the core of this energy development agenda are aggressive targets for RE deployment, higher energy efficiency goals, and the promotion of diverse energy technologies and solutions. The establishment of a resilient and climate-proof energy infrastructure is also deemed essential to safeguarding the nation's energy security and resilience in the face of evolving environmental challenges. These components constitute integral parts of a comprehensive strategy toward clean energy while ensuring the security and reliability of energy supply.

Energy frameworks will be transformed in line with the global energy transition as nations increasingly recognize the importance of shifting towards cleaner, more resilient, and sustainable energy systems. Aligning itself with this shift, the Philippines has already proactively engaged in strategic endeavors aimed at contributing to and advancing a low-carbon energy future. Capitalizing on its vast renewable energy (RE) resources such as biomass, solar, wind, geothermal, hydropower, and ocean energy, the country embarks on various initiatives to further explore and accelerate the development and increase the utilization of these clean and indigenous energy sources. Moreover, the country prioritizes the active promotion of energy efficiency to optimize energy use and encourage sustainable practices across various sectors, complementing its efforts in promoting RE adoption and enhancing overall energy sustainability.

> ***Renewable energy is the way forward. We are aggressively promoting renewables, so that it provides a 35.0 percent share in the power mix by 2030, and then on to 50.0 percent by 2040. To accelerate the realization of this green energy goal, we have opened renewable energy projects to foreign investments.***
>
> *- President Ferdinand R. Marcos Jr.*
> *2023 State of the Nation Address (SONA)*

Along with policy and regulatory reforms, investment opportunities and incentives will also be expanded to foster an environment conducive to greater private sector investments in the promotion and integration of renewables, including the adoption of alternative fuels and emerging energy technologies. Concurrently, equal emphasis will be placed on the expansion and modernization of power infrastructure, particularly on transmission network upgrades, to accommodate the integration of renewables and ensure a stable and resilient energy supply.

The government will intensify its effort to facilitate energy transition through policy reinforcement, investment facilitation, technological innovation, and infrastructure development.

Energy Sector Strategic Direction

With the overall thrust of creating a strong foundation for inclusive growth, the government is engaging in strategies consistent with the following: a) *AmBisyon Natin 2040, which embodies the long-term vision of every Filipino; b) the 8-Point Socio-Economic Agenda of President Marcos Jr. Administration* anchored on the *Philippine Development Plan (PDP) 2023-2028* with focus on economic and social transformation (creating more job opportunities, accelerating poverty reduction and providing affordable and clean energy, among others); and c) the *United Nations' Sustainable Development Goals (SDGs)*. Actualizing these directions guided the DOE in crafting the overall government energy agenda that aim to facilitate access to *affordable energy, secure a reliable and resilient energy supply, and transition to clean, sustainable, and climate-centered energy resources*, coined as the ***ARC objectives.***

Access to Affordable Energy

Expanding access to electricity services is a fundamental and urgent requirement of the country. Universal access is considered an effective tool in alleviating poverty and spurring economic activities, especially in rural areas. This aligns with the UN's SDG that aims to guarantee access to affordable, reliable, sustainable, and modern energy for all. Corollary to this, the sector aims to achieve full electrification of households in the country. Alongside other electrification strategies such as expanding household regular connections, extending distribution lines, and installing stand-alone home system, the government is promoting the use of microgrid system in unserved and underserved areas through the implementation of Republic Act (RA) No. 11646, also known as the *Microgrid Systems Act (MGSA) of 2022*. Likewise, the DOE is exerting its best efforts to strengthen the country's distribution system through continuous partnerships and collaborations with the National Electrification Administration (NEA), Electric Cooperatives (ECs), and private Distribution Utilities (DUs) to ensure they remain cognizant of fulfilling their electrification mandate.

The country has initially realized the vision of having a *"One Grid Philippines"* with the interconnection of the Mindanao grid with the Visayas and Luzon grids[1]. This contributes immensely to the improvement of power supply reliability and resilience amid aging power facilities and energy security issues across the grids. Complementing this effort likewise necessitates interconnecting off-grid areas to the national grid. Relatedly, the government intends to pursue hybridization and distributed energy system (DES) in missionary areas to provide communities with access to modern fuels in the countryside.

ACCESS TO AFFORDABLE ENERGY

- Achieve 100 percent household electrification by 2028 (based on 2020 PSA Census)
- through the Total Electrification Program
- Interconnection of off-grid areas to the national grid
- Hybridization and DES in off-grid areas
- Access to modern fuels and productive uses of RE for household and other social and economic activities
- Compliance with the Competitive Selection Process (CSP) Policy
- Rationalization and graduation of Universal Charge for Missionary Electrification (UCME) subsidy
- Review energy taxation
- Power of choice and consumer welfare protection

Recognizing that consumers must benefit from the government's energy initiatives, the DOE, along with NEA and the Energy Regulatory Commission (ERC) will strictly enforce policies that will promote consumer welfare and protection to include CSP, rationalization, and graduation from the UC-ME subsidies, and the review of current energy taxation. Additionally, the DOE will intensify its multi-sectoral information, education, and communication (IEC) program to broaden the public's energy literacy through the conduct of nationwide campaigns that focus on reducing electricity use, fuel consumption, and the safe handling of petroleum products.

[1] *President Marcos Jr. officiated the historic switch-on of the Mindanao-Visayas Interconnection Project on 26 January 2024 at Malacañang Palace.*

Reliability and Resiliency

The development of the downstream natural gas industry boosts energy diversification and advancement in energy infrastructures. Given this, the sector seeks to build liquefied natural gas (LNG) receiving terminals and distribution infrastructure. Natural gas is a flexible fuel that will support VRE's intermittent nature, thus ensuring reliability of the power system. Currently, 16.0 percent of the country's power generation is dependent on indigenous Malampaya gas resource, highlighting the need for accelerating the development of other gas fields in the country.

To withstand natural and man-made disasters, energy facilities and infrastructures will also be designed to adapt to the impacts of climate change. The DOE's prime focus is to continuously improve the reliability, availability, and resilience of energy infrastructure and facilities. To attain this, the DOE enjoins all energy developers and proponents to implement their respective projects with strict adherence to standards and specified timelines.

RELIABLE AND RESILIENT ENERGY SUPPLY

- Resiliency and security of energy infrastructure
- Increase energy self-sufficiency level
- LNG as a transition fuel to complement variable RE (VRE)
- Timely completion of energy infrastructure projects
- Smart and Green Grid Plan (SGGP)
- Strict compliance with the Grid Operating and Maintenance Program
- Adequate levels of Ancillary Services

Driven with the goal of further increasing power supply security and reliability across the grids, the DOE initiated the formulation of the SGGP, which aims to modernize and fortify the existing transmission network, as well as ascertain critical transmission line expansion projects in order to prepare for the influx of additional RE capacities. The SGGP also complements the necessity for strict compliance of power generation companies with the Grid Operating and Maintenance Program (GOMP) and the procurement of adequate levels of Ancillary Services (AS) by the National Grid Corporation of the Philippines (NGCP).

In addition, the government is exploring all available alternatives to expand the grid at a pace that matches the increase in additional capacity requirements to assist in driving the country's economic growth. Such alternatives intend to provide greater transparency in the operation of the transmission system and accelerate the implementation of transmission projects.

Further, the DOE will continue to explore and harness indigenous sources of energy, such as renewables, fossil fuels, and alternative fuels as part of the government's thrust to increase the country's energy self sufficiency and diversify energy portfolio.

Clean and Sustainable Energy

In pursuit of a sustainable and integrated energy-environment approach, the DOE sets forth a comprehensive roadmap for expanding RE capacity, aiming for at least 35.0 percent share in the power generation mix by 2030, 50.0 percent by 2040, and more than 50.0 percent by 2050. Contributing to this agenda is the vast potential of offshore wind (OSW) which requires the construction of ports, highways, and other infrastructure to support and complement its holistic development.

Beyond renewables, the government is actively exploring low-carbon alternatives, such as nuclear energy, which involves the commissioning of at least 4,800 MW of potential capacity by 2050. The DOE is also delving into the feasibility of incorporating emerging cleaner fuels and technologies such as hydrogen, ammonia, and other ESS.

CLEAN, SUSTAINABLE, AND CLIMATE-CENTERED ENERGY RESOURCES

- Increase RE share in the power generation mix up to 35.0 percent by 2030, 50.0 percent by 2040, and more than 50.0 percent by 2050
- Increase port infrastructures to support the development of offshore wind projects
- 4,800 MW of nuclear capacity by 2050
- Strengthen energy efficiency and conservation (EEC) programs and initiatives
- Pursue alternative fuels and emerging technologies: Electric Vehicles (EVs), hydrogen and its derivatives, Energy Storage System (ESS), Small Modular Reactor (SMR)
- Strategic placements of ESS in the power systems including integration of ESS in Variables REs

Acknowledging the growing energy demand, the DOE prioritizes the push for higher EEC measures. This involves promoting advancements in technology and advocating for energy consumption practices in the transportation, residential, commercial, and industrial sectors, without foregoing greater productivity. Further, efforts extend to enhancing the fuel efficiency of transportation systems, primarily through the support and deployment of EVs and hybrid vehicles.

Lastly, facilitating access to concessional financing for the energy transition remains an important component of the DOE's strategy. To address environmental concerns associated with conventional fuels, the government is studying the voluntary retirement and repurposing of coal-fired power plants (CFPPs) to ensure their alignment with the clean energy transition.

Cross-cutting Measures

The DOE implements open governance in the permitting processes for power generation, transmission, and distribution projects. The full operationalization of the Energy Virtual One-Stop-Shop (EVOSS) System to streamline and expedite the approval process for energy projects by removing redundancy and bureaucratic red tape, contributes to a more transparent and efficient service delivery.

As energy facilities are critical in the security of supply, the DOE is strengthening inter-committee/interagency task forces that respond to energy-related concerns. This collaborative approach gathers broadbased support and cooperation among industry players and energy stakeholders. Additionally, the DOE is investing in human resource capacity building to enhance the technical, administrative, financial, and legal competencies of its workforce, which are essential in performing its functions and providing quality service to the public.

The DOE strengthens inclusivity and gender mainstreaming, aiming for equal contributions and benefits from energy access for both men and women. To create a conducive investment climate in the energy sector, the DOE emphasizes harmonization of laws, streamlining the processes, and integrating the energy projects in both national and local development plans.

To improve further, the DOE continues to push for the timely passage of the energy sector legislative agenda, along with the review of existing laws including the Electric Power Industry Reform Act (EPIRA), Downstream Oil Industry Deregulation Act, and other landmark legislations on RE and emerging technologies. These initiatives underscore the DOE's commitment to fostering an open, collaborative, and progressive energy landscape in the country.

I. ENSURING ENERGY SERVICE 24/7

A. Energy Situationer

Total Final Energy Consumption

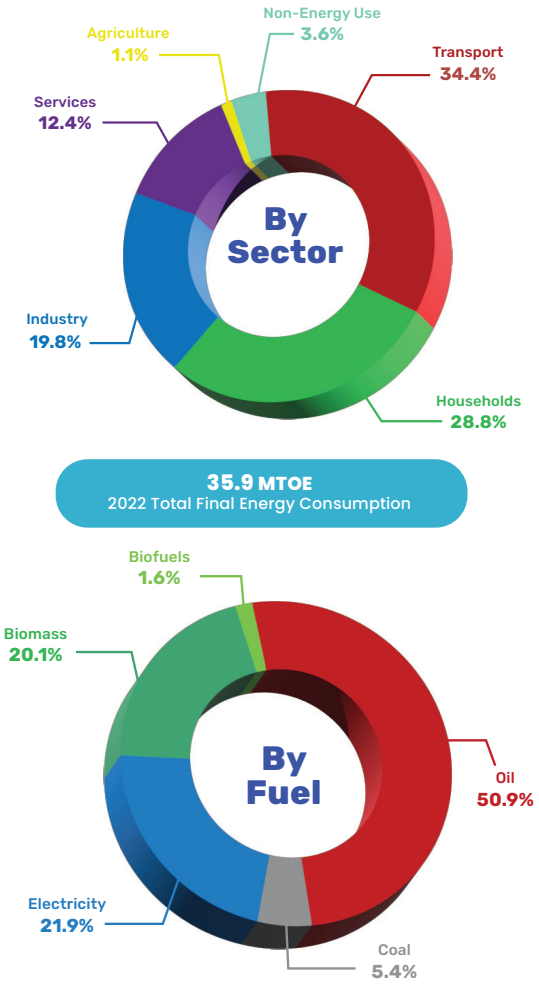
The country's total final energy consumption (TFEC)[2] grew moderately by 2.4 percent amidst the 7.6 percent economic expansion in 2022, as levels reached 35.9 million tons of oil equivalent (MTOE) *(Figure 1)* from 35.0 MTOE in 2021.

Major sectors such as transport, residential (households), and industry registered increments in their energy consumption for 2022. The transport sector contributed a share of 34.4 percent to the TFEC, followed by households at 28.8 percent and the industrial sector at 19.8 percent.

Oil, electricity, and biomass were the most consumed fuels for energy end-use activities. The country mostly relied on oil and oil products, which comprised 18.3 MTOE or 50.9 percent of the TFEC in 2022, an increase of 3.4 percent from 17.7 MTOE in 2021. Gasoline and diesel accounted for 75.4 percent of total oil consumption.

Electricity was the second most consumed fuel, with a 21.9 percent share of the TFEC, as its demand level posted an increase of 4.5 percent to 7.9 MTOE in 2022 from its 7.5 MTOE level in 2021. Meanwhile, biomass consumption, albeit with a share of 20.1 percent of the TFEC mix in 2021, grew modestly by 0.8 percent due to an increased preference for modern cooking equipment and appliances, specifically among households.

Figure 1. **Total Final Energy Consumption by Fuel and By Sector Shares (%), 2022**



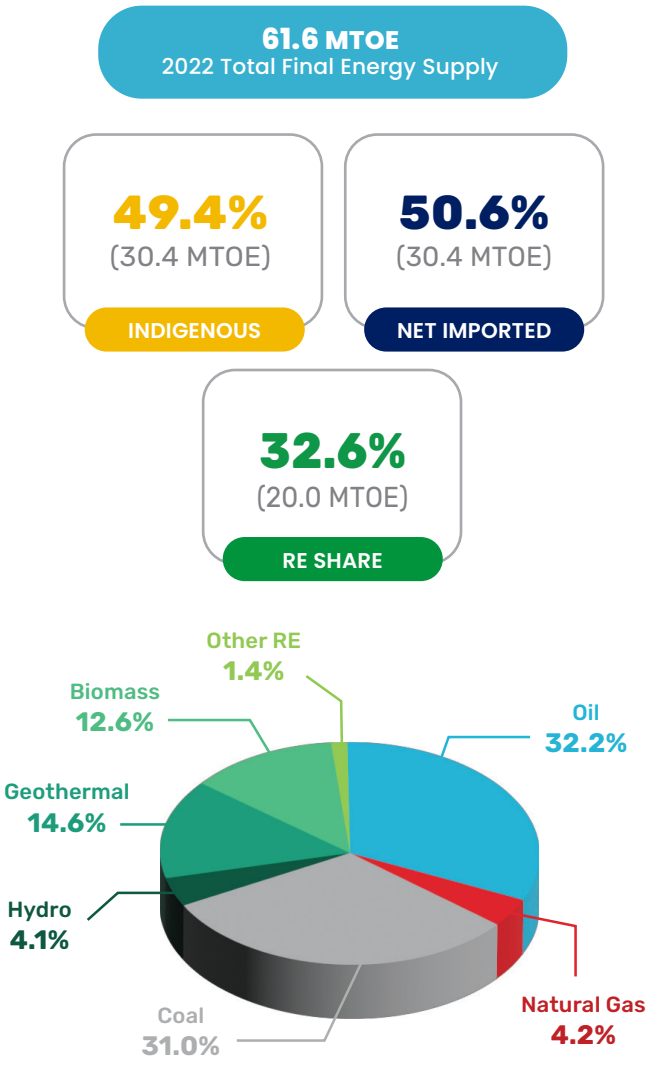
Total Primary Energy Supply

The TPES in 2022 reached 61.6 MTOE, higher by 4.7 percent vis-a-vis its year-ago level, which was predominantly sourced from oil and coal *[two-thirds of the total energy mix]*. Self-sufficiency stood at 49.4 percent, while net imports were at 50.6 percent *(Figure 2)*.

Oil returned to the top spot as the country's major energy source with its 32.2 percent share of the TPES in 2022. Its level increased by 12.3 percent to 19.8 MTOE driven by the increase in net oil imports given the limited domestic production. Coal supply grew at a slower rate of 0.9 percent to 19.1 MTOE from its previous year's level of 18.9 MTOE due to higher import prices but maintained its 31.0 percent share of the TPES. Natural gas posted a minimal contribution at 4.2 percent share because of its 7.4 percent reduction as fuel input for power generation in 2022. Meanwhile, the aggregate RE supply including biofuels reflected a share of 32.6 percent in the energy mix as levels grew by 3.3 percent from the previous year's 19.4 MTOE to 20.0 MTOE in 2022.

Fossil-fueled power plants constituted the bulk of electricity production with more than three-fourths (77.9 percent) share, while combined RE plants accounted for 22.1 percent in 2022. Coal contributed the biggest share of 59.6 percent (66.4 TWh) in power generation vis-à-vis 44.0 percent share (12.4 MW) in total installed capacity for the same year.

Figure 2. **Total Primary Energy Supply, by Fuel Shares (%), 2022**



[2] *TFEC is the total energy consumed by the end-users – households, industry, transport, services, and agriculture – such as electricity and petroleum products (i.e. gasoline, diesel, kerosene, etc.). These are energy products and fuels that are converted from the primary energy form, i.e., fuels and energy source (RE) to electricity, crude oil to petroleum products., which incur losses during the conversion process due to their thermal efficiencies. These losses make the difference between TPES and TFEC. For further details, see pp. 23-25 for the process flow of energy forms.*

Environmental Impact

Total greenhouse gas (GHG) emissions in 2022 reached 135.7 million tons of CO_2 equivalent ($MtCO_2e$), which is 4.0 percent more than the previous year's level of 130.4 $MtCO_2e$.

Power generation accounted for more than half (56.2 percent share) of the total GHG emissions during the year as increased output from CFPPs resulted in a 3.3 percent increase in GHG emissions to 76.3 $MtCO_2e$ compared to the 73.9 $MtCO_2e$ recorded in 2021.

Transport registered a double-digit growth of 12.3 percent to 35.4 $MtCO_2e$ in 2022 from its year-ago level of 31.5 $MtCO_2e$ and remained the highest GHG emitter among the end-use sectors, with a 26.1 percent share of the total GHG emissions. Heightened industrial activities resulted in a 3.5 percent increase in GHG emission level to 12.9 $MtCO_2e$ in 2022 (9.5 percent share) from its 2021 level of 12.5 $MtCO_2e$. Aggregate GHG emissions from other end-use sectors, such as agriculture, services, and household sectors declined by 18.6 percent from 12.1 $MtCO_2e$ in 2021 to 9.9 $MtCO_2e$ in 2022. Emissions from refinery production and own use of energy tripled from 0.4 $MtCO_2e$ in 2021 to 1.2 $MtCO_2e$ in 2022.

On the other hand, the implementation of mitigation measures, such as the utilization of RE in power generation, biofuels blending, and the application of energy efficiency on both the supply and demand sides resulted in the avoidance of 18.1 $MtCO_2e$ or 11.8 percent of the total hypothetical GHG emissions[3] in 2022.

Energy – Economy and Environmental Indicators

Energy use per unit of economic output improved through energy efficiency measures. This is evident in the 2.6 percent decline in the country's economy-wide energy intensity to 3.1 tons of oil equivalent per million pesos of real GDP (TOE/MPhP) compared to its a year-ago level of 3.2 TOE/MPhP. Electricity intensity likewise fell by 2.3 percent to 5.6 watt-hours per peso (Wh/PhP), while oil intensity increased by 3.4 percent to 8.1 barrels per peso (bbl/PhP) attributed to its increased utilization in the transportsector.

In 2022, the quantity of energy (overall) and electricity were less responsive to changes in economic output, marked by lower values for economy-wide energy-to-GDP elasticity (0.6 units) and electricityto-GDP (0.7 units) compared to 2021. However, oil-to-GDP stood at 1.5 units because of the strong domestic demand for oil and oil products that prevailed during the year.

Energy consumption per capita rose by 3.4 percent to 0.6 TOE, while electricity (1.0 MWh/person) and oil (1.4 BBL/person) were higher by 3.8 percent and 9.9 percent, respectively, than their 2021 levels. Progress in per capita levels for the year implies that a greater proportion of the Filipino population had improved access to energy.

Ongoing decarbonization initiatives drove the transition to cleaner energy resources in 2022 as the carbon intensity of energy supply remained constant at 2.2 tCO_2e/TOE, while the GHG intensity of power generation was lower by 1.8 percent at 0.7 tCO_2e/MWh vis-à-vis the previous year, given the higher generation output from aggregate RE sources. Meanwhile, GHG emissions per capita increased by 2.7 percent to 1.2 tCO_2e/person.

[3] *Hypothetical emission refers to the estimated emission if there had not been mitigation done. It is the sum of actual emission and the avoided/reduced emissions.*

B. Energy Demand and Supply Outlook

Key Findings

- The TFEC accelerates by 3.4 percent under the Reference Scenario (REF) to 90.6 MTOE by 2050 – almost three-times its 2022 level of 36 MTOE as the country returns to its pre-pandemic growth trajectory.
- The industrialization targets propel the industry sector, which exhibits the fastest growth in its energy requirement, accounting for close to a third (32 percent) of TFEC by 2050.
- Transport and household sectors also contribute to the increase in energy demand, while oil and electricity maintain their dominance.
- The transport sector bears the bulk of the reduction in energy consumption with target energy efficiency (10.0 percent savings in oil and electricity by 2040), 5.0 percent biodiesel blending by 2026 and a 50.0 percent penetration rate for electric vehicles (EVs) by 2040 under the Clean Energy Scenario (CES).
- Aggressive RE targets improve energy self-sufficiency to around 55.0 percent by the end of the planning period under the CES, contributing to the improvement of energy security.
- RE also dominates the country's capacity and generation mix in 2050 driven by the significant capacity additions from hydro, wind (onshore and offshore), and solar across the planning horizon. Aggregate generation output from wind and solar increases significantly and ramps up RE generation share to 65.0 percent (CES 1) and 70.7 percent (CES 2). Voluntary retirement and repurposing of CFPPs also contribute to the remarkable upturn in RE shares.
- Deployment of variable RE and improvement of reliability and resilience of the system requires more than 20 GW of Battery Energy Storage System (BESS) capacity projected to be installed by 2050 under the CES, which highlights the importance of integrating energy storage systems (ESS).
- The country's energy transition pathway through RE, nuclear and other new and efficient technologies contributions, and voluntary retirement and repurposing of coal plants potentially provide the largest contribution in decarbonizing the power generation sector, which bring down the sector's GHG emissions by a cumulative of 282.1 $MtCO_2e$ from 2023 to 2050.
- The National Determine Contribution (NDC) commitments projected GHG reduction and avoidance under this PEP ranges from 55.0 percent to 66.0 percent vis-à-vis the baseline scenario (PEP 2018-2040).
- The resulting electricity consumption per capita (as supported by 100.0 percent household electrification), share of RE in generation mix and energy intensity, exceed the energy sector targets identified under PDP 2023-2028, Sustainable Development Goal (SDG) 7, and targets under the ASEAN and APEC regional cooperation.
- Reductions in economy-wide energy intensity register at 4.0 to 6.0 percent average annual rate between 2030 and 2050 compared to 2022 level, with significant contribution from the transport, cement and iron and steel sub-sectors. However, there is a need to further improve efforts for the food and machinery and equipment sub-sectors to ensure economy-wide reduction targets are met.
- Total investment requirement under this PEP stands PhP20 trillion (USD357 billion) under the REF, while aggressive targets under the CES necessitate more investments of almost PhP28 trillion (USD506 billion) to PhP31 trillion (USD570 billion). These investments are expected to provide about 1.4 million to 1.8 million job opportunities for Filipino workers.

Methodologies and Assumptions

The Energy Outlook takes into account the country's growth trajectory as indicated in the PDP 2023-2028 and aligns with both *AmBisyon Natin* 2040 and President Marcos Jr. Administration's 8-point socio-economic agenda with a focus on protecting the purchasing power of families by reducing energy cost and creating more jobs with indigenous resources vis-à-vis energy security. The country sustained its 7.6 percent expansion in real gross domestic product (GDP) in 2022 with projected peak growth of 8.0 percent by 2028. Towards the end of the planning horizon, the Philippine economy registers annual increments of 7.1 percent.

The Energy Outlook also analyzes two (2) possible energy scenarios for the country's pathway to energy transition – Reference Scenario (REF) and Clean Energy Scenario (CES). The former primarily paints a situation where current energy policies are maintained, while the latter represents the energy sector's aggressive targets pursued within the planning horizon.

REFERENCE SCENARIO	CLEAN ENERGY SCENARIO - 1	CLEAN ENERGY SCENARIO - 2
SUPPLY	**SUPPLY: REFERENCE +**	**SUPPLY: REFERENCE +**
• Present development trends and strategies • Existing plants and committed power • projects and WESM-registered capacitiesas of May 2023 • 35% RE share by 2030; 50% by 2050 • Indigenous production targets by 2050 • LNG imports in 2023	• More than 50% RE share by 2050 • Capacity targets under NREP • **19 GW of OSW** • 40-year technical life for coal plants • Additional nuclear capacity of l,200 MW by 2032, 2,400 MW by 2035 and 4,800 MW by 2050	• More than 50% RE share by 2050 • Capacity targets under NREP • **50 GW of OSW** • 40-year technical life for coal plants • Additional nuclear capacity of 1,200 MW by 2032, 2,400 MW by 2035 and 4,800 MW by 2050
DEMAND	**DEMAND: REFERENCE +**	
• Reduction in economy-wide energy intensity consistent with regional targets o 10% EV penetration rate by 2040 o Current biofuels blending (B2 and EI0) o EEC efforts sustained at 5%	• Higher reduction in economy-wide energy intensity • 50% EV penetration rate by 2040 • BS and EI0 biofuels blending by 2026 • EEC rate on oil products and electricity use improve by 10% in 2040-2050 through heightened EE&C activities	

The DOE strategic framework builds on achieving access to affordable energy, reliability and resiliency, and clean and sustainable energy (ARC). These strategies are poised to be implemented with the following long-term targets.

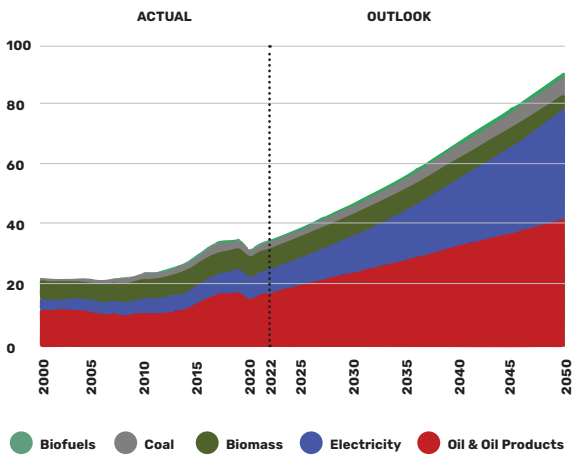
Reference Scenario (REF)

Energy consumption speeds up by 3.4 percent to 90.6 MTOE by 2050 under the REF, or almost tripling its 36 MTOE in 2022, with hefty average shares from transport (32.2 percent), industry (24.4 percent), and household (25.0 percent) sectors.

Industrialization targets propel the industry sector's energy consumption as it rises the fastest at 4.9 percent per year and accounts for close to a third (30.3 percent) of the TFEC by 2050. Efficiency measures implemented drive down energy use in both transport and household sectors, recording growths of 2.7 percent and 2.5 percent, respectively, albeit contributing an aggregate average share of 57.2 percent across the planning period.

Consumption of oil and oil products registers yearly growth of 3.1 percent and doubles its 2022 level to 43.2 MTOE by 2050 *(Figure 3).* Transport remains the most oil-intensive sector as gasoline and diesel comprises the bulk of its utilization, with average shares of 24.9 percent and 31.7 percent, respectively.

Figure 3. **Final Energy Consumption by Fuel, in MTOE, 2020-2040**



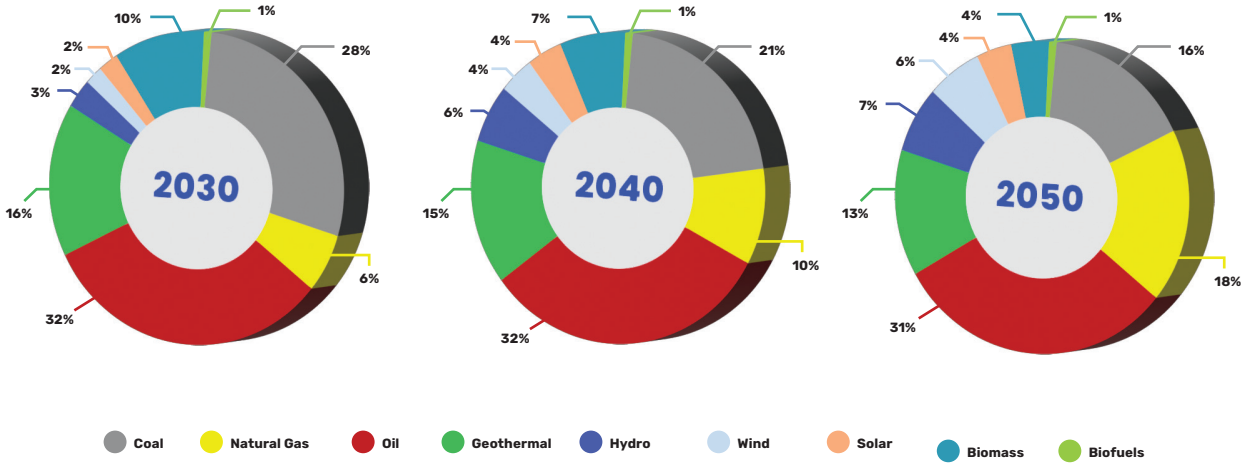
Electricity posts the fastest growth rate among the fuels at 5.5 percent per year with its consumption rising to 35.1 MTOE by 2050, while doubling its share in TFEC to 38.7 percent in 2050 from 21.9 percent in 2022. The uptrend in electricity utilization results from the government's attainment of its electrification and connectivity targets, including the increasing adoption of EVs for road transport and fully operational mass rail transit lines across the country.

Demand for traditional biomass drops by 1.2 percent a year within the planning period as increasing household income supports the transition to modern, cleaner, and more efficient fuels. Industry consumption of coal grows steadily at 4.2 percent a year reaching 6.1 MTOE by 2050, equivalent to a 6.7 percent share of the TFEC for the same year. This is due to increasing demand for building materials, particularly cement, iron, and steel that are essential for the country's infrastructure development.

The mandated blending of 2.0 percent for biodiesel and 10.0 percent for bioethanol pushes biofuel consumption to double by 2050 at 1.1 MTOE and equates to a 2.3 percent yearly increase between 2022 and 2050.

Total Primary Energy Supply. Economic and diversification/decarbonization goals under the Reference Scenario boost the TPES level to reach 140.5 MTOE in 2050—more than twice its 2022 level of 61.6 MTOE, with annual increments of 3.0 percent across the planning horizon.

Figure 4. **Energy Mix (by Fuel Shares) under the REF: 2030, 2040 and 2050**



While oil remains the country's main energy source, its share in the energy mix slightly decreases to 31.0 percent in 2050, down from the 32.2 percent recorded in 2022 *(Figure 4).* Despite this, it continues to sustain a robust demand from various end-use sectors, particularly transport. Conversely, the coal supply experiences gradual expansion at a rate of 0.6 percent due to its waning utilization for power generation consistent with decarbonization targets throughout the planning period. On the other hand, LNG imports beef up the country's natural gas supply as levels improve by 8.4 percent annually between 2023 and 2050 amidst declining domestic gas production. With the transition towards cleaner fuels in power generation, the total RE share to TPES rises from 32.6 percent in 2022 to 35.5 percent by the end of the planning period.

Aggregate domestic energy production exhibits yearly upticks of 2.1 percent and reaches 54.7 MTOE in 2050. This brings the country's energy self-sufficiency level to 38.9 percent, while net energy imports account for 61.1 percent of the country's TPES by the end of the planning period. Total RE supply level more than doubles to 49.9 MTOE by 2050 vis-à-vis its 2022 level of 20.0 MTOE and constitutes 90.3 percent of the domestic energy production during the same year.

The total supply requirement for power generation, specifically fuel input, increases annually by 3.5 percent, registering 85.0 MTOE in 2050, representing 60.5 percent of the TPES for the same period.

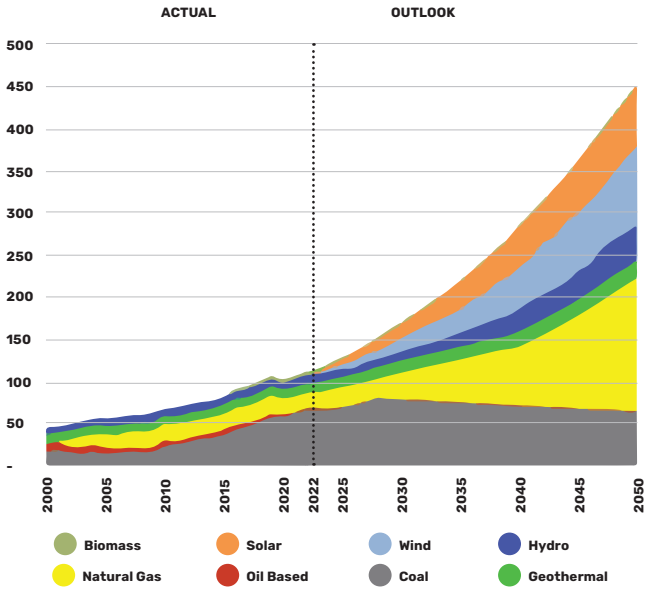
Renewable sources comprise half (51.3 percent share) of the fuel input mix in 2050, while natural gas constitutes 29.2 percent. Meanwhile, non-power requirements comprise almost 40.0 percent (39.5 percent) of the TPES in 2050, wherein oil accounts for 77.7 percent, with coal and biomass (including biofuels) contributing around 11.0 percent.

Power Demand and Supply. The country's total electricity sales expand at an annual rate of 5.5 percent from its 2022 level of 91.3 terawatt-hours (TWh) to 408.1 TWh by 2050 *(Figure 5).* The Luzon grid, being the center of economic activities, consistently comprises the largest share (more than 70.0 percent) in terms of electricity sales for the period 2022 to 2050. On the other hand, Visayas' growth prospects propel its grid electricity sales to increase the fastest at 6.3 percent.

Peak demand registers a threefold increase from 16.6 gigawatts (GW) in 2022 to 68.5 GW by 2050, corresponding to a 5.2 percent annual average growth rate. The Luzon grid also holds a substantial share in total peak demand accounting for 70.0 percent across the planning horizon.

Total gross generation grows at an annual rate of 5.1 percent, from 111.5 TWh in 2022 to 453.8 TWh in 2050.

Figure 5. **Gross Generation Output by Fuel (TWh), 2000-2050**



Between 2022 and 2050, the generation mix exhibits significant shifts due to milestone policies and strategies (i.e., sustained implementation of the coal moratorium), aggressive promotion of RE technologies (particularly solar and wind, vis-à-vis RE target shares of 35.0 percent by 2030 and 50.0 percent by 2040), and utilization of natural gas as a transition fuel.

The aggregate RE generation output increases remarkably by 8.3 percent from 24.6 TWh in 2022 to 230.2 TWh by 2050. Generation from solar and wind registers the fastest annual increase with 17.4 percent and 14.1 percent, respectively. Solar generation ramps up from 1.8 TWh in 2022 to 73.7 TWh by 2050, while wind accelerates from 1 TWh in 2022 to 92.8 TWh by 2050. The combined contribution of both sources accounts for 36.6 percent of total generation by 2050. The significant share of VRE (solar and wind) presents an opportunity for ESS to support grid stability given supply intermittency. The grid requires 65 GWh from battery energy storage systems (BESS) by 2030 and expands further to 466 GWh by 2040 and 1,021 GWh by 2050.

The voluntary retirement and repurposing of CFPPs can be contributing factors in the sizeable decline in coal generation output at an annual rate of 0.1 percent resulting in a generation share of 59.6 percent share (66.4 TWh) in 2022 to 14.1 percent share (63.8 TWh) in 2050. With the constraint on coal, natural gas takes on the role as transition fuel and results in more than 8.0 percent uptick in its generation output between 2022 and 2050. LNG becomes vital in ensuring sufficient supply for the country's power generation requirements with the projected commercial operation of seven (7) LNG projects.

The increase in both electricity sales and power generation necessitates an additional generating capacity of 122.7 GW by 2050, thereby raising the country's total installed capacity to 151.0 GW. This equates to a 6.2 percent annual rate of increase from the 28.3 GW level in 2022. A significant share comes from RE capacities with 70.7 percent (106.7 GW), with wind and solar contributing 21.4 percent (32.3 GW) and 37.4 percent (56.5 GW), respectively, which leads to a remarkable increase in the BESS from 156 MW in 2022 to 3.8 GW by 2050 to make the grid stable.

The continued implementation of the coal moratorium impacts the deployment of new coal capacities, except for those already in the pipeline between 2023-2027. The share of coal declines to 9.8 percent by 2050. Having a capacity addition of 21.9 GW between 2022 and 2050, natural gas as a transition fuel contributes 17.0 percent to the capacity mix by the end of the planning horizon.

Greenhouse Gas (GHG) Emissions. The country's total GHG emission doubles, registering 270.1 $MtCO_2e$ in 2050 compared to 135.7 $MtCO_2e$. in 2022.

As the system shifts to RE and natural gas for power generation, GHG emission in the transformation sector grows steadily at 1.6 percent a year across the planning period, while its aggregate share declines by 45.2 percent in 2050 from 57.1 percent in 2022. The transport sector is seen to contribute 27.1 percent and remains second to transformation in terms of GHG emissions.

The GHG emission from coal slows down over the planning horizon at a yearly rate of 0.5 percent, as levels reach 86.6 $MtCO_2e$ in 2050 vis-à-vis 2022's 75.2 $MtCO_2e$. Emission from natural gas accelerates by 8.4 percent annually with its level increasing tenfold from 6.1 $MtCO_2e$ in 2022 to 58.0 $MtCO_2e$ by 2050.

Clean Energy Scenarios (CES)

* CES 1 (with 19-GW OSW)

The **TFEC** tapers down slightly to 3.0 percent per year due to the impact of increasing EV penetration rate in road transport, higher biodiesel blending and energy savings on electricity and oil products under the CES compared to the REF. The transport and industry sectors contribute to the reduction with a decrease of 5.2 MTOE in their aggregate levels, while the rest of the end-use sectors (services, households, agriculture) and non-energy use account for the remaining 2.5 MTOE. The consumption of oil and oil products drops by as much as 7.0 MTOE by 2050 with biodiesel consumption rising to 731 kTOE in 2050 from 169 kTOE in 2022 due to a higher blend under CES. The EEC implementation on electricity in other sectors is offset by intensified utilization in the transport sector.

The **TPES** increases at 2.6 percent a year (0.4 percentage points slower than the REF) as levels reach 127.3 MTOE by 2050. The 13.2 MTOE difference between CES 1 and REF represents the impact of the adoption of new technologies (OSW and nuclear) and improved efficiency in new power plants resulting in lesser fuel requirements. In comparison to the REF, the share of RE in CES 1 by 2050 is 41.1 percent or 5.6 percentage points higher than REF's 35.5 percent. Meanwhile, fossil fuel (coal, oil, natural gas) share declines by 16.5 percentage points from 67.4 percent in 2022 to 51.0 percent in 2050. With the entry of nuclear energy starting 2032, it contributes 7.9 percent to the TPES by 2050.

With higher RE supply and entry of nuclear energy in the CES, **indigenous energy production** improves compared to the REF, while the volume of net energy imports drops by an average of 19.5 percent between 2022 and 2050. By 2050, net energy imports stand at 59.9 MTOE vis-à-vis total indigenous production of 67.4 MTOE. At this level, **self-sufficiency** advances to 52.9 percent in 2050 or 14.0 percentage points more than the REF's 38.8 percent for the same period.

Aggregate fuel inputs for power generation under CES 1 register a level of 79.2 MTOE and account for 62.2 percent of the TPES during the same period. This exhibits a decrease of 1.7 percentage points compared to the REF for the same year and indicates improved plant efficiencies and the displacement of fossil fuels to make way for the increasing share of renewables. Decommissioning of coal capacities under the CES 1 brings down its share in fuel input mix by 3.5 percentage points in 2050 compared to the REF. The **non-power requirement** reaches 48.2 MTOE and comprises more than a third (37.8 percent) of the energy mix by 2050, which is 1.7 percentage points less than the REF. Increasing the mandated biodiesel blend from 2.0 to 5.0 percent starting 2025 almost doubles its non-power application in 2050 between the REF and CES. Implementation of efficiency improvements in coal utilization for industrial processes reduces its use by 9.2 percent.

Power Demand and Supply. Implementation of EEC brings down electricity sales by 4.6 TWh in 2050 from its 408.1 TWh level under CES. As such, the CES 1 requires 129.7 GW of additional capacity to augment electricity needs by 2050. The capacity from RE is seen to account for 74.4 percent of the total equivalent to 114.8 GW. The impact of CFPPs decommissioning is felt in the decrease in installed capacity of around 3.6 GW compared to the REF. Despite the additional capacities, improved efficiencies of power plants under the CES lead to a slightly lower total **gross generation** level of 443.9 TWh vis-àvis 453.8 TWh under the REF. A higher share of variable REs (VREs) in this scenario results in more BESS (22.0 GW installed capacity) to support grid stability.

GHG emission level under the CES 1 will fall by 70.5 $MtCO_2e$ in 2050 as compared to the REF. The transformation sector contributes the largest share (69.0 percent) of the difference in GHG emission as a result of energy transition in the power sector. The energy savings to be realized on electricity and oil, as well as fuel diversification in the transport sector results in lower GHG emissions from end-use sectors.

* CES 2 (with 50-GW OSW)

This Plan also considers further increasing OSW capacity from 19 GW to 50 GW as represented by CES 2 and forms part of initiatives in energy diversification towards low-carbon, clean and sustainable fuels.

In terms of **TPES** level, the CES 2 is lower by 3.9 percent compared to the CES 1 because of more efficient technologies comprising the energy mix by 2050. Wind jumps up its share to 15.5 percent in 2050 from 4.4 percent in 2030 pushing the total RE share to 42.5 percent. The country's **self-sufficiency** improves to 54.8 percent compared to the CES 1 of 52.9 percent due to additional OSW capacity, and with a 7.8 percent reduction in the volume of net energy imports.

The entry of higher OSW capacity displaces other RE technologies (less capacity addition than CES 2) with lower capacity factors (e.g., solar and onshore wind) and is evident in terms of the **total generation**. The generation output from wind in the CES 2 expands remarkably from 0.9 percent share in 2022 to 49.5 percent share in 2050 bringing the aggregate RE share to as much as 70.7 percent during the same year. The BESS capacity reaches 24.7 GW under this scenario, which is a bit higher than the CES 1 due to the increased share of VREs.

The combined impact of increased clean energy (RE and nuclear) shares and reduction in fossil fuels brings down the GHG emission by a cumulative of 282.1 $MtCO_2e$ between 2022 and 2050. Of this volume, lower generation production from coal accounts for a cumulative reduction of 243.0 $MtCO_2e$, while natural gas contributes the remaining volume of 39.8 $MtCO_2e$ by 2050.

Impact of a 20.0 Percent Bioethanol (E20) Blend under CES 2 as a Hypothetical Scenario

Increasing the bioethanol blend to E20 (as a hypothetical scenario) for gasoline improves the country's position towards energy security, especially in the transport sector. It will further diversify fuel sources, reduce dependence on imported oil, address fuel price escalation, and mitigate GHG emissions.

Implementing E20 increases bioethanol demand to 12.1 MTOE by 2050 vis-à-vis E10 blending schedule under CES 1 and CES 2. It also translates to a cumulative reduction in TFEC[4] of 4.8 MTOE across the planning horizon. Gasoline demand decreases by 17.0 MTOE, while domestic production of bioethanol increases to 784.6 kTOE by 2050 from 205.7 kTOE in 2022. Meanwhile, cumulative GHG emission reduction due to E20 registers at 49.1 $MtCO_2e$ over the planning horizon.

[4] *Due to replacement of gasoline by bioethanol. Gasoline has a higher calorific value than bioethanol.*

Aligning with PDP 2023-2028's SDG-7 Targets

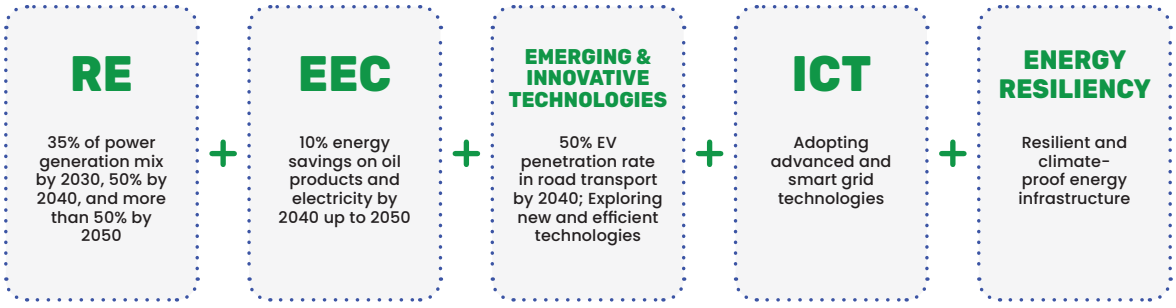
This plan complements the PDP 2023-2028 with the energy sector exceeding the targets identified and set under the government's overall plan that envisions achieving affordable, accessible, reliable, and clean energy (under subchapter outcome 4 of the Results Matrix) during President Marcos Jr. Administration. Accordingly, the plan will meet the following goals:

- **Increased proportion of households with access to electricity.** The government targets to achieve a 100.0 percent household electrification target by 2028.
- **Increased electricity consumption (in kWh) per capita.** Electricity per capita grows by 4.0 percent from 999 kWh to 1,262 kWh under the REF, while the two CES (CES 1 and CES 2) show slightly lower levels (1,250 kWh and 1,249 kWh) due to the impact of EEC measures.
- **Increase the share of renewable energy in the power generation mix.** Higher RE capacities under the CES 1 and CES 2 result in RE generation shares that exceed the PDP 2028 target by around 6.0 to 9.0 percentage points.
- **Decrease energy intensity measured in terms of primary energy and GDP.**[5] By 2028, the country's energy intensity level ranges from 2.5 to 2.4 TOE/MPhP (REF to CES 1 and CES 2) and translates to yearly average reductions of around 4.0 to 5.0 percent from 2022 level, indicating an improvement in energy efficiency.

C. Energy Transition

ENERGY TRANSITION PATHWAY

The energy transition pathway is poised to provide access to affordable, accessible, reliable, and clean energy, which will ensure a strongly rooted, comfortable, and secure life for Filipinos. For an efficient energy transition, the approach must be a gradual process, necessitating the enhancement of energy delivery through coordinated reforms and investments across the entire energy sector, all integrated into broader development initiatives. The key components enabling the energy transition pathway are encapsulated as follows:



PH CONTRIBUTION TO GLOBAL ENERGY TRANSITION

Offshore Wind Development and Support Port Infrastructure I Marine-Based Energy Resource Development I Rightskilling of Filipino Workforce and International Accreditation Initiative I Mining and Manufacturing of Green Materials I Voluntary Retirement and Repurposing of CFPPs

These goals support the Global Renewables and Energy Efficiency Pledge of tripling RE capacity with at least 11,000 GW by 2030 and doubling the global average annual rate of energy efficiency improvements from around 2.0 percent to over 4.0 percent every year until 2030.

[5] *Energy Intensity refers to the amount of energy needed to produce one unit of economic output. A lower number means improvements in energy efficiency but also depends on the structure of the economy. Highly industrialized economies tend to use a greater amount of energy per unit of economic output. For the Philippines, the Services sector, which accounts for the largest share to GDP, is a less energy-intensive sector.*

Demand-side mitigation measures flatten the TFEC by 12.7 MTOE in 2050 through a 10.0 percent energy savings on oil products and electricity from the implementation of EEC measures, a 50.0 percent EV penetration rate in road transport, and higher biofuel blending. The RE target share of 35.0 percent in the generation mix in 2030 triples the 2022 installed capacity of 8.3 GW to around 26 GW for the REF and CES 1 and to 30.5 GW in the CES 2. Increasing RE shares to 50.0 percent by 2040 and to more than 50.0 percent by 2050 translates to massive additional RE capacities in all the scenarios (REF and CES) coupled with voluntary retirement and repurposing of CFPPs. These targets would allow emerging technologies, such as hydrogen and its derivatives, to serve as alternative energy storage (and fuel) to make variable RE (solar and wind) stable and reliable for the system. On the other hand, nuclear power comprises a total of 4.8 GW by 2050. These measures result in a reduction in energy intensity at 4.0 percent average annual rate by 2030, 6.0 percent by 2040 and 4.0 percent by 2050 compared to 2022 level.

Accelerating the development of the energy transition targets requires infrastructure support i.e., information and communications technology (ICT) and port infrastructure to support OSW and marinebased energy resource development projects. Adopting ICT through advanced smart grid technologies as embraced in the SGGP, which is an integral part of this Plan, fortifies the country's energy infrastructure to be more resilient and climate-proof. These further ensure and enable the country's long-term vision and commitment to transition. Empowering the Filipino workforce through right skilling initiatives, international accreditation programs, and championing the mining and manufacturing of green materials are regarded as the Philippines' contribution in the global effort towards a just energy transition.

POLICY IMPLICATIONS TOWARDS ENERGY TRANSITION

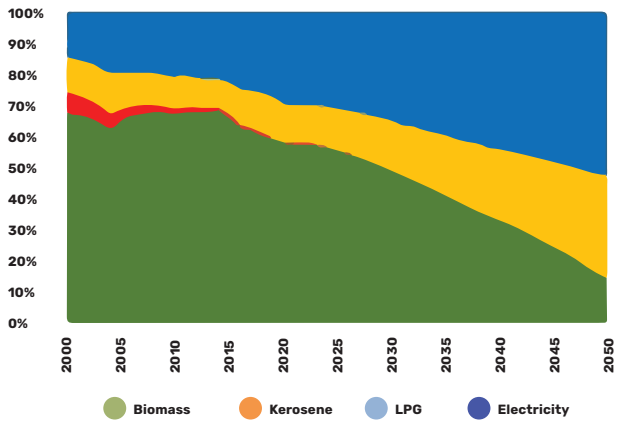
A. SUSTAINABILITY OF THE ENERGY SYSTEM

The 2023 Energy Transition Report of the World Economic Forum (WEF) ranks the Philippines at 94th out of 120 countries due to low scores in transition preparedness. This poses as a challenge for the energy sector to exert more efforts to support improvements in system performance and readiness for energy transition.

WEF 2023 considers two major areas in its assessment of energy transition efforts – (1) system performance (SP) which covers criteria on sustainability of energy system; and (2) readiness which covers policy enablers and mechanisms to improve SP. There are three (3) pillars under SP that are distinctively assessed for this PEP, i.e., **equitable**, **secure**, and **sustainable** dimensions.

*** Equitable Energy**

Figure 6. **Household Fuel Shares (%)**



Access to Modern Energy. The household sector's energy demand mix has been shifting towards modern fuels over the years. Electricity and liquefied petroleum gas (LPG) gradually displace traditional biomass (as cooking fuel) with households progressing towards middleincome class society with greater access to modern energy *(Figure 6)*.

Increased access to electricity stimulates its use as a modern fuel. Relatedly, expanding electricity services throughout the country is an outcome of the government's Total Electrification Program. As of December 2022,

household electrification level already reached 96.17 percent (based on the 2015 census of population), which means that about 25.91 million households are now enjoying the benefits of electricity service, while the remaining 879,232 households are still to be provided with access to electricity.[6]

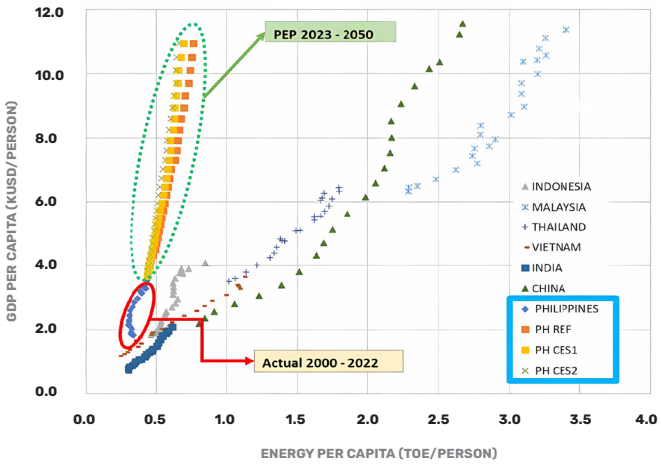
Affordability. The resulting trend in generation cost denotes a trade-off between decarbonizing the power sector and reducing the cost of electricity. This is a continuing challenge that needs to be addressed. However, sustaining economic growth (i.e. 7.1 percent annual average between 2022 and 2050) allows for higher disposable income, such that the share of household expenditure on energy declines to 5.3 percent by 2050.

The levelized cost of energy (LCOE) or blended rate[7] under the REF ramps up at an annual rate of 0.8 percent to PhP6.3/kWh in 2050 vis-à-vis its 2023 level of PhP5.1/kWh. With RE capital cost exhibiting a learning curve, the increase in blended rate further eases to 0.2 percent and 0.6 percent per year between 2023 and 2050 under the CES 1 and CES 2 scenarios, respectively. Due to steady increases in fossil fuel prices and technology capital cost, the REF's blended rate stands higher compared to other scenarios, while more RE technologies with higher capacity factor, such as OSW[8], contribute to lower blended rate under the CES 1 and CES 2.

Economic Development. The country's energy per capita consumption gradually increases despite the upsurge in income per capita within the planning horizon. This stems from the country's economic structure wherein the services sector is a major contributor to GDP.[9]

Figure 7 shows the relationship of energy per capita against GDP per capita (or income per capita) of selected ASEAN[10] member states, as well as India and China, for 2000-2022 compared with the Philippines' trajectory under the PEP's REF, CES 1 and CES 2 for the period 2023-2050. The Philippines is next to India with the lowest income per capita, while China and Malaysia are the highest with around USD 11,600 and USD 11,400 in 2022, respectively. The Philippines' energy per capita consumption level in 2022 is the lowest among the selected ASEAN countries in comparison at 0.61 TOE/person and increases slowly as income per capita[11] grows rapidly, while that of other countries are highly proportional to the increases in their per capita income.

Figure 7. **Energy per capita vs. GDP per capita trajectory of Selected Countries for 2000-2022 compared with PEP 2023-2050 for REF, CES 1 and CES 2**



*** Security of Energy Supply**

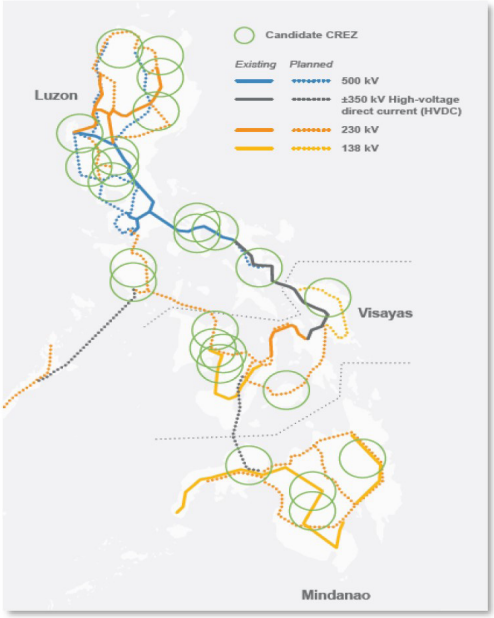
Supply Security. *Security of supply improves with the country's decarbonization target.* Higher RE share, production of low-carbon technologies, and the voluntary retirement and repurposing of CFPPs result in reduced fuel imports towards the end of the planning horizon. While the share of indigenous energy production declines from 49.2 percent in 2022 to 38.8 percent by 2050 under the REF, energy selfsufficiency significantly improves under the CES 1 and CES 2 trajectories with 52.8 percent and 54.7 percent, respectively *(Figure 76)*.

[6] *The household electrification target has been updated based on the 2020 Census of Population in the Electrification Chapter.*
[7] *The LCOE per scenario includes impact of BESS.*
[8] *The LCOE does not include the transmission cost for OSW. Please see Chapter III on Energy Demand and Supply Outlook.*
[9] *See scatter plots within the green dotted circle in Figure 6.*
[10] *Refers to the Association of Southeast Asian Nations.*
[11] *See blue scatter plots encircled with red line in Figure 6.*

Reliability and Resiliency. *Transmission infrastructure should be in place prior to the implementation of RE targets.* A reliable transmission infrastructure plays a significant role in integrating large-scale RE facilities. Deployment of large-scale wind and solar generation may only require a few years to put in place, while transmission planning and development would take about 10 years[12]. Financing RE development is one aspect of project implementation, but without accessible transmission infrastructures, RE facilities will remain as stranded capacities.

Designating RE zones simultaneous to the strategic development of new connections and modernization of existing transmission infrastructure addresses investment risks brought by barriers in the development process (Figure 8). The Competitive Renewable Energy Zones (CREZ) vision is to adopt pro-active transmission planning and implementation, and direct RE development to places that optimize the use of indigenous resources and maximize the benefits to the people.

Figure 8. **Designated RE Zones from CREZ-1**



Source: Grid Planning and Competitive Renewable Energy Zones (CREZ) in the Philippines

The CREZ process identified 25 RE Zones that are viable for development. These RE zones are also considered in the generation and transmission planning. The CREZ has progressed to include areas for battery storage to enhance the reliability of the grid with more VRE installation. The CREZ will be integrated into the SGGP to include the designated areas for OSW.

Integrating ESS to support deployment of VRE and improve reliability and resilience of the system. The total BESS capacity projected to be installed by 2050 reaches 22.0 GW for the CES 1 and 24.7 GW for the CES 2. Meanwhile, pump hydro storage contributes 2.4 GW by 2050 in both CES 1 and CES 2. There is a need to ensure grid stability and reliability as the share of VRE, which are prone to ramp down drastically from 100 percent of their capacity to zero percent at any time, in the generation mix under the CES 2 increases from 21.0 percent by 2030 to 35.3 percent by 2050. The combined share of ESS *considered in the capacity mix, which serves as ancillary services of the grid, only accounts for 1.9 percent in 2030 and 4.8 percent in 2050.*

For this purpose, LNG is seen to have a central role in supporting grid stability and needed flexibility in the power system. There is also an opportunity to produce green hydrogen (and its derivatives) should the awarded OSW services contracts provide a considerable amount of firm capacity for power generation.

*** Sustainable Energy**

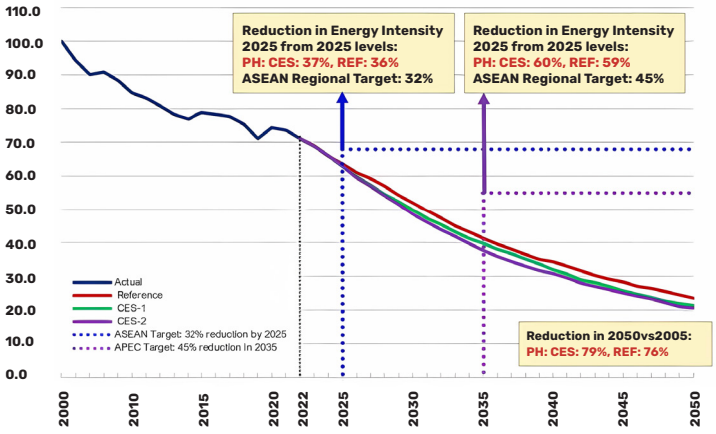
Energy Efficiency as a Way of Life. The Philippines' energy intensity registered an annual decline of 2.0 percent from 4.3 TOE/MPhP in 2005 to 3.1 TOE/MPhP in 2022. This translates to a cumulative efficiency gain of around 30.0 percent vis-à-vis 2005 baseline, higher than the APEC region's 22.0 percent[13]. The energy sector's achievement is attributed to the effective implementation of energy policies and the corresponding adoption of energy-efficient technologies and applications.

The ASEAN and APEC[14] regional cooperation have set forth targets on energy intensity reduction as among its energy goals. The ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase II seeks to reduce energy intensity by 32.0 percent in 2025 from 2005 as the base year and encourage further EEC efforts, especially in transport and industry sectors. The REF (PEP 2023-2050) is seen to reduce energy intensity by 4.0 percentage points higher than the ASEAN's target in 2025 *(Figure 9)*. APEC also sets its aspirational energy intensity reduction at 45.0 percent by 2035. The CES reaches this target in 2028 or seven years ahead with 46.0 percent reduction under the CES.

[12] *Source: 2020 National Renewable Energy Laboratory (NREL) et. al. "Ready for Renewables: Grid Planning and Competitive Renewable Energy Zones (CREZ) in the Philippines"*
[13] *APEC is on track to meet aspirational energy goals. (2022, September 22). [Press release]. https://www.apec.org/press/newsreleases/2022/apec-is-on-track-to-meet-aspirational-energy-goals*
[14] *Refers to the Asia Pacific Economic Cooperation*

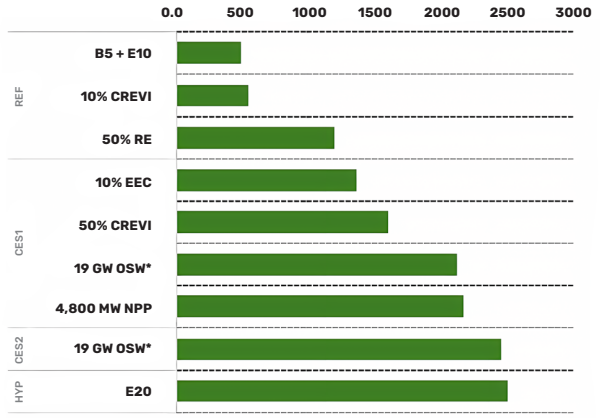
Energy efficiency and fuel diversification measures translate to a significant reduction in energy use per unit of economic output, particularly in energy-intensive sectors such as transport, cement, and iron and steel. However, there is a need to further improve efforts for the food and machinery, and equipment sub-sectors to ensure economywide reduction targets are met.

Figure 9. **Reduction in Energy Intensity as indicator of improvements in energy efficiency**



Share of Clean Fuel in the TPES. The overall sectoral targets transition the energy system to have an increasing share of clean fuels in the energy mix by 2050. The RE share in this PEP exceeds the targets set under APAEC, as well as the government's medium-term development plan (PDP 2023-2028). The share of clean energy, such as RE resources (excluding traditional biomass for cooking) and other emerging technologies (nuclear energy), in the TPES reaches 46.7 percent (CES 1) and 48.3 percent (CES 2) by 2050. However, there is a need to expand decarbonization efforts to non-power sectors like transport and industry.

Figure 10. **Cumulative GHG Avoidance and Reduction from 2023 to 2050 by Mitigation Measures in $MtCO_2e$**



** Includes emission reduction from RE due to retirement of CFPPs*

The ASEAN also recognizes the contribution of RE as an important mechanism to accelerate energy transition by setting up aspirational targets of 23.0 percent share of RE in the TPES and 35.0 percent share of RE in ASEAN installed power capacity by 2025.

GHG Avoidance and Reduction[15]. The combined impact of decarbonization targets brings down GHG emissions by 2,173.5 $MtCO_2e$ (CES 1) and 2,458.2 $MtCO_2e$ (CES 2), about 31.6 percent to 35.8 percent of the cumulative baseline emissions from 2023 to 2050, respectively. By end of the planning period, GHG emissions under the CES 1 shrink by 26.1 percent vis-à-vis the REF, while CES 2 brings an additional reduction of 6.8 percent.

- The total GHG emission still increases despite the existing mitigation measures because of the net increase in electricity production given the hike in its demand in the transport sector.

- Mitigation measures under the REF, such as increasing biodiesel blend to 5.0 percent by 2026, 10.0 percent EV penetration rate and a 50.0 percent RE share in the generation mix, result in a cumulative GHG emission avoidance and reduction of about 1,200.2 $MtCO_2e$ by 2050 *(Figure 10)*.

- Sustaining a 10.0 percent energy savings and a 50.0 percent EV target from 2040 onwards translates to an aggregate reduction of 1,606.6 $MtCO_2e$ in GHG emissions by the end of the planning horizon vis-à-vis the REF. With the entry of 19 GW OSW capacities and the 4,800 MW nuclear capacity by 2050, CES 1 pushes the cumulative GHG avoidance and reduction to 2,173.5 $MtCO_2e$ by 2050. This further increases to 2,458.2 $MtCO_2e$ with the expansion of OSW capacities to 50 MW under the CES 2. These values represent about 31.6 percent (CES 1) to 35.8 percent (CES 2) of the cumulative baseline emissions from 2023 to 2050.

[15] *GHG* **reduction** *is an action that decreases the amount of greenhouse gas emissions compared to prior practices. On the other hand, GHG* **avoidance** *is a mitigation action that prevents a carbon-emitting activity from happening (Source: Removal, reduction, and avoidance credits explained. (2023, October). Carbo Direct. https://www.carbon-direct.com/insights/how-do-carbon-credits-actually-work-removal-reduction-andavoidance- credits-explained). Further, emissions avoidance could be defined as the full displacement or prevention of GHG emissions expected to be generated by planned GHG emitting actions in energy, transport, manufacturing, agriculture, human induced deforestation, and other GHG emitting development activities (Source: Philippine Submission on SBSTA 56 Agenda Item 13 :Guidance on Cooperative Approaches Referred to in Article 6, Paragraph 4, of the Paris Agreement and Decision 3/CMA.3)., August 2022). GHG reduction initiatives include the use of alternative fuels (biofuel and electricity) for transport instead of petroleum products and the retirement of CFPPs. Meanwhile, decarbonizing the power generation sector through the use of clean and low-carbon technologies, such as RE and nuclear, contributes to GHG avoidance.*

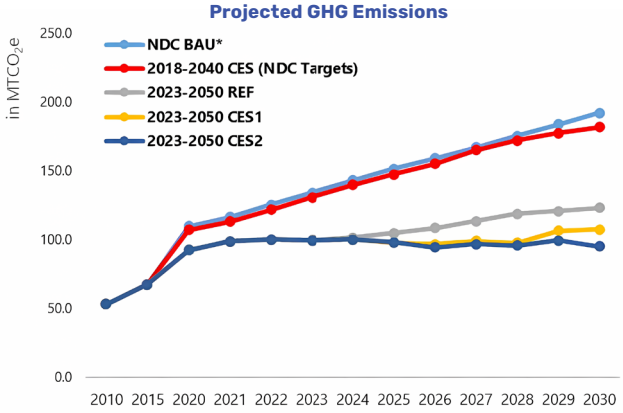
- In addition, these scenarios already incorporate the retirement of CFPPs with total capacities of 3,600 MW for CES 1 and 4,803 MW for CES 2 between 2023 to 2050 that results in a cumulative GHG emission reduction of about 6.1 $MtCO_2e$ and 8.1 $MtCO_2e$, respectively.

- A hypothetical scenario with a bioethanol blend of 20.0 percent by 2030 translates to an additional reduction of 48.8 $MtCO_2e$, which is 1.9 percent of total GHG reduction.

- The GHG avoidance under CES 2 is higher than CES 1 since the added RE capacity displaces more fossil fuel in the generation mix.

Carbon per Capita and Intensity. The aggressive targets for energy transition result in carbon per capita levels at 1.4 tCO_2e/person and 1.3 tCO_2e/person under CES 1 and CES 2, respectively, while carbon intensity to TPES decreases from a base year of 2.2 tons of CO_2 equivalent/TOE (tCO_2e/TOE) to 1.6 tCO_2e/TOE for CES 1 and 1.5 tCO_2e/TOE for CES 2.

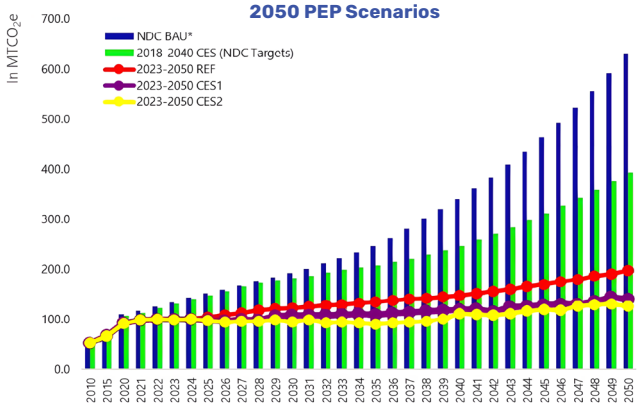
Figure 11. **Energy Sector NDC Assessment vs 2023-2050 PEP Projected GHG Emissions**



Nationally Determined Contribution (NDC) Assessment. For the past three years, from 2020 to 2022, the energy sector, excluding the transport sector, achieved a total GHG emission reduction of 52.9 $MtCO_2e$. This exceeded by about 15.0 percent of the total NDC target of 45.9 $MtCO_2e$, which includes both conditional and unconditional targets. This was further augmented by equivalent GHG avoidance from RE generation of about 144.2 $MtCO_2e$, exceeding the sector's target by more than four times or around 214.1 percent. Such is equivalent to almost 56.0 percent (55.8 percent) reduction in the sector's GHG emissions.

For the NDC assessment, the annual average growth rates of the PEP 2018-2040 were used as benchmarks – 6.3 percent for Business-as-Usual (BAU) and 4.8 percent for CES. These were applied to extrapolate the GHG reduction until 2050 for the long-term comparative assessment *(only covers energy used for power, industry, and other sectors)*. The projected GHG reduction of the current plan shows an estimated 54.5 percent for the REF scenario, 63.2 percent for the CES 1, and 66.4 percent for the CES 2 *(See Figure 12)* based on PEP 2018-2040. Combining GHG reduction and avoidance, the sector will be almost carbon neutral and will only be emitting an average of 3.1 $MtCO_2e$ from 2020-2050. If all the programs and projects identified in the CES 1 and CES 2 are realized, the sector will achieve below zero emissions by 2035 and 2032, respectively, based on the PEP 2018-2040 as the benchmark.

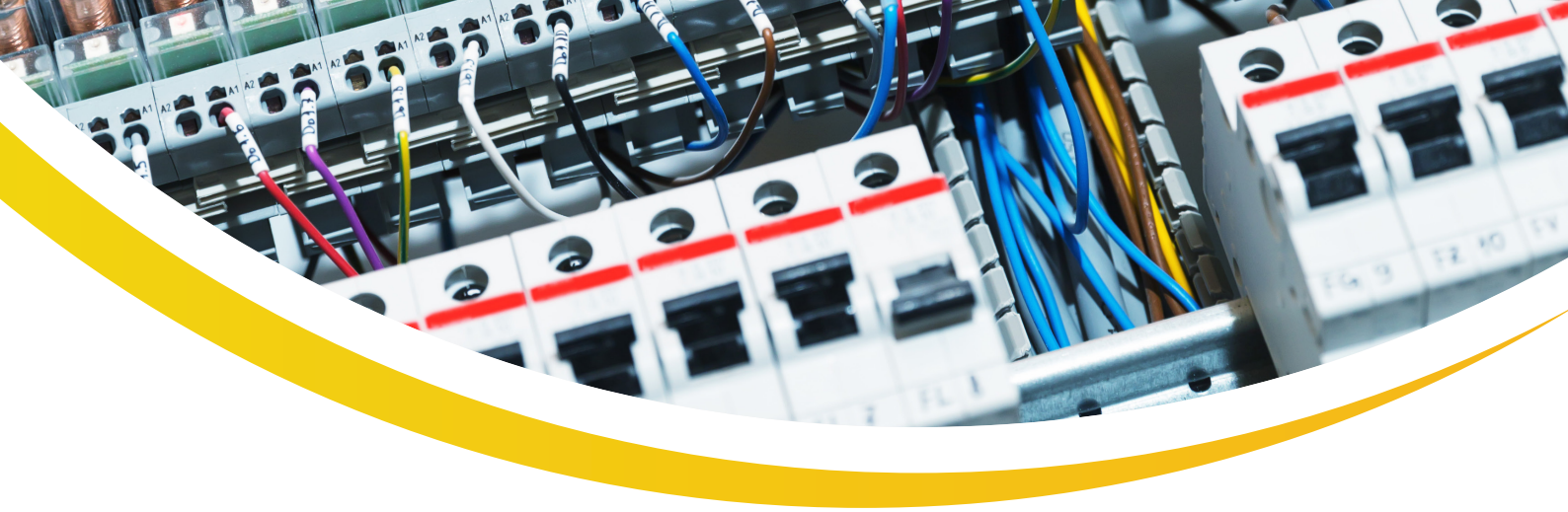
Figure 12. **Comparative Assessment of NDC Targets and 2023-2050 PEP Scenarios**



B. TRANSITION ENABLERS

Regulation and Political Commitment. Preferential Dispatch of all RE resources in the Wholesale Electricity Spot Market (WESM) encourages additional investments because of guaranteed dispatch to the grid at their full available capacity, allowing recovery of investments. Effective policy implementation implies that the government must go beyond mere legislation and demonstrate the will and commitment to further the development of renewables.

Policy Framework for OSW: Executive Order (EO) 21 "*Directing the Establishment of the Policy and Administrative Framework for Offshore Wind Development*" supports the aggressive development of the country's OSW potential, which drives the transition from a coal-dominated capacity mix to a RE-centered one.



The robust RE target and use of low-carbon technologies in power generation and demand-side showcase the country's decarbonization goals even without a commitment yet on net-zero emission as the government prioritizes energy security and reliability of energy supply. Natural gas serves as transition fuel in place of decommissioned CFPPs, while the coal moratorium policy in 2020 covers only new coal power projects. Hybridization of conventional energy (oil and coal) plants is also encouraged in balancing the effect of reduction in their utilization vis-à-vis their vital role in the country's energy security.

Accelerating renewable energy requires conducive regulatory and financial environment.

Balancing Energy Transition with the Development Agenda. The Philippines is also pursuing industrial policies aimed at boosting economic growth and achieving its development objectives. In charting the energy transition path, certain sectors may require flexibility in terms of meeting their energy requirements. For instance, the government plans to develop downstream industries such as ore processing and refineries within the mining sector. Mining is an energy-intensive activity that requires a stable power supply of its own use, which renewables alone cannot guarantee due to intermittency. Hence, possible policy exemptions must be carefully reviewed to ensure a balanced approach.

Finance and Investment. Conducive regulatory and financial environment ensures investor confidence and safeguards the benefits of the Filipinos. This includes allowing 100 percent foreign ownership in RE projects (geothermal, solar, wind, biomass, ocean, or tidal energy) for the promotion, exploration, development, and utilization of the country's RE resources; providing a sovereign guarantee for financing sustainable energy projects and those under the National Renewable Energy Program (NREP) through the Sustainable Energy Credit Guarantee Facility (SEGF) of the Philippine Guarantee Corporation (PHILGUARANTEE)[16]; and, issuing a 25-year green bond by private corporations, which amounted to USD6.58 billion worth in 2022, as part of the country's initiatives and foray into the Green and Sustainability Capital Market[17]. These initiatives are seen to contribute towards an improved share of investments from RE and low-carbon technology to GDP under this PEP – from 0.4 percent under the REF to 0.5 percent for the CES 1, and 0.7 percent for the CES 2.

Education and Human Capital. Global decarbonization efforts are poised to bring profound shifts in the energy sector's employment, which brings a massive and new opportunity for job creation in clean energy, while traditional energy sector jobs are seen to decline. This requires the development of new programs for education, certification, and vocational training along with targeted rightskilling programs for the existing workforce. Cognizant of this, the DOE and the Department of Labor and Employment (DOLE) spearhead the initiative on *the Rightskilling of Filipino Workforce to Support the Global Energy Transition*.

Rightskill Filipinos for full participation in an innovative and globally competitive economy that will support the clean energy future and Energy Transition Program of the country.

Innovation. To achieve the targets of this plan, the DOE shall continuously improve its existing electrification strategies, utilize advanced and emerging technologies, and adopt innovative solutions. The "Microgrid Systems Act", which promotes the use of microgrids to provide uninterrupted power in remote communities with due consideration on the cost-efficient, renewable, and environment-friendly power sources, also guides the government's electrification efforts.

[16] *Sustainable Energy Credit Guarantee Facility (SEGF). (n.d.). Philippine Guarantee Corporation. https://www.philguarantee.gov.ph/programs/guarantee-programs/corporate-msme/sustainable energy-credit-guarantee-facility-segf/*
[17] *Sustainable Finance Market Update as of December 2022. (2022, December 31). Securities and Exchange Commission. https://www.sec.gov.ph/cmsustainable-2022/sustainable-finance-market-update-as-of-december-2022/#gsc.tab=0*

Provision of Infrastructure to Accelerate Deployment of Low Carbon Technologies. The aggressive RE targets require the timely development of a green and smart transmission system to integrate and manage the additional RE capacity expected to come online from 2024 to 2050. ***The SGGP is envisioned as a strategic blueprint for the development, deployment, and operation of a modern transmission infrastructure that supports the integration of clean energy sources and enables a sustainable, reliable, and resilient power grid***. On the other hand, the Comprehensive Roadmap on Electric Vehicle Industry (CREVI) aggressive target of re-fleeting 50.0 percent of all vehicle fleets with EVs by 2040 requires infrastructure support for EV charging stations (EVCS).

Digital infrastructure readiness. The government shall address concerns on digital infrastructure that supports the deployment of RE and other clean energy sources and technologies. The DOE needs robust network support for the operation of the EVOSS and Smart Grid System, among others. Likewise, the integration of smart grid technology with RE improves the network's capability to manage the downtimes of VREs and ensures the prompt response of energy storage system, thus ensuring the reliability and resilience of the grid.

ALIGNING THE INITIATIVES FOR THE IMPROVEMENT OF THE ENERGY TRANSITION PATH

Improving the country's energy system performance and provision of enabling policies and other factors to further accelerate the positioning of the decarbonization targets and foster energy transition readiness, the following actions and initiatives need to align:

Improvement of Energy System Performance

Access to Modern Energy. Enhancing energy accessibility down to the poorest of the poor indicates an improvement in the lives of the Filipino people. This is considered under the economic and social agenda of the PDP 2022-2028 and the long-term vision AmBisyon Natin 2040 with the consolidated GDP growth target of more than 7.1 percent and is expected to lift household disposable income.

Improved electricity access will be attained by achieving 100 percent electrification by 2028 through interconnection of off-grid areas to the national grid, hybridization, and DES in off-grid areas, as well as improving access of the household to modern fuel (i.e., through productive uses of Renewable Energy for household and other social and economic activities). On the other hand, regular conduct of the Households Energy Consumption Survey (HECS) is essential to capture the updated energy consumption patterns and preferences of households, including access to clean cooking fuels and technologies and to effectively monitor the implementation of electrification targets. This will be further improved through the institutionalization of digitalized data-gathering programs, which are cost-effective ways of collecting timely data.

Affordability of Energy. Improved access to modern fuel drives economic growth, which will ultimately increase household disposable income. The latter leads to achieving affordability of energy as the share of household expenditure on energy decreases. The current initiative on CSP Policy promotes the power of choice and consumer welfare protection. It envisions reducing the blended rate of the DUs and end-use electricity rates through lower generation costs. On the other hand, consumers can be prosumers through the installation of solar PV for their homes to provide own-use electricity and may avail of net-metering from their DUs.

The government also needs to guarantee the effectiveness of financial enablers to reduce financial risk of RE to accelerate its deployment that will result in a more reasonable cost for the consumers. Likewise, the rationalization and graduation of the Universal Charge on Missionary Electrification (UC-ME) subsidy, as well as the review of taxation on energy serve as measures towards reasonably priced electricity supply.

> ***The realization of "One Nation, One Grid" aspiration is definitely a crucial turning point for this country in ensuring reliable power at all times.***
>
> *- President Ferdinand R. Marcos Jr.*

Reliability and Resiliency. Reliability and resiliency of energy supply may be sustained with an improved energy self-sufficiency level by making use of indigenous fuels such as RE and domestic resources to lessen the reliance on imported fuels. In line with this, there is a need to pursue the development of indigenous natural gas and ensure the availability of LNG supply to complement VRE for the reliability of the system, while transitioning to clean fuels. ***Ensuring the timely implementation of the transmission plan for the deployment of large-scale RE is equally important for the integration of RE***. The OSW needs to be designated in RE Zones to make it economically viable as this will address the financial barriers for RE deployment. Moreover, putting in place sufficient ESS and operational reserves to support a zero to 100 percent ramp-up of VREs will support the reliability of the system.

Clean and Sustainable Energy. Achieving the clean and sustainable pathway leads to diversifying the energy mix to provide a window for nuclear power, OSW, floating solar, and the development and production of green hydrogen. Accelerating the adoption of low-carbon technology requires policy mechanisms for voluntary retirement and repurposing of CFPPs to reduce their share in the generation mix. Such measures temper the reliance on imported coal to ensure the acceleration of RE and other low-carbon technologies. Traditional power plants need to be retrofitted to be flexible, while some of the new ones can be installed in a smaller capacity unit i.e., 100 MW per unit for this purpose, to support VREs and the reliability of the grid. It is also imperative to develop distributed and diverse energy systems, which include microgrids, ESS, and demand response technologies. Alongside these initiatives, it is likewise necessary to conduct comprehensive waste management studies for the entry of sizable capacity of VREs and BESS, and batteries for EVs to craft policies for proper waste disposal. Since aggressive RE targets increase the deployment of solar and wind technologies for power generation, BESS, and batteries from EVs, this may pose concerns on waste materials from these technologies and hazards to the environment. As such, there is a need to anticipate the needed regulation for the disposal of waste and decommissioning of the power plants using these technologies.

On the other hand, there is also a need to diversify transport fuel to reduce reliance on imported oil, improve energy security, and mitigate the adverse effects of the volatility of oil prices in the international market to the economy. Measures that can be implemented include increasing biofuels (bioethanol and biodiesel) blending using alternative feedstock including waste, intensifying the promotion and use of EVs in the transport sector, and considering off-grid Solar PV for EVCS to soften the reverse impact of CREVI in GHG emission in the electricity production.

D. Energy System

The country's reference energy system (RES), which shows the flow of all energy forms from the primary resources (TPES), oil refining, and power generation to the end-use sectors (TFEC), is illustrated in the Sankey Diagrams for 2022 and 2050 under the REF, CES 1, and CES 2 *(Figures 13-16)*. These diagrams provide a graphical representation of the following:

- How much energy supply is required to produce useful energy for the consumers?
- How much energy is required for each type of fuel, i.e., oil, coal, gas, and RE?
- How much energy is required by each sector of the economy?
- What are the available sources of energy in the country?
- How much energy is imported from other countries?

Table 1 summarizes the major energy data as derived from the energy flows in the Sankey Diagrams for 2022 and 2050.

Table 1. **Summary Table of Energy Data**

Energy Data & Indicators	2022	2050		
	Actual *(Figure 12)*	**Reference** *(Figure 13)*	**Clean Energy with 19 GW OSW** *(Figure 14)*	**Clean Energy with 50 GW OSW** *(Figure 15)*
TPES	**61.56 MTOE**	**140.50 MTOE**	**127.33 MTOE**	**122.32 MTOE**
Share of Indigenous Energy to TPES / Self-Sufficiency	49.42%	38.92%	52.93%	54.83%
Total RE Supply	20.04 MTOE	49.89 MTOE	52.38 MTOE	52.05 MTOE
RE Share of TPES	32.55%	35.51%	41.14%	42.55%
Total Fuel Inputs to Power Generation	32.72 MTOE	84.99 MTOE	79.15 MTOE	74.14 MTOE
Total Gross Generation	**9.59 MTOE (115.52 TWh)**	**39.02 MTOE (453.81 TWh)**	**38.17 MTOE (443.90 TWh)**	**38.25 MTOE (444.87 TWh)**
TFEC	**35.86 MTOE**	**90.59 MTOE**	**82.87 MTOE**	
Major Energy Consuming Sectors and their Shares of the TFEC	Transport (34.37%)	Industry (30.30%)	Industry (30.78%)	
Most Consumed Fuel and Share of TFEC	Oil (50.94%)	Oil (47.63%)	Oil (43.65%)	

Figure 13. **Philippine Energy Flow 2022, MTOE**

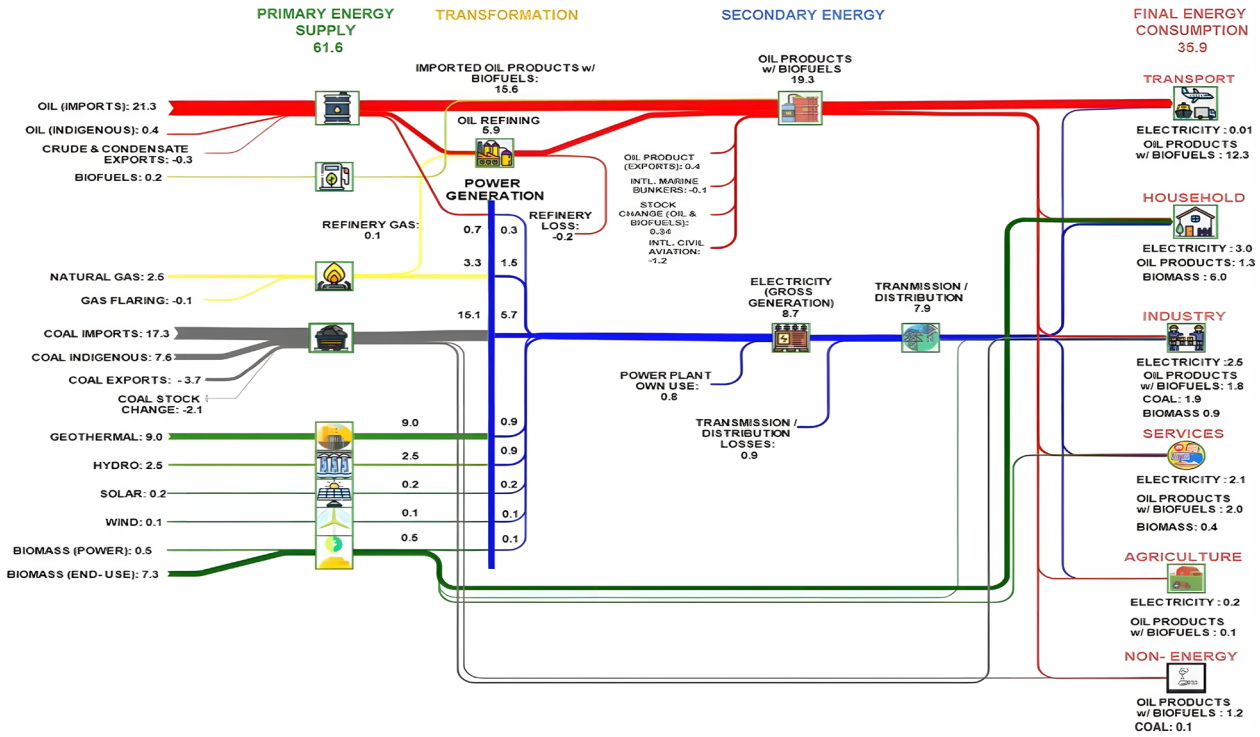


Figure 14. **Philippine Energy Flow 2050, Reference Scenario**

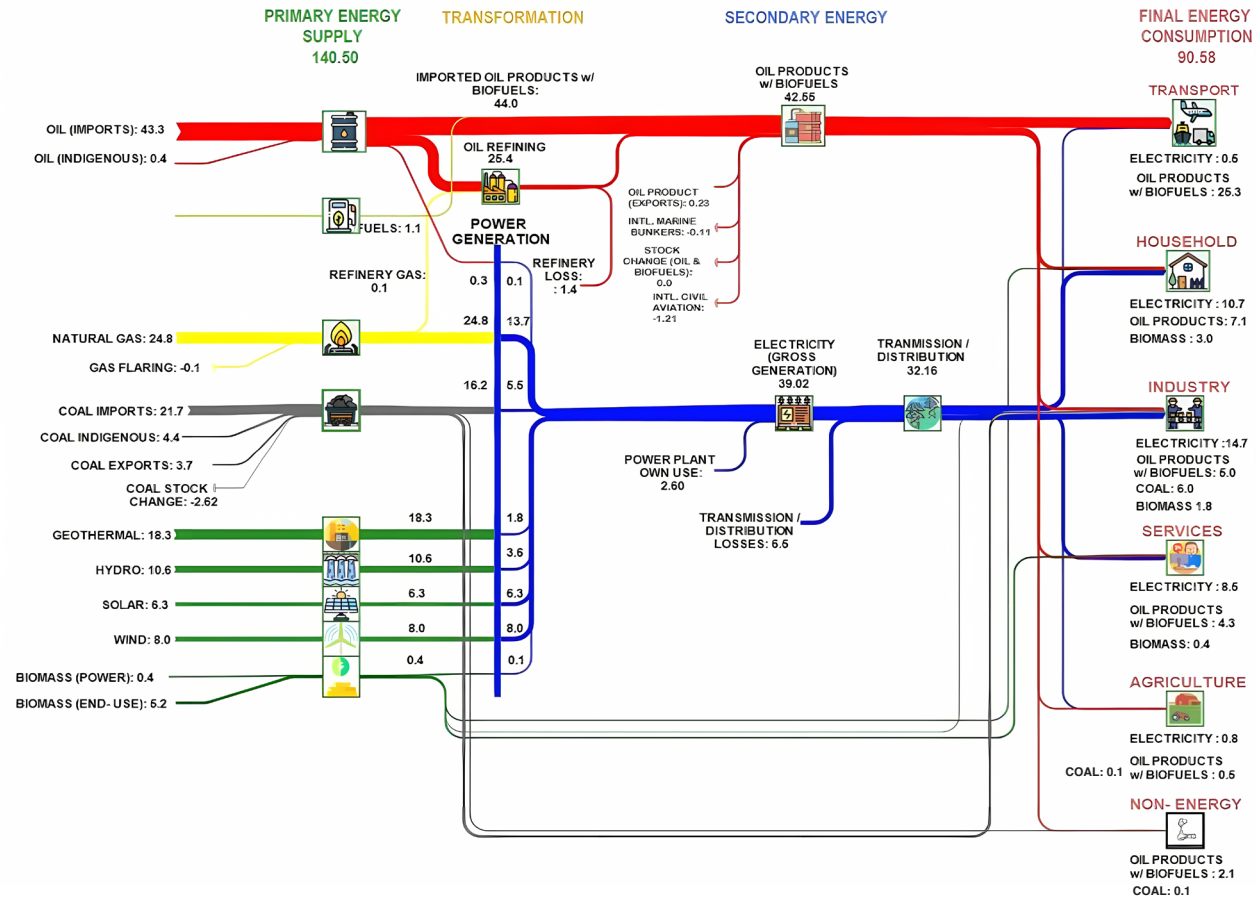


Figure 15. **Philippine Energy Flow 2050, Clean Energy Scenario 1 with 19 GW OSW**

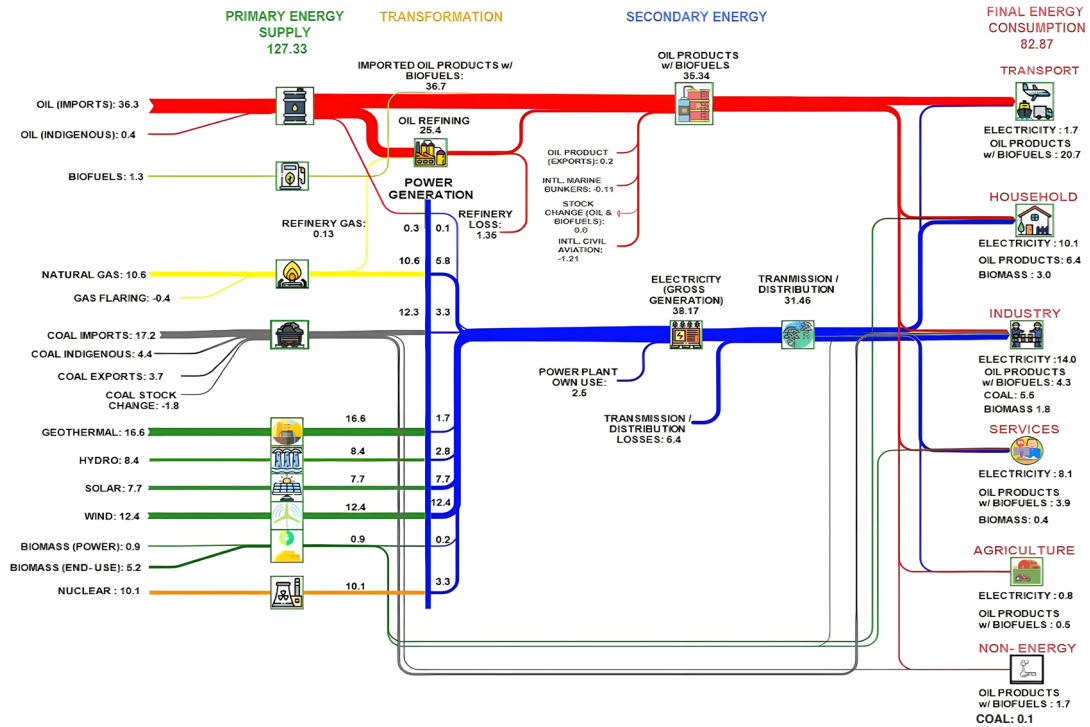
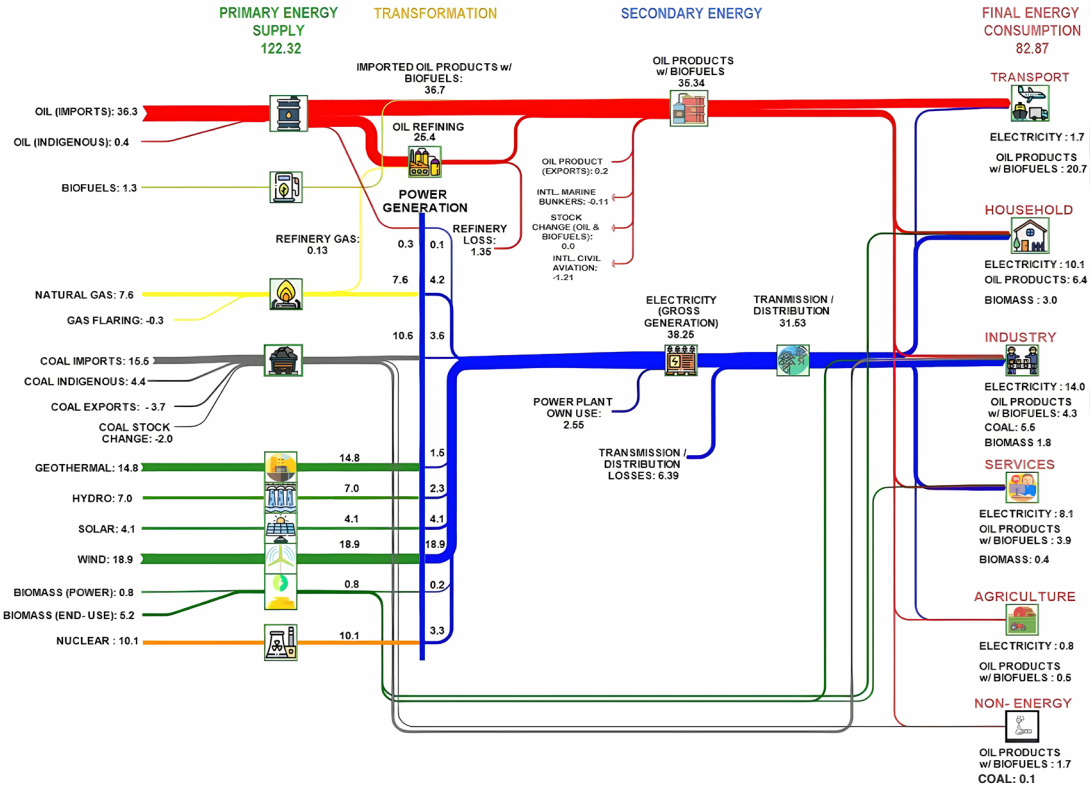


Figure 16. **Philippine Energy Flow 2050, Clean Energy Scenario 2 with 50 GW OSW**



II. CREATING WEALTH FOR THE FILIPINO

With increasing global demand for sustainable energy solutions, it is imperative to balance economic growth, energy productivity, and responsible environmental management. To achieve this, creation and efficient utilization of wealth must be intensified to respond to the requirements of a smooth energy transition with social and climate justice. Such improves the quality of life for the Filipinos towards the realization of having a robust economy and ensuring energy security.

Investment Requirements of the PEP

The PEP outlines the estimated sectoral energy investment requirements including the projected job generation for 2023–2050, encompassing various scenarios within the energy sector's planning framework. The scenarios comprise three trajectories: 1) the REF; 2) CES 1 underscoring high RE with low OSW utilization alongside nuclear; and 3) CES 2 with high RE and OSW utilization alongside nuclear.

Table 2. **Total Investment Requirement by Scenario, 2023-2050 (PhP Billion @2022 Prices)**

SECTOR	REF		CES 1		CES 2	
	2023-2028	2029-2050	2023-2028	2029-2050	2023-2028	2029-2050
Upstream	**624.85**	**2,169.33**	**625.53**	**2,161.91**	**625.68**	**2,162.88**
Oil and Gas	345.66	1,978.97	345.66	1,978.97	345.66	1,978.97
Coal	272.75	161.51	272.75	161.51	272.75	161.51
RE (Pre-Development)	6.45	28.86	7.13	21.44	7.28	22.41
Downstream	**395.10**	**7,779.33**	**1,849.71**	**11,420.42**	**1,849.71**	**11,420.42**
Oil Depot	50.75	47.88	42.35	42.35	42.35	38.70
Oil Import Terminal	-	25.01	-	-	-	-
LNG Terminal (FSRU)	-	11.14	-	-	-	-
Biodiesel	-	-	-	0.70	-	0.70
Bioethanol*	29.49	35.13	23.65	19.64	23.65	19.64
E-Vehicle	297.03	5,829.33	1,717.31	11,072.56	1,717.31	11,072.56
EV Charging Station	17.83	1,830.84	66.41	288.82	66.41	288.82
Power	**1,597.87**	**7,029.62**	**1,850.82**	**9,852.20**	**1,945.26**	**13,282.18**
Coal	350.55	-	334.38	-	334.38	-
Natural Gas	253.42	1,447.04	253.42	977.32	253.42	1,201.88
Oil-based	2.18	-	2.18	-	2.18	-
Other Technologies	-	-	-	1,738.60	-	1,738.60
Renewables	928.13	5,526.23	1,197.25	6,392.23	1,291.68	9,441.83
BESS	63.60	56.35	63.60	744.05	63.60	899.88
EEC Programs	**17.91**	**32.03**	**17.91**	**32.03**	**17.91**	**32.03**
Government	0.16	0.40	0.16	0.40	0.16	0.40
GEMP	0.07	0.08	0.07	0.08	0.07	0.08
PELP	0.05	0.03	0.05	0.03	0.05	0.03
VFELP	0.04	0.29	0.04	0.29	0.04	0.29
Private	17.74	31.63	17.74	31.63	17.74	31.63
DEs	9.08	16.22	9.08	16.22	9.08	16.22
ESCOs	8.54	15.26	8.54	15.26	8.54	15.26
PELP	0.11	0.07	0.11	0.07	0.11	0.07
VFELP	0.01	0.08	0.01	0.08	0.01	0.08
Total (PhP)	**2,635.74**	**17,010.31**	**4,343.97**	**23,466.56**	**4,438.56**	**26,897.51**
Total (USD)	**47.92**	**309.28**	**78.98**	**426.66**	**80.70**	**489.05**

*Note: * All bioethanol supply requirements are to be produced locally*
Conversion Rate used is PhP55/USD

To realize the required investments over the planning period, the government's role is to be facilitative as embodied in the policy support mechanisms. The DOE envisions private sector participation and the public-private partnership (PPP) mode to be in play. The projected financing requirements indicated in *Table 2* comprise the exploration and development of indigenous energy resources, the establishment of energy facilities necessary to ensure the continuous flow of energy supply (e.g., oil storage, LNG receiving terminals, biofuels production facilities, EVs and EVCS, and construction of additional power plants (excluding investment for transmission).

By 2050, the REF's total investment reaches PhP19,646.0 billion (USD357.2[18] billion), while the CES 1 is 41.6 percent higher than the REF at PhP27,810.5 billion (USD505.6 billion). On the other hand, the CES 2 requires a total investment of PhP31,336.1 billion (USD569.7 billion), 12.7 percent higher than the CES 1.

These investments are expected to generate more job opportunities for the Filipinos. Under the REF, about 79.9 percent of the employment generation is provided through the construction of RE-based power plants (1,152,533) followed by the EV installation with 8.1 percent (117,243 jobs). Similarly, the CES 1 and CES 2 offer more work for putting up RE-based power plants with 1,437,139 jobs and 1,688,331 jobs, about 66.1 percent and 67.5 percent of the total employment generation by 2050, respectively *(Table 3)*.

Following are the highlights of investment and employment opportunities per energy subsector over the planning period:

Table 3. **Job Generation, 2023-2050**

Sector	REF	CES 1	CES 2
Upstream	**49,411**	**65,709**	**115,173**
Oil and Gas	-	-	-
Coal	-	-	-
RE	**49,411**	**65,709**	**115,173**
Downstream	**144,351**	**451,300**	**451,300**
Oil Depot	18,474	15,181	15,181
Oil Import Terminal	1,312	-	-
LNG Terminal (FSRU)	907	-	-
Biodiesel	-	140	140
Bioethanol	6,415	4,298	4,298
E-Vehicle	117,243	431,681	431,681
Power	**1,245,622**	**1,654,561**	**1,930,896**
Coal	7,261	7,261	7,261
Natural Gas	62,578	45,727	53,930
Oil-based	56	56	56
Other Technologies	-	24,480	24,480
Renewables	1,152,533	1,437,139	1,688,331
BESS	23,194	139,898	156,838
EEC Programs	**2,615**	**2,615**	**2,615**
GEMP	921	921	921
PELP	343	343	343
VFELP	631	631	631
DEs	370	370	370
ESCOs	350	350	350
Total	**1,441,999**	**2,174,185**	**2,499,984**

Conventional Energy Fuels

Upstream Oil and Gas. The DOE is committed to boost the petroleum industry by organizing local and international roadshows under the Philippine Conventional Energy Contracting Program (PCECP) to promote exploration and development of oil and gas resources in the country.

With the promulgation of Presidential Decree (PD) No. 87, the oil and natural gas industry significantly contributed to economic growth through investments and employment of local experts and professionals for the operation, maintenance, and enhancement of upstream oil and gas infrastructures. Various incentives have been introduced to stimulate interest from potential developers and investors to intensify drilling activities aimed at expanding domestic reserves and increasing production of indigenous oil and gas in the country.

The ongoing awarding of Petroleum Service Contracts (PSCs) is expected not only to generate substantial investments for the country but also to create employment opportunities for Filipinos.[19] With additional production target outlined in the sector's roadmap, the projected investment by 2028 reaches PhP41.9 billion for oil and PhP303.7 billion for gas. These investments are anticipated to accumulate to PhP103.3 billion for oil and PhP1,875.7 billion for gas by the end of the planning period.

Upstream Coal. While there have been efforts to diversify the energy mix, coal still plays a substantial role in meeting the country's energy demand. Transitioning the coal sector requires reskilling and addressing the social impacts to communities hosting coal mining. Some industries, such as cement and steel production, rely on coal as a fuel source for their operations. As such, the continued development of the country's coal resource potential, estimated at 2,366.7 million metric tons (MMMT) as of 2022, will still be pursued.

By 2050, the projected investment requirement for coal exploration amounts to PhP5.6 billion, while the anticipated investment under the development and production phase is notably higher at PhP428.6 billion.

[18] Forex Rate used PhP55.0/USD
[19] Section 31 of PD No. 87

Downstream Industry

Natural Gas Industry. Mindful of the anticipated depletion of the Malampaya gas field by 2027, the government introduced the importation of LNG and facilitated the establishment and operation of LNG receiving facilities in the country. It is projected that an additional 3.98 million tons per annum (MTPA) of LNG facilities are needed in the REF to meet the projected natural gas supply requirements by 2050. This is on top of the ongoing LNG projects, which are targeted to be operational between 2023 to 2026. For CES 1 and CES 2, no additional LNG receiving terminals are needed as the ongoing LNG projects are enough to cover the natural gas requirements under the CES.

Should the construction of additional LNG facilities be needed, the investment requirement for an onshore LNG terminal is seen at PhP47.3 billion, while the Floating Storage and Regasification Unit (FSRU) requires a relatively lower investment at PhP11.1 billion. The construction of these new LNG facilities is expected to generate 907 jobs.

Downstream Oil Industry. The country's oil demand is projected to reach 442,649 thousand barrels (MB) under the REF and 384,491 MB in the CES by 2050, which includes jet fuel and a marine bunker for international passage. The increase in oil requirements in the planning period implies the necessity to establish additional facilities such as depots and import terminals to accommodate the demand growth.

The total depot capacity requirement under the REF is projected to increase significantly from 14,030 MB in 2028 to 27,268 MB in 2050. However, the CES has a lower capacity requirement of 11,708 MB and 22,408 MB in 2028 and 2050, respectively. This depot requirement corresponds to an estimated investment of PhP98.6 billion (REF) and PhP81.1 billion (CES) by 2050, generating additional 18,474 and 15,181 jobs, respectively.

On the other hand, the REF only requires additional oil import terminals as the existing total capacity is sufficient to accommodate the requirements of the CES. The REF needs an additional oil import terminal of 6,913 MB by 2049, bringing the total import terminal capacity to 344,281 MB. This entails an estimated investment of PhP25.0 billion by 2050 and creating additional 1,312 jobs for the Filipinos.

Biofuels

The biodiesel demand in the CES reaches 614.1 million liters (ML) in 2028 and is projected to escalate to 892.1 ML by 2050, doubling the demand projection in the REF, which stands at 260.8 ML and 422.7 ML, respectively. The growth in demand is attributed to the increase in biodiesel blend rate from 2.0 percent to 5.0 percent by 2026. On the other hand, the demand for bioethanol for both CES 1 and CES 2 reaches 759.7 ML in 2028 and 1,035.7 ML in 2050 reflecting a decrease of 9.7 percent and 22.5 percent, respectively, compared to the REF. The decline is due to increasing utilization of EVs.

To meet the biodiesel demand within the planning period, the country needs to put up an additional production capacity of 134.6 MLPY (both in CES 1 and 2), considering an 80.0 percent capacity utilization rate. This is in addition to the committed and proposed projects with a Notice to Proceed. By 2050, the production capacity of biodiesel increases to 1,15.1 MLPY.

On the assumption that all bioethanol supply requirements are to be fulfilled through local production, about 760.7 MLPY of additional production capacity is needed for both CES 1 and CES 2. However, if only 60.0 percent of the bioethanol supply requirement is produced locally, the additional production capacity decreases by 68.1 percent at 242.8 MLPY under the CES.

Expanding the production capacity of biofuels builds new investment prospects and livelihood opportunities within communities. To meet the capacity addition for biodiesel, an estimated total investment of PhP0.7 billion is required under CES by 2050. On the other hand, bioethanol production under REF demands a total investment of PhP64.6 billion by 2050, while the investment for CES is 33.0 percent lower at PhP43.3 billion. These new investments create employment opportunities for Filipinos thereby benefitting 140 workers for biodiesel and 4,298 workers for bioethanol by 2050 under the CES.

Renewable Energy

Providing access to financing and investment for RE projects enables the country's diversification to cleaner and more sustainable energy, as well as drives economic growth and job creation.

By 2050, the demand for additional power-generating capacities from RE technologies stands at 98.5 GW (REF), 106.6 GW (CES 1), and 106.9 GW (CES 2). The CES' capacity requirement is 8.0 percent higher than the REF. This results in further increasing deployment and expanding RE share in the power generation mix for sustainable energy options within the planning horizon.

The pre-development of these additional RE capacities involves substantial investments. Under the REF, the projected investment is PhP6.4 billion for 2028 and PhP28.9 billion by 2050. On the other hand, CES 1 necessitates an investment of PhP7.1 billion by 2028 and PhP21.4 billion by 2050. The increase is due to the introduction of the 19 GW OSW. Similarly, the CES 2 needs higher investment with 50 GW OSW, which amounts to PhP7.3 billion by 2028 and PhP22.4 billion by 2050.

These investments generate potential employment opportunities of 49,411 jobs in the REF, while the CES 1 and CES 2 foresee 65,709 and 115,173 job prospects, respectively. These employment opportunities signify a positive impact on the labor market, highlighting the socio-economic benefits linked with advancing RE development.

Power Development

The reliability and sustainability of electricity supply continue to stand as crucial pillars for the economy's growth. Implementing and operationalizing large-scale power infrastructure projects became indispensable for sustaining and propelling economic development. As the government anticipates a more robust and resilient power system, these initiatives play a pivotal role in ensuring a dependable and enduring foundation for progress.

In the planning horizon, expanding the power generation capacity stands as a crucial strategy to uphold the security and sustainability of the country's energy supply. By the end of President Marcos Jr. Administration in 2028, projections indicate total capacity additions of 18,528 MW (REF), 18,195 MW (CES 1), and 19,656 MW (CES 2), respectively. These expansions require significant capital investments amounting to PhP1,597.9 billion under REF, PhP1,850.8 billion for the CES 1, and PhP1,945.3 billion in the CES 2.

Within 2029-2050, the REF anticipates capacity additions totaling 104,180 MW equivalent to an investment of PhP7,029.6 billion. As the nation advances with the accelerated adoption of RE resources, the CES 1 requires a capacity addition of 111,486 MW needing an investment of PhP9,852.2 billion. Similarly, the CES 2 envisions capacity additions reaching 113,277 MW corresponding to an investment of PhP13,282.2 billion.

The anticipated capacity additions are expected to bring employment opportunities for Filipinos. Among the three scenarios, CES 2 will create the highest number of jobs with 1,930,896 work opportunities, followed by the CES 1 with 1,654,561 jobs and the REF with 1,245,622 jobs.

Alternative Fuels and Technologies

The enactment of RA 11697 or the Electric Vehicle Industry Development Act (EVIDA) of 2022 on 15 April 2022 sets the cornerstone for the government's policy framework to drive the advancement of the EV industry in the country. The formulation of CREVI offers essential strategies to effectively balance industry growth and market expansion.

By 2050, the CREVI sets a minimum of 10.0 percent EV share of the vehicle fleet for all sectors (except trucks) under the REF, while its aggressive target of re-fleeting 50.0 percent of all vehicle fleets is espoused under the CES 1 and CES 2.

These targets represent investments that will not only drive economic growth but also generate a variety of job opportunities for local skilled workers. Under the REF, the total investment in 2028 reaches PhP 314.9 billion comprising PhP 297.0 billion from EVs and PhP 17.8 billion from EVCS. On the other hand, the projected investment of PhP 1,783.7 billion in the CES is 466.5 percent higher than the REF during the same period. This is comprised of PhP 1,717.3 billion for EVs and PhP 66.4 billion for EVCS.

From 2029 to 2050, total investment further increases to PhP 7,660.2 billion in the REF (PhP 5,829.3 billion for EVs and PhP 1,830.8 billion for EVCS and PhP 11,362.4 billion in the CES (PhP 11,072.6 billion for EVs and PhP 288.8 billion for EVCS). These investments are expected to create employment with 117,243 under the REF and 431,681 jobs under the CES.

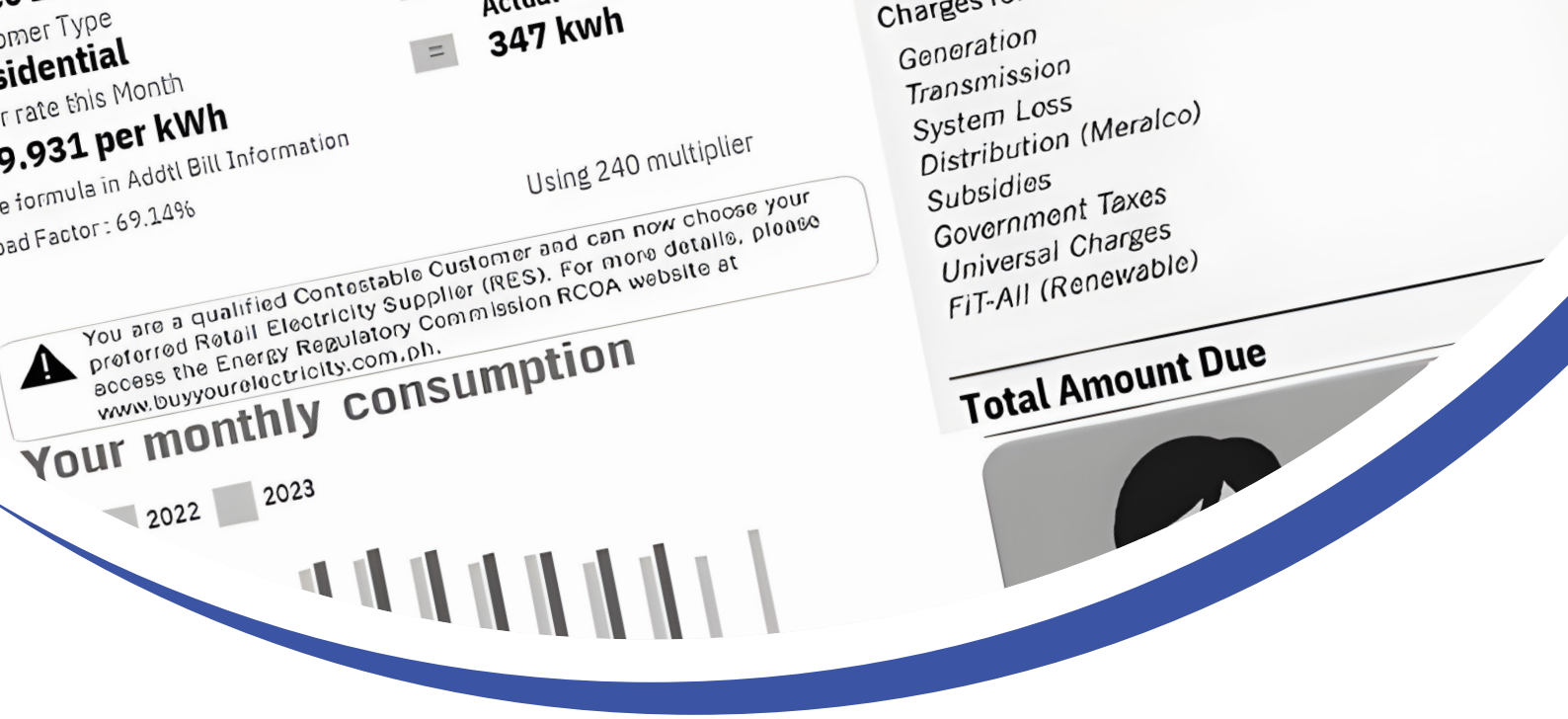
Energy Efficiency and Conservation Programs

Encouraging energy efficiency practices, promoting behavioral change, and facilitating collaboration among the government, industry, and civil society are crucial steps in advancing the country's journey toward a more resilient, inclusive, and environmentally sustainable energy future.

The DOE, working in conjunction with international partners and stakeholders, has initiated a range of programs aimed at promoting EEC across diverse sectors. Within the framework of the Government Energy Management Program (GEMP), the government has allocated PhP0.15 billion for demonstration projects focused on promoting solar PV technology for offices, EVCS demonstrations, and the facilitation of third-party energy audits for government entity buildings.

A total of PhP0.26 billion investment may also be generated from the implementation of the Philippine Energy Labelling Program (PELP) by both the government and private sectors, including the procurement of PELP System Development for the government sector, as well as the revenues from the label issuances and infrastructure development. Further, the development and annual maintenance of the web-based Application and Online Database System for Vehicles Fuel Economy Labelling Program (VFELP) could also provide a potential investment of PhP0.43 billion, including the revenues from application for company registration, transport vehicle registration, and fuel economy labeling issuance for vehicle manufacturers, importers, distributors, dealers, and rebuilders.

Further, it is estimated that a total investment of PhP25.3 billion from Designated Establishments (DEs) within the planning horizon could yield approximately 370 green jobs for the country. Additionally, an investment worth PhP23.8 billion from Energy Service Companies (ESCOs) is anticipated, generating 350 job opportunities for the country.



III. TRANSITION FINANCE

As the country implements a sustainable energy future in line with the SDGs, another critical issue is climate change and the need for an efficient, effective, and sustainable financial system. Corollary to this, it generates significant investments, jobs, growth, and facilitates the restoration of the ecosystem.

International organizations have stressed the importance of sustainable finance as a strategic approach that integrates environmental, social, and governance factors into investment decisions within the financial sector. This entails promoting climate mitigation strategies and mobilizing private finance for clean and resilient growth.

The **World Bank's Philippines Economic Update (PEU)** in June 2023 acknowledged that elevating the ambition of the Philippines' decarbonization endeavors and maximizing additional local and global environmental benefits necessitates corresponding international assistance and cost-sharing arrangements.[20] Some specific areas identified for further assessment of decarbonization policies and actions are:

- Assessing the impact of energy transition on resilience, including a deeper understanding of the geospatial nature of climate risks and their effects on expanding power system planning, along with implementing appropriate risk-mitigation measures;
- Understanding the necessary financing requirements for an energy transition and effectively allocating risks between the private and public sectors;
- Utilizing analytics to enhance the planning and execution of RE and EEC initiatives;
- Assessing the impact of accelerated electrification of the transport sector, considering the increased penetration of EVs in the Philippines;
- Evaluating carbon pricing as a supportive instrument for facilitating the energy transition; and
- Analyzing the socioeconomic impact of phasing down CFPPs in the Philippines.

Based on the **IEA World Energy Investment 2023 Report**, the world must invest about USD 1.7 trillion in clean energy initiatives, including key investments in RE, nuclear, energy grids, energy storage, low-emission fuels, and efficiency improvements, among others. The IEA's investment projection is crafted within a scenario aimed at propelling the world towards achieving net-zero emissions by 2050, thereby aligning with the transition to sustainable energy. Similarly, according to the **International Renewable Energy Agency (IRENA) World Energy Transition Outlook**, the world needs to invest around USD 131.0 trillion in RE by 2050 to achieve a net-zero emission future.

[20] *Source: The World Bank Philippines Economic Update: Securing a Clean Energy Future -June 2023*

Clean Energy Finance Initiatives in the Philippines

In the Philippines, several initiatives have been implemented to promote and facilitate clean energy finance. These initiatives aim to attract investment in clean energy projects and support the transition towards a more sustainable energy system. As highlighted in the 2023 **Climatescope Report** by Bloomberg New Energy Finance, the country ranks fourth among the most attractive emerging markets for RE. This underscores the effectiveness of the Philippines' robust clean energy programs and initiatives. Some of the key clean energy finance initiatives in the country include:

- The issuance of BSP Circular No. 1185 series of 2023 on 13 December 2023 amended the regulation on credit exposure limits to a single borrower and rates of required reserves. To support the scaling up of sustainable finance, the policy stipulated the following: a) grant of additional single borrower's limit (SBL) of 15.0 percent of net worth of loans, credit accommodation, and guarantees for the purpose of financing eligible green or sustainable projects including transitional activities to decarbonization; and b) gradual reduction of the reserve requirements (RR) rate to zero percent against new and outstanding sustainable bonds issued by banks.

- In April 2020, the Bangko Sentral ng Pilipinas (BSP) introduced the **Sustainable Finance Framework** aimed at minimizing risks faced by financial institutions. The framework is envisioned to be integrated by financial institutions into their sustainability principles and embedded in the corporate governance framework, risk management system, and strategic objectives. Successively, the *Philippine Sustainable Finance Roadmap* was launched in 2021 delineating and facilitating holistic strategies for sustainable finance.

- In support of the commitments outlined in the roadmap, the BSP through the Financial Sector Forum (FSF) issued the **Philippine Sustainable Finance Taxonomy Guidelines (SFTG)** through the BSP Circular 1187 series of 2024 issued on 21 February 2024, which serves as a tool for determining whether an economic activity is environmentally and socially sustainable, as well as guides stakeholders in their investment and financing decisions.

  Underlying the SFTG are several key principles, such as adopting a phased approach designed for inclusivity and related to key government policies and regional frameworks. Such primarily implies responsiveness to changes and periodic review. A phased approach allows for effective, iterative, cooperative, and user-focused development. It is inclusive in the sense that it offers direction to the financial sector and other potential users with respect to categorizing sustainable finance and investment activities. Moreover, inclusivity means that the taxonomy can be continuously tested, adjusted, and improved to better fit the demand of users.

- The **Securities and Exchange Commission (SEC)** issued corresponding guidelines to promote good governance and support the deepening of the capital market through sustainable investment products. The other SEC initiatives related to sustainable finance are its involvement in the ASEAN Capital Markets Forum (ACMF) and ASEAN Taxonomy Board.

- The **Philippine Guarantee Corporation (PHILGUARANTEE)**, as part of its mandate, provides credit guarantees for finances to support trade and investment, infrastructure, agricultural modernization, and energy, among others.

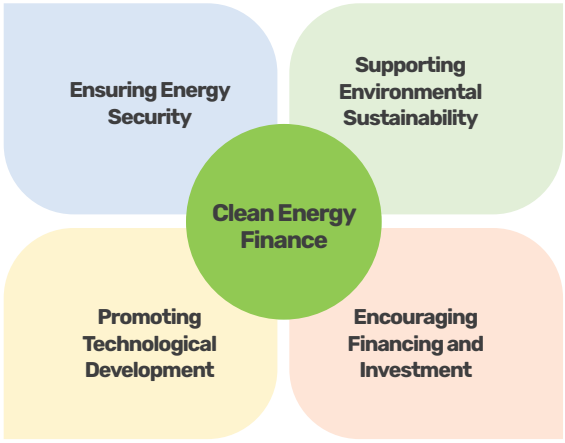
- The **OECD's Clean Energy Finance and Investment Mobilisation (CEFIM) Programme** established the Clean Energy Finance and Investment (CEFI) Roadmap specifically designed for the Philippines. This initiative seeks to unite governmental and private sector stakeholders in crafting a definitive action plan. The roadmap's primary focus is to identify and resolve financial and investment-related challenges within the country's clean energy sector, specifically targeting ***OSW*** and ***EEC in the public building sector***. These sectors have been identified as pivotal areas for mobilizing the financial system, aiding the government's transition towards a low-carbon economy. Establishing a robust policy framework and an attractive investment environment become imperative in mobilizing domestic and foreign capital, essential for meeting the country's clean energy ambitions.

To catalyze the growth of OSW and EEC and unlock investments capable of significantly uplifting local communities and the Philippine economy, the establishment of a **Clean Energy Finance Framework** is necessary. This framework is essential in aiding the government's ambition to provide a cleaner and more sustainable energy supply for the country. Illustrated in *Figure 17* is the framework's four (4) cornerstones:

i. Achieving energy security,
ii. Supporting environmental sustainability,
iii. Encouraging technological development, and
iv. Providing access to financing and investments

It aims to stimulate private investment by establishing funding channels and support programs, utilizing effective local and global connections.

Figure 17. **Clean Energy Finance Framework**



Ensuring Energy Security. As part of its commitment to ensuring energy security, the government recognizes the significant contributions of RE and EEC. Through strengthening these sectors, the government seeks to overcome the obstacles impeding the energy transition.

Supporting Environmental Sustainability makes it feasible to channel financial resources and investments toward achieving clean energy and sustainable finance goals. These initiatives will help reduce carbon footprints and achieve the targeted RE contribution to the generation mix.

Promoting Technological Development is a key in driving innovation and optimizing the application of efficient technologies. Achieving this necessitates collaboration with both domestic and international institutions, as well as sustained efforts in research and development (R&D).

Encouraging Financing and Investment from both the government and private sectors involves expanding access to capital to swiftly mobilize the necessary financial resources. This expedites project development and concurrently fosters potential employment prospects for Filipinos. One effective strategy involves benchmarking foreign investors' programs and considering the implementation of ordinances or circulars to incentivize local bank engagement in domestic initiatives.

Private Sector Initiative on Energy Transition Finance

As the government continues to utilize policy and finance to realize energy transition, the private sector sees this as guidance for adopting a proactive and adaptable strategy to achieve sustainability and facilitate transition efforts.

A case in point is the **ACEN** pioneering initiative in the early retirement of fossil-fuel plants specifically CFPPs and diesel-based plants. The company has successfully implemented an energy transition mechanism, which facilitated the divestment and early retirement of its 246-MW CFPP in Batangas. This combines public and private investments with the intent of retiring CFPPs earlier than scheduled. The mechanism was underpinned by debt and equity investors – *local private banks covering the debt with equity coming from the Government Service Insurance System (GSIS) and private companies*.

[4] *Due to replacement of gasoline by bioethanol. Gasoline has a higher calorific value than bioethanol.*

The Asian Development Bank (ADB) is also implementing its own ETM for the Mindanao Coal-fired Power Plant, which operates under a build-operate-transfer (BOT) arrangement. The ETM will finance the plant's retirement as early as 2026, five years before the BOT agreement ends.

Alternative mechanisms such as transition credits are being explored to facilitate the early retirement of coal and gradually replace it with renewables. This involves ensuring the affordability of substitute energy and facilitating fair transitions for the affected workers and local community.

Moreover, there is increasing awareness and interest from power industry stakeholders in **Carbon Markets** and **Carbon Credits**. A ***carbon market*** primarily operates as a trading system where carbon credits are bought and sold. This market can be used by companies and individuals to offset their GHG emissions by purchasing carbon credits from entities that remove or reduce GHG emissions.[21]

On the other hand, a ***carbon credit*** is generated by a project that has avoided or removed GHG emissions. Typically, a credit represents one (1) ton of carbon dioxide or its equivalent in the atmosphere. These projects often depend on the sale of carbon credits to sustain operations and undergo independent audits to verify the amount of carbon emissions avoided or reduced. Carbon credits also play a crucial role in facilitating finance for decarbonization projects, thus contributing significantly to the achievement of global climate goals.[22]

Energy Resiliency Financing

Improving the resilience of energy infrastructure and facilities necessitates a strategic commitment to investing in adaptation and mitigation strategies. By utilizing diverse funding mechanisms like Public-Private Partnerships (PPPs) and innovative financing platforms, energy stakeholders and development partners can pool resources to build a robust and resilient energy sector.

To facilitate investments in energy resiliency, the DOE is strengthening partnerships with other government agencies, development partners, and international funding institutions to explore viable international climate finance options. This entails accessing and leveraging resources from entities such as the Green Climate Fund (GCF), Global Environment Facility (GEF), Adaptation Fund (AF), Climate Technology Center and Network (CTCN), and the Loss and Damage Fund (LDF), among others. Such collaboration holds the potential to secure crucial funding streams that will greatly bolster efforts in fortifying the resilience of the energy sector against climate-related challenges.

Another crucial innovative approach to mitigate the financial impacts of various hazards is the **Disaster Risk Financing and Insurance (DRFI)**. The DRFI does not only protect energy infrastructure and systems from potential disruptions but also mitigates the impact on consumer rates. The DOE is poised to establish mechanisms and guidelines to further improve DRFI practices within the energy sector. These will guarantee accessible funding sources essential for fostering resilience, including safeguards to prevent any potential misuse or abuse of such financial resources.

[21] *Source: https://climatepromise.undp.org/news-and-stories/what-are-carbon-markets-and-why-are-they-important*
[22] *Source: https://www.climateimpact.com/services-projects/carbon-credits-explained-what-they-are-and-how-they-work/*

IV. CONSUMER EMPOWERMENT

Consumers form part of the energy system's entirety since utilization is determined and driven by the end-users. The DOE acknowledges that a ***"well-informed consumer is the best-protected consumer"*** because his or her decisions are made based on the value of information that enables empowerment and protection.

As energy transition is visualized in the country's planning horizon, important consumer decisions are made depending on the various energy options presented. These informed choices reinforce the envisioned meaningful and gradual shift to sustainable and reliable use of energy resources in meeting the required demand.

The DOE, in its formulation of policies, plans, and programs toward a low-carbon and sustainable future, always prioritizes the well-being of consumers. This affirms President Marcos Jr. Administration's goal of a better quality of life for Filipinos and that no one is left behind.

As consumers increasingly become a fundamental part of how energy policies are shaped, it is forward-looking for the government to continuously advance its role in the energy landscape. The twofold strategy to be undertaken in the mid- to long-term to bring more value to consumers are: a) clearly distinguish the areas in the country without access to affordable energy and needing developmental supports, and b) rationalize subsidies for electrification that continuously impact the general consumers as part of their electricity bill. Attending to these within the planning horizon creates a facilitative environment wherein consumers will be more attuned to their energy needs and choices.

> ***As we pursue the path of sustainable development, it is important that we develop a keen awareness of our energy consumption. With everyone's help, we can build more sustainable and reliant future for us and for the generations that will follow..***
>
> *- President Ferdinand R. Marcos Jr.*

Energy Efficiency and Conservation

The implementation of the EEC programs directly affects every Filipino as a consumer. Before the passage of RA 11285 or the *Energy Efficiency and Conservation Act of 2019*, the DOE has been steadily promoting the efficient use of energy to instill in the behavior of Filipinos and to contribute to the lowering and softening of the impact of electricity costs.

Philippine Energy Labeling Program (PELP). The guidelines for all energy-consuming product (ECP) manufacturers, importers, distributors, and dealers were issued pursuant to DC2020-06-0015. The enhanced program made it easier for consumers to compare the efficiency of ECPs through the energy labels, which contain information on the energy efficiency rating (including a star rating), estimated monthly energy consumption, and an embedded quick response (QR) code for the end user's reference.

Stakeholder Engagements. Mindful of both the public and private sectors' role in accelerating and sustaining EEC as a way of life, the IEC campaigns on EEC policies, programs, and best practices intensified the promotion and launching of *"You Have the Power."* The campaign is the DOE's response to the President's call to strengthen EEC efforts to help manage the growing energy demands of the country. It basically encourages Filipinos to have an energy-efficient lifestyle and instills the shared responsibility principle for the environment. The program also includes active engagement of the DOE in the various social media platforms to send and communicate the message of EEC's importance.

Renewable Energy Sector

Since the enactment of the Renewable Energy Act of 2008, the government advocated for the aggressive development of the country's RE resources. Following the strategic objective of transitioning to clean, sustainable, and climate-centered energy resources, the DOE issued policy mechanisms with consideration of the welfare of consumers and the future generations to come.

The **Renewable Portfolio Standards (RPS)** mandates power distribution utilities, generation companies with directly connected customers, and retail electricity suppliers to source an agreed portion of their energy supply from RPS-eligible facilities, which include biomass, solar, run-of-river and impounding hydroelectric power systems, ocean, and wind, among others. The policy effectively mobilizes the entire energy sector towards the country's elusive attainment for energy independence.

In support of this policy, two Department Circulars (DCs) were issued – DC2022-09-0030, which increased the minimum RPS annual percentage increment from 1.0 to 2.52 percent for grid-connected areas beginning 2023, and DC2023-05-0014 that promulgated the revised rules and guidelines governing the operationalization of the RPS for off-grid areas pursuant to Section 12 of the RE Act.

On the other hand, under the **Net-Metering Program (NMP)**, residential or house owners and commercial establishments are allowed to install solar photovoltaic (PV) panels of up to 100 kilowatts (kW) RE for own-use and sell unused electricity generated to the grid. In 2022, the "Guidebook on Net Metering" was published providing the guidelines, standards, and procedures for all net-metering arrangements from offer to after-sales services by installers and practitioners.

The **Green Energy Option Program (GEOP)** is another policy wherein consumers with 100 kW and above demand can also obtain electricity supply from RE suppliers. In September 2023, a total of 263 customers have already switched to GEOP, which translates to 87 MW (non-coincidental peak demand).

Power Sector

The DOE is focusing its efforts to support the Administration's socio-economic agenda that includes *reducing energy cost to families and ensuring energy security for the country.*

Lifeline Rate Implementation. As one of the measures to soften the burden of electricity prices to consumers particularly Filipino households, the government is mindful in maximizing the impact of the lifeline rate availment through the following: a) designing a better subsidy targeting scheme to reach the poorest of the poor; and b) improving the identification of beneficiaries which need it the most.

Over the course of the Marcos Jr. Administration, the government is committed to refining the policy approach in delivering the subsidy to the targeted beneficiaries and entitled consumers in the disadvantaged or marginalized sectors.

The passage of RA 11552[23] on 27 May 2021 further extends the lifeline rate implementation until 2051 and is seen to benefit qualified lifeline customers in the next three decades. As a mechanism designed to benefit low-income consumers, *the lifeline rate is a subsidized rate given to the said consumers who are unable to pay their electricity bills at full cost.* Qualifying for the program entails end-users to meet the criteria set in the law which are: a) beneficiaries of the Pantawid *Pamilyang Pilipino Program (4Ps)*;[24] and, b) customers considered to be living below the poverty threshold set by the Philippine Statistics Authority (PSA).

A Tripartite Advisory from the ERC, DOE, and the Department of Social Welfare and Development (DSWD) was issued on 13 June 2023 in reference to the implementation of RA 11552's Implementing Rules and Regulations (IRR) and with the release of lists of 4Ps beneficiaries to the DUs. The advisory reminded the DUs to: a) immediately implement the disqualification of those who are not eligible to avail of the lifeline rate as provided under Rule 6, Section 6 of the Lifeline IRR; and b) commence the acceptance and processing of applications from their consumers seeking to avail the lifeline rate program, as well as complete the processing of the applications on or before 1 August 2023. It also stated that starting August 2023, only those who have approved applications shall be entitled to avail of the lifeline rate program. It also revised the Certification and Application Form templates.

To beef up program registration, the DOE through a press release on 21 July 2023[25] and 31 July 2023[26] reiterated to qualified beneficiaries nationwide under the 4Ps list by the DSWD to register with their DUs to continue availing of the discount for lifeline consumers.

The reduction in electricity bills of lifeline rate beneficiaries varies depending on the prevailing rates of DUs or ECs in the country. The discount extended also differs based on the monthly consumption threshold level. In the case of consumers under the MERALCO franchise area, lifeline end-users with up to 20 kilowatt-hours (kWh) of monthly consumption are granted 100 percent discount on the generation charges including systems loss, transmission, and distribution components of the bill except for the fixed metering charge of PhP 5.00. Given these, the lifeline end-users will only shell out more or less PhP 20.00 in their electricity bills. It is important for qualified customers to avail lifeline rate through MERALCO as non-registration means that these customers are likely to pay more or less PhP 250.00 (within the 20-kWh threshold).

To further encourage beneficiaries to register, another tripartite advisory was issued on 1 August 2023, which moved the full implementation of the lifeline from August to September 2023.[27] A noticeable increase in the qualified marginalized end-users (QMEs) have registered under the program. However, there remained a substantial number of QMEs who have yet availed the benefits under the lifeline rate program. In response, a Tripartite Advisory was issued again on 1 September 2023 stating the full implementation of the lifeline rate program by 1 January 2024 to allow for an aggressive promotion and registration. Moreover, it specified that those with approved applications shall only be entitled to avail of the subsidy under the Lifeline Rate Program.[28]

As of 15 December 2023, the number of registered consumers already reached 191,399 out of the 4.2 million 4Ps beneficiaries.

[23] *RA 11552 or "An Act Extending and Enhancing the Implementation of the Lifeline Rate, amending for the Purpose Section 73 of RA 9136, otherwise known as the Electric Power Industry Reform Act of 2001, as Amended by RA 10150."*
[24] *RA 11310 or "An Act Institutionalizing the Pantawid Pamilyang Pilipino Program (4Ps)" signed by then President Rodrigo R. Duterte on 27 May 2021.*
[25] *Source: https://www.doe.gov.ph/press-releases/department-energy-doe-reminds-all-electricity-consumers-nationwide-who-are-list*
[26] *Source: https://www.doe.gov.ph/press-releases/doe-urges-4ps-beneficiaries-avail-government-electricity-lifeline-program*
[27] *Source: https://www.doe.gov.ph/announcements/tripartite-advisory-full-implementation-lifeline-irr-01-august-2023*
[28] *Source: https://www.doe.gov.ph/announcements/tripartite-advisory-lifeline-irr*

Graduation and rationalization of the Universal Charge for Missionary Electrification (UC-ME) subsidy. The existing UC-ME subsidy policy adopts a uniform pricing, providing the same level of subsidy to all consumer types in off-grid areas. However, this universal levy places a financial strain even on poor households within the main grid as they also contribute to subsidizing off-grid consumers. To alleviate this financial burden on consumers, the government is undertaking efforts to graduate from and rationalize the UC-ME subsidy.

Graduating from the UC-ME subsidy will involve interconnecting major island grids to the main grid, while rationalization necessitates the establishment of a new, well-targeted, and efficient subsidy policy through customer classification in missionary areas. Rationalization emphasizes the need for efficient targeting of poor and eligible electricity consumers, as well as a thorough assessment of the potential removal of automatic subsidies for commercial and industrial customers in off-grid areas. This approach aims to promote fairness and social equity by ensuring that the subsidy serves its intended purpose without disproportionately affecting certain demographics or hindering economic development.

Competitive Selection Process Policy. The CSP policy institutes the least-cost principle in the power supply contracting of the DUs/ECs. Enhancements in the policy led to the issuance of the DC2023-06-0021[29] and DC2022-06-0027[30] in June 2023 and June 2022, respectively. The former further streamlined the CSP procedure by defining the individual roles and responsibilities of the DOE, ERC, and NEA in the review of and approval of the DUs power supply aggrement (PSA) applications. The latter contained the guidelines for the accreditation of a Third-Party Auctioneer (TPA).

Energy Regulations 1-94. The ER 1-94 is a profit-sharing mechanism for the benefit of host communities to support their electrification, development and livelihood programs, reforestation, watershed management, health and environmental enhancement projects. It allocates one centavo per kWh sale to the local government units (LGUs), DUs, and indigenous cultural communities/indigenous people (ICCs/IPs).

The DOE, knowing the full benefits to be derived from ER 1-94, is closely working with all stakeholders including the host communities and ICCs/IPs to maximize the utilization of their equitable share or resources to assist in their identified and emerging needs.

Regulatory Initiatives for Consumers. Given the importance of power supply contracting and its impact on the rates passed on to consumers, the ERC initiated consumer-centered efforts, such as the PSA Caravan, Anti-Bill Shock Program, and suspension of feed-in tariff allowance (FIT-ALL) collection.

- *PSA Caravan* - A joint effort between the ERC and DOE that aimed to assist the DUs in rationalizing and optimizing their power supply. The objective is to ensure that power supply contracts entered by the DUs are adherent to the least-cost principle as this will eventually benefit and provide relief to consumers. The caravan also involved reviewing the PSAs of the DUs. The next step is rolling it out to cover off-grid areas and to assist the ECs.

- *Suspension of FIT-All Collection* - The initial implementation on the deferment of the FIT-All collection covered a period of three months (December 2022 – February 2023). The ERC extended it for another six (6) months covering March to August 2023. Relatedly, in the ERC's Resolution in August 2023, the suspension was extended starting September 2023 until otherwise lifted by the Commission in the event that the FIT-All Fund available shall be deemed insufficient to cover the monthly fund requirements.

- *Anti-Bill Shock Loan Program* - In April 2023, the ERC and Land Bank of the Philippines (LBP) launched the program to protect consumers from unforeseen increases in their electricity bills. The program implementation is undertaken by the DUs wherein staggered billing is applied, which provides flexibility to consumers in instances of electricity price hikes. This will effectively manage obligations and lessen the impact of bill shocks. The loan facility is deemed to be used by the DUs to fulfill their contractual obligations with power generation companies and suppliers.

[29] *"Prescribing the Policy for the Mandatory Conduct of the Competitive Selection Process by the Distribution Utilities for the Procurement of Power Supply for their Captive Market" issued on 30 June 2023*
[30] *"Providing the Guidelines for the Accreditation of Third-Party Auctioneer Pursuant to Section 5 of Department Circular No. DC2021-09-0030" issued on 20 June 2022*

Downstream Oil Industry

As an oil-importing country, the fluctuations in oil prices on the global market impact consumers. Petroleum products are fundamental commodities that are heavily utilized in both residential/households and transportation sectors. The DOE, as part of its mandate, ensures continuous supply and unimpeded access to petroleum products with the utmost consideration to public safety and product quality.

The development of the Philippine National Standards (PNS) for petroleum products and facilities are guarantees of promoting consumer welfare and protection. These standards ensure that consumers, the public transport sector, and manufacturers served by the downstream oil sector are provided access to products and facilities with the highest quality and safety. Likewise, the PNS guarantees the Philippines' compliance to global harmonization and maintains adherence to international trends on economic growth, as well as environmental protection. The DOE, apart from standards formulation, also monitors the industry through sampling of liquid petroleum products in terminals/depots and other facilities nationwide.

Following the passage of RA 11592 or the *LPG Industry Regulation Act of 2021*, the DOE strictly monitors the domestic LPG industry and safeguards consumers against malpractices. In 2022, the DOE together with the Department of Trade and Industry (DTI) issued Joint Department Circular (JDC) 2022-11-0002 on the LPG Cylinder Exchange, Swapping, and Improvement Programs. The Circular aims to ensure that only safe cylinders are circulated among the consuming public to prevent the occurrence of LPG-related accidents.

To further empower consumers, the DOE's communication initiatives employed through the IEC campaign intend to improve public awareness, address knowledge gaps, and change consumer behaviors in the downstream oil industry.

V. PROMOTING THE NATIONAL INTEREST WITH THE INTERNATIONAL COMMUNITY

The Philippines aligns its targets with the goals of the international community in veering away from conventional fuels and moving towards renewables and other sustainable energy solutions. While fossil fuels still play a significant role in most countries, including the Philippines, due to economic, political, and social factors, the country aims to achieve a low-carbon economy. Hence, it complements its fossil fuel-based energy resources with cleaner alternatives to reduce carbon emissions across all sectors in its nationally driven energy transition. To enable this, substantial resources are required to implement transformative and inclusive solutions for an affordable, reliable, secure, resilient, climate-centered, and sustainable energy industry. To mitigate the burden of transferring the cost of transition to the Filipino people, the country recalibrated policies and programs to attract foreign and local investors.

The Philippines engages in international partnerships and agreements to support its transition strategy and core energy diplomacy. Priority areas include mobilizing transition financing, accessing technology and capacity for improving transmission and distribution networks, enhancing energy system resilience and infrastructure, prioritizing RE projects, implementing EEC measures, promoting the critical minerals mining for low-carbon technologies, and pursuing R&D for emerging technologies.

The DOE's initiatives are also aligned with regional and international work plans, including those in ASEAN. These plans guide the implementation of various activities in collaboration with the regional and international community.

Further, the country's linkage with the international community features how the DOE addresses emerging issues and cross-sectoral concerns related to energy security, transition, and resilience at the regional and international levels. It also highlights the development partners (DPs) and international organizations (IOs) providing or offering financial and technical assistance for energy projects, further supporting the Philippines' energy initiatives. Through the years, the DOE has received support from these DPs and IOs that are geared towards the global movement on energy transition. The DOE remains optimistic in strengthening the linkages to pave the way for a cleaner, more resilient, and sustainable energy system in the country. More importantly, the DOE directs its policies to respond to the needs of the international community under the principle of mutual benefit.

VI. FOSTERING PARTNERSHIP WITH BARMM

Sustaining Peace, Security and Development for Bangsamoro Autonomous Region of Muslim Mindanao (BARMM)

The National Government is firm on its commitment to working closely with the Bangsamoro Government to facilitate the comprehensive development of the region, benefiting both the Bangsamoro people and the entire Mindanao region, and thereby, the whole country.

The strong collaborative efforts between DOE and the Ministry of Environment, Natural Resources and Energy (MENRE) are evident on the issuance of a Joint Circular on energy exploration and development. This partnership will continue to advance, enabling the region to effectively harness its energy resources and attract much-needed investments. BARMM's specific energy needs are addressed through constant dialogues and consultations, solidifying the region's integration into national energy strategies and initiatives. This cooperation not only advances the region's economic prospects but also contributes to broader national energy security and self-sufficiency objectives, while fostering peace and stability in the region.

Establishment of the Intergovernmental Energy Board

The BARMM was established by virtue of RA 11054 or the Bangsamoro Organic Law (BOL), which was signed into law on 26 July 2018. Article VI of the BOL established the Intergovernmental Relations Body (IGRB) with the primary mandate to coordinate and resolve issues on intergovernmental relations through regular consultation and continuing negotiation. The IGRB has activated mechanisms to facilitate cooperation and collaboration between the National Government and BARMM, including the Intergovernmental Energy Board (IEB).

The IEB is tasked with resolving all matters specified in Section 36, Article XIII of the BOL and other energy issues referred to by the IGRB. It was established in October 2020 whose members and representatives are composed of officials from the Bangsamoro Government and the National Government *(Figure 18)*. The Board is headed by the Secretary of Energy as Co-Chairperson for the National Government and the Minister of Environment, Natural Resources, and Energy as Co-Chairperson for the Bangsamoro Government.

The Board is mandated to assist the Bangsamoro Government in building a strong foundation in the regulation of engagements of the energy industry. The implementation of this intergovernmental relations mechanism is governed by the Terms of Reference (TOR) approved and signed by the parties which provided functions/ mandates and composition of IEB.

The IEB has created technical working groups (TWGs) to cater to the different areas of energy pursuant to Department Orders DO2022-07-0010 and DO2023-05-0013. The eight (8) TWGs that will address the current and emerging issues of the energy sector are: (1) Upstream Conventional Energy Resource Development (UCERD-TWG); (2) Power and Electrification (PE-TWG; (3) Energy Planning (EP-TWG); (4) Renewable Energy Development and Utilization (REDU-TWG); (5) Downstream Oil and Gas (DOG-TWG); (6) Energy Investment Regulations and Processes (EIRP-TWG); (7) Energy Efficiency and Conservation (EEC-TWG); and (8) Small-scale Coal Mining Resource Development (SSCMI-TWG).

> ***We will usher in a new era where BARMM becomes a shining beacon of sustainable development in Mindanao and the rest of the Philippines.***
>
> *- President Ferdinand R. Marcos Jr.*
> *1st BARMM LEGISLATIVE GENERAL ASSEMBLY*

Figure 18. **Intergovernmental Energy Board Composition**

Pursuant to the approved Terms of Reference of the IEB

The TWGs are mandated to provide technical assistance and policy recommendations to the IEB for the effective implementation of the BOL, specifically:

1. **UCERD-TWG** – joint exercise of power to grant rights, privileges, and concessions over the exploration, development, and utilization of uranium and fossil fuels such as petroleum, natural gas, and coal (excluding those that pertain to the small-scale mining industry) in the territorial jurisdiction of the Bangsamoro pursuant to Section 10, Article XIII of the BOL.

2. **PE-TWG** – (1) transfer of powers, functions, and responsibilities of the DOE-EPIMB to their counterpart in the MENRE, subject to limitations but with full consideration of the provisions of the BOL; (2) privatization of Agus-Pulangi Hydropower Complex and resolution of power issues; (3) transfer management of the ECs in BARMM jurisdiction; (4) management of electricity supply from Independent Power Producers (IPPs) and WESM Mindanao; and (5) other related issues and concerns.

3. **EP-TWG** – preparation of the energy plan and sharing, updating, and maintenance of socioeconomic indicators and energy database.

4. **REDU-TWG** – (1) transfer of powers, functions, and responsibilities of the DOE REMB pursuant to Section 32 of the Renewable Energy Act RA 9513 to its counterpart in the Bangsamoro Government; (2) enforcement and administration of Section 31 of the RE Act; (3) issuance of RE contracts and operating contracts for the exclusive right to explore and develop a particular area; and (4) implementation and enforcement of the RE Policy Mechanisms pursuant to the RE Act such as the Renewable Portfolio Standards (RPS), Green Energy Auction Program (GEAP), and Green Energy Option Program (GEOP), among others.

5. **DOG-TWG** – implementation and supervision of the non-pricing aspect of the Downstream Oil Industry Deregulation Act (RA 8479) pursuant to Section 2 (o) of the IEB TOR

6. **EIRP-TWG** – promotion of energy investments in the Bangsamoro region pursuant to Section 2 (d) of the BOL, particularly to identify policies to assist the Bangsamoro Government in the promotion of investments in energy and power generation sectors, both domestic and international, and in the implementation of the "EVOSS Act" (RA 11234).

7. **EEC-TWG** – implementation of the Energy Efficiency and Conservation Act, institutionalizing conservation, enhancing the efficient use of energy, and granting incentives to EEC projects.

8. **SSCMI-TWG** – joint exercise of the power to grant rights, privileges, and concessions over the exploration, development, and utilization of small-scale coal mining industry in the territorial jurisdiction of the Bangsamoro pursuant to Section 10 Article XIII of the BOL.

> ***"The successful establishment of this IEB Circular holds immense potential. It will not only contribute to the energy security of the country but also unlock vast opportunities for ergonomic growth in the Bangsamoro Autonomous Region",***
>
> *- Secretary Raphael P.M. Lotilla*
> *www.doe.gov.ph*

Facilitating Energy Development within BARMM

The concerted efforts of the DOE and MENRE illustrate the push for regional energy development that is viewed to significantly contribute to the improvement of energy supply and attainment of economic prosperity. Achieving these objectives requires advancing the components of the entire energy spectrum within the region.

The signing of Joint Award of Petroleum Service Contract and Coal Operating Contracts in the BARMM

Upstream and Conventional Energy Resources. The signing and issuance of the IEB Circular on the Joint Award of PSCs and Coal Operating Contracts (COCs) in BARMM witnessed by the President in Malacañang Palace on 06 July 2023 serves as a catalyst to further the sector's growth as well as attract foreign investments in the region.

The IEB Circular operationalizes the provision in Section 10, Article XIII of RA 11054 to jointly grant rights, privileges, and concessions for the exploration, development, and utilization of uranium and fossil fuels such as petroleum, natural gas, and coal within the territorial jurisdiction of the Bangsamoro. Once implemented, it will kickstart the application process for PSCs and COCs in BARMM. The framework also outlines the requisite requirements, procedures, and standards for companies seeking to apply for and operate PSCs and COCs and ensure that exploration and development activities will adhere to stringent rules and regulations, and best practices.

Correspondingly, a Joint Review and Evaluation Committee (Joint REC) was created in accordance with Section 2 of the approved IEB Circular. The Joint REC is supported by the Joint REC-TWG and Joint REC Secretariat. The REC-TWG is currently finalizing the draft Model Contract and Accounting procedures for the Joint Award of PSCs and COCs. On 26 February 2024, the 1st BARMM Conventional Energy Bid Round was launched, a testament of the National Government's commitment to help the Bangsamoro Government in its transition towards sustainable development.

Renewable Energy Sources. Harnessing the potential of renewable-based resources is a major priority in the BARMM's energy agenda. In maximizing these resources, the DOE is working with the Bangsamoro Government in pursuing clean and sustainable energy. Even prior to the enactment of BOL, several RE Service Contracts (RESCs) including hydro, solar, and biomass were awarded in BARMM. Two major hydro plants (Agus I and II) are located within the BARMM jurisdiction, and there are opportunities to tap other RE technologies.

Power and Electrification. In Mindanao, BARMM has the lowest household electrification level at 43.1 percent (as of December 2023). Therefore, one of the priority areas of the National Government is to assist the Bangsamoro Government in expanding electricity access to areas that are still unserved and underserved. Under the National Total Electrification Roadmap (NTER), various electrification strategies are to be employed from 2023-2028 to achieve the 100 percent household electrification level in BARMM.

Renewable will play a central role in this endeavor as it offers a pragmatic solution in bringing electricity to remote communities that are often difficult to connect to the main grid, through the use of standalone and microgrid systems.

This approach aligns with the government's objective of achieving total electrification, while promoting sustainability and resilience in BARMM.

The government through NEA continues to assist the Bangsamoro Government in improving the services of DUs in the area, as well as in promoting international interest to further mobilize technical and financial assistance to the region on energy and power.

Additionally, to capacitate MENRE in its future responsibility over the power sector, the DOE and its attached agencies provided an orientation covering the issuance of clearance to undertake the System Impact Study (SIS), Certificate of Endorsement to the ERC, and on EVOSS. The planned next steps are to provide hands-on training to MENRE on the processes, and orientation on the total electrification roadmap including the relevant data collection process and sharing.

Leveraging international cooperation, the DOE and MENRE are collaborating to attract development assistance and investments to address challenges in the energy sector in BARMM, particularly the required infrastructure to improve energy security and expand electricity access.

Downstream Oil. Ensuring supply security requires having the downstream oil-related facilities (e.g., depot/storage facility, liquid fuel retail outlets or LFROs, etc.) in place to complement the region's day-to- day activities. BARMM's storage capacity of 22.41 thousand barrels (MB) accounts for 0.4 percent of Mindanao's total storage capacity of 5,735.76 MB in 2022. In terms of sales for the same period, the region recorded 669.01 MB, or roughly 2.7 percent of Mindanao's total sales of 25,075.94 MB. On the distribution of petroleum products within the region, there are 19 operating LFROs comprised primarily of major and independent players in the market.

To advance downstream oil and natural gas development, the DOE extended assistance to MENRE (through orientation) by expounding on the various policies governing the industry, which include: a) revised Philippine Downstream Natural Gas Regulation (PDNGR); b) Liquid Petroleum Products (LPP) Industry Rules; and c) inspection manuals for LPG, LPP, and downstream natural gas.

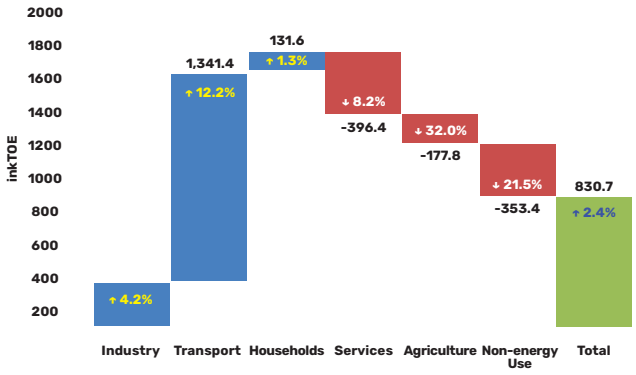
Moving forward, MENRE and DOE are targeting 2025 for the review and adoption of PDNGR and LPP Industry Rules and Inspection Manual for BARMM. Plans are also underway to establish a technical committee on standards and facilitate the turnover of the DOE's functions to MENRE.

CHAPTER I
ENERGY SITUATIONER

A. TOTAL FINAL ENERGY CONSUMPTION (TFEC)

The Philippine economy exceeded the government targets with a 7.6 percent expansion in 2022 – the fastest recorded in more than four (4) decades[31] driven by the removal of remaining restrictions on mobility and business activities. Despite a stellar economic performance, the country's TFEC[32] grew moderately by 2.4 percent to 35.9 million tons of oil equivalent (MTOE) from its 2021 level of 35.0 MTOE.

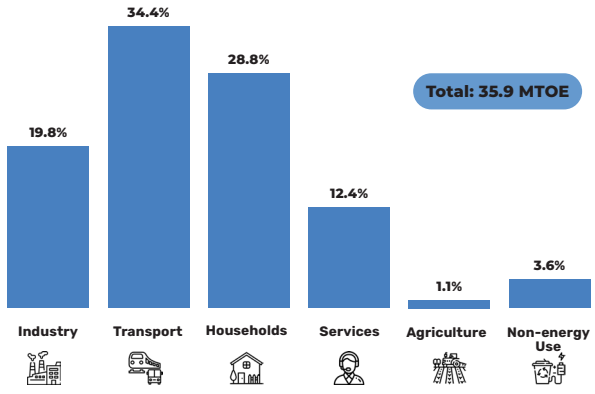
Figure 19. **Changes in Energy Consumption, by Sector (kTOE), 2022**



Major economic sectors such as transport, residential and industry registered increments in their energy utilization during the year *(Figure 19)*. The transport sector's energy use remained on the uptrend with a 12.2 percent hike in 2022 as all transport operations returned to their full capacity. It contributed a bulk share of 34.4 percent to the TFEC *(Figure 20)*. Household energy demand at 28.8 percent share to the TFEC slightly increased by 1.3 percent due to the resumption of onsite reporting for the majority of the country's workforce, including academic institutions. The energy utilized for industrial purposes, with a share of 19.8 percent, went up by 4.2 percent buoyed by the manufacturing sector's sustained post-pandemic recovery.

On the other hand, the services sector's energy consumption fell by 8.2 percent because of the decline in diesel demand. The agriculture sector's energy use decreased by 32.0 percent as weakened agriculture activities led to contractions in its electricity and diesel consumption during the period. Energy products, particularly naphtha and other petroleum products that are used as raw materials and feedstocks in various industrial processes, plummeted by 21.5 percent in 2022.

Figure 20. **Sectoral Shares to TFEC (Percent), 2022**

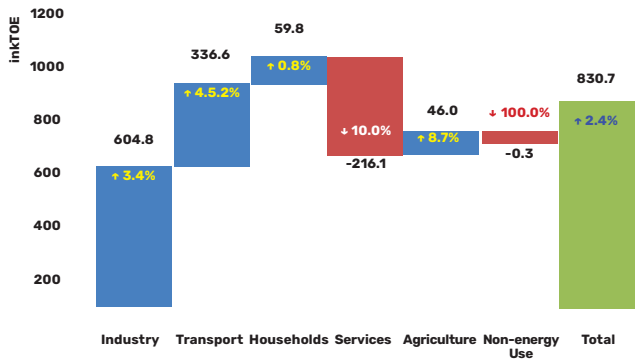


[31] https://www.dof.gov.ph/ph-economy-grows-by-7-6-in-2022-surpasses-dbcc-target/

[32] TFEC is the total energy consumed by the end-users such as households, industry, transport, services, and agriculture. Final energy is those that consumers purchase or receive such as electricity, and petroleum products (i.e. gasoline, diesel, kerosene, etc.). These are energy products and fuels that are converted from the primary energy form, i.e., fuels and energy source (RE) to electricity, crude oil to petroleum products., which incur losses during the conversion process due to their thermal efficiencies. These losses make the difference between TPES and TFEC. For further details, see pp. 23-25 of the Overview for the process flow of energy forms.

I. Total Final Energy Consumption, By Fuel

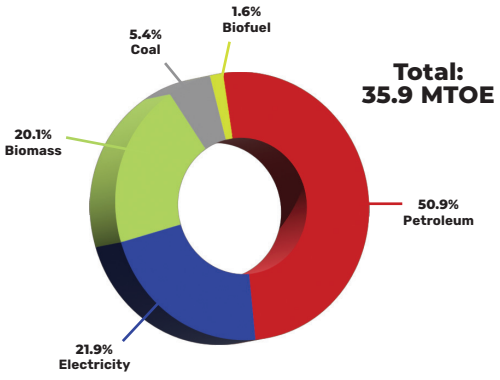
Figure 21. **Changes in Energy Consumption, by Fuel (kTOE), 2022**



Electricity maintained its position as the second most-consumed fuel in 2022. It contributed a 21.9 percent share to TFEC *(Figure 22)*, as demand levels posted an increase of 4.5 percent to 7.9 MTOE in 2022 from its 7.5 MTOE level in 2021. As business services and establishments reverted to their pre-pandemic operational capacities, electricity consumption in the services sector increased the fastest at 15.0 percent in 2022. The easing of travel restrictions also contributed to the 9.3 percent increase in the transport sector's electricity demand. The industry and household sectors, with a combined share of 70.3 percent to total

The country's continued reliance on oil and petroleum products was evident as their aggregate levels reached 18.3 MTOE or 50.9 percent of the TFEC in 2022, an increase of 3.4 percent from 17.7 MTOE in 2021 *(Figure 21)*. Gasoline and diesel, with a combined share of 75.4 percent of total oil consumption, remained the most used oil products. Gasoline consumption accelerated by 10.1 percent vis-à-vis diesel's gradual growth of 0.4 percent growth as domestic pump prices of the former became relatively cheaper compared to the latter during the year. Meanwhile, the resurgence of domestic tourism pushed the utilization of aviation fuels to a double digit hike of 76.6 percent during the same period.

Figure 22. **Fuel Shares to TFEC (Percent), 2022**



electricity consumption, registered increments of 4.4 percent and 1.0 percent, respectively. However, electricity use in the agriculture sector declined by 23.3 percent in 2022.

Increased preference for the use of modern equipment and appliances contributed to the waning popularity of biomass (fuelwood, charcoal and other biomass residues) for end-use applications. Its utilization slightly increased by 0.8 percent to 7.22 MTOE in 2022, from its 2021 level of 7.16 MTOE. Household consumption of biomass posted a modest growth of 1.0 percent, albeit an 82.6 percent share of total biomass demand in 2022. Demand for biomass as fuel in the food manufacturing industry and service establishments registered minimal growth of less than 1.0 percent each.

Coal consumption declined by 10.0 percent to 1.9 MTOE in 2022 vis-à-vis its year-ago level of 2.2 MTOE. It contributed a 5.4 percent share to TFEC during the same year. Reduction in coal utilization was reported in the basic metal and other chemicals industry due to rising coal import prices in 2022, as well as the shift towards diesel and electricity as primary fuels in their production processes.

Biofuels consumption (biodiesel and bioethanol) grew at 8.7 percent to 575.2 kTOE in 2022 from its year-ago level of 529.3 attributed to the strict compliance with the blending schedule mandated under the Biofuels Law, coupled with the effective campaign of the government to use cleaner and alternative fuels.

II. Total Final Energy Consumption, By Sector

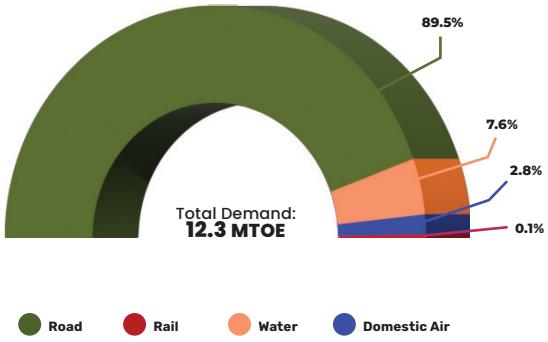
1. Transport

The lifting of stringent mobility restrictions served as a major catalyst for the 12.2 percent upsurge in the transport sector's energy consumption in 2022.

Energy consumption for road transport accelerated by 11.0 percent in 2022 from its year-ago level of 9.9 MTOE and maintained its substantial share of total transport demand at 89.5 percent *(Figure 23)*.

Domestic maritime traffic improved further in 2022 with the resumption of tourism, trade, and regular travel activities. Consistent with these gains, energy demand for in-land water transport in 2022 went up to 940.0 kTOE, or 11.7 percent higher than its 841.9 kTOE level in the previous year.

Figure 23. **Transport Demand, by Sub-sector Shares (Percent), 2022**



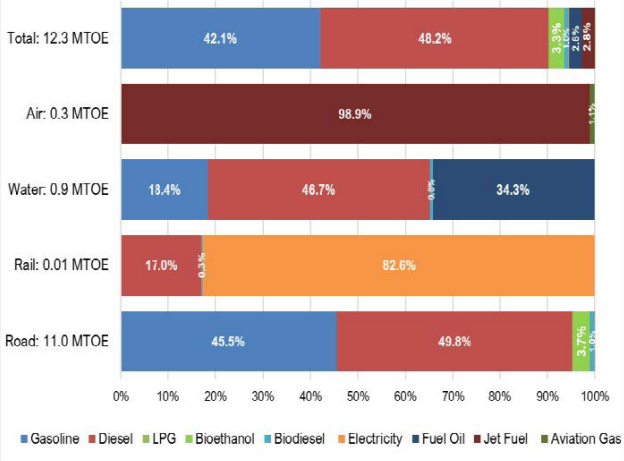
Domestic aviation's astounding performance brought about a 76.6 percent increment in its energy consumption from last year's 194.1 kTOE level to 342.9 kTOE in 2022. Major airlines likewise brought back fare promotions that supported the comeback of the domestic tourism industry and contributed to the four-fold increase in air passenger movement based on the data from the Civil Aeronautics Board (CAB).[33]

The massive rehabilitation of the Metro Rail Transit (MRT) 3 significantly improved its operations in 2022, as the rail lines ran at full capacity. As such, the aggregate energy consumption increased by 10.0 percent and reached 11.2 kTOE in 2022 vis-à-vis 10.1 kTOE in the previous year.

[33] Aircraft, Passenger, and Cargo Movements,2021 & 2022 https://caap.gov.ph/aircraft-passenger-and-cargo-movements/

All transport fuels registered an increase in their consumption levels during the year, except LPG whose demand fell by 91.9 percent vis-à-vis its year-ago level caused by its declining relevance as fuel for taxis. Utilization of aviation fuels (aviation gasoline and jet fuel) and fuel oil in water transport grew by 76.6 percent and 68.8 percent, respectively, given the increased demand for air and maritime travel. Gasoline and diesel, with a combined share of 90.3 percent of total transport demand *(Figure 24)*, went up by 10.1 percent and 9.9 percent, respectively, attributed to increased road traffic across the country. Consistent with the mandated blending schedule, bioethanol, and biodiesel likewise registered increments of 10.2 percent and 16.1 percent, respectively. The growing number of electric vehicles (EVs), coupled with the peak performance of the MRT and LRT during the year, paved the way for the 9.3 percent growth in electricity consumption in the transport sector during the year.

Figure 24. **Transport Final Energy Consumption, By Fuel per Sector and Total (Percent), 2022**

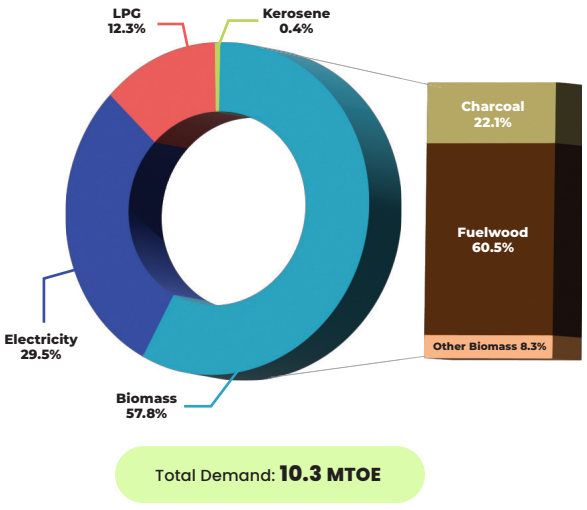


2. Households

The household sector remained the country's second major consumer of energy in 2022 and garnered a 28.8 percent share of the country's total energy consumption.

As the country emerged from lockdowns and restrictions imposed during the last two (2) years of the COVID-19 pandemic, a greater proportion of the working population returned to onsite reporting, while schools implemented hybrid and blended learning modalities, albeit with strict compliance to mandatory health requirements. These developments contributed to the slowdown of household energy consumption as levels slightly improved by 1.3 percent to 10.3 MTOE in 2022 from 10.2 MTOE in 2021.

Figure 25. **Energy Consumption of the Residential Sector, By Fuel (Percent), 2022**



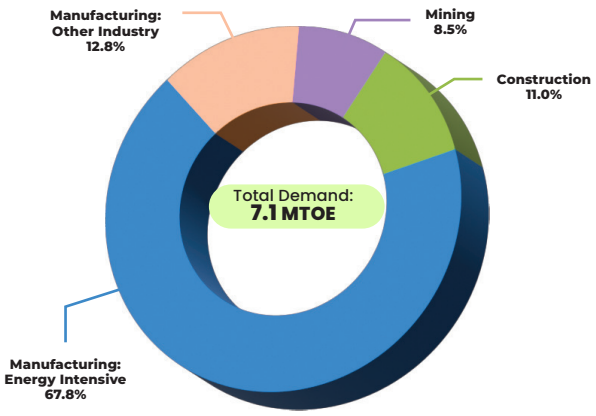
Households remained dependent on biomass as it accounted for more than half (57.8 percent share) of the sector's energy consumption *(Figure 25)*. Biomass consumption levels moderately increased by 1.0 percent to 6.0 MTOE in 2022 compared to the previous year, the bulk of which were fuelwood (69.5 percent share) and charcoal (22.1 percent share) used primarily as fuel for cooking and heating. Electricity contributed close to one-third (29.5 percent) of household's energy demand mix in 2022 at 3.0 MTOE or 1.0 percent more than its year-ago level. The increase in household electricity consumption is mirrored by the 0.8 percentage point improvement in the proportion of the household population with access to electricity recorded at 96.2 percent as of December 2022.

Despite the upward trend in average prices of LPG in 2022, its utilization as cooking fuel among households gained traction and increased the fastest by 4.1 percent to 1.3 MTOE, equivalent to a 12.3 percent share in the sector's demand mix. Households' preference for modern equipment for cooking and other activities drove kerosene consumption to decline by 10.8 percent to 45.8 KTOE during the year.

3. Industry

The country's industry sector grew steadily at 6.5 percent in 2022 vis-à-vis 2021 and remained resilient despite inflationary pressures on the cost of goods and intermediate inputs. In response to strong domestic demand, there was an increase in the proportion of industries that operated at full capacities which resulted in higher average capacity utilization during the year.[34] This propelled the 4.2 percent expansion in the sector's aggregate energy consumption to 7.1 MTOE from the 2021 level of 6.8 MTOE.

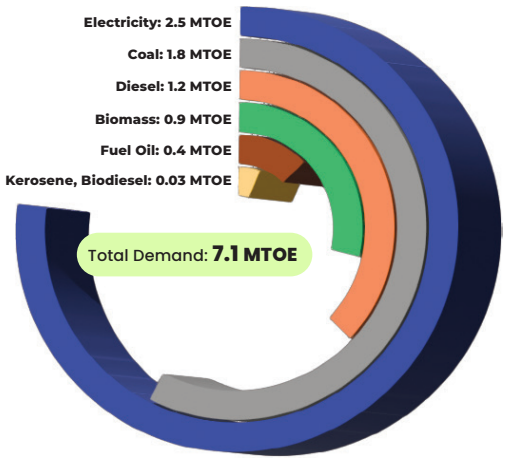
Figure 26. **Energy Consumption of the Industrial Sector, By Sub-sector (Percent), 2022**



The Monthly Integrated Survey of Selected Industries (MISSI) volume of production index increased by 15.1% in 2022, indicating that factory production output was still increasing, but at a slower rate than the 52.6 percent growth seen in 2021. As such, energy consumption in the manufacturing subsector, albeit accounting for the biggest share of the total industry at 80.5 percent *(Figure 26)*, grew marginally by 0.9 percent from last year's 5.7 MTOE. The consumption of energy-intensive manufacturing sub-sectors stood at 4.8 MTOE in 2022, up by 3.3 percent from its previous year's level, with positive contributions from food processing (4.7 percent increase with 21.9 percent share), machinery and equipment (31.1 percent increase with 7.1 percent share) and cement (0.2 percent increase with 14.5 percent share) that offset contractions in other sub-sectors level of energy consumption. On the other hand, combined energy utilization of other industries dropped by 10.3 percent during the year.

The mining sub-sector remained positive in 2022 as high metal prices and robust production output contributed to the 35.0 percent growth in the aggregate value of metal production compared to the previous year[35]. Increased metal demand from export partners like China helped to support mining activity, and the adoption of long-overdue government regulations attracted new players who were given permission to operate during the year. These developments pushed the sector's energy consumption to 604.2 kTOE in 2022, up by 26.8 percent compared to the previous year's 476.4 kTOE.

Figure 27. **Industry Energy Demand, by Fuel, 2022 (MTOE)**



Electricity acquired more than one-third (34.9 percent share) of the industry sector's energy demand mix during the year and was utilized in almost all industrial processes, particularly in food processing, iron and steel, and machinery and equipment industries. Its consumption reached 2.5 MTOE *(Figure 27)* or 4.4 percent more than its year-ago level of 2.4. MTOE. Coal accounted for more than a fourth (26.1 percent share) of total industry TFEC, but its utilization fell by 4.8 percent to 1.9 MTOE in 2022. Despite the cement sub-sector's increased consumption, higher coal prices gripped the iron and steel, and other manufacturing subsectors resulting in 18.1 percent and 27.5 percent reductions in coal demand, respectively. Consumption of oil products in the sector went up by 17.1 percent to 1.8 MTOE in 2022, translated to an aggregate share of 25.7 percent of the industry's TFEC. Diesel consumption escalated by 35.1 percent due to its increased utilization in assembly lines for machineries and equipment for mining and construction. On the other hand, LPG use went up by 1.4 percent. These offset the registered 8.7 percent and 44.2 percent downtrend consumption of fuel oil and kerosene, respectively, during the year. Biomass consumption remained at 924 kTOE, while biodiesel consumption increased significantly by 53.7 percent to 23.7 kTOE in 2022, consistent with the mandated blending schedule.

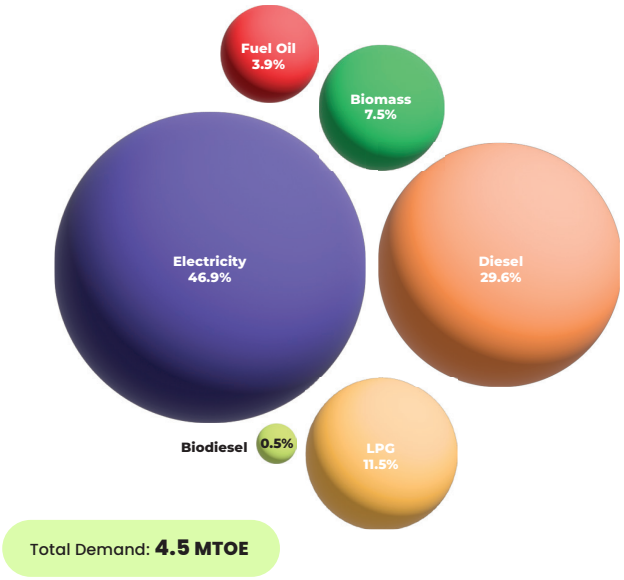
[34] *Monthly Integrated Survey of Selected Industries (https://psa.gov.ph/manufacturing/missi-table)*
[35] *Mines and Geosciences Bureau (MGB) Mineral Statistics 2021-2022*

4. Services[36]

The services sector continued to propel the country's post-pandemic and was the main driver of economic growth for 2022 with a 9.2 percent acceleration in aggregate gross value added (GVA) during the year. However, the significant shift in the energy demand mix for the sector, characterized by reduced dependence on diesel, moved down its energy consumption levels to 4.5 MTOE in 2022 or 8.2 percent less than the 4.8 MTOE recorded in the previous year.

The volume of diesel utilized fell sharply by 35.0 percent to 1.3 MTOE in 2022 compared to its year-ago level of 2.0 MTOE that put on a 12.2 percentage points reduction in its share to the sector's TFEC to 29.6 percent during the period *(Figure 28).* The reduction in the diesel demand also pulled down biodiesel consumption to 26.0 kTOE in 2022 vis-à-vis 40.0 kTOE in 2021. Consequently, the service sector's total electricity consumption went up to 2.1 MTOE in 2022, or 15.0 percent more than the 1.8 MTOE recorded in 2021. Aside from electricity, consumption of LPG and fuel oil, with a 15.4 percent combined share, also increased by 7.0 percent and 12.0 percent respectively. Biomass completed the demand mix with the 331.8 kTOE utilization during the year.

Figure 28. **Energy Consumption of the Services Sector, By Fuel Shares (Percent), 2022**



5. Agriculture

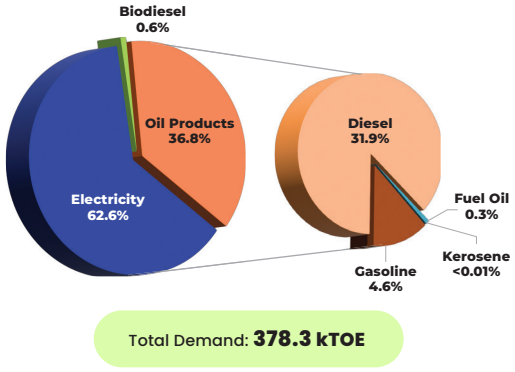
The agriculture sector, with the least contribution to GDP growth, lagged other output-producing sectors with a 0.5 percent increase in its GVA, albeit an improvement compared to its 0.3 percent contraction posted a year ago. However, its energy consumption lessened by 32.0 percent as its subsectors registered lower utilization in 2022 vis-à-vis 2021.

Farm output from the agri-industry decreased by 1.1 percent in 2022, pulled down by the adverse impact of successive weather disturbances 37 in the fourth quarter, as well as price hikes in production inputs (fertilizer, fuel, and others). This is evident in its 34.5 percent drop in energy use for agri-crop production from last year's 349.9 kTOE to 229.1 kTOE in 2022 *(Figure 29)*. Despite the gains in the livestock and poultry sub-sector during the year from negative growth registered in 2021, its energy consumption declined by 56.8 percent to 73.1 kTOE due to hampered repopulation of hogs and a limited number of operating livestock farms and facilities amidst the lingering impact of African Swine Fever (ASF). Higher production costs for farmers led to depressed agriculture activities as energy demand for agricultural support services also fell by 23.3 percent. Energy consumption in the forestry and fishery subsectors dropped by 20.5 percent and 27.7 percent, respectively, attributed to the weakened production volume output in 2022.

Figure 29. **Energy Consumption of the Agriculture & Forestry, By Sub-Sector (kTOE), 2021 vs 2022**

[36] *Trade and services, excluding Transport*
[37] *Typhoons Karding (international name: Noru) and Paeng (international name: Nalgae) caused agricultural damage worth P3.12 billion and P6.4 billion in the harvesting months of Q4 2022.*

Figure 30. **Energy Consumption of the Agriculture & Forestry Sector, By Fuel Shares (Percent), 2022**



Total Demand: **378.3 kTOE**

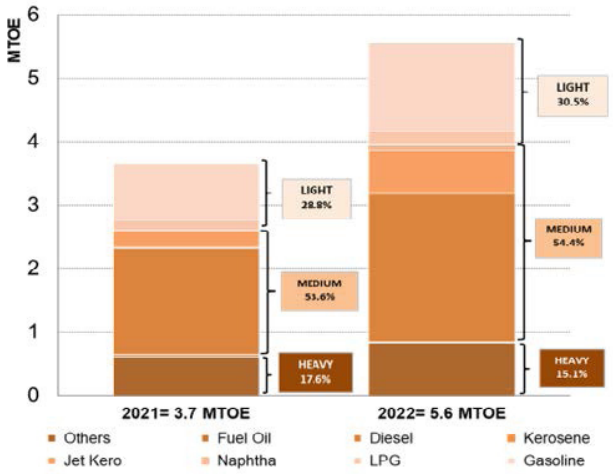
Electricity, with its 62.6 percent share to agriculture's TFEC dropped by 23.3 percent due to depressed demand from the agri-industry sub-sector. Diesel use for farm equipment fell by almost half (46.6 percent) to 120.6 kTOE in 2022, it accounted for 31.9 percent of the sector's demand mix, while biodiesel consumption mirrored its level of utilization reduction in the sector. Consumption of fuel and kerosene, with an aggregate share of 0.3 percent to the sector's TFEC, decreased by 45.6 percent. Gasoline completed the sector's demand mix, the only fuel in the sector that registered positive utilization level at 13.5 percent, from 15.4 kTOE in 2021 to 17.5 kTOE in 2022 *(Figure 30)*.

B. TRANSFORMATION

I. Oil Refining

Aggregate refinery production output from Petron's Bataan Refinery increased by 52.0 percent to 5.6 MTOE (43.8 million barrels (MMB)) compared to its year-ago level of 3.7 MTOE (28.8 MMB) *(Figure 31)*. The significant uptrend is associated with high demand for Petron's finished petroleum products due to the resumption of economic activities and improved mobility that came with the easing of stringent travel restrictions. The country's lone refinery in Limay, Bataan, capable of supplying around 40.0 percent of total fuel requirements with its 180,000 barrel-per-day (bpd) capacity was able to avoid maintenance downtime in 2022 due to enhancements and optimizations implemented by the Petron Corporation. It took advantage of favorable refining cracks[38] and boosted its over-all net income for the same period.

Figure 31. **Refinery Production, by Fuel, 2021 vs 2022 (MTOE)**



All marketable products registered higher volumes during the year, except for fuel oil which posted a steep decline of 75.5 percent. Diesel dominated total marketable products with its 41.9 percent share, as its volume increased significantly by 39.3 percent to 2.3 MTOE compared to 1.7 MTOE in 2021. Gasoline, which accounted for a 25.2 percent share also escalated to 1.4 MTOE or 56.6 percent more than its 2021 level of 893.5 kTOE. Notable increases were likewise recorded in other petroleum products such as jet fuel (152.7 percent), LPG (37.6 percent), kerosene (13.4 percent), and other petroleum products (47.5 percent) due to growing demand from the industry and aviation sectors.

II. Power Generation and Fuel Input

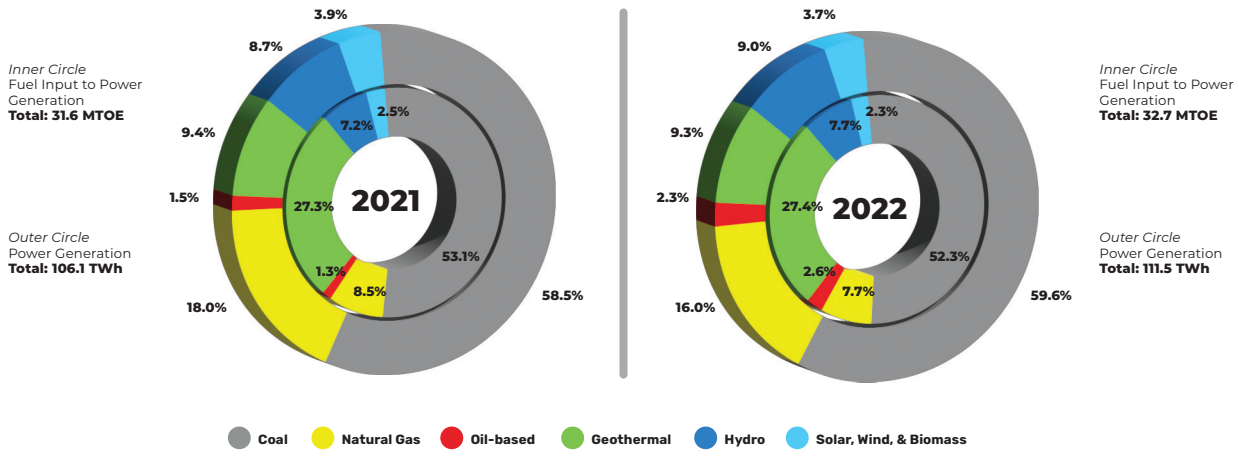
Total generation output from all power plants in 2022 exhibited a 5.1 percent gain and reached 111.5 tera-watt (TWh) from the previous year's 106.1 TWh. This is consistent with the growth in electricity demand as economic activities returned to their pre-pandemic trajectories. Coal-fired power plants supplied the bulk of the total power generation at 59.6 percent (66.4 TWh), followed by natural gas at 16.0 percent (17.9 TWh). Generation output from geothermal and hydro recorded at

[38] *https://www.petron.com/news/petron-marks-two-straight-years-of-growth-reports-p6-7b-net-income-in-2022/*

9.3 percent (10.4 TWh) and 9.0 percent share (10.1 TWh), respectively. On the other hand, the combined shares of solar, wind, and biomass contributed a 3.7 percent share (4.2 TWh), while at least 2.3 percent (2.5 TWh) came from oil to complete the country's generation mix for 2022.

Total fuel consumption of power plants went up by 3.7 percent to 32.7 MTOE in 2022 compared to 31.6 MTOE in the previous year. Fossil fuels owned close to two-thirds (62.6 percent) of the fuel input mix due to their reliability and baseload characteristics. The volume of coal input grew by 2.3 percent from its year-ago level of 16.8 MTOE to 17.1 MTOE in 2022 credited to additional capacity from the GNPower Dinginin Unit 2 that went online in October 2022. Utilization of natural gas for power generation descended further by 6.3 percent to 2.5 MTOE compared to its 2021 level of 2.7 MTOE, due to the termination of the Malampaya and Ilijan cooperation period on 04 June 2022.

Figure 31. **Refinery Production, by Fuel, 2021 vs 2022 (MTOE)**

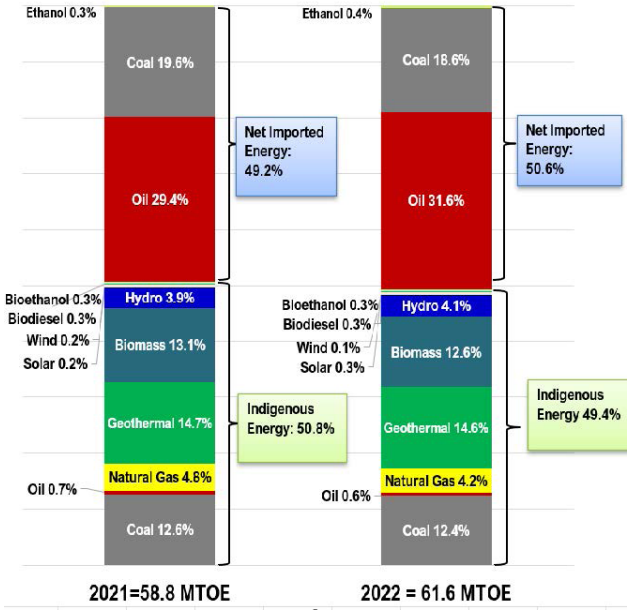


Combined fuel input of renewable energy sources remained at a level of 12.2 MTOE in 2022 from the previous year. Geothermal dipped by 2.4 percent from 9.2 MTOE in 2021, while hydro input went up by 9.8 percent from 2.3 MTOE in 2021 to 2.5 MTOE in 2022. Aggregated inputs from solar, wind, and biomass stood at 0.8 MTOE, 10.1 percent more than their previous year's level. This is attributed to the 24.0 percent and 13.3 percent leap of solar and biomass, respectively, for power generation during the period.

C. TOTAL PRIMARY ENERGY SUPPLY (TPES)

The aggregate volume of all primary energy sources for 2022 grew faster at 4.7 percent vis-à-vis the 2.4 percent growth in energy demand during the year. Of the 61.6 MTOE level of TPES, net imported energy reached 31.1 MTOE and maintained its ascent for two (2) consecutive years with a 7.6 percent increase vis-à-vis 2021. The level of indigenous energy resources slightly improved by 2.0 percent to 30.4 MTOE. With the fast-paced rise in net imported energy, energy self-sufficiency decreased by 1.3 percentage points to 49.4 percent in 2022 from 50.8 percent in 2021 *(Figure 33)*.

Figure 33. **Total Primary Energy Mix, by Fuel (% Shares), 2021 vs 2022**



Oil returned to the top spot as the country's major energy source with its 32.2 percent share to the TPES in 2022, its level increased by 12.3 percent to 19.8 MTOE driven by the hike in net oil importation given the limited domestic production. Coal's aggregate supply level slowed down due to higher import prices, grew by 0.9 percent to 19.1 MTOE from its previous year's level of 18.9 MTOE. While coal was able to maintain its 31.0 percent share to the TPES, natural gas posted a minimal contribution at 4.2 percent share due to its 7.4 percent reduction as fuel input for power generation in 2022. The aggregate supply of geothermal, hydro, solar, wind, and biomass (including biofuels) reflected a share of 32.6 percent in the energy mix, grew by 3.3 percent from the previous year's level of 19.4 MTOE to reach 20.0 MTOE in 2022.

I. Indigenous Energy

The share of total indigenous energy production to the energy mix remained on the downtrend at 49.4 percent vis-à-vis 51.1 percent in 2021. Gains achieved in the increased production of coal (2.9 percent), hydro (9.8 percent), solar (24.0 percent), biomass (1.6 percent), and biofuels (4.1 percent), were surpassed by the reduction of oil (8.7 percent), natural gas (7.4 percent), geothermal (2.4 percent) and wind (18.9 percent).

Fossil Fuels

Oil. The nation's total oil production, including condensate, decreased by 8.7 from its 2021 level to 357.6 kTOE in 2022 (1.2 percent of the overall indigenous energy supply). The remaining active oil fields in the nation, Galoc, and Alegria, declined their crude oil production at 11.6 percent and 32.7 percent, respectively. Similarly, condensate output continued to weaken in 2022, registered a reduction of 7.8 percent, as a result of the Malampaya gas field's declining viability.

Coal. Domestic coal production, with an 8.6 percent share to the indigenous energy production, improved by 2.9 percent to 7.6 MTOE (14,457.3 million metric tons (MMT)) from its 2021 level of 7.4 MTOE (14,047.7 MMT). The entirety (99.5 percent) of local coal was sourced from Semirara Mining, the country's primary coal mine located in Antique province, which reported a 3.1 percent increase in its coal volume in 2022. Coal mines in Cebu and Negros also reported a significant increase in production that compensated for the curtailed output from small-scale mines (-19.7 percent) and Bicol region (-71.2 percent).

Natural Gas. Natural gas production remained on the downtrend, reduced further by 7.4 percent in 2022 to 2.6 MTOE (112.2 billion standard cubic feet (BSCF)), which represented a 4.2 percent share to total domestic energy production. Implementation of Malampaya gas supply restrictions on Ilijan and San Gabriel Power plant from January to May of 2022, with the expiration of Ilijan Power plant's Gas Sales and Purchase Agreement (GSPA) on 5 June 2022, resulted to its diminished supply levels during the year.

Renewable Energy

Geothermal. Geothermal's share to the total indigenous energy supply stood at 29.5 percent in 2022, while its equivalent volume increased by 4.1 percent to 9.0 MTOE from previous year's 8.6 MTOE. Meanwhile, a total of 24 geothermal projects with a combined potential capacity of 870.6 MW[39] were awarded as of 2022.

Biomass. Total biomass[40] supply reached 7.73 MTOE in 2022 or 0.1 percent more than its 7.72 MTOE registered in the previous year. It contributed 25.4 percent to the total indigenous energy supply for the same period. The bulk of the increase in biomass supply is attributed to its higher utilization in power generation which was supported by 611 MW[41] of installed capacity. On the other hand, an additional capacity of 186.2 MW is expected from around 28 biomass projects awarded as of 2022.[42]

Hydro. Hydropower production went up by 9.8 percent from previous year's level of 2.3 MTOE to 2.5 MTOE in 2022, boosted by the above-normal rainfall conditions due to the La Niña phenomenon that persisted until the end of 2022. Hydropower contributed an 8.3 percent share to the total indigenous energy supply, supported by its aggregate capacities of 3,745 MW[43]. A total of 12,272.5 MW[44] potential capacity from 362 hydropower projects was awarded by end of 2022.

Solar. Preference for solar as a viable energy source has grown rapidly in recent years consistent with the government's push for sustainability. For 2022, solar supply levels posted an outstanding increase of 24.0 percent from its year-ago level of 126.4 kTOE to 156.7 kTOE in 2022, albeit a minimal share of 0.3 percent to TPES for the same period. In 2022, solar installed capacity reached 1,530 MW,[45] and its potential capacity of 21,413.6 MW[46] from 156 solar projects was awarded during the period.

Wind. Wind energy supply posted a sizable decline of 18.9 percent in 2022 from its previous year's level of 109.2 kTOE due to derating in its dependable capacity for 2022. While its share of the country's energy mix for 2022 was marginal at 0.1 percent, interest in wind energy development has been revitalized due to its colossal potential resources, which is aligned with the country's effort on energy transition goal. The total installed wind capacity reached 427 MW[47] with a potential capacity of 45,631 MW[48] from 21 energy projects awarded as of 2022.

Biofuels. Biofuels supply mirrored the uptrend in demand for gasoline and diesel consistent with the implementation of the mandated blending schedule. As such, the domestic supply of biodiesel and bioethanol climbed by 5.7 percent and 2.9 percent, respectively. In 2022, the country has 12 biodiesel producers with combined capacities of 677.9[49] million liters/year (MLPY) and 13 bioethanol facilities with 466.0 MLPY in operation. Four (4) biodiesel and two (2) bioethanol producers were also accredited for the construction of production plant projects.

[39] *https://www.doe.gov.ph/sites/default/files/pdf/renewable_energy/awarded_geothermal_2022-12-31.pdf*
[40] *Includes charcoal, fuelwood, rice hull bagasse, agriculture, animal and municipal wastes*
[41] *https://www.doe.gov.ph/sites/default/files/pdf/electric_power/04_LVM%20Grid%20Summary_Rev1_0.pdf*
[42] *https://www.doe.gov.ph/sites/default/files/pdf/renewable_energy/awarded_biomass_2022-12-31_own-use.pdf*
[43] *https://www.doe.gov.ph/sites/default/files/pdf/electric_power/04_LVM%20Grid%20Summary_Rev1_0.pdf*
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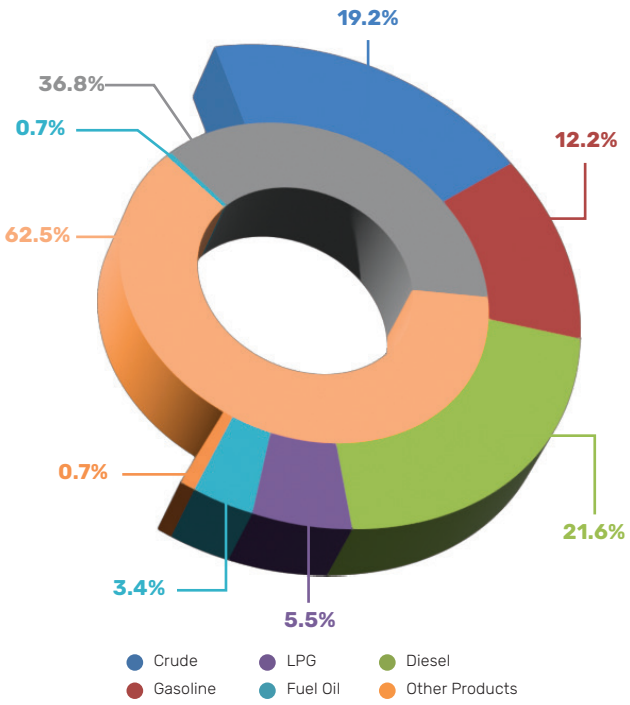
[48] *https://www.doe.gov.ph/sites/default/files/pdf/renewable_energy/awarded_wind_2022-12-31.pdf*
[49] *https://www.doe.gov.ph/renewable-energy/biodiesel?page=1*

II. Net Energy Imports[50]

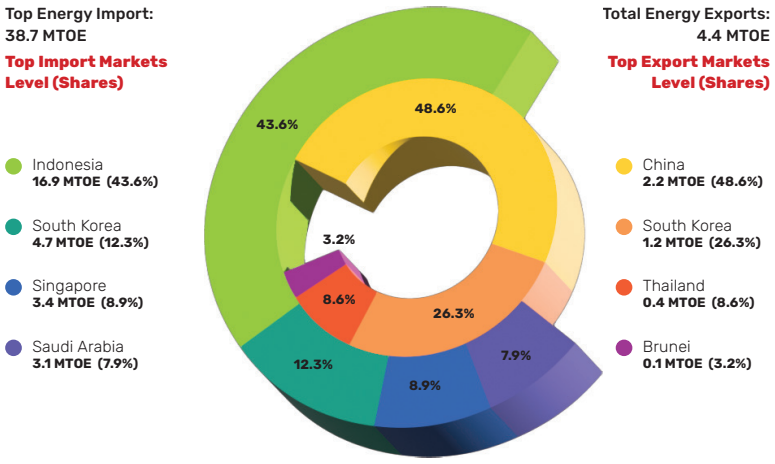
The volume of net imported energy reached 31.1 MTOE in 2022, 7.6 percent higher than its year-ago level of 28.9 MTOE. Of the total volume of net energy imports, oil and oil products accounted for more than half (62.5 percent share), while coal and ethanol contributed 36.8 percent and 0.7 percent shares, respectively *(Figure 34)*.

Figure 34. **Net Energy Imports, by Fuel (% Shares), 2022**



Volatile international prices due to lingering tension between Russia and Ukraine failed to prevent the country's import propensity since heightened economic activities created a strong domestic demand for oil products. This situation pushed the aggregate volume of oil imports by 13.8 percent to 21.3 MTOE in 2022 from the previous year's 18.7 MTOE. Crude oil, with a 27.4 percent share of total oil import volume for 2022, exhibited a marked increase of 46.0 percent to 5.8 MTOE vis-à-vis 4.0 MTOE in 2021 encouraged by the enhanced operation of Petron's Bataan refinery. The relatively slower increase in the international price of gasoline prices vis-à-vis diesel[51], coupled with increased demand from the aviation industry, served as the impetus for the 5.1 percent increase in imports of finished petroleum products to 15.4 MTOE in 2022 from its previous year's level of 14.7 MTOE. The import market for the Philippines remained unchanged with South Korea, Singapore, and China as top sources of finished oil products, while the Middle East supplied all the country's requirements for imported crude *(Figure 35)*.

Figure 35. **Top 4 Countries as Import Source and Export Destinations for 2022**



Total oil exports went down by 28.4 percent to 457.3 kTOE in 2022 compared to the previous year's level of 638.9 kTOE. Exports of finished oil products decreased by 29.1 percent as volume was directed to meet domestic consumption. Reduction in oil output of the Galoc oil field led to a 24.1 percent decline in crude exports, while the downtrend in Malampaya condensate also declined further by 7.8 percent during the year. The top export markets with almost a quarter share each were China (22.7 percent), Brunei (22.3 percent), and Thailand (22.2 percent).

Amplified demand for coal as a fuel for power generation necessitated the 4.7 percent increase in coal imports to 17.3 MTOE in 2022 from previous year's volume of 16.5 MTOE. Indonesia continued to contribute most of the country's coal imports with its 97.7 percent share, while Australia, Vietnam, Russia, and Thailand shared the remaining 2.3 percent. Coal exports decreased by 23.7 percent to 3.7 MTOE from its 2021 volume of 4.9 MTOE due to moderate movement of domestic coal production and slower demand from China, the country's top export destination, as it curbed its coal importation to encourage local production[52]. South Korea has emerged as a strong export market for Philippine coal with a 30.5 percent share, next to China's 55.8 percent share of total export.

The uptrend in the country's transport sector demand for petroleum products contributed to the 22.9 percent increase in bioethanol imports from its 2021 level of 125.9 kTOE to 154.7 in 2022.

[50] *This is derived as total primary energy supply (TPES) less indigenous production. Alternatively, it can also be calculated as the sum of imports and stock change (+/-) less exports and international bunkers (aviation and marine)*
[51] *Mean of Platts Singapore (MOPS) for gasoline per barrel was US$78.3 (2021) and US$111.1, while for diesel it was US$77.3 (2021) and US$134.5 (2022)*
[52] *China's hunger for coal sparks debate on self-sufficiency and imports (https://www.spglobal.com/commodityinsights/en/marketinsights/blogs/coal/032723-blog-chinas-hunger-for-coal-sparks-debate-on-self-sufficiency-andimports#:~:text=China%20imported%20293.20%20million%20mt,its%20requirements%20through%20domestic%20production)*

D. ENVIRONMENTAL IMPACT

Total greenhouse gas (GHG) emissions for 2022 increased by 4.0 percent to 135.7 million tons of CO_2 equivalent ($MtCO_2e$) or 4.0 percent more than previous year's 130.4 $MtCO_2e$. The gradual removal of COVID-19 restrictions throughout the year encouraged the rebound in economic activities and returned GHG emissions to pre-pandemic levels *(Table 4)*.

Table 4. **GHG Emission, by Sector: 2021 vs 2022**

Sector	CO2 Emission ($MtCO_2e$)		Total NonCO2 Emission ($MtCO_2e$)		Total GHG Emission*** ($MtCO_2e$)		Total GHG Emission (% Change)
	2021	2022	2021	2022	2021	2022	2021-2022
Electricity	73.59	75.98	0.29	0.30	73.88	76.28	3.25
Transport	31.32	35.18	0.22	0.24	31.53	35.42	12.32
Industry	12.44	12.88	0.07	0.07	12.50	12.94	3.52
Other Sectors*	12.05	9.81	0.08	0.06	12.13	9.88	(18.55)
Energy**	0.40	1.15	0.00	0.00	0.40	1.16	186.59
Total	**129.80**	**135.00**	**0.65**	**0.68**	**130.45**	**135.68**	**4.01**
% Distribution							**Change in Distribution**
Electricity	56.70	56.28	44.56	44.39	56.64	56.22	(0.41)
Transport	24.13	26.06	33.24	35.82	24.17	26.10	1.93
Industry	9.58	9.54	10.32	9.90	9.58	9.54	(0.05)
Other Sectors	9.28	7.27	11.78	9.39	9.30	7.28	(2.02)
Energy	0.31	0.85	0.10	0.50	0.31	0.85	0.54
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	

**includes emissions from the services, households, and agriculture*
***includes losses incurred in oil refining*
****Updated using GWP Values, Fifth Assessment Report (AR5), and EF based on 2006 IPCC Guidelines (Tier 1)*

Power generation accounted for more than half (56.2 percent share) of the total GHG emissions during the year. Increased output from coal-fired power plants resulted in a 3.3 percent increase in GHG emissions to 76.3 $MtCO_2e$ compared to the 73.9 $MtCO_2e$ recorded in 2021. Among end-use economic sectors, transport remained the biggest GHG emitter with a 26.1 percent share to total GHG emissions. Full seating capacities implemented for public transport, as well as eased mobility restrictions, pushed the sector's GHG emission to a double-digit hike of 12.3 percent to 35.4 $MtCO_2e$ in 2022 from its yearago level of 31.5 $MtCO_2e$. Amplified industrial production raised the sector's GHG emission by 3.5 percent to 12.9 $MtCO_2e$ in 2022 (9.5 percent share) from its 2021 level of 12.5 $MtCO_2e$. On the other hand, the decline in energy consumption of the agriculture, services, and household sectors weighed down their aggregate GHG emission (7.3 percent share), as it drastically fell by 18.6 percent from 12.1 $MtCO_2e$ in 2021 to 9.9 $MtCO_2e$ in 2022. Emissions from refinery production and own use of energy tripled from 0.4 $MtCO_2e$ in 2021 to 1.2 $MtCO_2e$ in 2022.

Table 5. **GHG Emission, by Fuel: 2021 vs 2022**

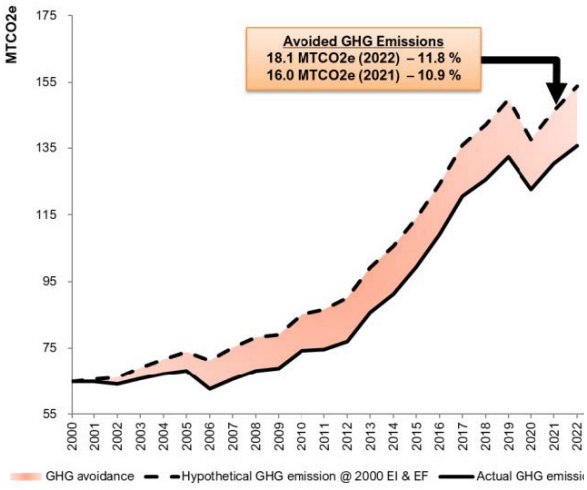
Sector	CO2 Emission ($MtCO_2e$)		Total NonCO2 Emission ($MtCO_2e$)		Total GHG Emission*** ($MtCO_2e$)		Total GHG Emission (% Change)
	2021	2022	2021	2022	2021	2022	2021-2022
Oil	49.49	54.07	0.31	0.33	49.81	54.40	9.22
Coal	73.71	74.83	0.33	0.34	74.05	75.17	1.52
Gas	6.59	6.11	0.01	0.01	6.60	6.11	(7.36)
Total	**129.80**	**135.00**	**0.65**	**0.68**	**130.45**	**135.68**	**4.01**
% Distribution							**Change in Distribution**
Oil	38.13	40.05	47.85	49.33	38.18	40.09	1.91
Coal	56.79	55.43	51.17	49.78	56.76	55.40	(1.36)
Gas	5.08	4.52	0.99	0.88	5.06	4.05	(0.55)
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	

****GWP Values and EF based on Fifth Assessment Report (AR5) and 2006 IPCC Guidelines (Tier 1), respectively*

By type of fuel, coal remained the major source of GHG emissions with a 55.4 percent share of the total GHG emissions in 2022. Steady demand for coal as fuel input in power generation led to a 1.5 percent increment in GHG emissions from coal as it reached 75.2 $MtCO_2e$ in 2022 from its year-ago level of 74.0 $MtCO_2e$ *(Table 5)*. Aggregate consumption of oil and oil products resulted in 54.4 $MtCO_2e$ or 40.1 percent of total GHG emissions in 2022. Intensified utilization of gasoline, fuel, and aviation fuels contributed to the 9.2 percent increase year-on-year in GHG emissions from oil. The downward trend in the use of natural gas for both power and non-power applications reduced the fuel's GHG emissions by 7.4 percent during the year.

Consistent with the commitment of the country to its Nationally Determined Contributions (NDC)[53], different mitigation measures pursued in the energy sector resulted in the avoidance of 18.1 $MtCO_2e$ or 11.8 percent of the total hypothetical[54] GHG emission in 2022 as shown in *Figure 36* and *Table 6*. Combined increments in generation output from geothermal, hydro, biomass, and variable RE (wind and solar) pushed avoided GHG emission from the power generation sector by 5.1 percent to 4.5 $MtCO_2e$ (2.9 percent of total GHG avoidance) vis-à-vis 4.3 $MtCO_2e$ from the previous year. On the other hand, demand-side management measures succeeded as GHG avoidance went up by 16.5 percent to 13.6 $MtCO_2e$ (8.9 percent share to total avoidance), with marked improvements from efficiency in electricity and fossil fuel consumption, as well as in biofuel blending. These developments contributed to a 13.4 percent increase in overall avoided GHG emissions for the year.

Figure 36. **Actual GHG Emission, Hypothetical GHG Emission and GHG Avoidance: 2000 – 2021**



Note: Hypothetical GHG Emission is equivalent to Actual GHG Emission plus GHG Emission Avoidance; GHG Base year is CY 2000 GHG Emission Level

[53] *Philippines | Climate Promise (undp.org)*
[54] *Refers to actual GHG emission plus total avoidance; or the level of GHG emission if there were no mitigation measures being adopted.*

Table 6. **CO_2 Avoidance from the Mitigation Measures (in $ktCO_2e$)**

GHG Reduction Measures	2021	Reduction Impact* %	2022	Reduction Impact* %	% Change
DEMAND SIDE	11,703.05	7.99	13,629.80	8.86	16.46
Efficiency in Electricity Consumption (EEC)	3,372.92	2.30	3,866.53	2.51	14.63
Efficiency in Fossil Fuel Consumption (EEF)	6,381.16	4.36	7,397.03	4.81	15.92
Biofuel	1,948.97	1.33	2,366.24	1.54	21.41
CNG/NG	0.00	0.00	0.00	0.00	11.46
SUPPLY SIDE					
Fuel Diversification in Power Generation @2018 GDP &EF**	4,252.64	2.90	4,468.24	2.91	5.07
Total Avoidance (Demand+Supply-EEC)	**15,995.70**	**10.90**	**18,098.04**	**11.77**	**13.43**
Actual GHG Emission	**130,449.12**		**135,679.36**		**4.01**
Hypothetical GHG Emission (Actual + Total Avoidance)	**146,404.82**		**153,777.39**		**5.04**

**Refers to the percent reduced emission (Total Avoidance / Hypothetical GHG Emission x 100)*
***Includes efficiency in Power Generation and EEC*

E. ENERGY – ECONOMY AND ENVIRONMENTAL INDICATORS[55]

The Philippine economy has effectively returned to its pre-pandemic trajectory signaled by the robust 7.6 percent expansion in gross domestic product (GDP) for 2022 – the fastest among the emerging economies in the ASEAN region and its best performance in almost four decades.

The government's effective pandemic risk management and removal of restrictions resulted in strong domestic demand, which was met by expansions of 9.2 percent and 6.5 percent in the aggregate GVA in the services and industry sectors, respectively, and represented the bulk of GDP at 91.1 percent share. Domestic trade, manufacturing, and construction

[55] *GDP figures as based on the PSA National Accounts of the Philippines (NAP), as of April 2022 (rebased 2018)*

each posted notable growth contributions of 8.7 percent, 4.9 percent, and 12.1 percent, respectively, which offset the minimal decrease of 0.5 percent registered in the agriculture, fishery, and forestry (AFF) sectors for the year. On the demand side, household consumption and investment lifted the economy, as each posted sizeable increments of 8.3 percent and 13.8 percent during the year.

Intensity. Energy intensity serves as an indicator of how much energy is used to produce one unit of economic output such that the rate of improvement in energy intensity is used as an indicator for improvements in energy efficiency.

For 2022, the country's economy-wide energy intensity stood at 3.1 tons of oil equivalent per million pesos of real GDP (TOE/MPhP) or 2.6 percent less than its year-ago level of 3.2 TOE/MPhP. Electricity intensity fell by 2.3 percent to 5.6 watt-hours per peso (Wh/PhP), while oil intensity increased by 3.4 percent to 8.1 barrels/PhP (bbl/PhP) attributed to its increased utilization in the transport sector *(Figure 37)*.

Figure 37. **Energy Indicators: 2021 vs 2022**

Indicators	Energy	Electricity	Oil
Intensity	2021: 3.17 TOE/MPhp 2022: 3.09 TOE/MPhp	2021: 5.72 Wh/Php 2022: 5.59 Wh/Php	2021: 7.80 bbl/Php 2022: 8.07 bbl/Php
Elasticity	2021: 0.68 2022: 0.62	2021: 0.75 2022: 0.67	2021: 1.36 2022: 1.49
Per Capita	2021: 0.53 TOE 2022: 0.55 TOE	2021: 962.9 kWh 2022: 999.5 kWh	2021: 1.31 bbl 2022: 1.44 bbl

Major economic sectors likewise exhibited reductions in their respective energy intensity. The services sector, which includes the transport subsector, went down by 3.4 percent to 1.5 TOE/MPhP. Industry, household, and agriculture sectors also reported cutbacks of 2.4 percent, 6.5 percent, and 32.3 percent in energy use per million pesos, respectively. These improvements in energy intensity meant significant achievements in programs and policies implemented under Republic Act 11285 or the Energy Efficiency and Conservation Act of 2019, as well as continued compliance under the Sustainable Development Goal (SDG) 7.3.[56]

[56] *Sustainable Development Goal 7.3 target calls for global progress on energy efficiency by doubling the rate of improvement in energy efficiency globally by 2030 (https://www.seforall.org goal-7-targets/energy-efficiency)*

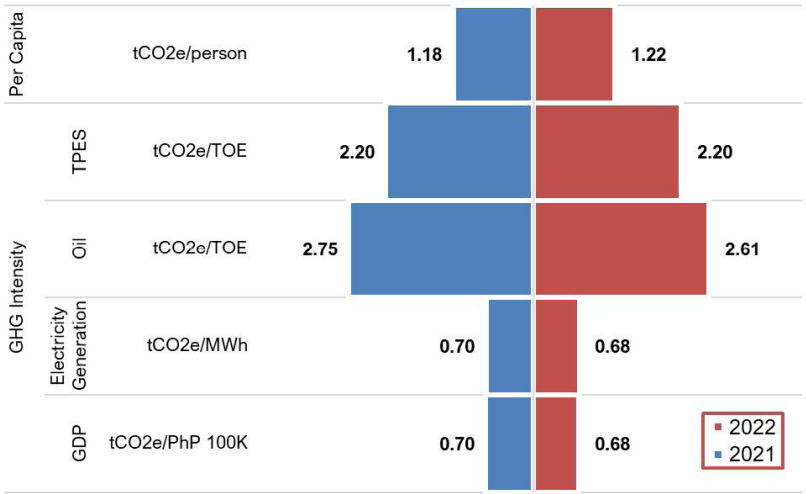
Elasticity. As the country's rate of economic expansion outpaced its energy requirement, economy-wide energy-to-GDP elasticity declined to 0.6 units in 2022 vis-à-vis 0.7 units from the previous year, while electricity-to-GDP was slightly lower at 0.7 units. These low elasticity values showed that the quantity of energy (overall) and electricity is less responsive to changes in economic output. On the other hand, oil-to-GDP stood at 1.5 units because of the strong domestic demand for oil and oil products that prevailed during the year.

Per Capita. Per capita levels of energy, electricity, and oil improved as pandemic restrictions were lifted during the year. Energy use per person rose by 3.4 percent to 0.6 TOE, while electricity (1.0 MWh/person) and oil (1.4 BBL/person) were higher by 3.8 percent and 9.9 percent, respectively than their 2021 levels *(Figure 37)*. Progress in per capita levels would imply that a greater proportion of the Filipino population had improved access to energy, including oil and electricity, during the year.

GHG Emission Indicators

Carbon intensity of energy supply, measured as the ratio of total GHG emission over total energy supply, remained constant at 2.2 tCO_2e/TOE, while the GHG emission per capita increased by 2.7 percent to 1.2 tCO_2e/person during the year attributed to the increase in energy per capita *(Figure 38)*. Consumption of oil products with a lesser carbon footprint contributed to the 4.9 percent decline in GHG intensity of oil consumption to 2.6 tCO_2e/TOE, while GHG intensity of power generation was lower by 1.8 percent at 0.68 tCO_2e/MWh vis-à-vis the previous year given the higher generation output from aggregate RE sources. Lastly, GHG emission per unit of economic output of a hundred thousand pesos went down by 3.3 percent to 0.68 tCO_2e/PhP100k, which indicated advances in the country's transition towards cleaner energy resources.

Figure 38. **Environmental Emission Indicators: 2021 vs 2022**



CHAPTER II
Energy Demand and Supply Outlook

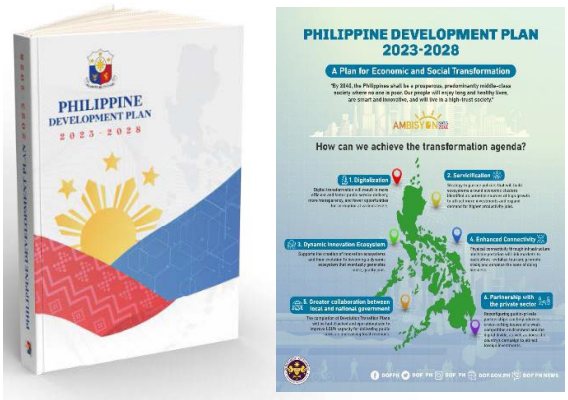
A. ENERGY DEMAND AND SUPPLY OUTLOOK

I. Methodologies and Assumptions

Socioeconomic Targets

The Energy Outlook incorporates socioeconomic assumptions consistent with the growth trajectory embodied in the medium-term Philippine Development Plan (PDP) 2023-2028 and anchored on the long-term vision of *AmBisyon Natin* 2040 that enables economic and social transformation for a prosperous, inclusive, and resilient society. The country sustains its 7.6 percent expansion in real gross domestic product (GDP) for 2022 and achieves its peak growth momentum of 8.0 percent by 2028. Moving towards the end of the planning horizon, the Philippine economy records average annual increments of 7.1 percent until 2050.

PDP 2023-2028: A Plan for Economic and Social Transformation



Source: DOF Website

This Energy Outlook uses other socioeconomic variables for assumptions and references consistent with previous editions. These include population, inflation rates, peso-dollar exchange rates and oil prices that are based on the (a) 2020 Census of Population (POPCEN) of the Philippine Statistics Authority (PSA), (b) Development Budget Coordinating Council (DBCC), (c) International Monetary Fund (IMF) and (d) World Oil Outlook (WOO) 2045 of the Organization of Petroleum Exporting Countries (OPEC).

Energy Demand and Supply Assumptions

Scenario Building

This Energy Outlook analyzes two (2) possible energy pathways for the country – the Reference Scenario (REF), which is also the Business-as-Usual (BAU) scenario wherein current energy policies are retained, and the Clean Energy Scenario (CES) which sets aggressive targets for the energy sector until 2050 *(Table 7)*, The Outlook also considers the Association of Southeast Asian Nations (ASEAN) and Asia-Pacific Economic Cooperation (APEC) regional targets on renewable energy (RE) shares[57] and improvement in energy intensity[58], as well as the attainment of Sustainable Development Goals (SDG) Goal 7 of ensuring access to affordable, reliable, sustainable, and modern energy for all. It sets 2022 as the base year, with 2023 as the first projection year.

Table 7. Demand and Supply Targets for Energy Outlook 2023-2050

	Scenario Assumptions	
	Reference Scenario (Business-as-Usual)	**Clean Energy Scenario (Alternative Scenario)**

Energy Demand	• Energy consumption levels support accelerated economic expansion.
	• Economy-wide energy intensity reduction in consistent with regional targets
	  ◦ Penetration rate of electric vehicles (EVs) for road transport: 10.0 percent by 2040 onwards
	  ◦ Current blending schedule for biofuels: 2.0 percent biodiesel and 10.0 percent bioethanol
	  ◦ Current efforts on energy efficiency and conservation (EEC) maintained
		Assumptions from the Reference Scenario, as well as the following:
		• Higher economy-wide reduction in energy intensity
		  ◦ Penetration rate of EVs for road transport expands to 50.0 percent by 2040 onwards
		  ◦ Biodiesel blending increases to 5.0 percent starting 2026
		  ◦ Energy savings from oil products and electricity use improve by 10.0 percent in 2040-2050 through heightened EEC activities

Energy Supply	• Current development trends and strategies continue.
	• List of Existing Power Plants and Committed Power Projects as of May 2023; WESM Registered Capacities as of May 2023
	• Reserve margin based on current reserve requirement (regulating, contingency and dispatchable reserve)
	• RE share in generation mix: at least 35.0 percent by 2030 and 50.0 percent by 2040 onwards
	  ◦ Capacity targets under the National Renewable Energy Program (NREP)
	  ◦ Capacity by grid under the Competitive RE Zone (CREZ)
	  ◦ Awarded contracts for RE
	• Indigenous production targets by 2050: Oil – 61.3 million barrels (MMB) at 2.3 MMB/year, Gas – 5.1 trillion cubic feet (TCF) at 0.2 TCF/year, Coal – 191 million metric tons (MMT) at 6.5 MMT/year
	• LNG imports augment domestic natural gas supply starting 2023.
		Assumptions from the Reference Scenario, including the following:
		• RE share in generation mix by milestone years: 35.0 percent by 2030, 50.0 percent by 2040, and more than 50.0 percent by 2050
		  ◦ Offshore Wind (OSW) awarded contracts scenario options
		  * 19 Gigawatt (GW) by 2050 (CES 1)
		  * 50 GW by 2050 (CES 2)
		• OSW by grid location[59]
		• Nuclear capacity: 1.2 GW by 2032; 2.4 GW by 2035; 4.8 GW by 2050
		• Technical life for coal plants sets at 40 years

Note: Reference date for energy and energy-related data, including socioeconomic indicators, used in the simulation for this Energy Outlook is 07 July 2023.

[57] *Under the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 aspirational targets: 23.0 percent share of RE in Total Primary Energy Supply (TPES) and 35.0 percent share of RE in installed power capacity by 2025. Meanwhile, APEC targets to double the share of RE in the energy mix by 2030 (with 2010 as base year).*
[58] *APEC target of 45.0 percent reduction in energy intensity by 2035 with 2005 as the base year period; and APAEC target of 20.0 percent energy intensity by 2020 and 32.0 percent by 2025 based on 2005 levels.*
[59] *World Bank. (2022). Offshore Wind Roadmap for the Philippines. Energy Sector Management Assistance Program. NW, Washington, DC:*

Methodologies and Energy Models

Energy Supply and Demand Outlook of this plan uses extensive energy modeling methodologies and tools.

Final Energy Consumption

Forecasting of final energy demand employs econometric models using Simple Econometric Simulation System, Expanded (Simple E^2, version 14) – an add-in application for MS Excel developed by the Institute of Energy Economics, Japan (IEEJ). The Simple E^2 integrates and controls native functions in MS Excel to provide various estimations, such as ordinary least squares (OLS), auto-regression, and non-linear. Groups (system) of equations, which can be simultaneously done, including forward-looking models, and can include various forms of regression models and defined equations.

Energy models also consider relevant factors and information that impact energy consumption by sector, such as:

- The **Transport** demand model separately estimates the four (4) modes of transportation such as road, rail, air, and water. The model for road transport uses the number of vehicles as a function of GDP, while the estimation of vehicle fleet employs the Winfrey Survival Model combined with average passenger and vehicle-kilometer traveled and fuel economy to derive energy consumption. The model for rail transport utilizes the number of passengers for the Philippine National Railways (PNR) and Metro Rail Transit/Light Rail Transit (MRT/LRT) lines and urban population as indicators. On the other hand, the indicators for water and air transport include the number of passengers, kilometer/ton-kilometer flown, cargo throughput, and sub-sectoral value-added. The Outlook also incorporates the expansion plans and new projects/programs of the Department of Transportation (DOTr) with the development in other related sectors, notably local tourism. The transport energy demand model of the Economic Consulting Associates (ECA)[60] which was also adopted for the 2050PH Calculator serves as a reference/validation model.

- The **Industry** demand model comprises energy-intensive and less-energy-intensive industry models. The energy-intensive industries cover food processing, sugar, paper and pulp industries, cement manufacturing, chemicals, basic metal, and machinery and equipment. Other manufacturing activities, mining, and construction fall under less-energy-intensive industries. Macroeconomic variables such as gross value added (GVA), commodity prices, population, as well as specific industry production targets and sectoral roadmaps serve as predictor variables in the regression models on a per fuel basis for each of the mentioned industry sub-sectors.

- The **Household** sector model considers socio-economic indicators, such as household final consumption expenditure (HFCE) and household population from the PSA in projecting energy consumption. Correlation between household cooking fuels (liquefied petroleum gas or LPG, electricity, kerosene, and traditional biomass) serves as the basis for the substitution effect on household fuels. The 2011 Household Energy Consumption Survey (HECS) data is the basis for traditional biomass demand.

- The **Services** and **Agriculture** sectors demand models utilize GVA for trade and services, and agriculture, fishery, and forestry (AFF), respectively, aside from other socio-economic factors.

Electricity demand models utilize gross regional domestic expenditure (GRDP), sectoral GVA per region, number of households and population through a bottom-up approach with disaggregation by grid (Luzon, Visayas and Mindanao). Peak demand estimates use the 2016 to 2022 average load factors by grid, i.e., 70.2 percent for Luzon, 70.2 percent for Visayas and 68.7 percent for Mindanao. Electricity demand is based on sales, which is the volume of energy sold by the distribution utilities (DUs) to their customers, and also covers those directly connected customers.

Fuel displacement for gasoline and diesel (and even ethanol and biodiesel) vis-à-vis electricity due to penetration of EVs based on the Comprehensive Electric Vehicle Industry (CREVI) Roadmap, and higher biofuel blend use direct estimation with data/indicators on average mileage, fuel economy and vehicle population.

[60] *Led by Prof. Ronwaldo del Mundo of the University of the Philippines' (UP) College of Engineering*

Power Demand and Supply Outlook

For the power outlook, the DOE relies on the Power System Planning and Market Simulation Software (PLEXOS) developed by the Energy Exemplar for Capacity Expansion Model (CEM). The CEM provides optimized projections of generation output and capacity consistent with the assumptions in *Table 8* and in conjunction with the scenario-specific assumptions from *Table 7*. On the demand side, the projected electricity sales including transmission and distribution losses (system losses) and own use of power plants are summed up to get the total power generation output.

Table 8. **Power Demand and Supply Outlook Assumptions**

Particulars	Inputs
Electricity Demand	• 2022 Hourly Demand from NGCP • 2023-2050 Demand Forecast • 2016-2022 average load factors of the Luzon, Visayas, and Mindanao grids for peak demand estimates
Generator Parameters	• List of Existing Power Plants and Committed Power Projects as of May 2023 • WESM Registered Capacities as of May 2023 • Operating parameters of existing power plants based on generation companies' submissions. • Reserve provision classified as Regulating, Contingency, and Dispatchable Reserves • Fuel Costs (Coal, Gas, Oil, and Uranium) • NASA MERRA weather data to generate Solar and Wind Profiles
New Build Options	• Large Gas, LNG Internal Combustion Engines, Biomass, WTE, Geothermal, Ground-mounted Solar, Roof-mounted Solar, Floating Solar, On and Offshore Wind, ROR, Impounding Hydro, Pumped Hydro, battery energy storage system (BESS), Nuclear, and Other Technologies are used for new build options • Costs are based on the 2022 National Renewable Energy Laboratory (NREL) database • CREZ parameters and Awarded Service Contracts as of June 2023 are set as limits for RE
Limitations	• Considers 3 major nodes for analysis: Luzon, Visayas, and Mindanao • RE Targets set to 35.0 percent share by 2030 and 50.0 percent by 2040 onwards in REF and more than 50.0 percent by 2050 under CES. • Interconnection between Leyte to Luzon HVDC and MVIP

Energy Outlook Simulation and Scenario Building

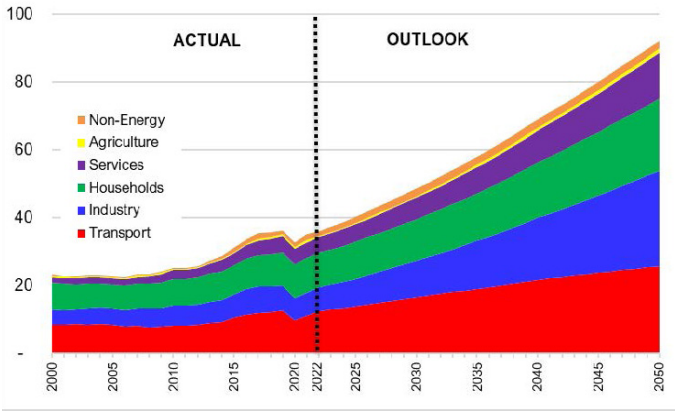
The Low Emissions Analysis Platform or LEAP (Long-range Energy Alternatives Planning System) developed by Stockholm Environment Institute (SEI) as an integrated modelling tool, incorporates the results of the models for energy demand and power outlook and reflects the current and future scenarios of resource extraction and production, and socioeconomic development. LEAP provides estimates for an overall energy outlook for each scenario as specified in *Table 7*. This tool also computes greenhouse gas (GHG) emissions using default emission factors and global warming potential with a time horizon of 100 years (GWP-100) by the Intergovernmental Panel on Climate Change (IPCC).

II. Reference Scenario

A. TOTAL FINAL ENERGY CONSUMPTION

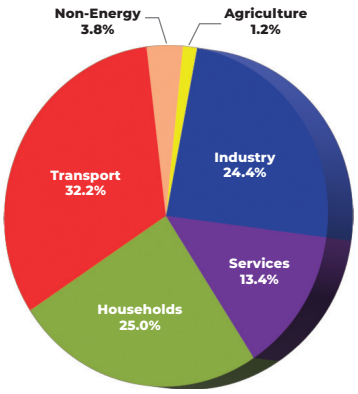
The country's TFEC[61] returns to its prepandemic levels in 2023 and records a level of 37.3 million tons of oil equivalent (MTOE). By 2050, TFEC reaches 90.6 MTOE at a rate of 3.4 percent per year across the planning horizon *(Figure 39)*. Of the 54.7 MTOE increase between 2022 and 2050, the industry sector requires more than one-third (37.2 percent), followed by the transport sector with 24.5 percent share. Households and services sectors account for 19.1 percent and 15.9 percent, respectively, while agriculture sector and non-energy use have the least contributions with an individual share of less than 2.0 percent.

Figure 39. **Total Final Energy Consumption by Sector (MTOE), 2000-2050**



Across the planning horizon, key growth sectors – industry, agriculture, and services, register the fastest increase in their respective energy consumption levels. The industry sector, with an average share of 24.4 percent *(Figure 40)*, leads with its 4.9 percent expansion as continuing growth in demand for industrial materials and the government's thrust for industrialization propels its energy requirement. Adoption of new agricultural innovations results in a 4.5 percent rise in energy use in the agriculture sector, while a robust and competitive business environment contributes to the 3.9 percent uptick in energy demand of the services sector. Efficiency measures slow down energy use in the transport and household sectors as they post 2.7 percent and 2.5 percent growths, respectively, albeit contributing a combined average share of 57.2 percent across the planning period. On the other hand, the volume of coal and oil products for non-energy use advances by 1.9 percent between 2022 and 2050.

Figure 40. **Total Final Energy Consumption by Average Shares Per Sector (Percent), 2022-2050**



Total Final Energy Consumption, by Fuel

Oil consumption increases by more than twice its 2022 level to 43.2 MTOE by 2050, expanding yearly at 3.1 percent *(Figure 41)*. Despite the country's continued reliance on oil products, its aggregate share to TFEC drops to 47.6 percent by end of the planning period vis-à-vis 50.9 percent in 2022. Transport holds its position as the most oil-intensive sector as its consumption of gasoline and diesel accounts for bulk of the total oil demand, with average shares of 24.9 percent and 31.7 percent, respectively.

[61] TFEC is the total energy consumed by the end-users such as households, industry, transport, services, and agriculture. Final energy is those that consumers purchase or receive such as electricity, and petroleum products (i.e. gasoline, diesel, kerosene, etc.). These are energy products and fuels that are converted from the primary energy form, i.e., fuels and energy source (RE) to electricity, crude oil to petroleum products., which incur losses during the conversion process due to their thermal efficiencies. These losses make the difference between TPES and TFEC. For further details, see pp. 23-25 of the Overview for the process flow of energy forms.

Figure 41. **Final Energy Consumption by Fuel, in TOE, 2020-2040**

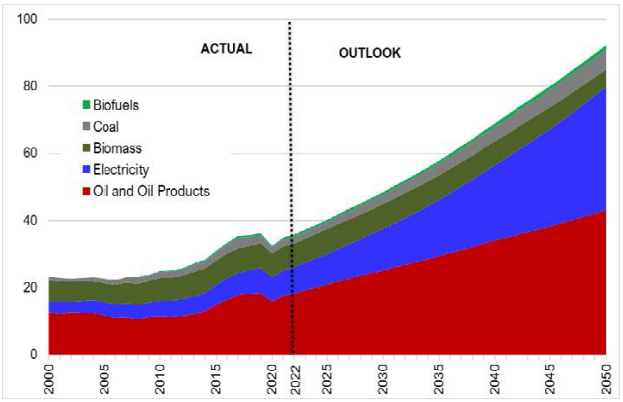
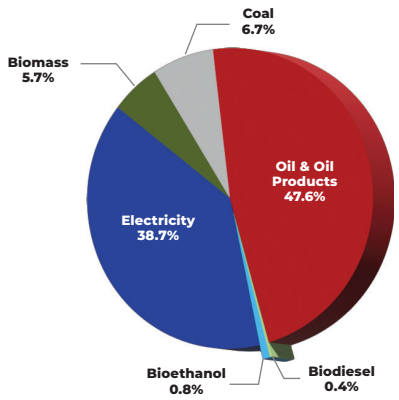


Figure 42. **Total Final Energy Consumption by Fuel Shares (Percent), 2050**



The aggregate consumption of coal for non-power applications (i.e., as fuel and/or raw material for various industrial processes) grows steadily by 4.2 percent to 6.1 MTOE by 2050 and represents a share of 6.7 percent to TFEC for the year. As the country's infrastructure development accelerates further, it sustains coal consumption in the cement and iron and steel subsectors to meet the demand for building materials.

Electricity demand accelerates the fastest at 5.5 percent per year, as levels rise almost five times from the 2022 level to 35.1 MTOE by 2050. Achievement of the government's targets on electrification and connectivity, growing preference towards electric vehicles (EVs) for road transport, and new operational mass rail transit lines across the country almost doubles the electricity's share in TFEC to 38.7 percent in 2050 from 21.9 percent in 2022 *(Figure 42)*. Electricity use in the transport sector speeds up by 14.5 percent, while industrial establishments and households account for a combined share of 51.4 percent out of the 27.2 MTOE additional electricity consumption between 2022 and 2050.

Demand for traditional biomass shrinks at a yearly rate of 1.2 percent across the planning horizon consistent with the transition to cleaner and more efficient fuels. Households, despite being the major user of traditional biomass, particularly for cooking and heating purposes, exhibit a yearly reduction of 2.4 percent from 2022 to 2050 as rising incomes support the growing preference for modern fuels such as electricity and LPG. On the other hand, biomass waste demand from food processing and sugar manufacturing subsectors, as well as from food service exhibit a moderate uptrend each year of 2.3 percent and 0.5 percent, respectively.

Physical connectivity infrastructures such as roads, bridges, seaports, airports, and mass transport accounts for 83.0 percent of the Build Better More (BBM) program.

Consistent with the government's decarbonization efforts is compliance with the mandated blending of 2.0 percent for biodiesel and 10.0 percent for bioethanol. It brings the level of aggregate biofuel consumption to double by 2050 at 1.1 MTOE and equates to a 2.3 percent yearly increase between 2022 and 2050.

Total Final Energy Consumption by Sector

Transport. Continuing the gains from the *Build, Build, Build* (BBB) programs to *Build Better More* (BBM) programs further expand infrastructure development nationwide, with high-impact priority projects that boost inter-connectivity and support the rising momentum of economic activities and regional development. As such, the energy requirement of the transport sector grows by 2.7 percent and reaches 25.7 MTOE by 2050. It contributes an average share of 32.3 percent to TFEC across the planning horizon *(Table 9)*.

Table 9. **Transport Final Energy Consumption, By Fuel (MTOE)**

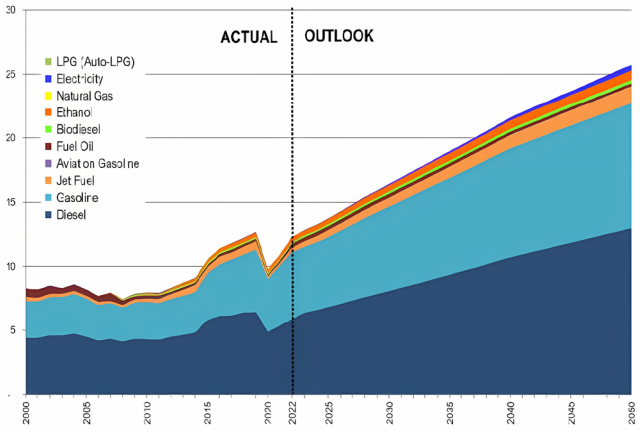
Fuel Type	2022		2030		2040		2050		2022-2050	
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares	AAGR (%)*	Avg. % Shares
Oil Products	**11.79**	**95.67**	**15.68**	**95.44**	**20.49**	**94.90**	**24.29**	**94.37**	**2.61**	**95.09**
LPG (Auto-LPG)	**	***	**	***	**	***	**	***	***	***
Aviation Gasoline	0.00	0.03	0.01	0.04	0.01	0.05	0.02	0.07	5.57	0.05
Gasoline	5.19	42.10	6.56	39.90	8.45	39.13	9.71	37.74	2.26	39.30
Jet Fuel	0.34	2.75	0.69	4.18	1.02	4.73	1.33	5.16	4.99	4.41
Diesel	5.94	48.17	8.12	49.41	10.74	49.76	13.00	50.51	2.84	49.75
Fuel Oil	0.32	2.62	0.31	1.90	0.27	1.23	0.23	0.89	-1.22	1.58
Biofuels	**0.52**	**4.25**	**0.66**	**4.04**	**0.86**	**3.99**	**1.00**	**3.90**	**2.35**	**4.00**
Biodiesel	0.12	0.95	0.16	0.98	0.21	0.98	0.26	1.00	2.85	0.98
Ethanol	0.41	3.30	0.50	3.06	0.65	3.01	0.75	2.90	2.20	3.02
Electricity	**0.01**	**0.08**	**0.09**	**0.52**	**0.24**	**1.11**	**0.45**	**1.73**	**14.47**	**0.90**
Total	**12.32**	**100**	**16.43**	**100**	**21.59**	**100**	**25.74**	**100**	**2.67**	**100**

**Average annual growth rates (AAGR), **values less than 0.01 MTOE, ***percent less than 0.1 percent*

Energy utilization for road transport accounts for 89.0 percent share of the sector's energy demand between 2022 and 2050 with the realization of key infrastructure flagship projects (IFPs) that provide upgraded roads, bridges, and urban mobility options.[62] Strong domestic tourism and trade activities drive the 5.0 percent and 2.1 percent acceleration in air and maritime transport, respectively. As new and additional mass railway systems come online across the archipelago, rail transport demand expands by 4.8 percent each year.

The transport sector relies heavily on oil products with an average share of 95.1 percent of its total energy demand between 2022 and 2050 *(Figure 43)*. Rising disposable income, improved purchasing power and efficient transport network are factors that contribute to robust vehicles sales. These developments result in yearly hikes in the volume of gasoline and diesel demand of 2.3 and 2.8 percent, respectively, across the planning timeline. Gasoline contributes an average share of 39.3 percent, while diesel accounts for 49.8 percent share of the transport sector's total energy demand. Consumption of fuel oil for inter-island maritime transport declines by 1.2 percent each year, while auto-LPG remains unpopular as its demand levels remain below 1.0 MTOE throughout the planning horizon.

Figure 43. **Transport Final Energy Consumption by Fuel (MTOE), 2000-2050**



Cognizant of the efforts towards low carbon transitioning of the transport sector, the government pushes for the increased utilization of alternative fuels, such as biofuels and electricity. Sustaining the mandated blend of 2.0 percent biodiesel and 10.0 percent bioethanol from 2022 to 2050 moves the country's aggregate biofuel demand towards 1.0 MTOE level in 2050, growing at 2.4 percent a year. Meanwhile, the CREVI sets forth the required policies for the commercial scale roll-out of EVs to achieve a 10.0 percent penetration rate by 2040 onwards under its Business-as-Usual (BAU) scenario, including putting up of necessary infrastructure for EV Charging Stations (EVCS). These developments, along with the operation of new rail systems across the country, propels the transport sector's

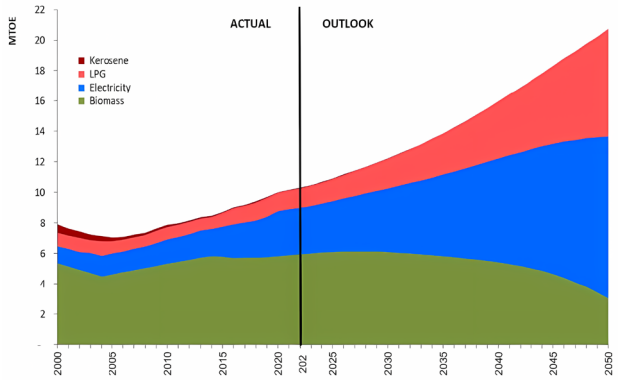
[62] *List of Physical Connectivity Infrastructure Flagship Projects (IFPs) https://neda.gov.ph/infrastructure-flagship-projects/*

electricity demand to reach 446.2 thousand tons of oil equivalent (kTOE) by 2050 from 10.1 kTOE in 2022, which translates to yearly increases of 14.5 percent.

Households. Both the PDP2023-2028 and *AmBisyon Natin* 2040 blueprints envision the country's transition from a low-middle to upper-middle income economy through inclusive and sustainable economic growth and accelerated human capital development for better job opportunities. These social gains translate to increased household income that encourages greater preference for modern energy sources. As household energy consumption increases by 2.5 percent and registers 20.7 MTOE level by 2050 *(Figure 44)*, the combined share of electricity and LPG stands at 85.4 percent vis-à-vis 14.5 percent aggregate share of traditional biomass and kerosene during the same period.

(from left to right): Perspectives of the Bataan-Cavite Interlink Bridge and New Manila International Airport (NMIA) in Bulacan; Portion of the Metro Manila Subway Project in Valenzuela (July 2023) and the Port of Calapan at Oriental Mindoro [Sources: ABS-CBN News, Department of Transportation (DOTr), Philippine Ports Authority (PPA)]

Figure 44. **Household Final Energy Consumption by Fuel (MTOE), 2000-2050**



Access to clean and modern fuels (electricity and LPG) improves as households transition from low- to uppermiddle income groups.

Household electricity demand posts a yearly increase of 4.6 percent, which translates to more than three-fold growth from 2022 level of 3.0 MTOE to 10.7 MTOE in 2050. With the achievement of the DOE's target of 100 percent household electrification by 2028 and the emerging prominence of "future ready" smart homes and cities as innovative, convenient, and eco-friendly living solutions, electricity takes on the role of primary fuel for most household activities. Significant gains among the number of *prosumer* households that are availing themselves of the government's net-metering program, including the shift to solar rooftop installations, ensure better access to affordable, reliable, sustainable, and modern energy.

The households' LPG requirement rises six (6) times its 2022 level of 1.3 MTOE to 7.1 MTOE in 2050 *(Table 10)*. The passage of Republic Act (RA) 11592 or the *LPG Industry Regulation Act*, which aims to regulate the domestic LPG gas industry and ensure consumer protection against malpractices, induces the 6.3 percent growth in the fuel's utilization, primarily for cooking and heating purposes.

Traditional biomass continues to be an important fuel among households and accounts for a 14.6 percent share in the demand mix for 2050 due to the practice of using multiple stove-and-fuel combinations called "fuel stacking". However, with shift towards modern and clean fuels such as electricity and LPG, traditional biomass consumption decreases by 2.4 percent between 2022 and 2050 and levels drop significantly from 6.0 MTOE in 2022 to 3.0 MTOE by the end of the planning horizon. Kerosene exhibits the same declining trend as its utilization contracts by 6.3 percent per year.

Smart living spaces and solar PV installations for households (left): Twin Oaks Place in Greenfield District in Mandaluyong City touted as the "first future-ready" home in the country; (right) solar net-metered community at Imperial Homes Corp.'s Via Verde Trece Martires development in Cavite. [Sources: Greenfield Development Corporation, Manila Standard]

Table 10. **Household Final Energy Consumption, By Fuel (MTOE)**

Fuel Type	2022		2030		2040		2050		2022-2050	
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares	AAGR (%) *	Avg.%Shares
Oil Products	**1.31**	**12.72**	**1.97**	**16.06**	**3.76**	**23.52**	**7.07**	**34.07**	**6.20**	**21.20**
LPG	1.27	12.27	1.94	15.83	3.75	23.42	7.06	34.03	6.33	21.03
Kerosene	0.05	0.44	0.03	0.23	0.02	0.09	0.01	0.04	-6.34	0.17
Electricity	**3.04**	**29.46**	**4.18**	**34.13**	**6.81**	**42.56**	**10.65**	**51.33**	**4.58**	**39.39**
Biomass	**5.96**	**57.82**	**6.10**	**49.81**	**5.43**	**33.92**	**3.03**	**14.60**	**-2.39**	**39.41**
Total	**10.31**	**100**	**12.24**	**100**	**16.00**	**100**	**20.75**	**100**	**2.53**	**100**

**Average annual growth rates (AAGR)*

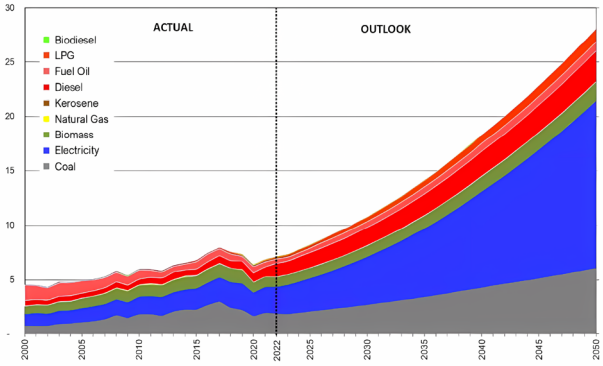
(top) Factory equipment for battery production and (bottom) software for energy management are among the technologies envisioned under the industry 4.0. (Source: Bosch Media Service)

Key Growth Sectors: Industry, Services and Agriculture

The country's robust economic growth momentum until 2050 hinges on the strong expansion of key growth sectors – industry, services, and agriculture. In addition to continuing policy reforms, the Regional Comprehensive Economic Partnership (RCEP), which opens a gateway of opportunities for increased market access, enhanced investment opportunities, and strengthened regional supply chains, presents an opportunity for the country to leverage its competitive advantages in priority sectors, while fostering innovation and technological advancements. These developments drive the uptrend in the energy requirement of the industry, services and agriculture sectors throughout the planning period.

Industry. Consistent with its thrust for industrialization under Industry 4.0, the government seeks to revitalize local industries by encouraging innovations and technology adoption (artificial intelligence (AI), smart manufacturing, [63] etc.), as well as business-matching and servification or embedding services into industries to add greater value to local products. These goals necessitate the 4.9 percent annual rate of expansion in the aggregate energy requirement of the industry sector – the fastest among end-use economic sectors throughout the planning period *(Figure 45)*.

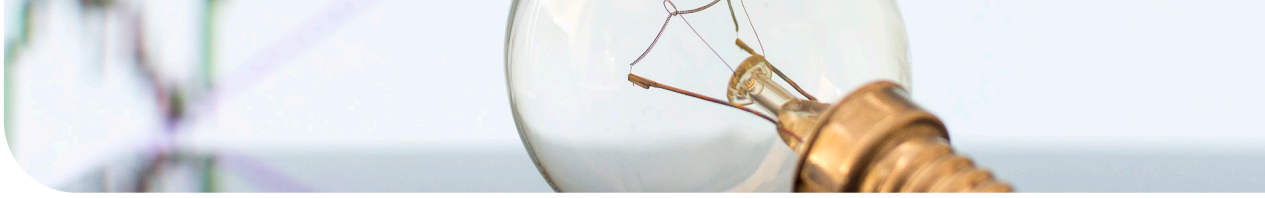
Figure 45. **Industry Final Energy Consumption by Fuel (MTOE), 2000-2050**



Electricity plays an important role in transitioning to Fourth Industrial Revolution (FIRe) or Industry 4.0 and accounts for more than half of Industry's energy requirement by 2050.

As the sector's demand level rises to 27.4 MTOE in 2050, it contributes close to one-third (30.3 percent) of TFEC during the year. With all industries using electricity to fuel their production processes, its aggregate utilization expands sixfold from 2022 level of 2.5 MTOE to 14.7 MTOE by 2050 and translates to a 6.6 percent annual rate of increase. Electricity plays an important role in

[63] *NEDA. (2023). PDP2023-2028 briefer. Philippine Development Plan. Retrieved September 19, 2023, from https://pdp.neda.gov.ph/wpcontent/uploads/2023/01/PDP-2023-2028-Briefer.pdf*



transitioning the sector to the fourth Industrial Revolution (Industry 4.0), which utilizes the Internet of Things (IoT), AI, cloud computing, and digital platforms in key manufacturing industries such that by the end of the planning period, it accounts for 53.6 percent of the sector's total energy requirement.

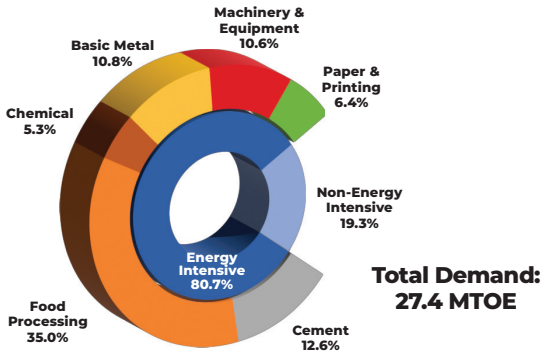
Amidst the momentum for the utilization of clean fuels, coal and oil still play a significant role in the sector with 21.9 percent and 17.8 percent shares by 2050, respectively, to the industry's TFEC. As these fuels heat-up boilers in the production and processing of various manufacturing industries, demand for coal and oil accelerates moderately at 4.3 percent and 3.6 percent per year, respectively, between 2022 and 2050 *(Table 11)*.

Table 11. **Industry Final Energy Consumption, By Fuel (MTOE)**

Fuel Type	2022		2030		2040		2050		2022-2050	
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares	AAGR (%) *	Avg. %Shares
Oil Products	**1.8**	**25.67**	**2.68**	**24.98**	**3.82**	**21.30**	**4.89**	**17.84**	**3.59**	**22.51**
LPG	0.2	2.85	0.41	3.86	0.77	4.30	1.20	4.36	6.55	4.01
Kerosene	0.0	0.16	0.02	0.22	0.03	0.18	0.04	0.14	4.47	0.19
Diesel	1.2	16.88	1.69	15.74	2.29	12.77	2.84	10.33	3.12	13.89
Fuel Oil	0.4	5.78	0.55	5.14	0.73	4.05	0.82	3.00	2.52	4.42
Coal	**1.8**	**26.11**	**2.69**	**25.10**	**4.27**	**23.79**	**6.02**	**21.93**	**4.29**	**24.13**
Biodiesel	**0.0**	**0.33**	**0.03**	**0.31**	**0.05**	**0.25**	**0.06**	**0.20**	**3.12**	**4.13**
Electricity	**2.4**	**34.90**	**4.31**	**40.23**	**8.43**	**46.97**	**14.72**	**53.64**	**6.57**	**44.39**
Biomass	**0.9**	**13.00**	**1.00**	**9.38**	**1.38**	**7.69**	**1.75**	**6.39**	**2.31**	**4.39**
Total	**7.1**	**100**	**10.71**	**100**	**17.95**	**100**	**27.44**	**100**	**4.94**	**100**

**Average annual growth rates (AAGR)*

Figure 46. **Industry Final Energy Consumption by Sub-Sector Shares (%): 2050**



Cement manufacturing accounts for the bulk of coal consumption in response to the robust demand for building materials as priority projects under various infrastructure development plans materialize across the planning horizon *(Figure 46)*. Diesel is the most consumed oil product and contributes 10.3 percent share to the industry's TFEC by 2050. Its demand level increases at a yearly rate of 3.1 percent to 2.8 MTOE by the end of the planning period owing to its use as fuel in machinery and equipment. On the other hand, the demand for LPG, fuel oil, and kerosene are also on an uptrend with annual increments of 6.6 percent, 2.5 percent, and 4.5 percent respectively. Biodiesel demand grows parallel to diesel in compliance with the mandated blending rate and registers a 3.1 percent hike per year between 2022 and 2050. The requirement for biomass[64] as fuel primarily for food processing and sugar manufacturing doubles to 1.8 MTOE by 2050 from its 2022 level of 0.9 MTOE.

Services. The services sector continues to be the backbone and main driver of economic growth. Conscious of this vital role, the sector's transition into a modern, productive, and resilient sector providing higher value-added and differentiated services requires harnessing the potential of the Philippines creative industries, information technology, and business process management sectors as key players in global value chains. These robust growth prospects drive the 4.0 percent acceleration in the sector's aggregate energy demand as levels reach 13.2 MTOE by 2050 *(Figure 47)*.

Arthaland Century Pacific Tower *is among the most highly sought-after global business addresses in BGC. It is a LEED Platinum and BERDE 5-star certified building (the highest categories in both green building rating standards), on track for WELL v2 certification, and stands as the world's first EDGE Zero Carbon certified project (Source: Arthaland Properties website)*

[64] *Includes charcoal, fuelwood, rice hull, bagasse, agriculture, and animal waste.*

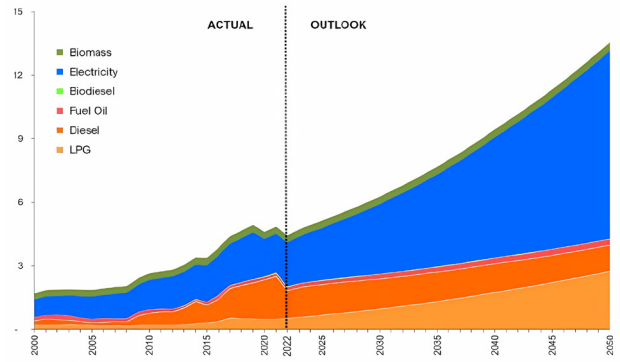
Electricity supports majority of the sector's energy requirement across the planning timeline. Technological innovations drive the growing demand for smart buildings and workspaces with digital tools for seamless collaboration and data-driven decisions, including cutting-edge facilities and equipment for efficient performance of service establishments. As such, demand for electricity ramps up by 5.1 percent and reaches 8.5 MTOE by 2050 vis-à-vis 2.1 MTOE in 2022 and results in an additional 17.5 percentage points in its share of the sector's energy demand mix *(Table 12)*.

Table 12. **Services Final Energy Consumption, By Fuel (MTOE)**

Fuel Type	2022		2030		2040		2050		2022-2050	
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares	AAGR (%) *	Avg. %Shares
Oil Products	**2.00**	**45.04**	**2.61**	**42.10**	**3.37**	**36.69**	**4.28**	**32.56**	**2.75**	**38.98**
LPG	0.51	11.55	0.98	15.73	1.75	19.07	2.76	20.96	6.18	17.33
Diesel	1.32	29.60	1.42	22.90	1.36	14.77	1.23	9.35	-0.24	18.57
Fuel Oil	0.17	3.89	0.22	3.47	0.26	2.84	0.29	2.24	1.92	3.08
Biodiesel	**0.03**	**0.58**	**0.03**	**0.45**	**0.03**	**0.29**	**0.02**	**0.18**	**-0.24**	**0.37**
Electricity	**2.09**	**46.93**	**3.22**	**51.81**	**5.43**	**59.03**	**8.47**	**64.39**	**5.13**	**55.88**
Biomass	**0.33**	**7.45**	**0.35**	**5.64**	**0.37**	**3.99**	**0.38**	**2.87**	**0.46**	**4.77**
Total	**4.45**	**100**	**6.21**	**100**	**9.19**	**100**	**13.16**	**100**	**3.95**	**100**

**Average annual growth rates (AAGR)*

Figure 47. **Services Final Energy Consumption by Fuel (MTOE): 2000-2050**



Aggregate consumption of oil rises steadily at 2.8 percent per year to 4.3 MTOE by 2050 and accounts for about a third (32.6 percent) of the demand mix for the same year. With an increasing number of service establishments adopt solar PV systems as a clean and sustainable energy source for back-up power, diesel loses its viability as fuel for generators and declines at an annual rate of 0.2 percent across theplanning horizon. Maintaining a 2.0 percent blending schedule for biodiesel results in consumption level that is also on a downtrend as it drops to 24 kTOE in 2050. On the other hand, LPG use, particularly among food services establishments and other similar businesses, speeds up by 6.2 percent between 2022 and 2050, while fuel oil grows modestly by 1.9 percent during the same period. Biomass completes the sector's demand mix with 378 kTOE consumption in 2050.

Agriculture. The agriculture sector has a critical role in economic growth and development since ensuring food security and ending hunger are key goals towards societal transformation, while its modernization is an essential condition in achieving the country's industrialization goals. Conscious of these needs, the government has set forth a National Agricultural and Fisheries Modernization and Industrialization Plan (NAFMIP) as a directional plan that steers sector-wide growth and guides the trajectory of more detailed and operations-oriented and technology-driven agri-fishery development plans such as the Commodity System

(top) Factory equipment for battery production and (bottom) software for energy management are among the technologies envisioned under the industry 4.0. (Source: Bosch Media Service)

[64] *Includes charcoal, fuelwood, rice hull, bagasse, agriculture, and animal waste.*

Roadmaps, Provincial Commodity Investment Plans (PCIPs), and Comprehensive Land Use Plans (CLUP).[65] These transformational initiatives propel the 4.5 percent increase in the agriculture sector's total energy consumption to 1.3 MTOE by 2050 – more than three (3) times its 2022 level of 0.4 MTOE *(Figure 48)*.

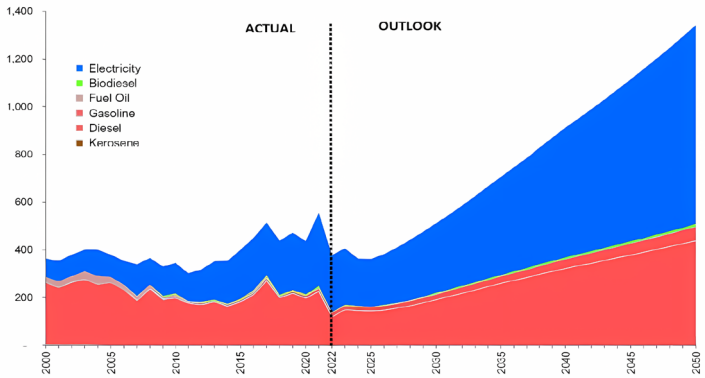
Table 13. **Agriculture Final Energy Consumption, By Fuel (kTOE)**

Fuel Type	2022		2030		2040		2050		2022-2050	
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares	AAGR (%) *	Avg. %Shares
Oil Products	**139.26**	**36.81**	**215.96**	**42.69**	**362.93**	**40.87**	**499.47**	**38.28**	**4.67**	**41.19**
Kerosene	0.14	0.04	0.01	0.00	**	***	**	***	-40.22	***
Diesel	120.61	31.88	192.83	38.12	323.42	36.42	438.27	33.59	4.72	36.64
Gasoline	17.45	4.61	22.75	4.50	39.08	4.40	60.71	4.65	4.55	4.47
Fuel Oil	1.05	0.28	0.37	0.07	0.43	0.05	0.50	0.04	-2.65	0.07
Biodiesel	**2.38**	**0.63**	**3.80**	**0.75**	**6.38**	**0.72**	**8.65**	**0.66**	**4.72**	**0.72**
Electricity	**236.69**	**62.56**	**286.13**	**56.56**	**518.73**	**58.41**	**796.67**	**61.06**	**4.43**	**58.09**
Total	**378.33**	**100**	**505.90**	**100**	**888.04**	**100**	**1,304.78**	**100**	**4.52**	**100**

**Average annual growth rates (AAGR), **values less than 0.01 kTOE, ***shares less than 0.01 percent*

Upgrades in agricultural production and activities from being resource-based to technology-based drive the growth in the sector's energy requirement. Electricity expands at an annual rate of 4.4 percent to 0.8 MTOE in 2050, while diesel rises slightly faster at 4.7 percent per year and reaches 0.4 MTOE by the end of the planning horizon *(Table 13)*. The realization of the Philippine Center for Postharvest Development and Mechanization (PHilMech) target of achieving a level of at least four horsepower (hp) per hectare (ha)[66] and the adoption of smart farming technologies push the aggregate share of electricity and diesel to 94.7 percent of the agriculture sector's energy requirement in 2050. Gasoline and other oil products complete the range of fuels for the production, harvesting, and other agriculture-related processes. Utilization of gasoline, specifically in the fishery sub-sector, exhibits an upward trend towards 61 kTOE by 2050 and offsets the reductions in fuel oil (2.7 percent) and kerosene (40.2 percent) compared to their 2022 levels.

Figure 48. **Agriculture Final Energy Consumption by Fuel (MTOE): 2000-2050**



B. TOTAL PRIMARY ENERGY SUPPLY

The level of TPES under the Reference Scenario reaches 140.5 MTOE in 2050 from 61.6 MTOE in 2022. It exhibits an annual growth rate of 3.0 percent from 2022 to 2050 *(Table 14)*.

[65] *BFAR. (2023, June 23). National Agriculture and Fisheries Modernization and Industrialization Plan 2021-2030. Retrieved September 19, 2023, from https://www.bfar.da.gov.ph/wp-content/uploads/2022/08/06232022_NAFMIP-2021-2030.pdf*

[66] *Why today's farmers need to mechanize. (n.d.). Philippine Center for Postharvest Development and Mechanization. Retrieved September 23,2023, from https://www.philmech.gov.ph/?page=story_full_view&action=story_fullview&recordID=202282484053AMa6f3cd&recordCategory=RCEF#gsc.tab=0*

Table 14. **Total Primary Energy Supply, By Fuel (MTOE)**

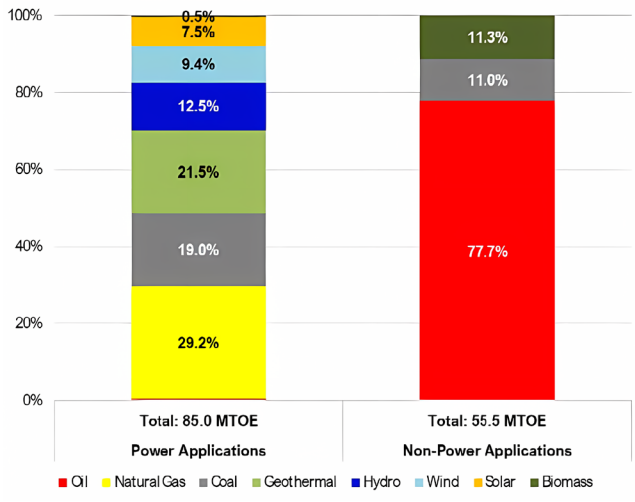
Fuel Type	2022		2030		2040		2050		AAGR (%) *
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares	2022-2050
Coal	**19.08**	**30.99**	**22.63**	**28.40**	**22.43**	**20.83**	**22.28**	**15.86**	**0.56**
Natural Gas	**2.61**	**4.24**	**4.92**	**6.18**	**10.83**	**10.06**	**24.82**	**17.67**	**8.37**
Oil-based	**19.83**	**32.22**	**25.58**	**32.10**	**34.50**	**32.05**	**43.50**	**30.96**	**2.84**
Renewable	**20.04**	**32.55**	**26.56**	**33.33**	**39.89**	**37.06**	**49.89**	**35.51**	**3.31**
Geothermal	8.96	14.56	12.36	15.51	16.23	15.08	18.30	13.03	2.58
Hydro	2.51	4.08	2.70	3.39	6.65	6.18	10.59	7.54	5.27
Wind	0.09	0.14	1.34	1.69	4.21	3.91	7.98	5.68	17.44
Solar	0.16	0.25	1.54	1.94	4.30	3.99	6.34	4.51	14.13
Biomass	7.73	12.56	7.88	9.89	7.56	7.02	5.60	3.98	-1.15
Biofuels	0.59	0.95	0.73	0.91	0.94	0.87	1.09	0.78	2.24
Total	**61.56**	**100**	**79.69**	**100**	**107.65**	**100**	**140.50**	**100**	**2.99**
Self-Sufficiency (%)		**49.4**		**49.5**		**41.6**		**38.9**	

**Average annual growth rates*

Oil remains the country's main energy source, albeit with a slightly lower share of the energy mix in 2050 at 31.0 percent vis-à-vis 32.2 percent share in 2022. The bulk of oil supply supports the steady demand for oil and oil products, particularly from the transport sector. Coal supply expands slowly by 0.6 percent as its utilization for power generation diminishes across the planning period because of decarbonization targets. LNG imports augment natural gas supply and result in an 8.4 percent increase in levels between 2022 and 2050. The transition towards cleaner fuels, especially in power generation, sustains the 3.3 percent expansion in aggregate RE supply. Wind and solar post double-digit growths of 17.4 percent and 14.1 percent, respectively, while geothermal and hydro also add up to the increase in RE shares from 32.6 percent in 2022 to 35.5 percent by the end of the planning period. On the other hand, biomass supply contracts by 1.2 percent as demand for clean fuel for cooking improves, particularly in the household sector.

Energy Supply for Power Application. Total supply requirement for power generation, i.e., fuel input, grows at an average rate of 3.5 percent from 32.7 MTOE in 2022 to 85.0 MTOE in 2050. Combined RE sources constitutes the bulk (51.3 percent share) of the fuel input mix in 2050 as it increases yearly by 4.6 percent. Natural gas accounts for more than a quarter (29.2 percent) of the 2050 fuel input mix and accelerates by 8.5 percent across the planning horizon (Figure 49). Given the shift towards low-carbon energy resources, coal supply for power generation contracts yearly by 0.2 percent and loses 33.3 percentage points in its share to the fuel input mix between 2022 (52.4 percent) and 2050 (19.0 percent). Oil remains the least contributor to fuel input with 0.4 percent share, while its levels decline by 3.0 percent towards the end of the planning period as energy storage systems (ESS) are more favored to maximize the electricity supplied by RE.

Figure 49. **2050 Energy Supply for Power and Non-Power Applications: By Fuel Shares (%)**



Note: Biomass for non-power includes biofuels

Energy Supply for Non-Power Application. Close to two-fifths (39.5 percent) of the TPES in 2050 provides for the country's non-power requirements. Oil accounts for 77.7 percent of the total energy supply for non-power applications, while both coal and biomass (including biofuels) contribute around 11.0 percent share.

Indigenous Supply

The country's indigenous energy supply exhibits yearly increments of 2.1 percent and reaches 54.7 MTOE in 2050, from 30.4 MTOE in 2022 *(Figure 50)*. Total RE production more than doubled to 49.4 MTOE between 2022 and 2050 and constitutes 90.3 percent of domestic energy production in 2050.

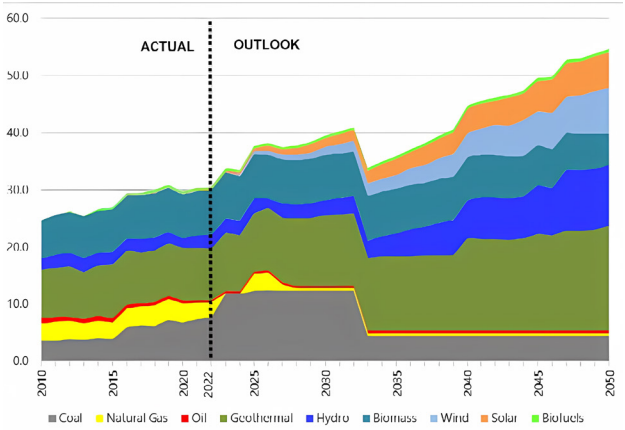
- ### Fossil Fuels

Domestic oil supply level grows slowly by 0.5 percent across the planning horizon. With the increasing supply volume of renewables, oil contributes a small share of 0.8 percent to total indigenous energy in 2050. Other potential crude oil areas in addition to Galoc and Alegria oil fields sustain domestic oil production at 2.3 MMB per year between 2022 and 2050.

Indigenous coal contributes a diminished 8.0 percent share to total domestic energy production in 2050 vis-à-vis 25.1 percent in 2022. Domestic coal production level drops to 4.4 MTOE in 2050 compared to 7.6 MTOE in 2022 with yearly contractions of 2.0 percent. Despite the downtrend, local coal targets a yearly production output of 6.5 MMT and continues to provide for the coal requirement of some power plants, as well as in the cement and basic metal subsectors.

With declining reserves of the Malampaya gas fields, **natural gas** share to indigenous supply stands at 1.0 percent in 2050, as levels post a 5.3 percent annual rate of reduction to 0.6 MTOE in 2050 in comparison to 2.6 MTOE in 2022. The government is keen to explore other potential natural gas fields consistent with the target production level of 0.2 TCF/year.

Figure 50. **Total Indigenous Energy Supply, by Fuel (MTOE), 2010-2050**



- ### Renewable Energy

Geothermal energy level doubles to 18.3 MTOE by 2050 from 9.0 MTOE in 2022. It maintains its pivotal role as a major RE resource with steady increments of 2.6 percent across the planning horizon. With an additional capacity of 1.4 GW by 2050, geothermal continues to augment the country's electricity needs. The DOE leads in the "Geothermal De-risking Roadmap for the Philippines" that seeks to identify, evaluate, and recommend pre-development stage de-risking strategies in assessing and prioritizing policies and regulations that can increase geothermal development in the country.[67]

By 2050, **hydro** supply level rises more than four times to 10.6 MTOE from 2022 level of 2.5 MTOE and provides reliable source of electricity and as an ESS through pump storage technology. With 10.3 GW of additional capacities coming online across the planning horizon, hydro supply registers a 5.3 percent expansion and an improved share of 19.4 percent to total indigenous production by 2050.

50% RE shares by 2040 and onwards sustains energy security, with lesser reliance on imported fuels.

Solar and wind assume their new roles as significant drivers of the country's energy transition throughout the planning horizon. **Solar** production output soars at 14.1 percent per year as levels increase from 0.2 MTOE in 2022 to 6.3 MTOE. Mainstreaming of solar technology propels the 11.0 percentage points increase in its share of total domestic energy production by 2050. The country's solar power industry attracts massive investment interest that pushes total installed capacity to 56.5 TW by the end of the planning period vis-a-vis 1.5 TW of capacity in 2022. **Wind** energy takes a double-digit growth of 17.4 percent yearly as its supply reaches 8.0 MTOE by 2050. Effectiveness of landmark policies on offshore wind (OSW) shows in the remarkable increase in wind capacity of more than 30 GW between 2022 and 2050.

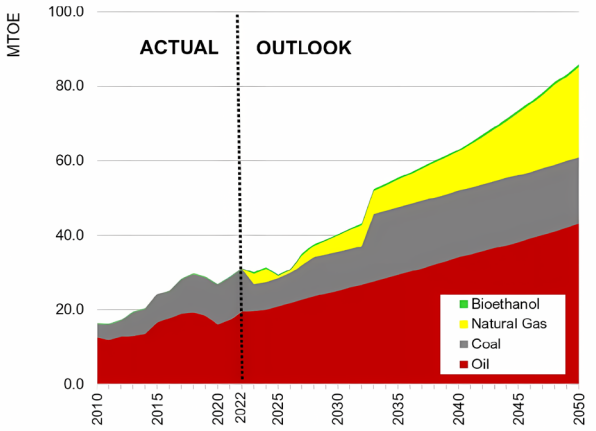
[67] *With technical assistance from the Asian Development Bank (ADB)*

Consistent with the shift towards modern and clean fuels, traditional **biomass**[68] supply suffers yearly declines of 1.1 percent, while its share of total domestic energy production in 2050 drops by more than half to 10.2 percent vis-à-vis 25.4 percent share in 2022. The downtrend stems from its reduced utilization among end-use sectors, particularly households. Of the 5.6 MTOE biomass supply levels in 2050, 0.4 MTOE serves as fuel input to power generation for the 92 MW additional capacities to come online across the planning period.

Domestic production of **biofuels** stands at 0.6 MTOE in 2050 and completes the total indigenous energy mix with a share of 1.0 percent. In response to maintaining the current blending schedule for both bioethanol and biodiesel, total biofuel supply moves slowly at 0.1 percent between 2022 and 2050.

Net Energy Imports

Figure 51. **Net Energy Imports, By Fuel (MTOE), 2020-2050**



Net energy imports register yearly gains of 3.7 percent, as levels rise to 85.8 MTOE by 2050 vis-à-vis 31.1 MTOE in 2022. It accounts for 61.1 percent of the country's TPES by the end of the planning period.

Net oil imports lead with an average share of 57.3 percent between 2022 and 2050 *(Figure 51)*. To meet the robust demand for non-power uses, net oil imports rise at an annual rate of 2.9 percent to 43.1 MTOE, or more than double the 2022 level of 19.5 MTOE.

Coal's sustained utilization in various industrial processes propels the 1.6 percent steady increase in its net import volume towards 17.9 MTOE by 2050. Despite the reduction in coal requirement for power generation, it remains a significant energy source and contributes an average share of 27.1 percent to net energy imports across the planning horizon.

LNG imports augment the country's demand for natural gas and compensate for the declining domestic output from Malampaya and other gas fields vis-à-vis its increased utilization as a transition fuel for power generation. As such, LNG imports accelerate by 8.3 percent per year, while levels leap from zero volume in 2022 to 24.3 MTOE by 2050. The country expects to fully operate seven (7) LNG projects (storage and receiving facilities, import terminals, and regasification facilities across the planning period with total capacities of around 22 MTPA.

Commercial operation of the seven (7) LNG projects between 2022 and 2050 provides the needed infrastructure for LNG imports.

Maintaining the 10.0 percent bioethanol blend across the planning period drives the volume of ethanol imports to 0.5 MTOE by 2050 from 0.2 MTOE in 2022. It contributes an average share of 0.7 percent to net energy import mix over the planning period.

C. POWER DEMAND AND SUPPLY

Electricity Sales

Total electricity sales expand more than four times its 2022 level of 91.3 terawatt-hours (TWh) at an annual rate of 5.5 percent to 408.1 TWh by 2050. As the bulk of economic activities remain concentrated in the Luzon grid, it consistently contributes the largest share (more than 70.0 percent) of total electricity sales between 2022 and 2050.

[68] *Includes charcoal, fuelwood, rice hull, bagasse, agriculture, municipal and animal waste.*

Peak Demand

With the uptrend in electricity sales, total peak demand increases more than three times its 2022 level of 16.6 gigawatts (GW) to 68.5 GW by 2050, which corresponds to an annual average growth rate of 5.2 percent (Table 15). With its robust regional growth prospects, the Visayas grid outpaces the other two grids with a 5.6 percent expansion in peak demand, while the Luzon grid accounts for bulk of the country's total peak demand at an average share of 70.0 percent across the planning horizon.

Table 15. **Peak Demand and Electricity Sales**

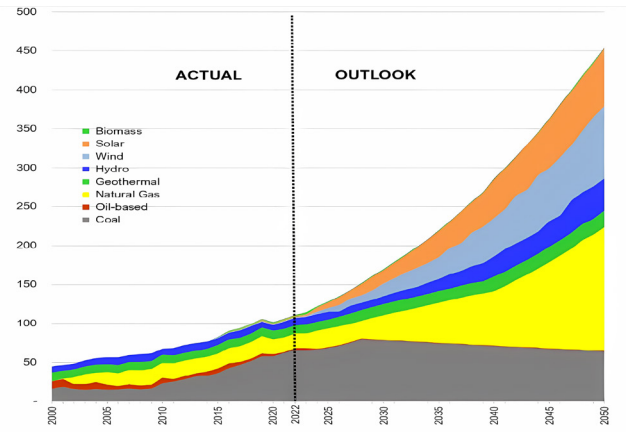
Year	Luzon		Visayas		Mindanao		Philippines	
	Peak Demand (MW)	Electricity Sales (GWh)	Peak Demand (MW)	Electricity Sales (GWh)	Peak Demand (MW)	Electricity Sales (GWh)	Peak Demand (MW)	Electricity Sales (GWh)
2022	12,113	67,536	2,316	11,866	2,167	11,931	16,596	91,333
2028	16,149	90,901	3,280	17,085	3,153	16,811	22,582	124,797
2030	18,038	101,777	3,753	19,710	3,585	18,973	25,376	140,459
2040	29,984	177,810	6,634	37,729	6,140	33,647	42,758	249,186
2050	48,014	290,557	10,678	63,260	9,791	54,240	68,483	408,057
AAGR (%)*	**5.04**	**5.35**	**5.61**	**6.16**	**5.53**	**5.56**	**5.19**	**5.49**

**Average annual growth rates for 2022-2050; sales exclude system's losses and own use*

Total Gross Generation

The total gross generation accelerates at an annual rate of 5.1 percent and rises to 453.8 TWh from its 2022 level of 111.5 TWh *(Figure 52 and Table 16)* to meet the demand requirements. Aggressive promotion of RE technologies, particularly solar and wind, as means to achieve the target RE shares of 35.0 percent by 2030 and 50.0 percent by 2040 onwards result in heightened RE contributions of 59.6 TWh in 2030, 144.8 TWh in 2040 and 230.2 TWh in 2050. Milestone policies and strategies, such as the sustained implementation of the coal moratorium and utilization of LNG as a transition fuel, also contribute to the significant shift in the country's power generation mix. Full commercial operation of the seven LNG projects likewise ensures sufficient supply for the country's power generation requirements.

Figure 52. **Gross Generation Output by Fuel (TWh), 2000-2050**



Solar and wind generation output levels register the fastest increase with double-digit average growths of 17.4 percent and 14.1 percent, respectively. Solar generation output expands from 18.0 TWh in 2030 to 73.7 TWh by 2050, while aggregate generation from onshore and offshore wind ramps up to 92.8 TWh by 2050 compared to 15 TWh in 2030.

RE and natural gas drives energy transition in the power generation with their combined aggregate share of more than 80% in the generation mix by 2050

Energy transition in the power generation sector takes place as coal generation output drops at a yearly rate of 0.1 percent, while both total RE and natural gas generation outputs expand by more than 8.0 percent between 2022 and 2050. Coal registers a sizeable decline in its share in the generation mix - from 59.6 percent share (66.4 TWh) in 2022 to 14.1 percent share (63.8 TWh) in 2050. With committed coal-fired power plants (CFPPs) still in the pipeline until 2030, coal's share to power mix stands at 49.5 percent (78.2 TWh) but declines further to 24.9 percent (71.2 TWh) by 2040.

The RE targets centered on variable RE or VRE such as solar and wind, provide an opportunity for ESS to support the grid stability due to intermittent supply. Starting in 2030, the grid requires 65 GWh from BESS and expands to 466 GWh by 2040 and 1,021 GWh by 2050.

Table 16. Gross Generation Output, By Fuel (TWh)

Fuel Type	2022		2030		2040		2050		AAGR* (%)
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares	2022-2050
Coal	**66.43**	**59.57**	**78.18**	**45.90**	**71.17**	**24.86**	**63.77**	**14.05**	**-0.15**
Natural Gas	**17.88**	**16.04**	**31.48**	**18.48**	**69.26**	**24.19**	**158.76**	**34.98**	**8.11**
Oil-based	**2.52**	**2.26**	**1.07**	**0.63**	**1.06**	**0.37**	**1.06**	**0.23**	**-3.03**
Renewable	**24.68**	**22.13**	**59.62**	**35.00**	**144.82**	**50.58**	**230.23**	**50.73**	**8.30**
Geothermal	10.42	9.35	14.38	8.44	18.88	6.59	21.29	4.69	2.58
Hydro	10.08	9.04	10.53	6.18	25.95	9.06	41.30	9.10	5.16
Wind	1.03	0.92	15.63	9.17	49.00	17.11	92.76	20.44	17.44
Solar	1.82	1.63	17.96	10.54	49.99	17.46	73.72	16.24	14.13
Biomass	1.32	1.19	1.12	0.66	1.00	0.35	1.16	0.26	-0.47
Total	**111.52**	**100**	**170.35**	**100**	**286.31**	**100**	**453.81**	**100**	**5.14**
BESS			**0.06**		**0.47**		**1.02**		**11.00**

**Average annual growth rates*

Total Installed Capacity

The uptrend in electricity sales and resulting power generation requires an additional capacity of 122.7 GW by 2050 constituting committed and new build power generation. It brings the country's total installed generating capacity to 151.0 GW for the same year and translates to a 6.2 percent annual rate of increase from the 2022 installed generating capacity level of 28.3 GW. *(Figure 53 and Table 17)*. Installed capacity from BESS also expands remarkably from 156 MW in 2022 to 3.8 GW by 2050 as this will complement the intermittency of VREs.

Figure 53. **Installed Generating Capacity, By Fuel (MW), 2023-2050**

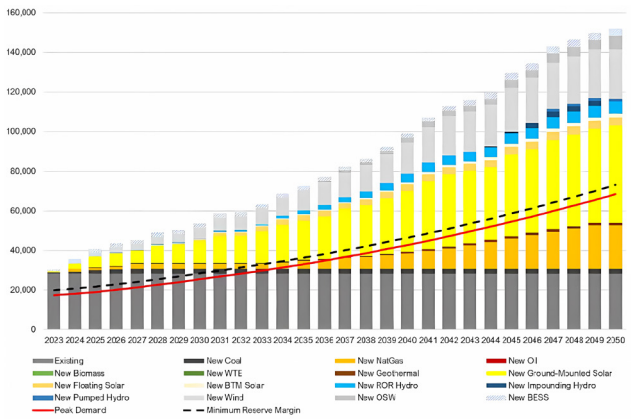


Table 17. Installed Capacity, By Fuel (MW)

Fuel Type	Total Capacity		Capacity Additions				Total Capacity	
	2022		2023-2028		2029-2050		2050	
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares
Coal	**12,428**	**43.98**	**2,305**	**12.44**	**-**	**-**	**14,733**	**9.76**
Natural Gas	**3,732**	**13.21**	**2,413**	**13.02**	**19,468**	**18.69**	**25,613**	**16.97**
Oil	**3,834**	**13.57**	**20**	**0.11**	**-**	**-**	**3,854**	**2.55**
Renewable	**8,265**	**29.25**	**13,791**	**74.43**	**84,712**	**81.31**	**106,768**	**70.72**
Geothermal	1,952	6.91	425	2.29	930	0.89	3,307	2.19
Hydro	3,745	13.25	295	1.59	9,970	9.57	14,011	9.28
Wind	427	1.51	3,700	19.97	28,142	27.01	32,269	21.37
Solar	1,530	5.41	9,328	50.35	45,620	43.79	56,478	37.41
Biomass	611	2.16	42	0.23	50	0.05	703	0.47
Total	**28,259**	**100**	**18,528**	**100**	**104,810**	**100**	**150,967**	**100**
BESS	**156**	**-**	**2,080**	**-**	**1,544**	**-**	**3,780**	**-**

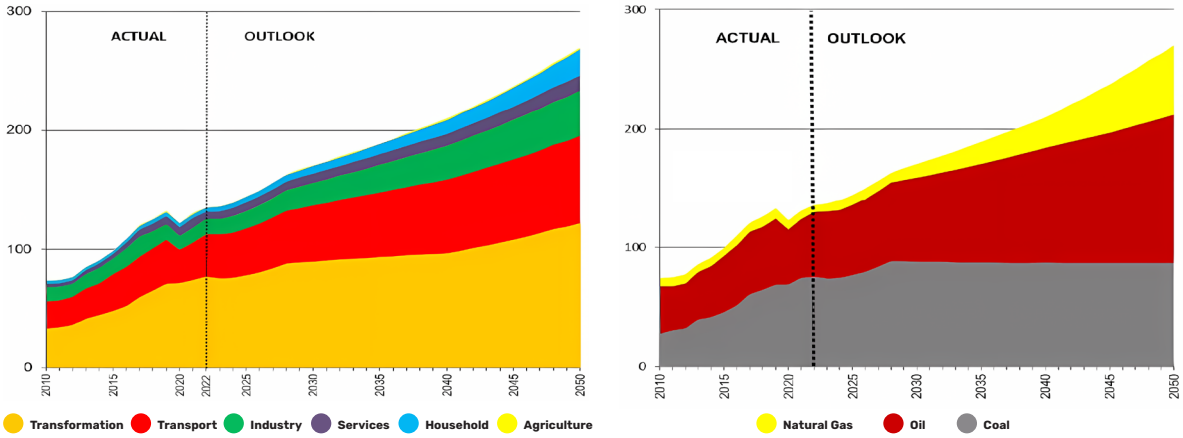
Note: The reference date for 2022 total capacity is 07 July 2023

The RE capacities constitute 70.7 percent (106.7 GW) of the installed generating capacity by the end of the planning horizon, wherein wind and solar have significant shares of 21.4 percent (32.3 GW) and 37.4 percent (56.5 GW), respectively. Natural gas, as a transition fuel, contributes 17.0 percent with capacity additions of 21.9 GW between 2022 and 2050. The advisory on coal moratorium impedes the deployment of new capacity for coal except for the projects that are already in the pipeline and scheduled between 2023-2027. The shares of coal and oil decline to 9.8 percent and 2.6 percent, respectively, in 2050.

D. GREENHOUSE GAS (GHG) EMISSIONS

Energy supply and demand dynamics translate to doubling of the GHG emission to 270.1 million metric tons of CO2 equivalent ($MtCO_2e$) in 2050 compared to its 2022 level of 135.7 $MtCO_2e$. With the shift towards RE and natural gas as primary fuels for power generation, the GHG emission in the transformation sector grows steadily at 1.6 percent across the planning horizon. Its share in total GHG emissions drops to 45.2 percent in 2050 from 57.1 percent in 2022 consistent with the decarbonization target in power generation. Increased energy consumption in the industry and transport sectors results in yearly increase of 4.0 percent and 2.6 percent, respectively, in their GHG emission between 2022 and 2050. By 2050, the transport sector contributes 27.1 percent and maintains its position as the second largest emitter next to the transformation sector.

Figure 54. **GHG Emission, by Sector (left) and by Fuel (right): Reference Scenario (in $MtCO_2e$), 2010 – 2050**



Weakened reliance on coal, specifically in the power generation sector, slows down the fuel's GHG emission at an annual rate of 0.5 percent towards 86.6 $MtCO_2e$ in 2050 as compared to 2022 level of 75.2 $MtCO_2e$. On the other hand, as oil demand remains upbeat, its associated GHG emission rises by 3.0 percent per year across the planning horizon. With the influx of LNG imports, the GHG emission from natural gas accelerates by 8.4 percent each year as its level shoots up almost 10 times from 6.1 $MtCO_2e$ in 2022 to 58.0 $MtCO_2e$ in 2050 *(Figure 54)*.

HIGHLIGHTS FOR ENERGY SUPPLY AND DEMAND OUTLOOK 2023-2028

Total Final Energy Consumption

Under the REF scenario, TFEC expands at an annual rate of 3.9 percent and reaches 45.0 MTOE by 2028 from its 2022 level of 35.9 MTOE. Energy requirement for industrial processes registers the fastest growth of 5.2 due to improved production capacities and robust consumer demand. As realization of mobility infrastructure projects between 2022 and 2028 sustain the transport sector's position as most energy-intensive, it accounts for 34.1 percent of TFEC. Oil and electricity continue to provide for bulk of energy requirements across all sectors with a total share of 76.4 percent in 2028.

[23] *RA 11552 or "An Act Extending and Enhancing the Implementation of the Lifeline Rate, amending for the Purpose Section 73 of RA 9136, otherwise known as the Electric Power Industry Reform Act of 2001, as Amended by RA 10150."*
[24] *RA 11310 or "An Act Institutionalizing the Pantawid Pamilyang Pilipino Program (4Ps)" signed by then President Rodrigo R. Duterte on 27 May 2021.*

Table 18. **TFEC Under Reference Scenario, By Sector, 2022-2028 (in MTOE)**

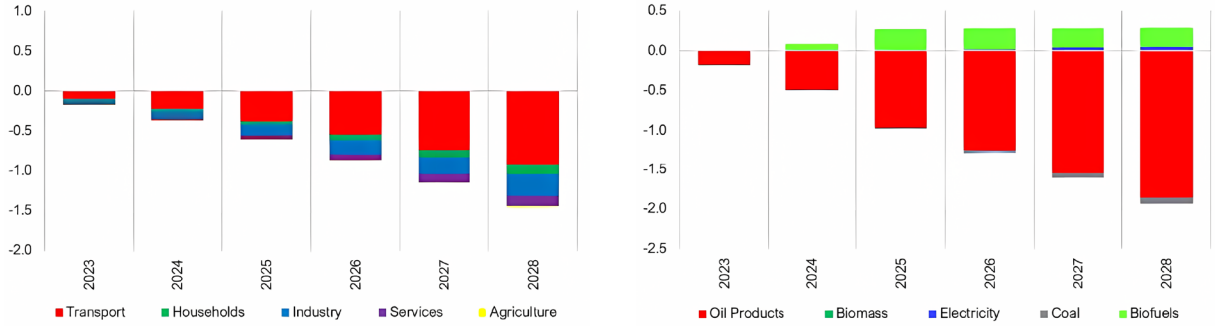
Sectors	Actual	Outlook						AAGR (%)
	2022	2023	2024	2025	2026	2027	2028	2022-2028
Agriculture	0.38	0.41	0.36	0.36	0.38	0.41	0.44	2.48
Industry	7.11	7.31	7.73	8.19	8.67	9.15	9.65	5.23
Services	4.45	4.73	4.93	5.12	5.32	5.53	5.75	4.36
Household	10.31	10.47	10.68	10.92	11.17	11.42	11.69	2.11
Transport	12.32	12.83	13.25	13.75	14.30	14.86	15.41	3.79
Non-Energy	1.29	1.55	1.73	1.85	1.95	2.02	2.07	8.25
Total	**35.86**	**37.31**	**38.68**	**40.18**	**41.79**	**43.39**	**45.00**	**3.86**

Table 19. **TFEC Under Reference Scenario, By Fuel, 2022-2028 (in MTOE)**

Fuel	Actual	Outlook						AAGR (%)
	2022	2023	2024	2025	2026	2027	2028	2022-2028
Coal	1.95	1.94	2.04	2.15	2.27	2.39	2.52	4.38
Oil & Oil Products	18.27	19.27	20.11	20.99	21.92	22.78	23.62	4.38
Biodiesel	0.17	0.18	0.19	0.19	0.20	0.21	0.21	3.97
Bioethanol	0.41	0.39	0.40	0.42	0.43	0.45	0.47	2.48
Electricity	7.85	8.26	8.61	9.05	9.55	10.12	10.73	5.34
Biomass	7.22	7.27	7.33	7.38	7.41	7.44	7.45	0.53
Total	**35.86**	**37.31**	**38.68**	**40.18**	**41.79**	**43.39**	**45.00**	**3.86**

Incorporating demand-side targets under the CES results in a 5.3 MTOE cumulative reduction in TFEC between 2022 and 2028 vis-à-vis the REF (Figure 55). Transport posts the largest decline compared to its levels under the REF as alternative fuels (electricity, biodiesel) displace portions of the sector's gasoline and diesel consumption during the period. Implementation of EEC, particularly on electricity and oil products, reduces the energy requirement among sectors. On a per fuel basis, the consumption of biodiesel doubles as the mandated blend increases from 2.0 percent to 5.0 percent starting 2026.

Figure 55. **Sectoral (left) and Fuel (right) Level Difference, Clean Energy vs Reference, 2023-2028 (MTOE)**



Total Primary Energy Supply

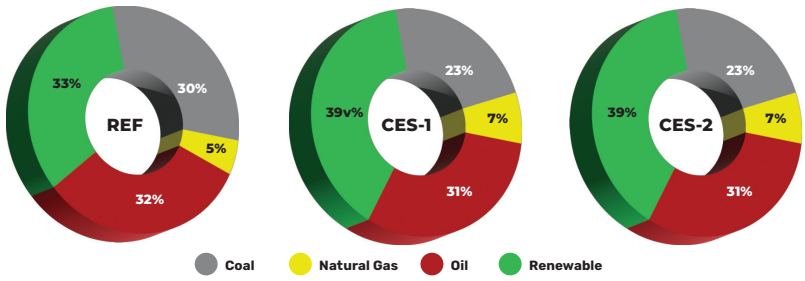
Table 20. **TPES Under Reference Scenario, by Fuel, 2022-2028**

Source	Actual	Outlook						AAGR (%)
	2022	2023	2024	2025	2026	2027	2028	2022-2028
Coal	**19.83**	**20.10**	**20.46**	**21.34**	**22.27**	**23.13**	**23.97**	**3.21**
Natural Gas	**2.61**	**2.82**	**3.58**	**3.65**	**3.74**	**3.62**	**3.52**	**5.11**
Oil	**19.08**	**19.02**	**19.18**	**19.75**	**20.44**	**21.58**	**22.78**	**3.01**
Renewable	**20.04**	**21.69**	**21.52**	**22.24**	**22.57**	**23.96**	**24.93**	**3.71**
Geothermal	8.96	10.23	9.88	10.24	10.98	11.37	11.98	4.95
Hydro	2.51	2.41	2.55	2.53	1.58	2.51	2.36	-1.01
Wind	0.09	0.09	0.28	0.42	0.73	0.81	0.87	46.21
Solar	0.16	0.23	0.47	0.60	0.92	0.87	1.22	40.86
Biomass	7.73	8.16	7.73	7.83	7.72	7.74	7.82	0.19
Biofuels	0.59	0.57	0.59	0.61	0.64	0.66	0.68	2.57
Total	**61.56**	**63.64**	**64.73**	**66.98**	**69.01**	**72.29**	**75.21**	**3.39**
RE Share (%)	**32.55**	**34.09**	**33.24**	**33.20**	**32.70**	**33.15**	**33.15**	

By 2028, the country's energy supply requirement reaches 75.2 MTOE as it grows yearly at a rate of 3.4 percent *(Table 20)*. Under the REF, RE supports around 33.1 percent of the country 's energy needs in 2028. Geothermal accounts for 48.0 percent of the total RE followed by biomass at 31.4 percent. Hydro contributes around 9.5 percent, while the rest comes from solar, wind, and biofuels. Between 2022 and 2028, oil and coal still account for more than 30.0 percent of the country's supply sources as both fuels are used for power and end-use applications such as transport and industry. Also, committed CFPPs are still up within this period. Meanwhile, natural gas accounts for 4.7 percent of the TPES.

The impact of the energy supply-side assumptions under the alternative energy scenarios, CES 1 and CES 2, manifests in the higher RE shares of 38.6 percent and 39.2 percent, respectively, from 33.1 percent in the REF *(Figure 56)*. This includes the impact of almost 2.0 GW of OSW capacities that form part of the country's energy supply in 2028.

Figure 56. **2028 Energy Mix, Fuel, Levels: REF, CES 1 and CES 2**



Given the initiative towards energy transition, the share of coal declines from 30.3 percent in the REF to around 23.0 percent for both the CES energy mixes in 2028. There is also an increase in contribution from natural gas as LNG imports start to figure in the energy mix for the same year.

PEP 2023 – 2050 vs PDP 2023 – 2028

Comparison of Results Matrix for Subchapter Outcome 4 Indicators

Results Matrices (RM) accompany every chapter of the PDP 2023-2028 and contain indicator statements and targets to be achieved for the next six years. It is an instrument designed to provide results orientation to the PDP, anchored on results-based management (RbM), which is a strategy that focuses on performance by highlighting achievements of outcomes and impacts. Chapter 12 of the PDP titled "Expand and Upgrade Infrastructure" outlines the current challenges faced in infrastructure space, specifically in the sectors of connectivity, water, energy, and social infrastructure. It also emphasizes that economic transformation for our infrastructure sector will begin by "building better and more."

Energy-sector-related targets and indicators are provided under Subchapter Outcome 4. These are aligned with the SDG 7 that call for affordable, reliable, sustainable, and modern energy for all by 2030. The SDG 7 has three core targets as follows: (1) ensure universal access to affordable, reliable, and modern energy services; (2) increase substantially the share of renewable energy in the global energy mix; and (3) double the global rate of improvement in energy efficiency. Each of these core targets has corresponding measurable indicators, called SDG Tier 1 indicators, that form part of the RM for the Subchapter on Energy. The succeeding sections discuss these indicators in comparison with the PEP 2023-2050 for the medium-term 2023-2028.

The PEP 2023-2050 exceeds the targets identified under the PDP 2023-2028 Subchapter Outcome 4: affordable, accessible, reliable and clean energy provided based on the resulting SDG Tier 1 Indicators.

SDG Tier 1 Indicator 7.1.1 Proportion of population with access to electricity

a. **(Increased) proportion of households with access to electricity:** The government, through the DOE, targets the achievement of the 100 percent household electrification target by 2028.

Table 21. **Household Electrification Level (in Percent)**

	Actual		Medium-Term Outlook					
	2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
PDP 2023-2028	95.41	96.71	95.41	95.5	TBD	TBD	TBD	TBD
PEP 2023-2050*			93.09	94.8	96.8	98.6	99.9	100.0

**2021-2022 are actual data from Rural Electrification Administration and Management Division of the Electric Power Industry Management Bureau (REAMD-EPIMB)*

b. **(Increased) electricity consumption (in kWh) per capita:** The table below shows the projected level of electricity consumption per capita (in kWh) from the Energy Outlook 2023-2028, which exceeds the target for all years compared to the PDP 2023-2028. Electricity per capita grows by 4.0 percent from 999 kWh to 1,262 kWh under the REF, while the two clean energy scenarios (CES 1 and CES 2) show slightly lower levels due to the impacts of EEC.

Table 22. **Electricity Consumption (kWh) per capita**

	Actual		Medium-Term Outlook					
	2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
PDP 2023-2028	963	999	897	945	996	1,051	1,110	1,172
PEP 2023-2050*								
Reference			1,002	1,057	1,100	1,149	1,203	1,262
CES 1			1,002	1,057	1,096	1,142	1,194	1,250
CES 2			1,002	1,057	1,096	1,141	1,194	1,249

**2021-2022 are actual data from the Energy Balance Table or EBT (as of 07 July 2023)*

SDG Tier 1 Indicator 7.2.1 Renewable energy share in total final energy consumption

a. **(Increased) share of renewable energy in the power generation mix:** As more RE capacities are expected to take hold under the CES 1 and CES 2, RE shares are higher than the targets under PDP 2023-2028. Specifically, RE share by 2028 is 6.0 to 9.0 percentage points higher under the PEP vis-à-vis the PDP. The country is likewise on-track to achieve its RE target in 2030 as the share climbs further to 35.0 percent under the REF, and higher at more than 40.0 percent for both the CES 1 and CES 2.

Table 23. **RE Share in Generation Mix (in Percent)**

	Actual*		Medium-Term Outlook					
	2021	2022	2023	2024	2025	2026	2027	2028
PDP 2023-2028	22.4	22.1	24	26	28	30	32	33
PEP 2023-2028								
Reference			23.9	25.6	27.2	28.8	30.3	31.9
CES 1			23.9	28.0	29.6	34.6	34.3	39.2
CES 2			23.9	28.0	30.7	37.5	37.2	41.8

**2021-2022 are actual data from the EBT (as of 07 July 2023)*

SDG Tier 1 Indicator 7.3.1 Energy intensity measured in terms of primary energy and GDP

a. **(Decreased) energy intensity measured in terms of primary energy and GDP:** Energy intensity is the amount of energy needed to produce one unit of economic output. A lower number means that the economy produces value using a lesser amount of energy, whichindicates improvements in energy efficiency. However, this result depends on the structure of the economy. Highly industrialized economies tend to use a greater amount of energy per unit of economic output. For the Philippines, the economic structure focuses more on services which is a less energy-intensive sector. By 2028, the country's energy intensity level ranges from 2.5 to 2.4 TOE/PhP million (REF to CES 1 and CES 2) and translates to yearly average reductions of around 4.0 to 5.0 percent from 2022 level. Using 2005 as base year, energy intensity level drops by as much as 50.0 percent by 2030.

Table 24. **Energy Intensity (TOE per PhP Million at 2018 Constant Prices)**

	Actual*		Medium-Term Outlook					
	2021	2022	2023	2024	2025	2026	2027	2028
PDP 2023-2028	3.20	3.09	TBD	TBD	TBD	TBD	TBD	TBD
PEP 2023-2028								
Reference			3.00	2.86	2.76	2.65	2.57	2.48
CES 1			2.99	2.87	2.73	2.60	2.49	2.36
CES 2			2.99	2.87	2.73	2.59	2.47	2.35

**2021-2022 are actual data from the EBT (as of 07 July 2023)*

III. Clean Energy Scenario

The CES presents the impact of progressive initiatives toward energy transition in addition to current decarbonization strategies under the REF. The CES also covers expansion to a more diversified energy mix characterized by the entry of OSW (19.0 GW for CES 1 and 50.0 GW for CES 2) and nuclear power, as well as voluntary retirement and possible repurposing of CFPPs. On the demand side, CES adopts higher biodiesel blend, EEC target, and EV penetration rate.

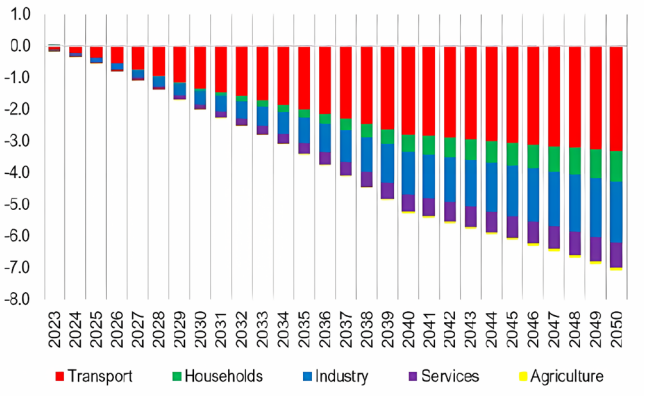
A. TOTAL FINAL ENERGY CONSUMPTION

The demand-side targets under the CES slow down the progress of TFEC as it grows at an annual rate of 3.0 percent between 2022 and 2050 or 0.4 percentage points less than the REF with 3.4 percent. By 2050, TFEC under the CES stands at 82.9 MTOE or 7.7 MTOE lower than the REF for the same period.

Changes by Sector

All sectors register reduced energy consumption under the CES compared to the REF *(Figure 57)*. Of the difference between the two scenarios in 2050, the transport and industry sectors comprise 5.2 MTOE, while the rest of the end-use sectors (services, households, agriculture) and nonenergy use, contribute to the remaining 2.5 MTOE. The reduction in energy consumption for the transport sector stems from the displacement of gasoline and diesel due to the target increase of EV penetration in road transport, combined with higher biodieselblend and fuel savings on other oil products. In addition, energy savings (electricity and oil) effectively taper down the energy requirement of other sectors.

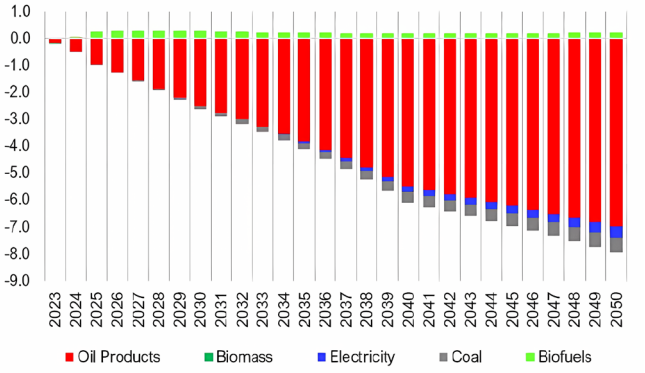
Figure 57. **Level Changes in TFEC By Sector (CES-REF) (MTOE), 2023– 2050**



Changes by Fuel

Total consumption of oil and oil products falls by as much as 7.0 MTOE in 2050 under the CES vis-à-vis the REF. Gains from the implementation of EEC on electricity in other sectors are offset by the rise in the transport sector's utilization. This brings the net decline in electricity utilization to 395 kTOE in 2050 between the two scenarios *(Figure 58)*. Biodiesel levels rise twice as much in the CES to 731 kTOE in 2050 from 169 kTOE in 2022. These changes reflect the impact of fuel diversification in end-use sectors due to an increase in biofuel blend rate, as well as EEC and CREVI targets.

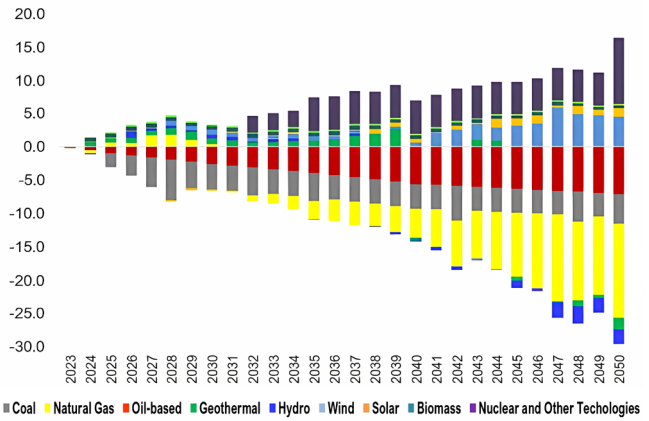
Figure 58. **Level Changes in TFEC By Fuel (CES-REF) (MTOE), 2023– 2050**



B. TOTAL PRIMARY ENERGY SUPPLY

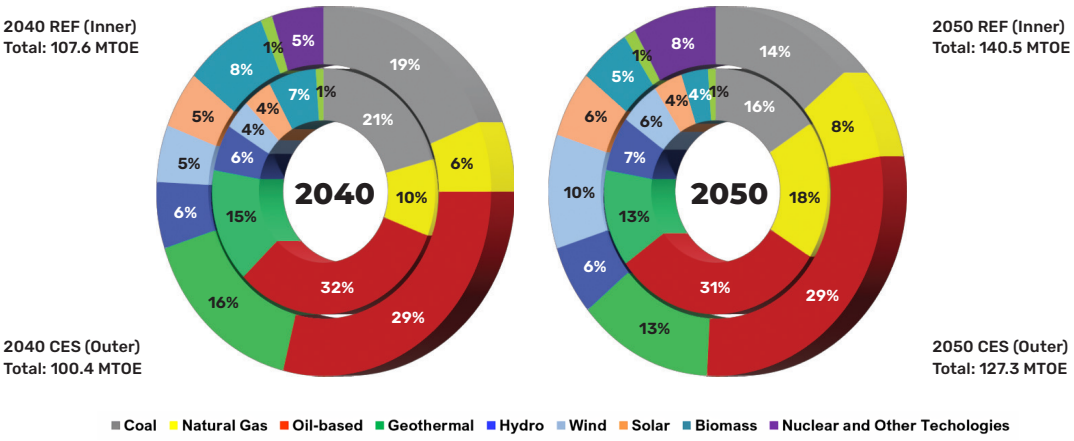
With the dynamic changes in the country's TFEC and power sector, the TPES under the CES registers a 2.6 percent annual increase between 2022 and 2050, which is 0.4 percentage points slower than the rise in TPES under the REF. As total energy supply under the CES stands at 127. 3 MTOE by 2050, the gap between the two scenarios reaches 13.2 MTOE (Figure 59) due to the adoption of new technologies (OSW and nuclear), as well as new power plants with improved efficiency and requiring lesser fuel than the existing ones.

Figure 59. **Level Changes in TPES, by Fuel: CES-REF (MTOE): 2023-2050**



Total RE share in the CES energy mix in 2050 stands at 41.1 percent or 5.6 percentage points more than the REF's 35.5 percent in 2050 *(Figure 60)*. With the aggressive promotion and utilization of RE for power generation, the share of fossil fuels (coal, oil, and natural gas) diminishes by a cumulative 16.5 percentage points and drops to 51.0 percent by 2050 vis-à-vis 67.4 percent in 2022. Nuclear enters the country's energy mix by 2032 and accounts for 7.9 percent share to TPES in 2050.

Figure 60. **2050 Energy Mix, 2040 vs 2050 for REF and CES**



Changes in Energy Supply for Power Application

Total fuel requirements for power generation in 2050 under the CES register a level of 79.2 MTOE and account for 62.2 percent of TPES during the same period. This is 1.7 percentage points lower than the REF for the same year, which reflects improved plant efficiencies, as well as the displacement of fossil fuels to give way for the increasing share of renewables. Decommissioning of coal capacities leads to a reduction in coal's share to fuel input mix between the REF and the CES at 3.5 percentage points for 2050. The increase RE share from 51.4 percent to 58.0 percent in 2050, bulk of which comes from OSW and solar, brings down natural gas share by 15.8 percentage points under the CES vis-à-vis the REF for the same year *(Table 25)*.

Table 25. **Fuel Input, By Fuel (MTOE), 2040 and 2050 for REF vs. CES**

Source	2040				2050				% Pts Diff in Shares CES vs REF	
	REF		CES		REF		CES			
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares	2040	2050
Coal	**18.07**	**29.61**	**14.76**	**24.81**	**16.19**	**19.04**	**12.28**	**15.52**	**-4.79**	**-3.52**
Natural Gas	**10.83**	**17.74**	**6.50**	**10.93**	**24.82**	**29.20**	**10.61**	**13.40**	**-6.82**	**-15.80**
Oil-based	**0.35**	**0.57**	**0.29**	**0.48**	**0.35**	**0.41**	**0.29**	**0.36**	**-0.09**	**-0.05**
Renewable	**31.78**	**52.08**	**32.90**	**55.30**	**43.64**	**51.35**	**45.91**	**58.00**	**3.22**	**6.66**
Geothermal	16.23	26.60	15.82	26.59	18.30	21.53	16.56	20.92	-0.01	-0.62
Hydro	6.65	10.90	6.46	10.87	10.59	12.46	8.41	10.62	-0.04	-1.84
Wind	4.21	6.90	4.84	8.14	7.98	9.38	12.43	15.70	1.24	6.32
Solar	4.30	7.04	4.86	8.17	6.34	7.46	7.65	9.67	1.12	2.21
Biomass	0.38	0.63	0.91	1.53	0.44	0.51	0.87	1.09	0.90	0.58
Nuclear Energy	**-**	**-**	**5.04**	**8.48**	**-**	**-**	**10.06**	**12.71**	**8.48**	**12.71**
Total	**61.02**	**100**	**59.50**	**100**	**84.99**	**100**	**79.15**	**100**	**0.00**	**0.00**

Changes in Energy Supply for Non-Power Application

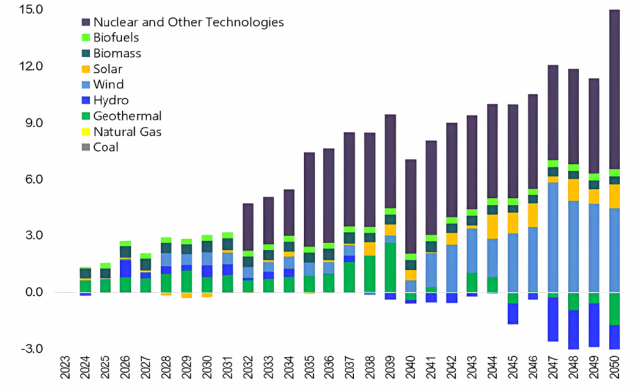
Non-power requirement under the CES stands at 48.2 MTOE and accounts for more than a third (37.8 percent) of the 2050 energy mix, albeit 1.7 percentage points lower than the REF for the same year *(Table 26)*. By the end of the planning period, target energy savings from oil and bioethanol bring a 16.2 percent and 28.9 percent reduction in their levels under the CES, respectively. Meanwhile, as the mandated biodiesel blend increases from 2.0 percent to 5.0 percent effective 2026, its non-power utilization also increases twice as much in 2050 between the REF and the CES. Efficiency improvements in the use of coal among industrial processes also reduces its utilization by 9.2 percent between the two scenarios.

Table 26. **Non-Power Requirements, By Fuel (MTOE) REF vs CES**

Fuel	2022	2050		% Change in Levels CES-REF
	Actual	REF	CES	
Coal	1.95	6.10	5.54	-9.15
Oil	18.27	43.15	36.17	-16.18
Biodiesel	0.17	0.35	0.73	111.07
Bioethanol	0.41	0.75	0.58	-22.45
Biomass	7.22	5.16	5.16	0.00
Total	**28.01**	**55.50**	**48.18**	**-13.19**
Share to TPES	**45.49**	**39.50**	**37.84**	

Changes in Indigenous Energy

Figure 61. **Level Changes in Indigenous Energy by Fuel (CES-REF) (MTOE), 2023 – 2050**

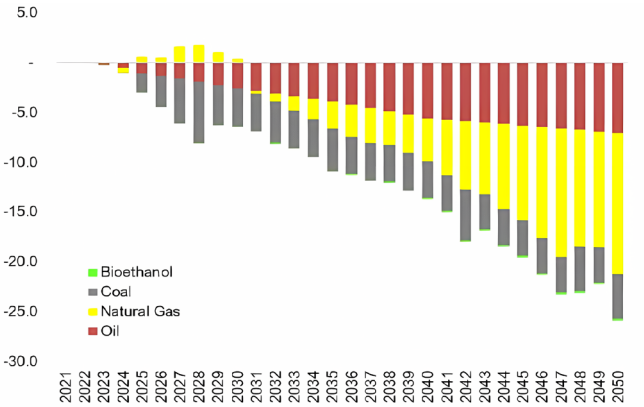


Aggregate supply of RE and nuclear energy drives the 0.8 percentage points difference in annual growth rate of total indigenous energy, from 2.1 percent under the REF to 2.9 percent under the CES by 2050. Nuclear and wind exhibit the largest positive level changes between the REF and the CES due to higher contribution in the generation mix, while the expansion in biodiesel blend rate also contributes to the difference between the two scenarios across the planning timeline *(Figure 61)*. The entry of nuclear energy in 2032 complements the country's push for energy transition and self-sufficiency. Despite the importation of uranium minerals, its enrichment, i.e., conversion to useful energy for nuclear power generation, is considered a domestic energy production, such that by 2050, domestic nuclear energy supply reaches 10.1 MTOE. These trends in indigenous energy supply sustain the country's self-sufficiency under the CES as it reaches 52.8 percent in 2050 or 14.0 percentage points higher than the REF's 38.8 percent for the same period. Higher renewable energy supply in the CES translates to improved self-sufficiency levels vis-à-vis the REF despite increasing LNG imports for power generation.

Changes in Net Energy Imports

The volume of net energy imports under the CES is lower than the REF by an average of 19.5 percent between 2022 and 2050 *(Figure 62)*. The changes in net energy imports reflect the decreasing utilization of natural gas and coal in CES with substantial RE inputs for power generation. Similarly, the reduction in demand for mostly imported fuels such as coal, oil, and bioethanol in other industries results in lower net energy imports under the CES compared to the REF across the planning horizon. By 2050, net energy imports rise to 59.9 MTOE, which translates to yearly increase of 2.4 percent. Of the 25.9 MTOE difference in the level of net energy imports between the scenarios, natural gas makes up the biggest share at 54.9 percent, followed by oil with 27.2 percent, coal with 17.2 percent, and bioethanol for the remaining 0.6 percent.

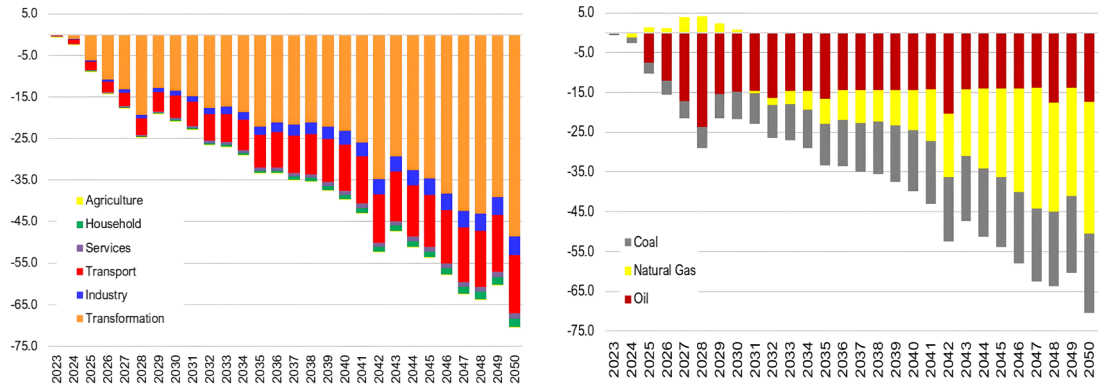
Figure 62. **Level Changes in Net Energy Imports, by Fuel (CES-REF) (MTOE), 2023 – 2050**



Changes in GHG Emissions

Demand and supply-side mitigation measures reduce the level of GHG emission under the CES by as much as 70.5 $MtCO_2e$ by 2050 *(Figure 63)*. The transformation sector takes the biggest chunk (69.0 percent share) of the difference in GHG emission between the scenarios because of energy transition in the power sector. The expected energy savings on electricity and oil, as well as fuel diversification in the transport sector, also result in lower GHG emissions from end-use sectors.

Figure 63. **Level Changes in the GHG Emission (CES-REF) ($MtCO_2e$), 2023–2050 (left) by Sector & (right) by Fuel**



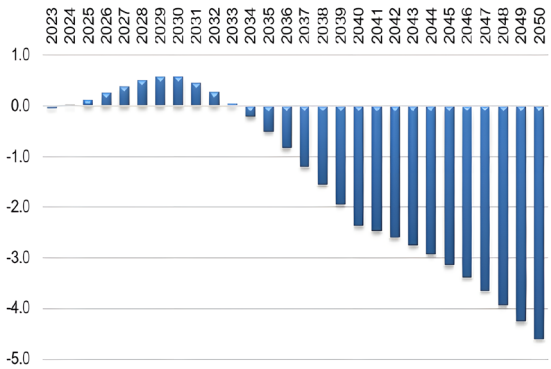
In terms of fuel, natural gas accounts for 47.1 percent of the total GHG reduction between the CES and REF by the end of the planning period. Due to large volume of aggregate RE resources as fuel input to power generation, the GHG emission from natural gas drops by more than half from 58.0 $MtCO_2e$ in the REF to 24.8 $MtCO_2e$ in the CES in 2050. Oil is still the biggest source of GHG emission for both scenarios. However, its level under the CES is lower by 19.9 $MtCO_2e$ compared to the REF in 2050, while coal also registers a reduction of 17.3 $MtCO_2e$ for the same year.

C. POWER SUPPLY AND DEMAND

Changes in Electricity Sales

Total electricity sales under the CES reach 403.5 TWh in 2050 vis-à-vis 408.1 TWh under the REF, as the difference between the two scenarios peak at 4.6 TWh *(Figure 64)*. Gains in energy savings offset the expected hike in transport's electricity consumption with the impact of a 50.0 percent penetration rate of EVs. The annual rate of increase in electricity sales under the CES registers at 5.4 percent.

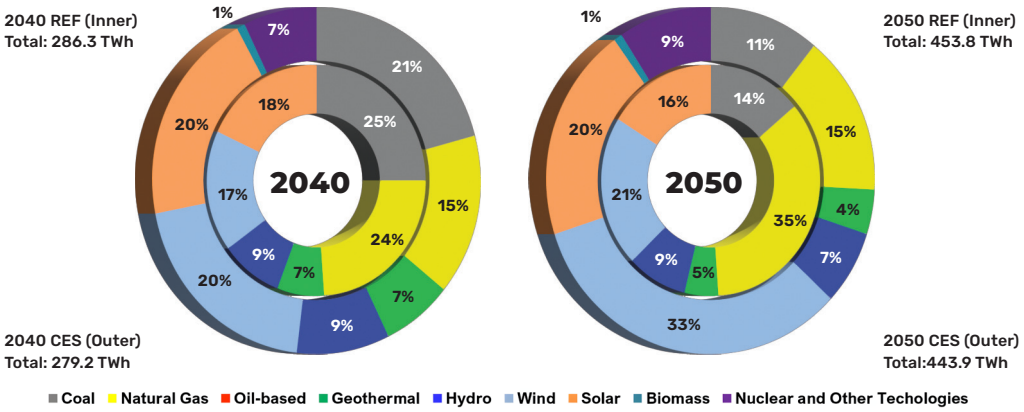
Figure 64. **Level Changes in Electricity Sales (GWh) (CES-REF), 2023–2050**



Changes in Gross Generation

The CES paves the way for the crucial role of RE in changing the country's generation mix through its 50.0 percent share by 2040, which increases further to more than 50.0 percent by 2050 *(Figure 65)*. Improved efficiency of power plants under the CES results in slightly lower gross generation level of 443.9 TWh vis-à-vis 453.8 TWh under the CES. However, the power mix changes significantly as decarbonization takes place through combined RE and natural gas that constitute 71.8 percent share and 80.2 percent share in 2040 and 2050, respectively, which effectively reduces coal's share to 20.9 percent and 11.0 percent for the same milestone years.

Figure 65. **Gross Generation Mix by Fuel Shares, 2040 & 2050 | REF vs CES**



The realization of RE target shares under the CES induces a significant rise in wind generation output to 144.5 TWh by 2050, which translates to a 32.6 percent share in the generation mix for the same year *(Table 27)*. This is due to OSW awarded contracts that bring an additional 19 GW capacities by the end of the planning period. Despite the natural gas' role as a transition fuel, it gives way for the increasing share of VRE, such as solar and wind, and thus reflects a declining share in the generation mix under CES at around 15.0 percent for 2040 and 2050. The CES also provides a window for the entry of nuclear and other emerging technologies. Generation output from these energy sources rises from 9.7 TWh in 2032 to 19.4 TWh in 2040. By the end of the planning timeline, it accounts for 8.7 percent of the country's generation mix equivalent to 38.6 TWh.

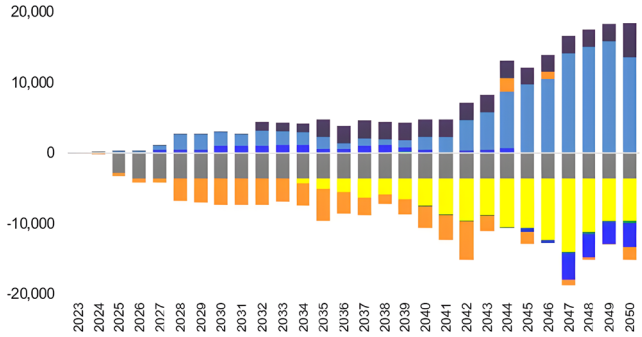
Table 27. **Gross Generation, By Fuel (TWh), 2040 & 2050 for REF vs CES**

Source	2040				2050				% Pts Diff in Shares CES vs REF	
	REF		CES		REF		CES			
	Levels	% Shares	Levels	% Shares	Levels	% Shares	Levels	% Shares	2040	2050
Coal	**71.17**	**24.86**	**58.45**	**20.94**	**63.77**	**14.05**	**48.64**	**10.96**	**-3.92**	**-3.09**
Natural Gas	**69.26**	**24.19**	**41.59**	**14.90**	**158.76**	**34.98**	**67.87**	**15.29**	**-9.29**	**-9.70**
Oil-based	**1.06**	**0.37**	**0.88**	**0.32**	**1.06**	**0.23**	**0.88**	**0.20**	**-0.06**	**-0.04**
Renewable	**144.82**	**50.58**	**158.90**	**56.92**	**230.23**	**50.73**	**287.90**	**64.86**	**6.34**	**14.13**
Geothermal	18.88	6.59	18.40	6.59	21.29	4.69	19.25	4.34	0.00	-0.35
Hydro	25.95	9.06	25.22	9.03	41.30	9.10	32.79	7.39	-0.03	-1.71
Wind	49.00	17.11	56.32	20.17	92.76	20.44	144.54	32.56	3.06	12.12
Solar	49.99	17.46	56.52	20.24	73.72	16.24	88.99	20.05	2.78	3.80
Biomass	1.00	0.35	2.45	0.88	1.16	0.26	2.33	0.52	0.53	0.27
Nuclear and Other Technologies	**-**	**-**	**19.36**	**6.93**	**-**	**-**	**38.62**	**8.70**	**6.93**	**8.70**
Total	**286.31**	**100**	**279.19**	**100**	**453.81**	**100**	**443.90**	**100**	**-**	**-**
BESS	0.47		7.78		1.02		24.55		*	*

Changes in Total Installed Capacity

The CES generates 3.4 GW aggregate capacity more than the REF *(Figure 66)* as its levels rise to 154.3 GW in 2050. Wind and nuclear and other emerging technologies account for bulk of the increase, as new capacities of around 13.6 GW and 4.8 GW, respectively, come online across the planning horizon. These offset the reduced capacities from coal, natural gas, solar, and hydro.

Figure 66. **Level Changes in Installed Capacities by Fuel (CES-REF) (MW) 2023 - 2050)**



From the 2022 total installed capacity level of 28.6 GW, the CES requires 129.7 GW of additional capacity *(excluding decommissioned capacities)* to provide for the country's electricity needs by 2050 *(Table 28)*. In the same year, aggregate RE installed capacity stands at 114.8 GW and represents the biggest chunk of the mix at 74.4 percent. Along with the voluntary retirement and possible repurposing of CFPPs, the CES allows for the reduction in its total installed capacities of around 3.6 GW compared to the REF across the planning horizon. The BESS also ramps up its contribution to total installed capacity with 22.0 GW under the CES in 2050 with the increased capacity of VREs.

Table 28. **Installed Capacity, By Fuel (MW)**

Fuel Type	Total Ca pacity		Capacity Additions 2023-2050		Total Capacity: 2050			
	2022				REF		CES	
	Levels	%Shares	REF	CES	Levels	%Shares	Levels	%Shares
Coal	**12,428**	**43.98**	**2,305**	**2,305**	**14,733**	**9.76**	**11,111**	**7.20**
Natural Gas	**3,732**	**13.21**	**21,881**	**15,989**	**25,613**	**16.97**	**19,721**	**12.78**
Oil	**3,834**	**13.57**	**20**	**20**	**3,854**	**2.55**	**3,854**	**2.50**
Renewable	**8,265**	**29.25**	**98,503**	**106,568**	**106,768**	**70.72**	**114,833**	**74.41**
Geothermal	1,952	6.91	1,355	1,005	3,307	2.19	2,957	1.92
Hydro	3,745	13.25	10,265	6,800	14,011	9.28	10,546	6.83
Wind	427	1.51	31,842	45,460	32,269	21.37	45,887	29.74
Solar	1,530	5.41	54,948	53,164	56,478	37.41	54,694	35.44
Biomass	611	2.16	92	138	703	0.47	749	0.49
Nuclear and Other Technologies	**-**	**-**	**-**	**4,800**	**-**	**-**	**4,800**	**3.11**
Total	**28,259**	**100**	**122,708**	**129,681**	**150,967**	**100**	**154,319**	**100**
BESS	**156**		**3,624**	**21,859**	**3,780**		**22,015**	

Note: Reference date for 2022 total capacity is 07 July 2023

D. IMPACT OF 50 GW ADDITIONAL OFFSHORE WIND (OSW) CAPACITY

Cognizant of the need to transition the country's energy sector, the DOE remains steadfast in its commitment towards the aggressive promotion of renewable energy, which results in the immense interest in RE resources. The OSW holds the greatest potential in diversifying our energy portfolio towards low-carbon, clean, and sustainable fuels with a total of 178 GW of OSW potential capacity. Potential areas currently under consideration comprise 18 GW of fixed and 160 GW of floating capacities over six (6) development areas from Northwest Luzon down to the Negros/Panay area. Thus, from a CES 1 with 19 GW OSW capacity by 2050, this PEP considers further increasing OSW to 50 GW capacity (CES 2). It is also noteworthy to mention that OSW provides the highest capacity factor (with an average of 44.0 percent) than any other VRE technology.

Total Primary Energy Supply

TPES under the CES 2 with 50-GW OSW is 3.9 percent lower compared to the CES 1 with 19-GW OSW capacities as more efficient technologies comprise the country's energy mix in 2050 *(Table 29)*. Wind's share to the energy mix also ramps up from 4.4 percent in 2030 to 15.5 percent by 2050 which pushes the total RE share to 42.5 percent during the same year. Wind energy consistently displaces a portion of the contribution of other RE sources, including coal and natural gas. The decline in coal's share in the TPES to 13.2 percent in 2050 vis-à-vis its 31.0 percent share in 2022, is an outcome of the decommissioning of power generation capacities (voluntary retirement) across the planning horizon *(Figure 67)*.

Figure 67. **TPES Mix, by Fuel Shares (%): 2030, 2040 and 2050, CES 1 (19 GW OSW) vs CES 2 (50 GW OSW)**

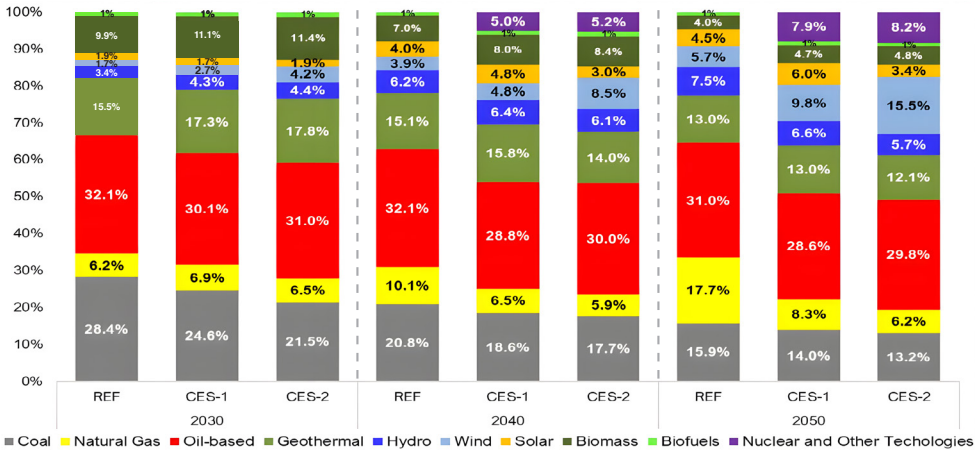


Table 29. **Total Primary Energy Supply, By Fuel (MTOE): 2022, 2040 & 2050: CES 1 vs CES 2**

Source	2022 ACTUAL	CES 1 [with 19 GW OSW			CES 2 [with 50 GW OSW]		
		2030	2040	2050	2030	2040	2050
Coal	**19.08**	**18.84**	**18.72**	**17.82**	**15.93**	**17.05**	**16.13**
Natural Gas	**2.61**	**5.30**	**6.50**	**10.61**	**4.81**	**5.74**	**7.62**
Oil-based	**19.83**	**23.02**	**28.95**	**36.46**	**23.02**	**28.95**	**36.46**
Renewable	**20.04**	**29.28**	**41.21**	**52.38**	**30.43**	**39.76**	**52.05**
Geothermal	8.96	13.19	15.82	16.56	13.17	13.56	14.79
Hydro	2.51	3.29	6.46	8.41	3.27	5.93	6.96
Wind	0.09	2.06	4.84	12.43	3.15	8.20	18.95
Solar	0.16	1.30	4.86	7.65	1.39	2.85	4.10
Biomass	7.73	8.49	8.08	6.03	8.49	8.09	5.93
Biofuels	0.59	0.96	1.14	1.31	0.96	1.14	1.31
Nuclear and Other Tech	**-**	**-**	**5.04**	**10.06**	**-**	**5.04**	**10.06**
Total	**61.56**	**76.45**	**100.43**	**127.33**	**74.19**	**96.55**	**122.32**
RE Share (%)	**32.55**	**38.31**	**41.03**	**41.14**	**41.02**	**41.18**	**42.55**
Self-Sufficiency	**49.42**	**55.28**	**51.04**	**52.93**	**58.51**	**51.58**	**54.83**

As the additional OSW capacity boosts the level of total RE supply, the CES 2 effectively leads to increased indigenous energy. It translates to an improved self-sufficiency level of 54.8 percent from 52.9 percent under the CES 1, and much higher than its 2022 level of 49.4 percent. With such selfsufficiency level by 2050, the volume of net energy imports stands at 55.3 MTOE, or 7.8 percent less than CES 1's 59.9 MTOE for the same year.

Total Installed Capacity

Increasing OSW capacity to 50.0 GW slightly pushes the country's total installed capacity to 156.4 GW in 2050 compared to 154.3 GW under the CES 1 (Table 30). As wind's share to the capacity mix gets bigger under the CES 2, it also displaces other RE capacities, specifically solar. By 2050, RE share under the CES 2 declines to 73.7 percent from 74.4 percent under the CES 1. This slight reduction is primarily due to the displacement of technologies with lower capacity factors, such as solar and onshore wind (Figure 68). Meanwhile, the increased share of RE and decommissioning of 4.3 GW capacity from CFPP lead to increased natural gas capacities by 2.9 GW between the two CES scenarios. Meanwhile, the BESS capacities reach 24.7 GW under CES 2, a bit higher than CES 1 due to increased share of VREs.

Figure 68. **Capacity Mix, by Fuel Shares (%): 2030, 2040 and 2050. CES 1 (19 GW OSW) vs CES 2 (50 GW OSW)**

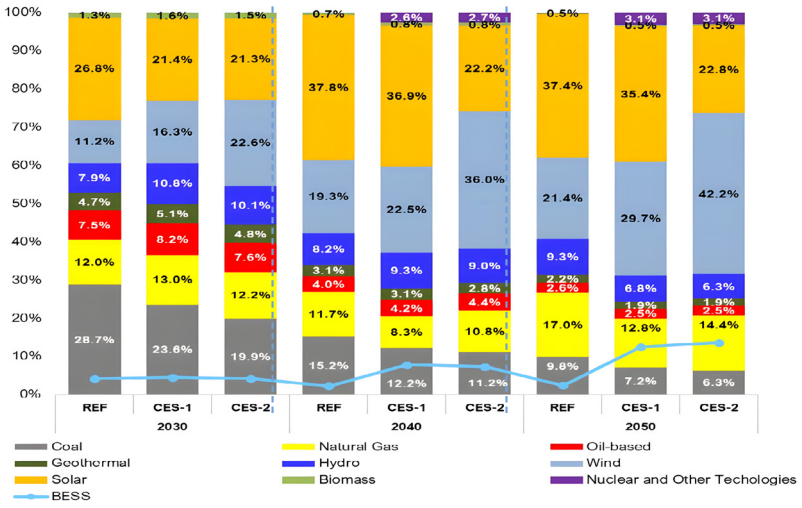


Table 30. **Capacity Additions and Total Installed Capacity, By Fuel (MW): CES 1 vs CES 2**

Source	2022 Total Capacity	CES 1 [with 19 GW OSW]			CES 2 [with 50 GW OSW]		
		Capacity Additions		2050 Total Capacity	Capacity Additions		2050 Total Capacity
		2023-2028	2029-2050		2023-2028	2029-2050	
Coal	**12,428**	**2,305**	**-**	**11,111**	**2,305**	**-**	**9,929**
Natural Gas	**3,732**	**2,413**	**13,576**	**19,721**	**2,413**	**16,444**	**22,589**
Oil-based	**3,834**	**20**	**-**	**3,854**	**20**	**-**	**3,854**
Renewable	**8,265**	**13,458**	**93,110**	**114,833**	**14,919**	**92,033**	**115,217**
Geothermal	1,952	425	580	2,957	425	580	2,957
Hydro	3,745	770	6,030	10,546	770	5,410	9,926
Onshore Wind	427	3,910	22,050	26,387	5,371	10,037	15,835
Offshore Wind	-	2,000	17,500	19,500	2,000	48,100	50,100
Solar	1,530	6,231	46,934	54,694	6,231	27,890	35,651
Biomass	611	122	16	749	122	16	749
Nuclear and Other Technology	**-**	**-**	**4,800**	**4,800**	**-**	**4,800**	**4,800**
Total	**28,259**	**18,195**	**111,486**	**154,319**	**19,656**	**113,277**	**156,389**
BESS	**156**	**2,080**	**19,779**	**22,015**	**2,080**	**22,426**	**24,662**
RE Share (%)	**29.25**	**73.96**	**83.52**	**74.41**	**75.90**	**81.25**	**73.67**

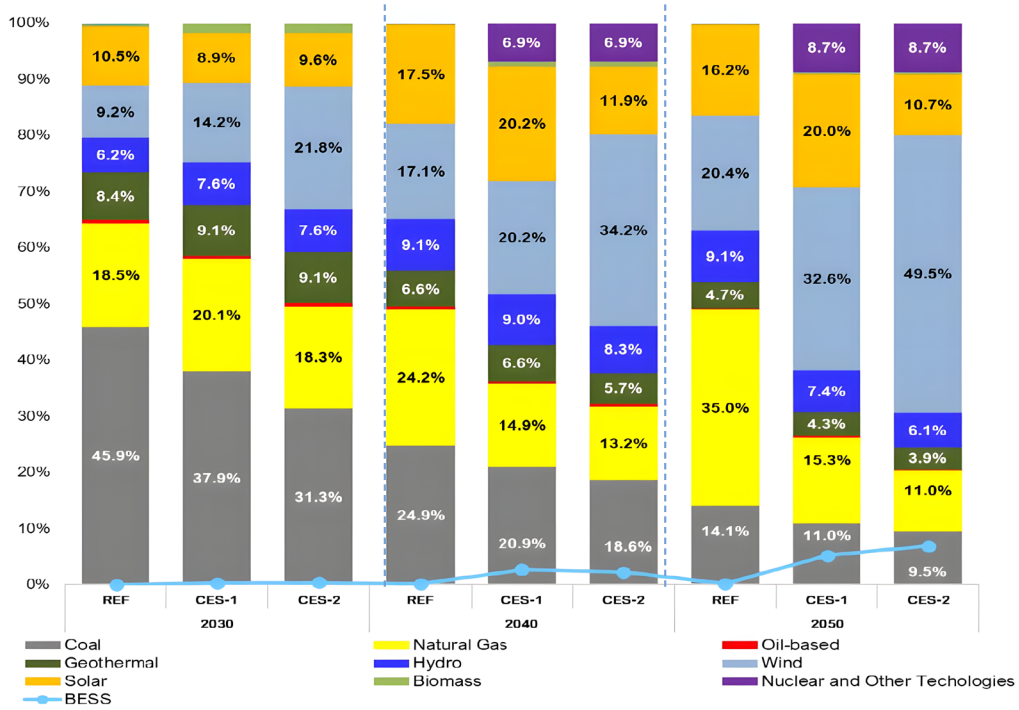
Gross Power Generation

The power generation mix under CES 2 highlights the immense output from wind power plants. From 0.9 percent share in 2022, wind's contribution expands remarkably to 49.5 percent share in 2050, which brings the aggregate share of RE to as much as 70.7 percent during the same year *(Table 31)*. Consistent with the structure of the capacity mix, wind power replaces a portion of other RE, specifically solar, as well as coal and natural gas *(Figure 69)*.

Table 31. **Gross Generation, By Fuel (TWh): 2022, 2040 & 2050: CES 1 vs CES 2**

Source	2022 Actual	CES 1 [with 19 GW OSW]			CES 2 [with 50 GW OSW]		
		2030	2040	2050	2030	2040	2050
Coal	**66.43**	**64.08**	**58.45**	**48.64**	**52.65**	**51.96**	**42.05**
Natural Gas	**17.88**	**33.90**	**41.59**	**67.87**	**30.77**	**36.74**	**48.77**
Oil-based	**2.52**	**0.88**	**0.88**	**0.88**	**0.88**	**0.89**	**0.88**
Renewable	**24.68**	**70.00**	**158.90**	**287.90**	**83.68**	**169.85**	**314.55**
Geothermal	10.42	15.35	18.40	19.25	15.31	15.77	17.21
Hydro	10.08	12.82	25.22	32.79	12.77	23.14	27.15
Wind	1.03	23.94	56.32	144.54	36.65	95.33	220.38
Solar	1.82	15.08	56.52	88.99	16.14	33.15	47.74
Biomass	1.32	2.81	2.45	2.33	2.81	2.45	2.07
Nuclear and Other Technology		**-**	**19.36**	**38.62**	**-**	**19.36**	**38.62**
Total	**111.52**	**168.86**	**279.19**	**443.90**	**167.99**	**278.80**	**444.87**
BESS		**0.59**	**7.78**	**24.55**	**0.63**	**6.48**	**33.15**
RE Share (%)	**22.13**	**41.45**	**56.92**	**64.86**	**49.81**	**60.92**	**70.71**

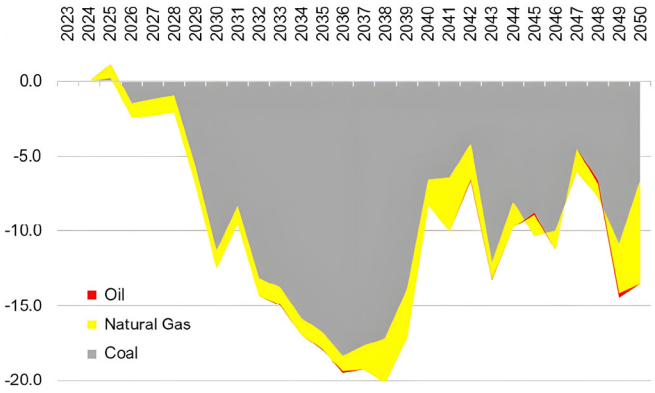
Figure 69. **Generation Mix, by Fuel Shares (%): 2030, 2040 and 2050. CES 1 (19 GW OSW) vs CES 2 (50 GW OSW)**



GHG Emissions

The transformation sector, i.e., power generation, gets a respite from GHG emissions due to the impact of CES 2 pathway. Between 2022 and 2050, the cumulative reduction in GHG emission of the sector is 282.1 $MtCO_2e$ due to the additional 50.0 GW OSW capacity. In terms of fuel, emission from coal is likewise reduced by a cumulative of 243.0 $MtCO_2e$ across the planning horizon *(Figure 70)*. The GHG emission from natural gas also registers a cumulative reduction of 39.8 $MtCO_2e$ by 2050.

Figure 70. **Level Change in GHG Emission: CES 1 vs CES 2 ($MtCO_2e$), 2023-2050**



IMPACT OF A 20.0 PERCENT BIOETHANOL (E20) BLEND UNDER CES 2 AS A HYPOTHETICAL SCENARIO

Aside from the power sector, the transport sector also requires more efforts for diversification to further reduce the dependence on imported oil, address fuel price escalation concerns and mitigate the upsurge in GHG emission. A hypothetical scenario of 20.0 percent bioethanol blend (E20) for gasoline provides an opportunity to achieve energy security and affordability objectives of the sector.

Integrating E20 from 2023 to 2050 brings the cumulative reduction in the transport sector's gasoline demand to 17.0 MTOE vis-à-vis its level under the CES with a 10.0 percent blending schedule. As the higher blend also ramps up bioethanol demand by a cumulative volume of 12.1 MTOE by 2050, TFEC levels between the two CES scenarios differ by a total of 4.8 MTOE across the planning horizon.[69] To meet the increase in blend, domestic production of bioethanol supply level rises to 784.6 kTOE by 2050 visà- vis 205.7 kTOE under CES 2. The impact of this hypothetical fuel diversification measure in the transport sector also allows the avoidance of a cumulative 49.1 $MtCO_2e$ in GHG emissions from 2023 to 2050.

[69] *Due to replacement of gasoline by bioethanol. Gasoline has a higher calorific value than bioethanol.*

B. ENERGY TRANSITION

Energy is one of the most important factors that influence the rate of progress, as well as sustainable development of the country. Sustainability is an important paradigm in the energy transition where all dimensions of sustainability are addressed by policy formulation and implementation, planning, operation, and dispatch of the energy resources in both generation and consumption. The energy sector recognizes that energy transition is a new path for economic development and innovation that does not compromise the environmental integrity and sustainability motivated by the challenges of climate change, natural disasters, and natural resource depletion.

The country's energy transition is currently driven by increased energy security, technology developments and innovation, improved energy efficiency and conservation, enhanced energy solutions and measures, and modernized energy systems that mitigate and avoid greenhouse gas emissions and reduce risks. Further, the move towards attaining a just energy transition compelled the energy sector, being the cornerstone of sustainable development, to recalibrate its policies, programs, strategies, and measures.

Moreover, in the sustainable energy's perspective, the energy transition in the country does not eliminate the use of fossil fuels but ensures that energy systems are sufficient, provide access for all, and environmental sustainability. Thus, maximizing the gains and benefits from RE resources and technologies increase indigenous energy sources, thus reducing energy import dependency. On the other hand, energy efficiency and conservation reduce energy demand and energy intensity per output of gross domestic product (GDP). All these measures will also result in emission reduction. With this backdrop, the sector will be steered on its path to creating a sustainable future.

THE PHILIPPINE ENERGY TRANSITION PROGRAM

The Philippine Energy Transition Program (PETP) serves as major component of the blueprint for the country's commitment to achieve a just energy transition. It is composed of various sector-specific strategies on how to decarbonize the country's energy system. Under the PETP, deployment of renewable energy (RE) projects will be accelerated, putting offshore wind (OSW) development at the forefront towards the achievement of our renewable energy targets. Cognizant to this is the building and expansion of necessary port infrastructure to support OSW and other marine-based energy resource development projects such as floating solar, ocean and tidal energy. To accommodate and manage the entry of additional renewable energy capacity, the DOE is looking that the modernization of the grid through the roll-out of the Smart Green Grid Project (SGGP). The SGGP will ensure that grid integrity and reliability is maintained amidst the rapid expansion of the grid to accommodate new sizeable RE capacity and connect demand centers with new sources of supply. On conventional energy sources, the PETP also aims to promote voluntary retirement and repurposing of existing CFPPs.

Equally important under the PETP is the incorporation of plans to decarbonize the transportation sector, primarily through increased utilization of electric vehicles (EVs). Lastly, continuous promotion of Energy Efficiency and Conservation (EEC) measures will be pursued under the PETP, through energy performance standards and labeling, as well as methods like demand-side management in both government and private sector organizations.

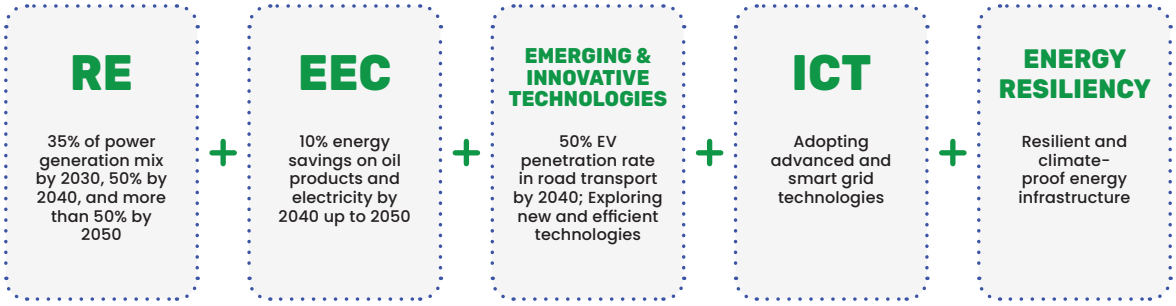
The sector's responses are articulated to be more robust over the planning period and likely to result in utilizing new and advanced technologies and increasing capacity-building initiatives and adopting innovative financing mechanisms. Thus, developing green financing mechanisms is crucial to accelerate a just transition that will incentivize investments in low-carbon technologies. Mobilizing private capital and reducing financial risks associated with green projects will result in sustainable energy projects.

The DOE has been collaborating with various development partners and international organizations including the Energy Transition Council (ETC), Energy Transition Partnership (ETP), Energy Transition Mechanism (ETM), and Clean Energy Finance and Investment Mobilization (CEFIM). Details of these various engagements are discussed in Forging Strategic Alliances with the International Community Chapter of this Plan.

The Philippines recognizes that the process of transitioning to a clean and sustainable energy system is already underway and that the strategies for low carbon and climate-and disaster-resilient solutions reflect the country's commitment to achieve such goal. However, significant strides must still be pursued to close the financing gap and redirect capital flows to achieve the envisioned just energy transition.

I. Energy Transition Pathway

The energy transition pathway is poised to provide access to affordable, accessible, reliable, and clean energy, which will ensure a strongly rooted, comfortable, and secure life for Filipinos. For an efficient energy transition, the approach must be a gradual process, necessitating the enhancement of energy delivery through coordinated reforms and investments across the entire energy sector, all integrated into broader development initiatives. The key components enabling the energy transition pathway are encapsulated as follows:



PH CONTRIBUTION TO GLOBAL ENERGY TRANSITION

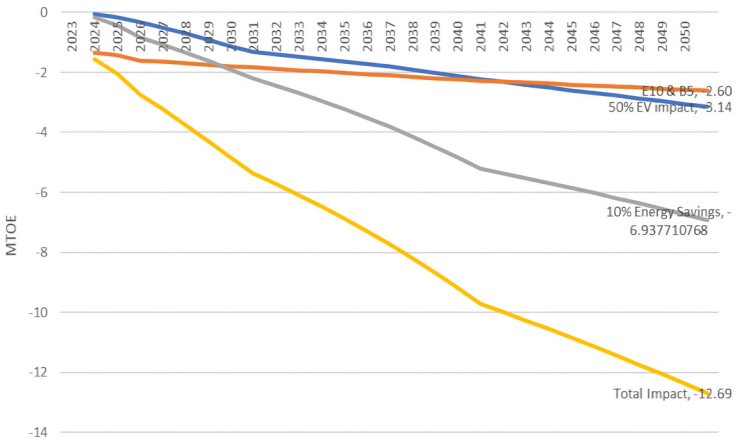
Offshore Wind Development and Support Port Infrastructure I Marine-Based Energy Resource Development I Rightskilling of Filipino Workforce and International Accreditation Initiative I Mining and Manufacturing of Green Materials I Voluntary Retirement and Repurposing of CFPPs

These goals support the Global Renewables and *Energy Efficiency Pledge* of tripling RE capacity with at least 11,000 GW by 2030 and doubling the global average annual rate of energy efficiency improvements from around 2.0 percent to over 4.0 percent every year until 2030. The country participated in this initiative at the 28th Conference of Parties (COP28) under the United Nations Framework Convention on Climate Change (UNFCCC), which aims to collectively meet the goal of the Paris Agreement in keeping the global temperature well below two degrees Celsius (2°C), while pursuing efforts to limit this to one point five degrees Celsius (1.5°C).

Demand-side mitigation measures such as: (1) 10.0 percent energy savings on oil products and electricity by 2040 up to 2050 through the implementation of energy efficiency and conservation measures; (2) 50.0 percent EV penetration rate in road transport by 2040 onwards, and (3) higher biofuel blending flatten the overall consumption by 12.7 MTOE by 2050. Reduction in TFEC reaches 10.0 percent up to 12.3 percent by 2030 and 2050, respectively, relative to the case without mitigation measures. The EV penetration and biofuels contribute around 3.0 percent each, while the rest (6.0 percent) comes from energy saving measures *(Figure 71)*.

Supply-side mitigation measures. Increasing the penetration of RE sources in the power generation mix to 35.0 percent by 2030 more than triples the 2022 RE capacity at 8.3 GW, while higher RE shares of 50.0 percent by 2040 and more than 50.0 percent by 2050 result in massive additional RE capacities in all scenarios coupled with voluntary retirement and possible repurposing of CFPPs. These targets would allow hydrogen and its derivatives to serve as alternative energy that can be stored to support variable RE (solar and wind) for a more stable and reliable system. On the other hand, nuclear power comprises a total of 4.8 GW by 2050.

Figure 71. **Energy Consumption Reduction from the Demand-side Mitigation Measures, 2023-2050**



These supply-side measures give way for TPES levels to exhibit improvements in energy intensity at 4.0 percent average annual rate by 2030, 6.0 percent by 2040 and 4.0 percent by 2050.

Energy transition enablers. To further ensure and accelerate the country's long-term vision and commitment, the energy transition measures include: infrastructure support such as adopting information and communication technology (ICT) through advanced smart grid technologies as embraced in the Smart and Green Grid Plan (SGGP) and port infrastructure to support OSW and marine based energy resource development projects; fortifying our energy infrastructure to be resilient and climate-proof; empowering the Filipino workforce through rightskilling initiatives and international accreditation programs; and, championing the mining and manufacturing of green materials.

II. Policy Implications Towards Energy Transition

The Philippines ranks 94th out of 120 countries in the 2023 Energy Transition Report of the World Economic Forum (WEF) due to low scores in transition preparedness. As the country is keen to achieve a clean energy future, its 2023 ranking poses a challenge for the energy sector to exert efforts to further support improvements in system performance and readiness for energy transition.

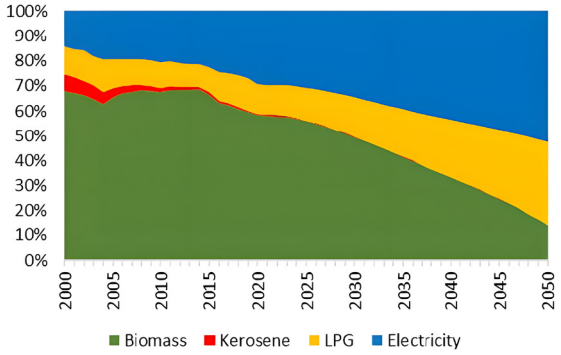
A. SUSTAINABILITY OF THE ENERGY SYSTEM

- ***Equitable Energy***

Access to Modern Energy. The household sector's energy demand mix has been shifting toward modern fuels over the years. Electricity and LPG displace traditional biomass as cooking fuel as households move towards the long-term vision of middle-income class society and greater access to modern energy *(Figure 72)*.

The current administration envisions achieving 100 percent household electrification by 2028, which aligns with the DOE's commitment in advancing sustainable rural development and alleviating poverty by providing electricity access for all. As of December 2022, the country's household electrification level was 96.2 percent (based on the 2015 census of population), which means that about 25.9 million households are now enjoying the benefits of electricity service, while the remaining 879,232 households are still to be provided with electricity access.

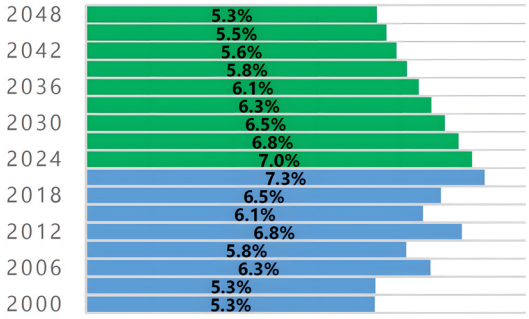
Figure 72. **Household Fuel Shares (%)**



Currently, preparations are underway for the conduct of the 2024 Household Energy Consumption Survey (HECS). The 2024 HECS seeks to update the 2011 baseline for the number of households with access to modern energy.

Affordability. Among major economies, the share of energy expenditure to the average household expenditure ranges from 3.2 percent to 7.2 percent.[70] The 2021 Family Income and Expenditure Survey (FIES)[71] records that a typical Filipino household spends 7.3 percent on energy, slightly higher compared to the Italy's (one of the major economies reviewed by the IEA) 7.2 percent. This is due to the impact of COVID restrictions where most of the household members follow work-from-home (WFH) arrangements. Before the pandemic, the share was lower by almost 1.0 percentage point. With the 7.1 percent annual average economic growth throughout the planning horizon, it is expected that the share of energy expenditure to the average household expenditure declines to 5.3 percent *(Figure 73)*. This is closer to the mid-level shares of the developed and major economies such as France, the United Kingdom, and Japan.

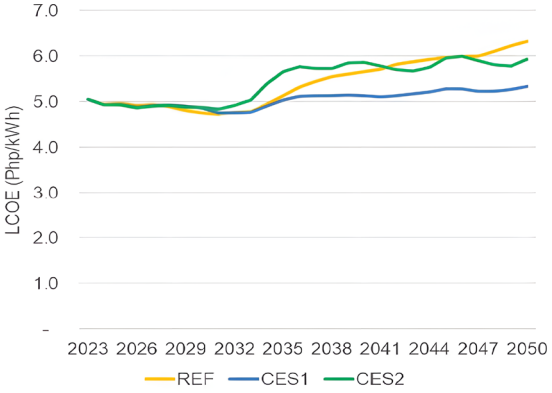
Figure 73. **Share of Household expenditure in average household incomes, 2000-2021**



Note: CY 2000-2021 are based on the Family Income Expenditure Surveys conducted every 3 years (PSA, 2000-2021); 2024 onwards are approximations.

Blended Generation (levelized cost of electricity or LCOE). The blended rate of power generation cost under the REF increases at an annual rate of 0.8 percent between 2023 level of PhP5.1/kWh to PhP6.3/kWh by 2050. The RE capital cost exhibiting a learning curve slows down the blended rate to 0.2 percent and 0.6 percent for CES 1 and CES 2, respectively (Figure 74). The REF appears to have the highest blended rate due to steady increases in fossil fuels and technology capital costs. However, as technologies with higher capacity factor, particularly OSW, have increased shares under CES 2, it translates to lower blended rate compared to the other two scenarios.

Figure 74. **Blended rate of generation cost for the period 2023-2050 by Scenario**



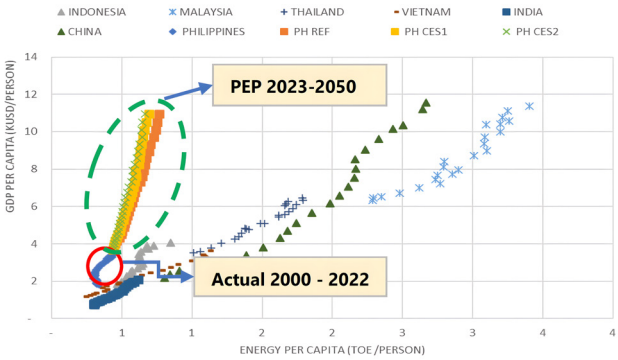
Blended rate does reflect the true cost of energy but only represents the trajectory of generation cost when targets are in place. The cost pathway shows that as we decarbonize the electricity sector, the trade-off is to pay higher cost of electricity. However, sustaining economic growth allows for higher disposable income, of which 5.3 percent will be spent on energy expenditures of the households thereby achieving affordability of energy *(Figure 73)*.

[70] *IEA. (2023, May 26). Shares of home energy expenditure in average household incomes in major economies, 2021-2022. Retrieved from IEA: https://www.iea.org/data-and-statistics/charts/shares-of-home-energy-expenditure-in-average-household-incomes-in-major-economies-2021- 2022, License: CC BY 4.0*
[71] *PSA. (2000-2021). Family Income Expenditure Survey. Manila: Philippine Statistics Authority*

Economic Development. The economic structure of a country serves as an indicator of how much energy is required to fuel its development, i.e., whether the sectors that drive economic growth are energy intensive (industry) or less energy intensive (services and agriculture). Figure 75 shows the relationships of energy per capita and GDP per capita (or income per capita) of selected ASEAN countries, India, and China for 2000-2022 compared with the Philippines' trajectory under the PEP's REF, CES 1 and CES 2 for the period 2023-2050. It is evident that the Philippines is next to India with the lowest income per capita, while China and Malaysia are the highest with around USD 11,600 and USD 11,400 in 2022, respectively. On the other hand, the Philippines' 2022 energy per capita consumption level is the lowest among the countries in comparison at 0.61 TOE/person next to India's 0.44 TOE/person. Meanwhile, Singapore and Malaysia have the highest energy per capita at 12.7 TOE/person and 3.4 TOE/person, respectively. The graph also shows that between 2000 and 2022, the country's energy consumption per capita did not increase substantially despite increasing income per capita *(see blue scatter plots encircled with red line in Figure 75)*, while most of the ASEAN countries' energy consumption per capita is highly proportional to the increases in their per capita income.

In this PEP update, the impact of having the Services sector as the major contributor to GDP can be seen in the movement of the energy per capita vis-à-vis GDP per capita – with a steep upward trend *(see scatter plots within the green dotted circle in Figure 75)*. The country's energy per capita consumption gradually increases despite the upsurge in income per capita across the planning horizon.

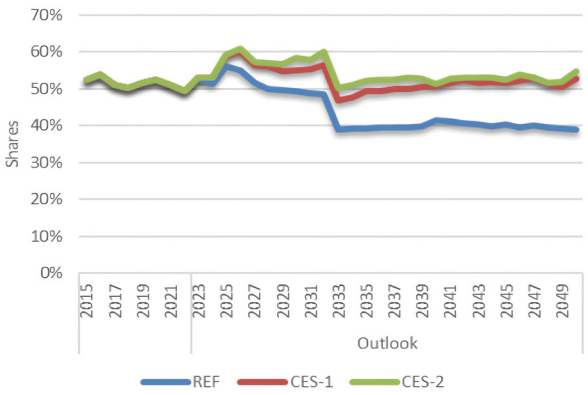
Figure 75. **Energy per capita vs. GDP per capita trajectory of ASEAN Countries for the Period 2000-2022 compared with PEP's REF, CES 1 and CES 2 for the period 2023-2050**



❖ *Security of Energy Supply*

Supply Security. Higher RE share, production of low-carbon technologies, voluntary retirement and possible repurposing of CFPPs result in reduced fuel imports towards the end of the planning horizon. Local production share declines from 49.2 percent in 2022 to 38.8 percent by 2050 under the REF. Compared to the CES 1 and CES 2 trajectories, it increases to 52.8 percent and 54.7, respectively *(Figure 76)*. This indicates that the security of supply improves with the country's decarbonization target.

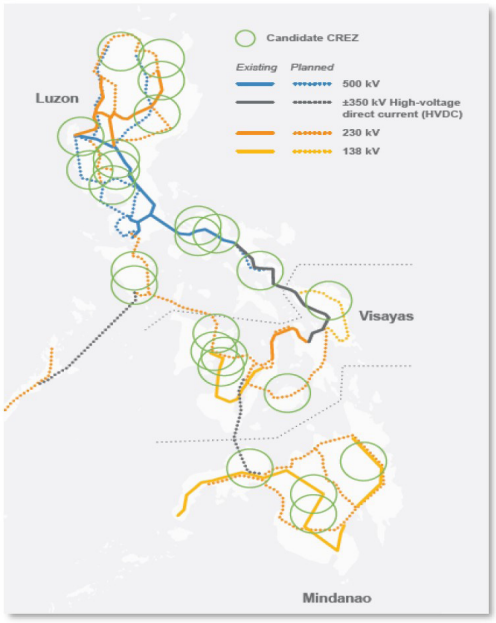
Figure 76. **Share of Indigenous Production to TPES**



Reliability and Resilience. Reliable transmission infrastructure plays a significant role in integrating large-scale renewable energy facilities. Deployment of large-scale wind and solar generation may only require a year or less, while transmission planning and development may take 10 or more years. The RE development requires financing, but remote wind or solar power projects cannot be implemented without accessible transmission infrastructures. Thus, the transmission infrastructure should be in place prior to the implementation of RE targets.

Designating RE zones simultaneous to the strategic development of new connections and modernization of existing transmission infrastructure addresses investment risk brought by barriers in its development process. The CREZ vision is to adopt pro-active transmission planning and implementation, and direct RE development to places that optimize the use of indigenous resources and maximize the benefits to the people.

Figure 77. **Designated RE Zones from CREZ-1**



Source: Grid Planning and Competitive Renewable Energy Zones (CREZ) in the Philippines

To improve the reliability of the transmission system, the government led the conduct of the CREZ Process with the issuance of a Department Circular DC2018-09-0027 for the "Establishment and Development of Competitive Renewable Energy Zones in the Country" on 13 September 2018 to support the DOE in overcoming RE development obstacles, such as transmission constraints, regulatory barriers, and financial investments by the private sector. This process identified 25 RE zones that are viable for development, which are also considered in the generation and transmission planning *(Figure 77)*. The CREZ has progressed to include areas for battery storage to enhance the reliability of the grid with more VRE installation under CREZ-2.

Moreover, the DOE is formulating a strategic blueprint (SGGP) for the development, deployment, and operation of a modern transmission infrastructure that supports the integration of clean energy sources and enables a sustainable, reliable, and resilient power grid. This initiative shall integrate the results of CREZ-1 and CREZ-2.

Figure 78. **VRE and ESS Shares to Generation Mix**

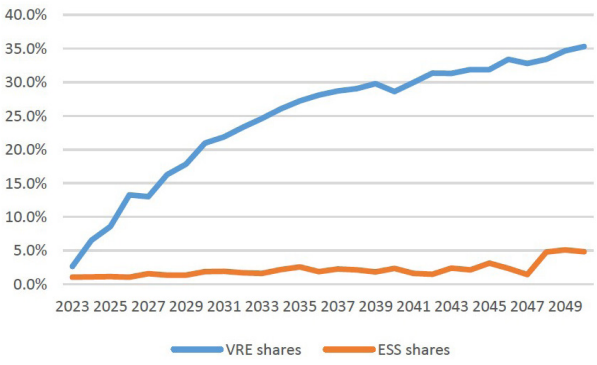
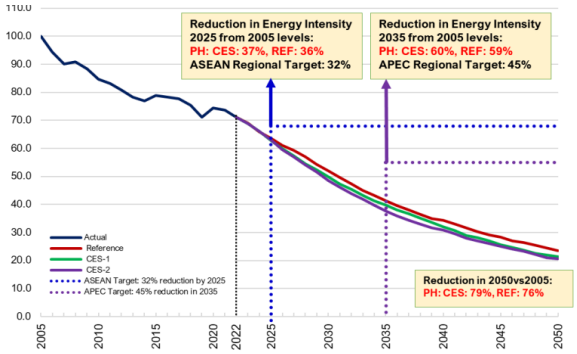


Figure 53 (Section A of this Chapter) illustrates how the ESS, such as BESS and hydropower pump storage plants contribute to the grid performance reliability as part of the operational reserve requirements. About 22 GW of BESS will be installed by 2050 for CES 1 and 24.7 GW for CES 2, while pump hydro storage will contribute 2.3 GW and 2.1 GW for CES 1 and CES 2 by 2050, respectively. However, there is a need to ensure grid reliability as the share of VRE, which are prone to ramp down drastically from 100 percent of their capacity to zero percent at any time, in the generation mix under CES 2 increases from 21.0 percent in 2030 to 35.3 percent by 2050 (Figure 78). The ESS considered in the capacity mix serves as ancillary services of the grid. However, the combined share only accounts for 1.9 percent by 2030 to 4.8 percent by 2050. With this, LNG plays a vital role in supporting grid stability, while decommissioned traditional CFPPs can be retrofitted to be flexible for this purpose. There is also an opportunity to produce green hydrogen should the awarded service contracts (SCs) for OSW provide a considerable amount of firm capacity for power generation.

❖ *Sustainability of Energy*

Energy Efficiency as a Way of Life. The Philippines' energy intensity registered an annual decline of 2.0 percent from 4.3 TOE/MPhP in 2005 to 3.1 TOE/MPhP in 2022. This translates to a cumulative efficiency gain of around 30.0 percent vis-à-vis 2005 baseline, higher than the APEC region's 22.0 percent[72]. The energy sector's achievement is attributed to the effective implementation of energy policies and the corresponding adoption of energy-efficient technologies and applications.

Figure 79. **Reduction in Energy Intensity as indicator of improvements in energy efficiency**



The ASEAN and APEC regional cooperation has set forth targets on energy intensity reduction among its energy goals. The ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase II seeks to reduce energy intensity by 32.0 percent by 2025 from 2005 as the base year and encourage further energy efficiency and conservation efforts, especially in transport and industry sectors. The PEP 2023- 2050 achieves the ASEAN target in 2023 or two years earlier and exceeds the same by 4.0 percentage points by 2025. The APEC also sets its aspirational energy intensity reduction at 45.0 percent by 2035. The CES breaches this level in 2028 or seven years ahead with a 46.0 percent reduction in energy intensity *(Figure 79)*.

Table 32 shows energy intensity per end-use sectors in 2022, 2030 and 2050 for both the REF and CES demand scenarios. Energy efficiency, including fuel diversification measures translate to a significant reduction in energy use per unit of economic output, particularly in energy-intensive sectors such as transport, cement and iron and steel. However, there is a need to further improve efforts for the food and machinery and equipment sub-sectors, to ensure economy-wide reduction targets are met.

Table 32. **End-use Sectoral Energy Intensity, in TOE/PhP Million: 2022., 2030 and 2050**

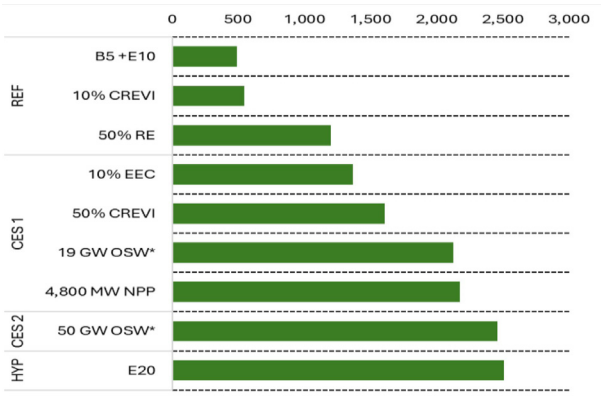
Sector/Sub-Sector	Energy Intensity					% Reduction from 2022			
	2022	2030		2050		2030		2050	
	Actual	REF	CES	REF	CES	REF	CES	REF	CES
Transport	**18.16**	**9.90**	**9.11**	**1.90**	**1.66**	**-45.45**	**-49.85**	**-89.53**	**-90.87**
Industry	**1.35**	**1.15**	**1.11**	**0.76**	**0.71**	**-14.46**	**-17.61**	**-43.26**	**-47.27**
Energy Intensive	1.52	1.45	1.40	1.30	1.21	-4.76	-7.94	-14.85	-20.74
Cement	11.20	10.57	10.12	12.21	11.09	-5.63	-9.67	8.96	-1.02
Food	1.15	1.28	1.25	2.02	1.91	12.01	9.39	75.85	66.54
Chemical	0.52	0.48	0.46	0.33	0.30	-8.25	-12.09	-36.90	-42.40
Iron & Steel	5.03	2.37	2.29	0.66	0.61	-52.84	-54.49	-86.94	-87.87
Machinery & Equipment	0.86	1.07	1.02	1.22	1.11	25.17	19.50	42.78	30.23
Paper and Printing	4.88	2.58	2.49	2.46	2.30	-47.04	-49.00	-49.61	-52.83
Other Industries	1.09	0.76	0.72	0.28	0.26	-30.17	-33.36	-74.06	-76.05
Services	**0.36**	**0.29**	**0.28**	**0.17**	**0.16**	**-20.69**	**-23.04**	**-54.06**	**-56.84**
Agriculture	**0.21**	**0.18**	**0.17**	**0.14**	**0.13**	**-17.46**	**-20.03**	**-32.32**	**-36.70**
Households	**0.71**	**0.50**	**0.49**	**0.22**	**0.20**	**-29.74**	**-30.74**	**-69.59**	**-71.27**

Note: Sectoral intensities may not add-up to economy-wide intensity due to sector-specific Gross Value Added (GVA) used as denominator

[72] *APEC is on track to meet aspirational energy goals. (2022, September 22). [Press release]. https://www.apec.org/press/newsreleases/ 2022/apec-is-on-track-to-meet-aspirational-energy-goals*

GHG Avoidance and Reduction. Mitigation measures under the REF, such as increasing biodiesel blend to 5.0 percent by 2026, 10.0 percent penetration rates for EVs and a 50.0 percent RE share in the generation mix, result in a cumulative GHG emission avoidance and reduction of around 1,200.2 $MtCO_2e$ by 2050.

Figure 80. **Cumulative GHG Avoidance and Reduction from 2023 to 2050 by Mitigation Measures in $MtCO_2e$**



*Includes emission reduction from RE due to retirement of CFPPs

Sustaining a 10.0 percent energy savings and a 50.0 percent EV target from 2040 onwards translates to an aggregate reduction of 1,606.6 $MtCO_2e$ in GHG emissions by the end of the planning horizon vis-à-vis the REF. With the entry of 19 GW OSW capacities and the 4,800 MW nuclear capacity by 2050, CES 1 pushes the cumulative GHG avoidance and reduction to 2,173.5 $MtCO_2e$ by 2050. This further increases to 2,458.2 $MtCO_2e$ with the expansion of OSW capacities to 50 MW under the CES 2. These values represent about 31.6 percent (CES 1) to 35.8 percent (CES 2) of the cumulative baseline emissions from 2023 to 2050. In addition, these scenarios already incorporate a cumulative reduction in GHG emissions between 6.1 $MtCO_2e$ (CES 1) and 8.1 $MtCO_2e$ (CES 2) from the retirement of CFPPs, about 3,660 MW and 4,803, respectively *(Figure 80)*.

Amidst the robust decarbonization targets in the power sector and demand-side, net-zero is far from being reached within the planning horizon. Thus, there is a need to explore more mitigation measures in the transport sector, the next largest emitter after the power sector. If we hypothetically increase the blend of bioethanol to 20.0 percent by 2030, this translates a reduction of 48.8 $MtCO_2e$ or 1.9 percent of total GHG avoidance and reduction.

By scenario, the impact of our decarbonization targets shrinks the GHG emission by 26.1 percent by 2050 as compared to the REF and further declines by 6.8 percent under CES 2. Voluntary retirement and possible repurposing of CFPPs to clean fuel can also accelerate the achievement of low carbon targets. The LNG comes in and serves as a transition fuel to achieve reliability of the system along with BESS and other ESS such as pump storage hydro and hydrogen production to compensate for the decommissioning of CFPPs and intermittent RE.

Carbon per Capita and Intensity. Carbon per capita increases from a level of 1.2 ton of CO_2 equivalent per person (tCO_2e/person) in 2022 to 1.9 tCO_2e /person in 2050. The progressive targets for energy transition reflect on the CES 1 and CES 2 levels of carbon per capita at 1.4 tCO_2e/person and 1.3 tCO_2e/person, respectively, tempering potential increase of GHG emission at the end of the planning period *(Figure 81)*. On the other hand, carbon intensity to TPES declines with the decarbonization targets for both the demand- and supply-side measures. The carbon intensity to TPES decreases from a base year of 2.2 tons of CO_2 equivalent per TOE (tCO_2e/TOE) in 2022 to 1.9 tCO^2e/TOE in 2050 for REF, 1.6 tCO_2e/TOE for CES 1 and 1.5 tCO_2e/TOE for CES 2 *(Figure 82)*.

Figure 81. **Carbon emission per capita**

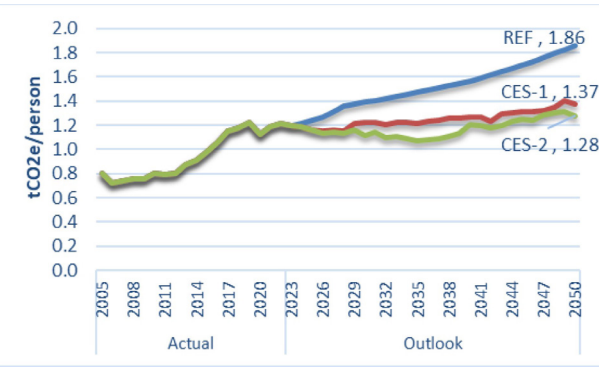
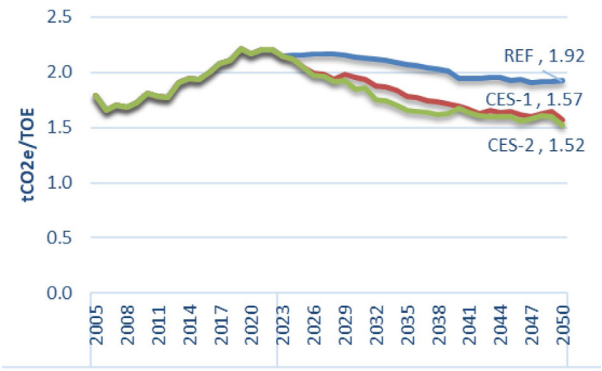


Figure 82. **Carbon intensity to TPES**

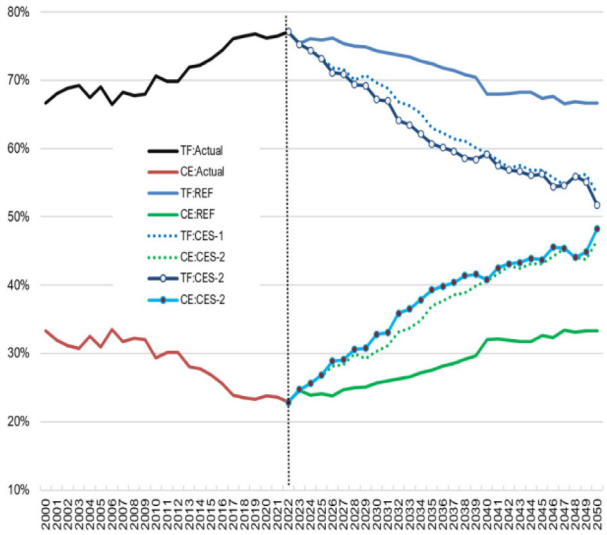


Share of Clean Fuel in the TPES

Overall sectoral targets usher energy transition through decarbonization of TPES beyond 2050. In *Figure 83*, clean energy sources, such as RE resources (excluding traditional biomass cooking) and other emerging technologies like nuclear, reach 46.7 percent by 2050 for CES 1 and 48.3 percent for CES 2. This shows that robust targets in power generation alone do not satisfy the goal of transitioning to clean fuel and calls for more accelerated efforts for non-power, such as transport sector.

On the other hand, the 2025 RE share under this PEP exceeds the targets under the APAEC. The ASEAN recognizes the role of RE as an important mechanism to accelerate energy transition by setting up aspirational targets of 23.0 percent share of RE in the TPES and a 35.0 percent share of RE in installed power capacity by 2025. It is also noteworthy that under the CES, RE shares exceed the targets under the PDP 2023-2028.

Figure 83. **Share of clean fuel and non-clean fuel in the TPES, 2023-2050**



Note: TF refers to traditional fuels such coal, oil gas and traditional biomass for cooking fuel, which pose health hazard; while CE stands for clean energy and covers RE (excluding traditional biomass for HH) and other emerging technologies such as nuclear energy.

B. TRANSITION ENABLERS

Regulation and Political Commitment

Preferential Dispatch of All RE Resources in the Wholesale Electricity Spot Market (WESM): All RE generating units are given a preference in the WESM dispatch schedule. This is to encourage additional investments because of guaranteed dispatch in the grid at their full available capacity, allowing recovery of investments.

Policy Framework for Offshore Wind: Executive Order (EO) 21 "Directing the Establishment of the Policy and Administrative Framework for Offshore Wind Development" supports the aggressive development of the country's OSW potential. These policies drive the transition from a coal-dominated capacity mix to a RE-centered one. Following EO 21, the DOE issued DC2023-06-0020 titled "Policy and Administrative Framework for the Efficient and Optimal Development of the Country's Offshore Wind (OSW) Resources," on 16 June 2023.

Initiatives on Marine Spatial Planning, Grid Readiness, and Permitting and Consenting are being undertaken to hasten the development of OSW resources.

Accelerating renewable energy requires conducive regulatory and financial environment.

Despite the robust RE target and use of low-carbon technologies in power generation, as well as in the demand-side, **the country does not commit to net-zero emission goals as it prioritizes energy security and reliability of energy supply.** As such, natural gas serves as transition fuel in place of decommissioned CFPPs, while the coal moratorium policy in 2020 covers only new coal power projects. The energy sector likewise encourages hybridization of conventional energy (oil and coal) plants in balancing the effect of reduction in their utilization vis-à-vis their vital role in the country's energy security.

Finance and Investment

Accelerating RE requires a conducive regulatory and financial environment. The enabling policies in place to ensure investor confidence and to safeguard the benefits of the Filipinos include:

- Allowing 100 foreign ownership in RE projects [geothermal, solar, wind, biomass, ocean, or tidal energy] for the promotion, exploration, development, and utilization of the country's RE resources;

- Providing a sovereign guarantee for financing sustainable energy projects through the Sustainable Energy Credit Guarantee Facility (SEGF) of the Philippine Guarantee Corporation (PHILGUARANTEE)[73], which has been set since 2014; and,

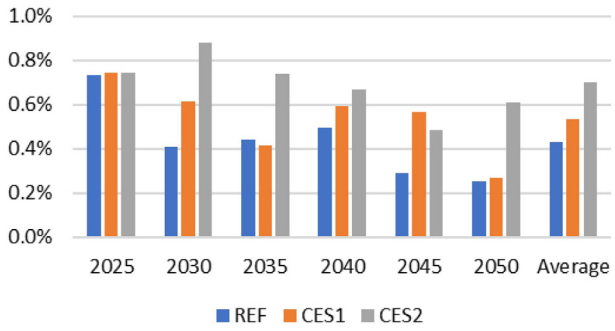
- Issuing 25-year green bonds by private corporations, which amounted to USD6.58 billion worth in 2022, as part of our initiatives and foray into the Green and Sustainability Capital Market[74]

  In the Sustainable Bond Allocation and Impact Report of the government covering green bond issuances from March 2022 to January 2023, which amounted to USD3.55 billion, 0.1 percent was provided for RE development.[75] This was used in promoting RE through information, education, and campaigns (IECs) throughout the country. This resulted in the awarding of RE contracts with a potential capacity of more than 70 MW from CY 2020 to August 2023.

Share of RE and Other Low-carbon Technology Investment to GDP

Although the bulk of RE installed capacity will be in place beyond 2030, the total share of RE investment to GDP is decreasing due to the declining capital cost of clean technology *(Figure 84)*. The total annual average share of investments from RE and low-carbon technology to GDP accounts for 0.4 percent under the REF, 0.5 percent for CES 1, and 0.7 percent for CES 2.

Figure 84. **Share of Low-Carbon Technologies' Investment to GDP**



Education and Human Capital

Global decarbonization efforts are poised to bring profound shifts in the energy sector's employment, which bring a massive and new opportunity for job creation in clean energy while traditional energy sector job sees to decline.[76] This requires the development of new programs of education, certification, and vocational training along with targeted rightskilling programs for the existing workforce. This plan identifies more than 106 GW of new capacity by 2050 from RE technologies that are estimated to create more than 1.2 million green jobs by 2050. The government recognizes this by directing the DOE and the Department of Labor and Employment (DOLE) to spearhead an initiative on the Rightskilling of Filipino Workforce to Support the Global Energy Transition.[77] The primary objectives of this initiative are to:

- Sustain technical education and skills development to enhance human capital and build a skilled "green" workforce capable of driving sustainable development in the Philippines;
- Match job offers and demands the Philippine Energy Transition Program requires;
- Provide capacity-building for Philippine institutions, including local government units (LGUs), to enhance governance and institutional capacities in implementing policies and programs supporting the green economy;
- Share information on best practices and innovations towards improving resource use efficiency, minimizing waste generation, and scaling up RE and EEC; and,
- Support investments in climate change adaptation, mitigation, and environmental protection measures, including the development and transfer of green technologies and innovations.

[73] Sustainable Energy Credit Guarantee Facility (SEGF). (n.d.). Philippine Guarantee Corporation. https://www.philguarantee.gov.ph/programs/guarantee-programs/corporate-msme/sustainable-energy-credit-guarantee-facility-segf/
[74] Sustainable Finance Market Update as of December 2022. (2022, December 31). Securities and Exchange Commission. https://www.sec.gov.ph/cmsustainable- 2022/sustainable-finance-market-update-as-of-december-2022/#gsc.tab=0
[75] Bureau of Treasury. (2023). Sustainability Bond: Allocation and Impact Report. https://www.treasury.gov.ph/wpcontent/ uploads/2023/10/Sustainable-Bond-Report-and-DNV External-Review.pdf
[76] IEA. (2022, September). Skills Development and Inclusivity for Clean Energy Transition. Retrieved from International Energy Agency: https://www.iea.org/reports/skills-development-and-inclusivity-for-clean-energy-transitions, License: CC BY 4.0
[77] DOE. (2023, August 04). Concept paper for the Rightskilling of Filipino Workforce to Support Global Energy Transition. Taguig, Metro Manila, Philippines.

Innovation

To improve the reliability, efficiency, flexibility, and resiliency of the power system and promote consumer empowerment, the national policy framework for smart grid and roadmap for DUs was rolled out in 2020. The main goal for the power sector is to establish flexible and interconnected smart grids for all the areas in the Philippines to have an optimized energy system for the different island grids across the country. This is part of the commitment to ensure 100 percent electrification of all households in the country so that no one will be left behind with all the advancements in the energy industry.

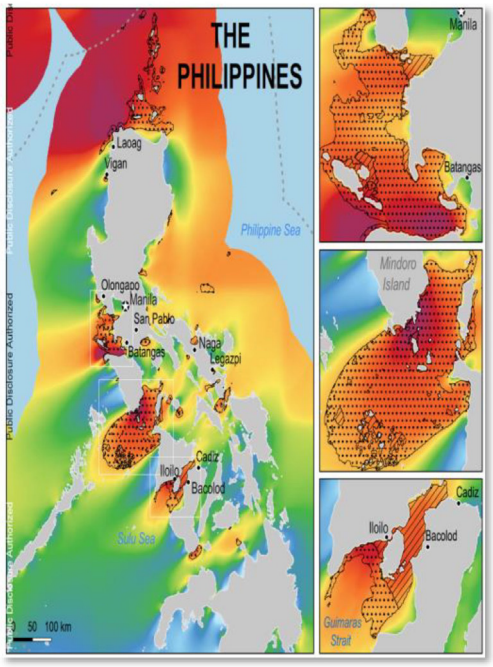
To achieve this goal, the DOE shall continuously improve its existing electrification strategies, utilize advanced and emerging technologies, and adopt innovative solutions. To further guide the government in its electrification efforts, RA 11646, or the "Microgrid Systems Act of 2022" was passed, which promotes the use of microgrids to provide uninterrupted power in remote communities with due consideration on the cost-efficient, renewable, and environment-friendly power sources.

Provision of Infrastructure to Accelerate Deployment of Low Carbon Technologies

The aggressive RE targets require the timely development of a green and smart transmission system to integrate and manage the additional RE capacity expected to come online from 2024 to 2050. The SGGP is envisioned as a strategic blueprint for the development, deployment, and operation of a modern transmission infrastructure that supports the integration of clean energy sources and enables a sustainable, reliable, and resilient power grid.

The 178 GW Offshore wind (OSW) resource based on World Bank (WB) study *(Figure 85)* offers promising interest to the investors as the DOE granted OSW Service Contracts (80 OSW projects with 62.3 GW potential capacity as of October 2023). The Philippines needs to invest in maritime facilities such as port areas that can accommodate the construction, maintenance, and repairs of OSW farms. This is being coordinated with the Department of Transportation (DOTr) and the Philippine Ports Authority (PPA) in identifying potential ports and private investors that can upgrade these ports.

Figure 85. **OSW Potential Areas**

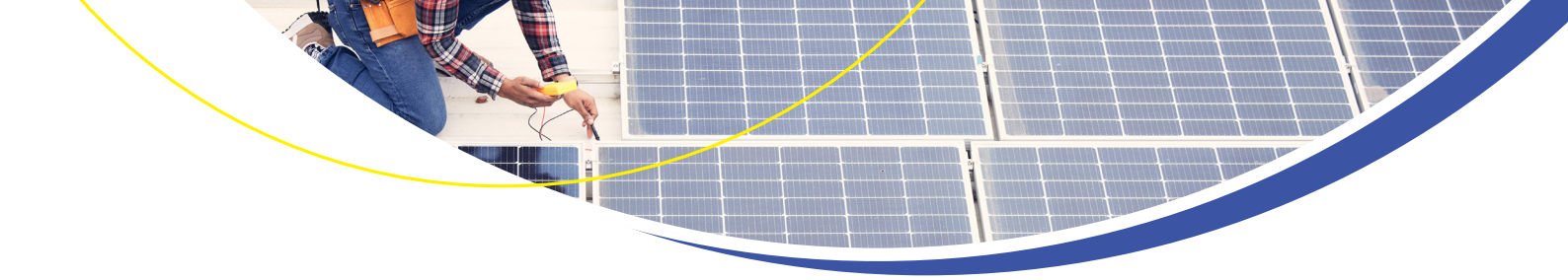


The issuance of the Electric Vehicle Industry Development Act (EVIDA) and the formulation of CREVI shall accelerate the adoption of EVs. The CREVI sets a minimum 10.0 percent EV share in the vehicle fleet by 2040 under the Business-as-Usual (BAU) Scenario, while the CES sets an ambitious target of re-fleeting 50.0 percent of all vehicle fleets by the same year. Such requires infrastructure support for EVCS.

Digital infrastructure readiness

The Philippines ranks 71st out of 131 economies included in the 2022 Network Readiness Index (NRI)[78]. The country's strength for the NRI relates to Impact criteria (50th) with sub-criteria relating to the economy, quality of life, and SDG contributions. However, for technology concerns (with sub-criteria concerning access, content, and future technologies), the country needs to put more effort into improving the country's ranking (85th). The government needs to address this concern as this will support the deployment of RE and other clean energy sources and technologies. The DOE needs network support for the operation of the Energy Virtual One Stop Shop (EVOSS) and Smart Grid System, among others.

[78] *Portulans Institute. (2022). Benchmarking the Future of the Network Economy. Retrieved from Network Readiness Institute 2022: https://networkreadinessindex.org/*



The EVOSS System is an online portal that allows the coordinated submission and synchronous processing of all required data and information and provides a single decision-making portal for actions on applications for permits or certifications necessary for, or related to, an application of a proponent for new power generation, transmission, or distribution projects. With an array of permits and licenses needed for RE projects, the DOE is now in the process of integrating the remaining relevant agencies and entities into the EVOSS System platform. Additional agencies will also be included as identified under EO 21, such as the PPA, Civil Aviation Authority of the Philippines (CAAP), Maritime Industry Authority (MARINA), and Philippine Coast Guard (PCG). The DOE needs network support for the operation of EVOSS and Smart Grid System, among others.[79]

As of 23 June 2023, the DOE already processed 25 entity applications in the EVOSS platform, while 10 from related agencies' clearances on compliances to operation, such as power supply and RE program agreements, as well as physical permits, clearances and working condition certificates.

Deployment of RE and other clean energy sources and technologies needs network support for the operation of the Energy Virtual One Stop Shop (EVOSS) and Smart Grid systems among others.

On the other hand, RE integration with smart grid to improve the network system to anticipate the downtimes of VREs and immediate response of ESS/BESS requires network support to foster reliability and resilience of the grid.

C. ALIGNING THE INITIATIVES FOR THE IMPROVEMENT OF ENERGY TRANSITION PATH

The existing plans, programs, and strategies are geared towards energy transition and are further discussed in the succeeding chapters. As to how these will position the country in the energy transition index, the following actions and initiatives direct them for the improvement of energy system performance and provision of enabling policies and other factors to further accelerate the positioning of the decarbonization targets and foster energy transition readiness.

1. Improvement of Energy System Performance

- **Implement 100 percent household by 2028 and improve greater access to modern energy along with the following measures:**
  - Interconnection of off-grid areas to the national grid.
  - Hybridization and Distributed Energy Systems (DES) in off-grid areas.

- **Institutionalize the regular conduct of HECS.** The regular conduct of HECS is essential to capture the updated energy consumption patterns and preferences of the households, including access to clean cooking fuels and technologies.

- **Diversify energy supply by making use of indigenous resources to reduce net imports and improve energy security with the following measures:**
  - **Increase energy self-sufficiency level** by making use of indigenous fuels such as RE and domestic resources.
  - **Ascertain the availability of LNG to complement VRE**, while transitioning to clean fuels for the reliability of the system.

Expanding the bioethanol to E20 by 2030 further pulls down the GHG emissions by 1.3 percent or 49.0 $MtCO_2e$ while considering solar PV for EV charging station tempers the negative impact of EV.

[79] DOE. (2023, 25 July). Press Releases. Retrieved from Philippines Department of Energy: https://www.doe.gov.ph/press-releases/energy-sectorensured- adequate-energy-supply-during-first-year-marcos-jr

- **Consider other fuels in the energy mix**, i.e., use of nuclear power, green hydrogen, offshore wind, floating solar, etc.

- **Provide policy mechanisms for the voluntary retirement and repurposing of CFPPs** to decrease our reliance on imported coal and to ensure the acceleration of RE and other low carbon technologies. Traditional power plants need to be retrofitted or repurpose for clean energy or technology.

- **Diversify the transport fuel to reduce reliance on imported oil, improve energy security and mitigate the adverse effects of the volatility of oil prices in the international market to the economy** by increasing the biofuel blend and intensify promotion on the use of EVs in the transport sector. A hypothetical scenario in which bioethanol blend increases to 20.0 percent (E20) by 2030 serves as an opportunity for a cumulative GHG reduction of 48.9 $MtCO_2e$ over the planning period, while the increase in biodiesel blend also pushes GHG reduction due to higher carbon content of diesel than gasoline. Likewise, considering off-grid Solar PV for EVCS may also soften the reverse impact of CREVI on GHG emission from electricity production.

> ***Global decarbonization efforts are poised to bring profound shifts in the energy sector's employment which brings a massive and new opportunity for job creation in clean energy while traditional energy sector job opportunities will decline. [IEA, 2022]***

- **Develop distributed and diverse energy systems**, which include microgrids, ESS, and demand response technologies.

2. Provision of Energy Transition Enablers

- **Ensure timely implementation of transmission plan for the deployment of large-scale RE.** The DOE's assessment of the implementation rate of the Transmission Development Plans (TDPs) submitted by the National Grid Corporation of the Philippines (NGCP) poses concerns on RE deployment. Since 2009, the transmission grid only increased by 8.0 percent in terms of line expansion. During the pre-pandemic years, the NGCP's line expansion, on average, was only at a 1.0 percent progress rate per year (DOE, 2023). The timely implementation of transmission projects is crucial in the integration of large-scale VREs.

> ***For one, we will make sure that grid connections, the needed highways for electricity, will be completed in a timely manner so that additional generation capacity will be delivered down to the distribution sector and ultimately to the household level.***
>
> *- DOE Secretary R. P. M. Lotilla*

- **Put in place sufficient ESS/BESS and operational reserves to support zero to 100.0 percent ramp-up of VREs.**

- **Guarantee effectiveness of financial enablers to accelerate deployment.** The government issued key enablers for the financial investment of RE, i.e., 100 percent foreign ownership, issuance of green bonds and sovereign guarantee for NREP projects. Since 2014, the latter has been in place with financial allocations. Apparently, this allocation has not yet been fully implemented due to a lack of technical capability in some financial/banking institutions to facilitate it. Thus, the need to provide capacity building.

- **Continue collaborating with Department of Science and Technology (DOST) to provide innovative technologies that will localize the materials needed to support decarbonization,** i.e., for fast charging of EVs, production of hydrogen, uranium enrichment, and smart technologies for electricity transmission.

- **Encourage participation of LGUs, communities and private sectors in the implementation of decarbonization targets** by providing capacity building and conduct of IECs to rally the targets, plans and programs and the benefits to the end-use sectors, as well as to the people.

- **Coordinate with DICT to ensure readiness of digital infrastructure** to support the EVOSS operation, installation of smart grid and other technologies that require network support.

- **Conduct comprehensive waste management studies for the entry of sizeable capacity of VREs and BESS and batteries for EVs to identify policy for proper waste disposal.** The decarbonization targets are seen to increase deployment of VREs, i.e., solar and wind technologies for power generation, BESS, and batteries from EVs. This may pose concerns on waste materials from these technologies and hazard to the environment. As such, there is a need to anticipate the needed regulation for the disposal of waste and decommissioning of the power plants using these technologies.

- **Team up with DOLE, other relevant agencies, and international development partners to equip Filipino workforce to support global energy transition through rightskilling.** The PDP 2023-2028 [NEDA, 2022] aims to equip Filipinos with skills to participate fully in an innovative and globally competitive economy that will support the clean energy future and Energy Transition Program (ETP) of the country. The PEP's sustainable pathway creates about a million green jobs for the development of RE notwithstanding the jobs created indirectly as a spillover to other economic sectors, such as industrial, services, and agriculture. Training and rightskilling of the workforce from traditional energy sector jobs is necessary for deployment for green jobs. Further, developed economies that are ahead in implementing their decarbonization targets are also in need of a considerable workforce. With this, there is an opportunity to learn from their expertise through accreditation of our competencies, and for possible job abroad of Filipino green workforce.

Rightskill Filipinos for full participation in an innovative and globally competitive economy that will support a clean energy future and Energy Transition Program of the country.

Annexes

Annex 1. Total Final Energy Consumption, By Sector, Reference Scenario (In Million Tons of Oil Equivalent, MTOE)

Sector	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Agriculture	0.41	0.36	0.36	0.38	0.41	0.44	0.47	0.51	0.54	0.58	0.62	0.65	0.69	0.73	0.77	0.81	0.85	0.89	0.93	0.96	1.00	1.04	1.08	1.13	1.17	1.21	1.26	1.30	1.22	2.48	3.70	5.79	3.92	4.52
Industry	7.31	7.73	8.19	8.67	9.15	9.65	10.17	10.71	11.29	11.90	12.54	13.22	13.93	14.67	15.44	16.25	17.08	17.95	18.78	19.63	20.51	21.41	22.35	23.31	24.31	25.32	26.37	27.44	24.40	5.23	5.26	5.30	4.34	4.94
Services	4.73	4.93	5.12	5.32	5.53	5.75	5.98	6.21	6.45	6.71	6.97	7.25	7.54	7.85	8.16	8.49	8.83	9.19	9.53	9.88	10.25	10.62	11.01	11.42	11.83	12.26	12.70	13.16	13.38	4.36	4.25	4.00	3.65	3.95
Households	10.47	10.68	10.92	11.17	11.42	11.69	11.96	12.24	12.53	12.84	13.16	13.51	13.87	14.25	14.66	15.08	15.53	16.00	16.44	16.90	17.37	17.85	18.33	18.80	19.28	19.76	20.25	20.75	25.01	2.11	2.17	2.71	2.63	2.53
Transport	12.83	13.25	13.75	14.30	14.86	15.41	15.93	16.43	16.94	17.44	17.95	18.46	18.97	19.49	20.01	20.53	21.06	21.59	22.01	22.43	22.85	23.27	23.68	24.09	24.51	24.92	25.33	25.74	32.18	3.79	3.66	2.77	1.77	2.67
Non-Energy	1.55	1.73	1.85	1.95	2.02	2.07	2.13	2.17	2.21	2.25	2.28	2.31	2.34	2.36	2.38	2.40	2.42	2.43	2.42	2.40	2.38	2.36	2.34	2.31	2.29	2.26	2.23	2.19	3.81	8.25	6.75	1.13	-1.02	1.92
Total	**37.31**	**38.68**	**40.18**	**41.79**	**43.39**	**45.00**	**46.63**	**48.27**	**49.97**	**51.72**	**53.53**	**55.40**	**57.35**	**59.35**	**61.42**	**63.56**	**65.77**	**68.06**	**70.11**	**72.21**	**74.36**	**76.55**	**78.79**	**81.07**	**83.38**	**85.73**	**88.13**	**90.59**	**100**	**3.86**	**3.79**	**3.49**	**2.90**	**3.37**

Annex 2. Total Final Energy Consumption, By Sector, Clean Energy Scenario 1 (In Million Tons of Oil Equivalent, MTOE)

Sector	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Agriculture	0.41	0.36	0.36	0.37	0.40	0.43	0.46	0.49	0.52	0.56	0.59	0.62	0.66	0.69	0.73	0.76	0.79	0.83	0.86	0.90	0.94	0.97	1.01	1.05	1.09	1.13	1.18	1.22	1.24	2.07	3.29	5.40	3.94	4.27
Industry	7.28	7.66	8.07	8.50	8.93	9.37	9.84	10.32	10.83	11.36	11.93	12.52	13.14	13.79	14.46	15.15	15.87	16.62	17.39	18.18	19.01	19.85	20.73	21.63	22.56	23.52	24.50	25.50	24.67	4.72	4.77	4.88	4.38	4.67
Services	4.72	4.89	5.06	5.24	5.43	5.62	5.82	6.02	6.24	6.46	6.70	6.94	7.19	7.46	7.73	8.02	8.32	8.62	8.94	9.28	9.62	9.97	10.34	10.72	11.11	11.52	11.93	12.36	13.64	3.96	3.86	3.65	3.67	3.72
Households	10.46	10.65	10.87	11.10	11.33	11.57	11.81	12.07	12.33	12.60	12.88	13.18	13.50	13.84	14.18	14.55	14.93	15.33	15.74	16.16	16.59	17.02	17.45	17.88	18.31	18.73	19.16	19.60	25.80	1.94	1.98	2.42	2.49	2.32
Transport	12.73	13.03	13.37	13.76	14.13	14.48	14.81	15.11	15.49	15.87	16.24	16.62	16.99	17.36	17.73	18.10	18.46	18.82	19.19	19.55	19.92	20.28	20.64	21.00	21.36	21.72	22.08	22.44	31.16	2.73	2.58	2.22	1.77	2.16
Non-Energy	1.53	1.67	1.73	1.80	1.84	1.88	1.90	1.92	1.94	1.95	1.96	1.96	1.96	1.96	1.96	1.95	1.94	1.93	1.92	1.91	1.89	1.88	1.86	1.84	1.82	1.79	1.77	1.74	3.50	6.45	5.12	0.06	-1.02	1.09
Total	**37.11**	**38.25**	**39.46**	**40.77**	**42.06**	**43.35**	**44.64**	**45.93**	**47.34**	**48.80**	**50.30**	**51.85**	**53.45**	**55.09**	**56.79**	**58.52**	**60.31**	**62.15**	**64.05**	**65.98**	**67.96**	**69.98**	**72.04**	**74.13**	**76.26**	**78.42**	**80.62**	**82.87**	**100**	**3.21**	**3.14**	**3.07**	**2.92**	**3.04**

Annex 3. Total Final Energy Consumption, By Fuel, Reference Scenario (In Million Tons of Oil Equivalent, MTOE)

Fuel	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Coal	1.94	2.04	2.15	2.27	2.39	2.52	2.65	2.78	2.92	3.06	3.21	3.36	3.51	3.67	3.83	4.00	4.18	4.36	4.53	4.69	4.86	5.03	5.21	5.38	5.56	5.74	5.92	6.10	6.08	4.38	4.57	4.60	3.41	4.16
Natural Gas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oil Products	19.27	20.11	20.99	21.92	22.78	23.62	24.44	25.23	26.04	26.86	27.70	28.56	29.44	30.34	31.26	32.20	33.17	34.15	34.96	35.77	36.61	37.47	38.35	39.25	40.19	41.15	42.13	43.15	50.54	4.38	4.12	3.08	2.37	3.12
Biodiesel	0.18	0.19	0.19	0.20	0.21	0.21	0.22	0.23	0.23	0.24	0.24	0.25	0.26	0.26	0.27	0.28	0.28	0.29	0.30	0.30	0.31	0.31	0.32	0.32	0.33	0.33	0.34	0.35	0.44	3.97	3.67	2.57	1.75	2.59
Bioethanol	0.39	0.40	0.42	0.43	0.45	0.47	0.49	0.50	0.52	0.53	0.55	0.56	0.58	0.59	0.61	0.62	0.64	0.65	0.66	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74	0.75	0.98	2.48	2.72	2.58	1.40	2.20
Electricity	8.26	8.61	9.05	9.55	10.12	10.73	11.38	12.08	12.81	13.59	14.41	15.27	16.18	17.13	18.13	19.18	20.28	21.43	22.57	23.76	25.00	26.29	27.63	29.02	30.46	31.95	33.49	35.09	28.76	5.34	5.53	5.90	5.06	5.49
Biomass	7.27	7.33	7.38	7.41	7.44	7.45	7.45	7.45	7.44	7.43	7.41	7.40	7.38	7.35	7.32	7.28	7.23	7.17	7.10	7.01	6.90	6.76	6.59	6.38	6.13	5.84	5.51	5.16	13.19	0.53	0.40	-0.38	-3.24	-1.19
Total	**37.31**	**38.68**	**40.18**	**41.79**	**43.39**	**45.00**	**46.63**	**48.27**	**49.97**	**51.72**	**53.53**	**55.40**	**57.35**	**59.35**	**61.42**	**63.56**	**65.77**	**68.06**	**70.11**	**72.21**	**74.36**	**76.55**	**78.79**	**81.07**	**83.38**	**85.73**	**88.13**	**90.59**	**100**	**3.86**	**3.79**	**3.49**	**2.90**	**3.37**

Annex 4. Total Final Energy Consumption, By Fuel, Clean Energy Scenario 1 (In Million Tons of Oil Equivalent, MTOE)

Fuel	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Coal	1.92	2.01	2.11	2.21	2.32	2.43	2.54	2.66	2.78	2.90	3.02	3.14	3.27	3.40	3.53	3.67	3.81	3.96	4.11	4.26	4.42	4.57	4.73	4.89	5.05	5.21	5.38	5.54	6.07	3.78	3.98	4.06	3.41	3.81
Natural Gas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oil Products	19.10	19.63	20.15	20.68	21.24	21.77	22.26	22.73	23.29	23.86	24.44	25.02	25.61	26.21	26.82	27.42	28.04	28.66	29.32	30.00	30.69	31.40	32.14	32.89	33.67	34.48	35.31	36.17	47.68	2.96	2.77	2.34	2.35	2.47
Biodiesel	0.18	0.28	0.38	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.69	0.70	0.71	0.72	0.73	0.94	19.91	15.07	1.78	1.65	5.36
Bioethanol	0.39	0.39	0.40	0.41	0.42	0.42	0.43	0.44	0.45	0.46	0.47	0.47	0.48	0.49	0.50	0.50	0.51	0.52	0.52	0.53	0.54	0.54	0.55	0.56	0.56	0.57	0.57	0.58	0.89	0.75	0.93	1.68	1.14	1.27
Electricity	8.26	8.61	9.06	9.58	10.15	10.77	11.43	12.13	12.85	13.61	14.41	15.26	16.14	17.06	18.03	19.05	20.11	21.22	22.36	23.54	24.77	26.04	27.36	28.73	30.15	31.61	33.13	34.69	30.56	5.41	5.58	5.76	5.04	5.45
Biomass	7.27	7.33	7.38	7.41	7.44	7.45	7.45	7.45	7.44	7.43	7.41	7.40	7.38	7.35	7.32	7.28	7.23	7.17	7.10	7.01	6.90	6.76	6.59	6.38	6.13	5.84	5.51	5.16	13.85	0.53	0.40	-0.38	-3.24	-1.19
Total	**37.11**	**38.25**	**39.48**	**40.77**	**42.06**	**43.35**	**44.64**	**45.93**	**47.34**	**48.80**	**50.30**	**51.85**	**53.45**	**55.09**	**56.79**	**58.52**	**60.31**	**62.15**	**64.05**	**65.98**	**67.96**	**69.98**	**72.04**	**74.13**	**76.26**	**78.42**	**80.62**	**82.87**	**100**	**3.21**	**3.14**	**3.07**	**2.92**	**3.04**

Annex 5. **Total Primary Energy Supply, Reference Scenario (In Million Tons of Oil Equivalent, MTOE)**

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**20.10**	**20.46**	**21.34**	**22.27**	**23.13**	**23.97**	**24.78**	**25.58**	**26.39**	**27.21**	**28.05**	**28.91**	**29.79**	**30.69**	**31.61**	**32.55**	**33.51**	**34.50**	**35.30**	**36.12**	**36.96**	**37.82**	**38.70**	**39.60**	**40.53**	**41.49**	**42.48**	**43.50**	**32.00**	**3.21**	**3.23**	**3.04**	**2.34**	**2.84**
Natural Gas	**2.82**	**3.58**	**3.65**	**3.74**	**3.62**	**3.52**	**4.27**	**4.92**	**5.55**	**6.10**	**6.74**	**7.33**	**7.98**	**8.53**	**9.24**	**9.83**	**10.31**	**10.83**	**12.04**	**13.33**	**14.58**	**15.81**	**17.27**	**18.69**	**20.17**	**21.94**	**23.22**	**24.82**	**9.59**	**5.11**	**8.24**	**8.20**	**8.65**	**8.37**
Coal	**19.02**	**19.18**	**19.75**	**20.44**	**21.58**	**22.78**	**22.68**	**22.63**	**22.58**	**22.60**	**22.50**	**22.47**	**22.44**	**22.47**	**22.40**	**22.39**	**22.38**	**22.43**	**22.36**	**22.34**	**22.33**	**22.37**	**22.31**	**22.30**	**22.29**	**22.34**	**22.29**	**22.28**	**23.81**	**3.01**	**2.16**	**-0.09**	**-0.06**	**0.56**
Renewable	**21.69**	**21.52**	**22.24**	**22.57**	**23.96**	**24.93**	**25.48**	**26.56**	**27.28**	**28.08**	**28.82**	**30.00**	**31.00**	**32.21**	**33.27**	**34.57**	**35.69**	**39.89**	**40.76**	**41.27**	**41.80**	**42.53**	**44.78**	**45.00**	**47.94**	**48.24**	**49.09**	**49.89**	**34.61**	**3.71**	**3.58**	**4.15**	**2.26**	**3.31**
Geothermal	10.23	9.88	10.24	10.98	11.37	11.98	11.91	12.36	12.41	12.62	12.82	13.00	13.10	13.09	13.22	13.27	13.25	16.23	15.98	16.05	15.92	16.14	16.99	16.74	17.55	17.54	17.70	18.30	14.43	4.95	4.10	2.76	1.21	2.58
Hydro	2.41	2.55	2.53	1.58	2.51	2.36	2.47	2.70	2.98	3.08	3.05	3.64	4.00	4.76	4.98	5.64	6.14	6.65	7.40	7.36	7.30	7.32	8.49	8.22	10.67	10.63	10.72	10.59	5.14	-1.01	0.92	9.44	4.76	5.27
Wind	0.09	0.28	0.42	0.73	0.81	0.87	1.04	1.34	1.56	1.87	2.13	2.15	2.42	2.89	3.03	3.72	3.93	4.21	4.44	5.29	5.33	6.28	5.87	6.43	6.13	6.77	7.62	7.98	2.99	46.21	40.49	12.11	6.59	17.44
Solar	0.23	0.47	0.60	0.92	0.87	1.22	1.48	1.54	1.75	1.91	2.22	2.60	2.90	2.87	3.46	3.37	3.83	4.30	4.48	4.20	4.97	4.63	5.36	5.77	5.96	5.97	6.00	6.34	2.90	40.86	33.11	10.78	3.96	14.13
Biomass	8.16	7.73	7.83	7.72	7.74	7.82	7.87	7.88	7.83	7.83	7.81	7.80	7.75	7.75	7.70	7.68	7.62	7.56	7.50	7.39	7.28	7.16	7.05	6.82	6.58	6.28	5.97	5.60	8.27	0.19	0.24	-0.42	-2.96	-1.15
Biofuels	0.57	0.59	0.61	0.64	0.66	0.68	0.71	0.73	0.75	0.77	0.79	0.81	0.83	0.86	0.88	0.90	0.92	0.94	0.96	0.97	0.99	1.00	1.02	1.03	1.05	1.06	1.08	1.09	0.88	2.57	2.73	2.58	1.51	2.24
Bioethanol	0.39	0.40	0.42	0.43	0.45	0.47	0.49	0.50	0.52	0.53	0.55	0.56	0.58	0.59	0.61	0.62	0.64	0.65	0.66	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74	0.75	0.61	2.48	2.72	2.58	1.40	2.20
Biodiesel	0.18	0.19	0.19	0.20	0.21	0.21	0.22	0.23	0.23	0.24	0.24	0.25	0.26	0.26	0.27	0.28	0.28	0.29	0.30	0.30	0.31	0.31	0.32	0.32	0.33	0.33	0.34	0.35	0.27	2.77	2.77	2.57	1.75	2.34
Other Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Supply	**63.64**	**64.73**	**66.98**	**69.01**	**72.29**	**75.21**	**77.21**	**79.69**	**81.80**	**83.98**	**86.12**	**88.72**	**91.21**	**93.91**	**96.52**	**99.33**	**101.89**	**107.65**	**110.46**	**113.06**	**115.66**	**118.52**	**123.06**	**125.59**	**130.93**	**134.01**	**137.08**	**140.50**	**100**	**3.39**	**3.28**	**3.05**	**2.70**	**2.99**

Annex 6. **Total Primary Energy Supply, Clean Energy Scenario - 1 (In Million Tons of Oil Equivalent, MTOE)**

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**19.93**	**19.92**	**20.32**	**20.96**	**21.53**	**22.05**	**22.55**	**23.02**	**23.58**	**24.15**	**24.72**	**25.30**	**25.90**	**26.50**	**27.10**	**27.71**	**28.32**	**28.95**	**29.61**	**30.28**	**31.00**	**31.69**	**32.42**	**33.19**	**33.96**	**34.80**	**35.59**	**36.46**	**29.71**	**1.78**	**1.88**	**2.32**	**2.33**	**2.20**
Natural Gas	**2.82**	**3.11**	**4.28**	**4.28**	**5.30**	**5.31**	**5.30**	**5.30**	**5.30**	**5.31**	**5.30**	**5.30**	**5.30**	**5.31**	**5.71**	**6.48**	**6.49**	**6.50**	**6.47**	**6.52**	**7.41**	**7.22**	**7.73**	**7.52**	**7.22**	**10.20**	**11.56**	**10.61**	**6.59**	**12.56**	**9.25**	**2.07**	**5.02**	**5.13**
Coal	**19.01**	**19.22**	**17.81**	**17.35**	**17.15**	**16.70**	**18.71**	**18.84**	**18.81**	**18.40**	**18.76**	**18.74**	**18.19**	**18.75**	**18.69**	**18.69**	**18.68**	**18.72**	**18.69**	**17.12**	**18.70**	**18.74**	**18.71**	**18.72**	**18.73**	**17.83**	**18.76**	**17.82**	**21.15**	**-2.20**	**-0.15**	**-0.06**	**-0.49**	**-0.24**
Renewable	**21.70**	**22.70**	**23.64**	**25.28**	**26.02**	**27.64**	**27.96**	**29.28**	**30.38**	**30.14**	**31.29**	**32.91**	**33.25**	**34.74**	**36.66**	**37.80**	**39.64**	**41.21**	**43.14**	**44.57**	**45.83**	**47.29**	**47.92**	**50.01**	**52.23**	**51.30**	**52.39**	**52.38**	**39.45**	**5.51**	**4.86**	**3.48**	**2.43**	**3.49**
Geothermal	10.23	10.51	10.91	11.78	12.11	12.96	13.09	13.19	13.35	13.26	13.55	13.83	13.97	14.04	14.84	15.23	15.88	15.82	16.25	16.09	16.97	16.96	16.41	16.82	17.27	16.60	17.12	16.56	15.86	6.34	4.95	1.83	0.45	2.22
Hydro	2.41	2.40	2.49	2.48	2.81	2.74	2.75	3.29	3.51	3.21	3.41	4.05	3.96	4.78	5.30	5.59	5.76	6.46	6.86	6.81	7.07	7.24	7.39	7.85	8.34	7.96	8.42	8.41	5.27	1.49	3.42	7.00	2.66	4.41
Wind	0.09	0.31	0.47	0.81	0.85	1.58	1.61	2.06	2.21	2.45	2.66	2.82	3.12	3.53	3.57	3.64	4.32	4.84	6.24	7.79	7.68	8.29	9.01	9.82	12.00	11.61	12.31	12.43	4.56	61.70	48.18	8.93	9.88	19.31
Solar	0.23	0.56	0.64	0.97	0.97	1.06	1.17	1.30	1.86	1.85	2.32	2.85	2.86	2.97	3.55	4.06	4.42	4.86	4.55	4.81	5.12	5.92	6.44	7.00	6.26	7.17	6.84	7.65	3.41	37.56	30.23	14.13	4.64	14.90
Biomass	8.17	8.24	8.35	8.34	8.37	8.36	8.39	8.49	8.47	8.37	8.34	8.33	8.29	8.34	8.31	8.18	8.14	8.08	8.08	7.89	7.80	7.66	7.45	7.27	7.10	6.70	6.42	6.03	9.21	1.32	1.18	-0.49	-2.89	-0.89
Biofuels	0.57	0.67	0.78	0.89	0.91	0.93	0.94	0.96	0.98	1.00	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.15	1.17	1.19	1.21	1.22	1.24	1.26	1.28	1.29	1.31	1.15	7.91	6.30	1.73	1.42	2.90
Bioethanol	0.39	0.39	0.40	0.41	0.42	0.42	0.43	0.44	0.45	0.46	0.47	0.47	0.48	0.49	0.50	0.50	0.51	0.52	0.52	0.53	0.54	0.54	0.55	0.56	0.56	0.57	0.57	0.58	0.54	0.75	0.93	1.68	1.14	1.27
Biodiesel	0.18	0.28	0.38	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.69	0.70	0.71	0.72	0.73	0.60	18.53	14.08	1.78	1.65	5.10
Other Technologies	-	-	-	-	-	-	-	-	-	**2.52**	**2.52**	**2.52**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**10.06**	**3.09**	**0.00**	**0.00**	**9.05**	**7.15**	**7.99**
Total Supply	**63.46**	**64.95**	**66.05**	**67.87**	**69.99**	**71.71**	**74.51**	**76.45**	**78.07**	**80.53**	**82.60**	**84.77**	**87.67**	**90.35**	**93.20**	**95.71**	**98.16**	**100.43**	**102.93**	**103.51**	**107.96**	**109.98**	**111.81**	**114.47**	**117.17**	**119.18**	**123.34**	**127.33**	**100**	**2.58**	**2.74**	**2.77**	**2.40**	**2.63**

Annex 7. **Total Primary Energy Supply, Clean Energy Scenario - 2 (In Million Tons of Oil Equivalent, MTOE)**

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**19.93**	**19.92**	**20.32**	**20.96**	**21.53**	**22.05**	**22.55**	**23.02**	**23.58**	**24.15**	**24.72**	**25.30**	**25.88**	**26.53**	**27.10**	**27.70**	**28.32**	**28.95**	**29.61**	**30.31**	**31.01**	**31.69**	**32.45**	**33.19**	**33.96**	**34.87**	**35.68**	**36.46**	**30.59**	**1.78**	**1.88**	**2.32**	**2.33**	**2.20**
Natural Gas	**2.82**	**3.11**	**3.88**	**3.88**	**4.81**	**4.82**	**4.81**	**4.81**	**4.81**	**4.82**	**4.81**	**4.81**	**4.81**	**4.82**	**5.04**	**5.18**	**5.08**	**5.74**	**4.93**	**5.46**	**6.93**	**6.49**	**8.34**	**6.95**	**7.89**	**10.60**	**10.04**	**7.62**	**6.15**	**10.76**	**7.93**	**1.79**	**2.87**	**3.90**
Coal	**19.01**	**19.22**	**18.11**	**16.97**	**16.84**	**16.46**	**17.24**	**15.93**	**16.67**	**15.02**	**15.23**	**14.68**	**13.89**	**14.05**	**14.16**	**14.30**	**15.12**	**17.05**	**17.03**	**16.05**	**15.59**	**16.68**	**16.07**	**16.17**	**17.18**	**15.84**	**15.97**	**16.13**	**19.35**	**-2.43**	**-2.23**	**0.68**	**-0.55**	**-0.60**
Renewable	**21.70**	**22.70**	**23.78**	**25.62**	**26.37**	**27.98**	**28.68**	**30.43**	**31.27**	**31.49**	**32.63**	**34.28**	**33.48**	**34.63**	**35.87**	**37.85**	**39.00**	**39.76**	**42.36**	**43.43**	**44.82**	**46.57**	**47.40**	**50.20**	**51.60**	**50.04**	**51.39**	**52.05**	**40.68**	**5.72**	**5.36**	**2.71**	**2.73**	**3.47**
Geothermal	10.23	10.51	10.92	11.79	12.11	12.96	13.10	13.17	13.34	13.31	13.53	13.67	12.87	12.80	12.76	13.36	13.53	13.56	14.05	14.09	14.90	15.20	15.65	16.19	16.70	15.19	14.88	14.79	15.41	6.34	4.93	0.29	0.87	1.81
Hydro	2.41	2.40	2.49	2.49	2.80	2.74	2.75	3.27	3.46	3.16	3.40	4.02	3.47	3.91	4.45	5.07	5.19	5.93	6.66	6.51	6.59	7.02	6.96	7.41	8.04	7.32	7.28	6.96	5.12	1.49	3.38	6.12	1.61	3.71
Wind	0.09	0.31	0.59	1.14	1.21	1.92	2.07	3.15	3.52	4.00	4.44	5.04	5.79	6.70	7.22	7.80	8.63	8.20	9.71	10.67	11.16	11.82	11.96	13.70	14.54	15.51	17.72	18.95	7.17	66.94	56.28	10.03	8.74	21.12
Solar	0.23	0.56	0.64	0.97	0.97	1.06	1.43	1.39	1.51	1.64	1.93	2.21	2.14	2.00	2.25	2.37	2.43	2.85	2.71	3.11	3.24	3.68	4.20	4.43	3.96	4.14	3.93	4.10	2.39	37.56	31.35	7.46	3.71	12.37
Biomass	8.17	8.24	8.36	8.35	8.37	8.36	8.40	8.49	8.47	8.37	8.31	8.31	8.15	8.15	8.11	8.14	8.09	8.09	8.08	7.87	7.73	7.64	7.41	7.22	7.10	6.61	6.29	5.93	9.41	1.32	1.17	-0.48	-3.06	-0.94
Biofuels	0.57	0.67	0.78	0.89	0.91	0.93	0.94	0.96	0.98	1.00	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.15	1.17	1.19	1.21	1.22	1.24	1.26	1.28	1.29	1.31	1.18	7.91	6.30	1.73	1.42	2.90
Bioethanol	0.39	0.39	0.40	0.41	0.42	0.42	0.43	0.44	0.45	0.46	0.47	0.47	0.48	0.49	0.50	0.50	0.51	0.52	0.52	0.53	0.54	0.54	0.55	0.56	0.56	0.57	0.57	0.58	0.56	0.75	0.93	1.68	1.14	1.27
Biodiesel	0.18	0.28	0.38	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.69	0.70	0.71	0.72	0.73	0.62	18.53	14.08	1.78	1.65	5.10
Other Technologies	-	-	-	-	-	-	-	-	-	**2.52**	**2.52**	**2.52**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**10.06**	**3.22**	**0.00**	**0.00**	**9.05**	**7.15**	**7.99**
Total Supply	**63.46**	**64.95**	**66.21**	**67.44**	**69.55**	**71.31**	**73.29**	**74.19**	**76.33**	**78.00**	**79.91**	**81.60**	**83.09**	**85.08**	**87.19**	**90.06**	**92.56**	**96.55**	**98.97**	**100.28**	**103.39**	**106.47**	**109.29**	**111.53**	**115.67**	**116.39**	**118.11**	**122.32**	**96.78**	**2.48**	**2.36**	**2.67**	**2.39**	**2.48**

Annex 8. Total Indigenous Energy Supply, Reference Scenario (In Million Tons of Oil Equivalent, MTOE)

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-40	'40-'50	'22-'50
Oil	**0.36**	**0.36**	**0.36**	**0.36**	**0.37**	**0.37**	**0.37**	**0.37**	**0.37**	**0.38**	**0.38**	**0.38**	**0.38**	**0.38**	**0.39**	**0.39**	**0.39**	**0.39**	**0.39**	**0.40**	**0.40**	**0.40**	**0.40**	**0.40**	**0.41**	**0.41**	**0.41**	**0.41**	**0.94**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**
Natural Gas	**0.01**	**0.01**	**3.04**	**3.04**	**1.12**	**0.45**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**1.99**	**-25.39**	**-17.47**	**0.00**	**0.00**	**-5.34**
Coal	**11.90**	**11.77**	**12.26**	**12.46**	**12.27**	**12.27**	**12.27**	**12.27**	**12.27**	**12.27**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**18.25**	**8.23**	**6.12**	**-9.84**	**0.00**	**-1.98**
Renewable	**21.51**	**21.32**	**22.02**	**22.34**	**23.72**	**24.67**	**25.20**	**26.26**	**26.97**	**27.75**	**28.48**	**29.65**	**30.63**	**31.83**	**32.87**	**34.15**	**35.26**	**39.45**	**40.31**	**40.80**	**41.32**	**42.05**	**44.28**	**44.50**	**47.42**	**47.72**	**48.56**	**49.35**	**78.83**	**3.71**	**3.58**	**4.15**	**2.27**	**3.31**
Geothermal	10.23	9.88	10.24	10.98	11.37	11.98	11.91	12.36	12.41	12.62	12.82	13.00	13.10	13.09	13.22	13.27	13.25	16.23	15.98	16.05	15.92	16.14	16.99	16.74	17.55	17.54	17.70	18.30	32.89	4.95	4.10	2.76	1.21	2.58
Hydro	2.41	2.55	2.53	1.58	2.51	2.36	2.47	2.70	2.98	3.08	3.05	3.64	4.00	4.76	4.98	5.64	6.14	6.65	7.40	7.36	7.30	7.32	8.49	8.22	10.67	10.63	10.72	10.59	12.15	-1.01	0.92	9.44	4.76	5.27
Wind	0.09	0.28	0.42	0.73	0.81	0.87	1.04	1.34	1.56	1.87	2.13	2.15	2.42	2.89	3.03	3.72	3.93	4.21	4.44	5.29	5.33	6.28	5.87	6.43	6.13	6.77	7.62	7.98	7.26	46.21	40.49	12.11	6.59	17.44
Solar	0.23	0.47	0.60	0.92	0.87	1.22	1.48	1.54	1.75	1.91	2.22	2.60	2.90	2.87	3.46	3.37	3.83	4.30	4.48	4.20	4.97	4.63	5.36	5.77	5.96	5.97	6.00	6.34	6.98	40.86	33.11	10.78	3.96	14.13
Biomass	8.16	7.73	7.83	7.72	7.74	7.82	7.87	7.88	7.83	7.83	7.81	7.80	7.75	7.75	7.70	7.68	7.62	7.56	7.50	7.39	7.28	7.16	7.05	6.82	6.58	6.28	5.97	5.60	18.41	0.19	0.24	-0.42	-2.96	-1.15
Biofuels	0.39	0.39	0.40	0.41	0.41	0.42	0.43	0.43	0.44	0.44	0.45	0.46	0.46	0.47	0.48	0.48	0.49	0.50	0.50	0.51	0.51	0.52	0.52	0.53	0.53	0.54	0.55	0.55	1.13	2.05	1.89	1.42	1.06	1.43
Bioethanol	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.50	0.00	0.00	0.00	0.00	0.00
Biodiesel	0.18	0.19	0.19	0.20	0.21	0.21	0.22	0.23	0.23	0.24	0.24	0.25	0.26	0.26	0.27	0.28	0.28	0.29	0.30	0.30	0.31	0.31	0.32	0.32	0.33	0.33	0.34	0.35	0.63	4.34	3.94	2.57	1.75	2.67
Other Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Supply	**33.77**	**33.45**	**37.68**	**38.20**	**37.48**	**37.75**	**38.41**	**39.47**	**40.17**	**40.96**	**33.78**	**34.95**	**35.93**	**37.13**	**38.17**	**39.46**	**40.57**	**44.76**	**45.62**	**46.12**	**46.64**	**47.37**	**49.60**	**49.82**	**52.75**	**53.04**	**53.89**	**54.68**	**100**	**3.66**	**3.31**	**1.27**	**2.02**	**2.12**

Annex 9. Total Indigenous Energy Supply, Clean Energy Scenario – 1 (In Million Tons of Oil Equivalent, MTOE)

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-40	'40-'50	'22-'50
Oil	**0.36**	**0.36**	**0.36**	**0.36**	**0.37**	**0.37**	**0.37**	**0.37**	**0.37**	**0.38**	**0.38**	**0.38**	**0.38**	**0.38**	**0.39**	**0.39**	**0.39**	**0.39**	**0.39**	**0.40**	**0.40**	**0.40**	**0.40**	**0.40**	**0.41**	**0.41**	**0.41**	**0.41**	**0.83**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**
Natural Gas	**0.01**	**0.01**	**3.04**	**3.04**	**1.12**	**0.45**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**1.81**	**-25.39**	**-17.47**	**0.00**	**0.00**	**-5.34**
Coal	**11.90**	**11.77**	**12.26**	**12.46**	**12.27**	**12.27**	**12.27**	**12.27**	**12.27**	**12.27**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**16.65**	**8.23**	**6.12**	**-9.84**	**0.00**	**-1.98**
Renewable	**21.52**	**22.51**	**23.45**	**25.08**	**25.81**	**27.43**	**27.73**	**29.05**	**30.14**	**29.89**	**31.03**	**32.64**	**32.98**	**34.46**	**36.37**	**37.50**	**39.34**	**40.90**	**42.82**	**44.24**	**45.50**	**46.95**	**47.58**	**49.66**	**51.87**	**50.94**	**52.03**	**52.01**	**74.66**	**5.56**	**4.90**	**3.48**	**2.43**	**3.50**
Geothermal	10.23	10.51	10.91	11.78	12.11	12.96	13.09	13.19	13.35	13.26	13.55	13.83	13.97	14.04	14.84	15.23	15.88	15.82	16.25	16.09	16.97	16.96	16.41	16.82	17.27	16.60	17.12	16.56	30.16	6.34	4.95	1.83	0.45	2.22
Hydro	2.41	2.40	2.49	2.48	2.81	2.74	2.75	3.29	3.51	3.21	3.41	4.05	3.96	4.78	5.30	5.59	5.76	6.46	6.86	6.81	7.07	7.24	7.39	7.85	8.34	7.96	8.42	8.41	10.10	1.49	3.42	7.00	2.66	4.41
Wind	0.09	0.31	0.47	0.81	0.85	1.58	1.61	2.06	2.21	2.45	2.66	2.82	3.12	3.53	3.57	3.64	4.32	4.84	6.24	7.79	7.68	8.29	9.01	9.82	12.00	11.61	12.31	12.43	8.79	61.70	48.18	8.93	9.88	19.31
Solar	0.23	0.56	0.64	0.97	0.97	1.06	1.17	1.30	1.86	1.85	2.32	2.85	2.86	2.97	3.55	4.06	4.42	4.86	4.55	4.81	5.12	5.92	6.44	7.00	6.26	7.17	6.84	7.65	6.57	37.56	30.23	14.13	4.64	14.90
Biomass	8.17	8.24	8.35	8.34	8.37	8.36	8.39	8.49	8.47	8.37	8.34	8.33	8.29	8.34	8.31	8.18	8.14	8.08	8.08	7.89	7.80	7.66	7.45	7.27	7.10	6.70	6.42	6.03	17.44	1.32	1.18	-0.49	-2.89	-0.89
Biofuels	0.39	0.48	0.58	0.69	0.70	0.71	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.94	1.60	11.37	8.74	1.30	1.26	3.36
Bioethanol	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.45	0.00	0.00	0.00	0.00	0.00
Biodiesel	0.18	0.28	0.38	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.69	0.70	0.71	0.72	0.73	1.15	20.34	15.38	1.78	1.65	5.45
Other Technologies	-	-	-	-	-	-	-	-	-	**2.52**	**2.52**	**2.52**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**10.06**	**6.04**	-	-	**9.05**	**7.15**	**7.99**
Total Supply	**33.79**	**34.64**	**39.11**	**40.94**	**39.57**	**40.51**	**40.94**	**42.26**	**43.35**	**45.63**	**38.85**	**40.46**	**43.31**	**44.81**	**46.70**	**47.84**	**49.67**	**51.25**	**53.16**	**54.59**	**55.84**	**57.31**	**57.93**	**60.01**	**62.23**	**61.31**	**62.38**	**67.40**	**100**	**4.89**	**4.19**	**1.95**	**2.78**	**2.88**

Annex 10. Total Indigenous Energy Supply, Clean Energy Scenario – 2 (In Million Tons of Oil Equivalent, MTOE)

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-40	'40-'50	'22-'50
Oil	**0.36**	**0.36**	**0.36**	**0.36**	**0.37**	**0.37**	**0.37**	**0.37**	**0.37**	**0.38**	**0.38**	**0.38**	**0.38**	**0.38**	**0.39**	**0.39**	**0.39**	**0.39**	**0.39**	**0.40**	**0.40**	**0.40**	**0.40**	**0.40**	**0.41**	**0.41**	**0.41**	**0.41**	**0.83**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**
Natural Gas	**0.01**	**0.01**	**3.04**	**3.04**	**1.12**	**0.45**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**0.56**	**1.81**	**-25.39**	**-17.47**	**0.00**	**0.00**	**-5.34**
Coal	**11.90**	**11.77**	**12.26**	**12.46**	**12.27**	**12.27**	**12.27**	**12.27**	**12.27**	**12.27**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**4.36**	**16.56**	**8.23**	**6.12**	**-9.84**	**0.00**	**-1.98**
Renewable	**21.52**	**22.51**	**23.59**	**25.42**	**26.16**	**27.76**	**28.46**	**30.20**	**31.03**	**31.24**	**32.37**	**34.02**	**33.20**	**34.35**	**35.58**	**37.55**	**38.69**	**39.45**	**42.04**	**43.10**	**44.49**	**46.23**	**47.06**	**49.85**	**51.25**	**49.68**	**51.02**	**51.67**	**74.73**	**5.77**	**5.40**	**2.71**	**2.74**	**3.48**
Geothermal	10.23	10.51	10.92	11.79	12.11	12.96	13.10	13.17	13.34	13.31	13.53	13.67	12.87	12.80	12.76	13.36	13.53	13.56	14.05	14.09	14.90	15.20	15.65	16.19	16.70	15.19	14.88	14.79	28.41	6.34	4.93	0.29	0.87	1.81
Hydro	2.41	2.40	2.49	2.49	2.80	2.74	2.75	3.27	3.46	3.16	3.40	4.02	3.47	3.91	4.45	5.07	5.19	5.93	6.66	6.51	6.59	7.02	6.96	7.41	8.04	7.32	7.28	6.96	9.51	1.49	3.38	6.12	1.61	3.71
Wind	0.09	0.31	0.59	1.14	1.21	1.92	2.07	3.15	3.52	4.00	4.44	5.04	5.79	6.70	7.22	7.80	8.63	8.20	9.71	10.67	11.16	11.82	11.96	13.70	14.54	15.51	17.72	18.95	13.43	66.94	56.28	10.03	8.74	21.12
Solar	0.23	0.56	0.64	0.97	0.97	1.06	1.43	1.39	1.51	1.64	1.93	2.21	2.14	2.00	2.25	2.37	2.43	2.85	2.71	3.11	3.24	3.68	4.20	4.43	3.96	4.14	3.93	4.10	4.46	37.56	31.35	7.46	3.71	12.37
Biomass	8.17	8.24	8.36	8.35	8.37	8.36	8.40	8.49	8.47	8.37	8.31	8.31	8.15	8.15	8.11	8.14	8.09	8.09	8.08	7.87	7.73	7.64	7.41	7.22	7.10	6.61	6.29	5.93	17.32	1.32	1.17	-0.48	-3.06	-0.94
Biofuels	0.39	0.48	0.58	0.69	0.70	0.71	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.94	1.59	11.37	8.74	1.30	1.26	3.36
Bioethanol	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.45	0.00	0.00	0.00	0.00	0.00
Biodiesel	0.18	0.28	0.38	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.69	0.70	0.71	0.72	0.73	1.15	20.34	15.38	1.78	1.65	5.45
Other Technologies	-	-	-	-	-	-	-	-	-	**2.52**	**2.52**	**2.52**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**5.03**	**5.03**	**5.04**	**5.03**	**10.06**	**6.08**	-	-	**9.05**	**7.15**	**7.99**
Total Supply	**33.79**	**34.64**	**39.25**	**41.29**	**39.92**	**40.84**	**41.66**	**43.40**	**44.24**	**46.97**	**40.18**	**41.83**	**43.53**	**44.70**	**45.91**	**47.89**	**49.03**	**49.81**	**52.38**	**53.45**	**54.84**	**56.60**	**57.41**	**60.20**	**61.60**	**60.05**	**61.38**	**67.06**	**100**	**5.03**	**4.54**	**1.39**	**3.02**	**2.86**

Annex 11. Net Imported Energy, Reference Scenario (in Million Tons of Oil Equivalent, MTOE)

Energy Source	Outlook																												Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	19.74	20.10	20.98	21.90	22.76	23.60	24.41	25.21	26.01	26.83	27.67	28.53	29.41	30.31	31.23	32.17	33.13	34.11	34.91	35.73	36.56	37.42	38.29	39.20	40.13	41.09	42.07	43.09	57.45	3.26	3.28	3.07	2.36	2.88
Natural Gas	2.81	3.57	0.61	0.70	2.50	3.07	3.71	4.36	4.99	5.53	6.18	6.77	7.42	7.97	8.68	9.26	9.75	10.27	11.47	12.77	14.02	15.24	16.71	18.12	19.61	21.38	22.66	24.26	13.95	1.77	5.62	8.94	8.98	8.30
Coal	7.12	7.41	7.49	7.98	9.30	10.52	10.40	10.35	10.31	10.32	18.15	18.11	18.08	18.11	18.04	18.03	18.02	18.07	18.00	17.99	17.97	18.01	17.95	17.94	17.94	17.98	17.93	17.93	27.91	-1.40	-1.24	5.73	-0.08	1.62
Bioethanol	0.19	0.20	0.21	0.23	0.25	0.26	0.28	0.30	0.31	0.33	0.34	0.36	0.37	0.39	0.40	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.69	3.44	4.08	4.08	2.00	3.33
Total Net Import	**29.86**	**31.28**	**29.30**	**30.81**	**34.81**	**37.46**	**38.80**	**40.22**	**41.62**	**43.02**	**52.34**	**53.77**	**55.28**	**56.78**	**58.35**	**59.87**	**61.33**	**62.89**	**64.84**	**66.95**	**69.02**	**71.15**	**73.45**	**75.77**	**78.19**	**80.97**	**83.20**	**85.81**	**100**	**3.13**	**3.25**	**4.57**	**3.16**	**3.69**

Annex 12. Net Imported Energy, Clean Energy Scenario – 1 (in Million Tons of Oil Equivalent, MTOE)

Energy Source	Outlook																												Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	19.57	19.56	19.96	20.60	21.16	21.68	22.18	22.65	23.20	23.77	24.35	24.93	25.52	26.11	26.72	27.32	27.93	28.56	29.22	29.88	30.60	31.29	32.02	32.79	33.56	34.39	35.19	36.05	62.01	1.81	1.90	2.35	2.36	2.22
Natural Gas	2.81	3.11	1.24	1.24	4.18	4.86	4.74	4.74	4.74	4.75	4.74	4.74	4.74	4.75	5.15	5.91	5.92	5.94	5.91	5.96	6.85	6.66	7.16	6.96	6.66	9.64	11.00	10.05	11.07	11.56	6.73	2.29	5.40	4.83
Coal	7.10	7.46	5.55	4.89	4.87	4.43	6.43	6.57	6.54	6.12	14.41	14.38	13.83	14.39	14.34	14.33	14.32	14.37	14.33	12.76	14.34	14.39	14.36	14.37	14.38	13.47	14.40	13.47	26.28	-14.64	-6.71	8.14	-0.64	0.58
Bioethanol	0.18	0.19	0.19	0.20	0.21	0.22	0.23	0.23	0.24	0.25	0.26	0.27	0.28	0.28	0.29	0.30	0.31	0.31	0.32	0.32	0.33	0.34	0.34	0.35	0.36	0.36	0.37	0.37	0.65	0.21	0.87	3.00	1.83	1.97
Total Net Import	**29.67**	**30.31**	**26.94**	**26.93**	**30.42**	**31.20**	**33.57**	**34.19**	**34.72**	**34.90**	**43.75**	**44.31**	**44.36**	**45.54**	**46.49**	**47.87**	**48.49**	**49.17**	**49.77**	**48.93**	**52.12**	**52.67**	**53.88**	**54.46**	**54.95**	**57.86**	**60.96**	**59.93**	**100**	**0.03**	**1.17**	**3.70**	**2.00**	**2.37**

Annex 13. Net Imported Energy, Clean Energy Scenario – 2 (in Million Tons of Oil Equivalent, MTOE)

Energy Source	Outlook																												Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	19.57	19.56	20.07	20.60	21.16	21.68	22.18	22.65	23.20	23.77	24.35	24.92	25.50	26.14	26.71	27.32	27.94	28.56	29.22	29.92	30.62	31.29	32.05	32.79	33.56	34.46	35.27	36.05	65.73	1.81	1.90	2.35	2.36	2.22
Natural Gas	2.81	3.11	0.84	0.84	3.69	4.37	4.25	4.25	4.25	4.26	4.25	4.25	4.25	4.26	4.47	4.62	4.51	5.18	4.37	4.90	6.37	5.93	7.77	6.38	7.32	10.04	9.48	7.06	10.52	9.22	5.28	2.01	3.14	3.47
Coal	7.10	7.46	5.86	4.51	4.57	4.19	4.97	3.65	4.39	2.75	10.87	10.33	9.53	9.69	9.80	9.94	10.77	12.69	12.68	11.69	11.23	12.32	11.71	11.81	12.83	11.49	11.62	11.78	23.08	-15.41	-13.30	13.26	-0.75	0.10
Bioethanol	0.18	0.19	0.19	0.20	0.21	0.22	0.23	0.23	0.24	0.25	0.26	0.27	0.28	0.28	0.29	0.30	0.31	0.31	0.32	0.32	0.33	0.34	0.34	0.35	0.36	0.36	0.37	0.37	0.69	0.21	0.87	3.00	1.83	1.97
Total Net Import	**29.67**	**30.31**	**26.96**	**26.15**	**29.63**	**30.47**	**31.62**	**30.78**	**32.09**	**31.03**	**39.72**	**39.77**	**39.56**	**40.38**	**41.28**	**42.17**	**43.52**	**46.75**	**46.58**	**46.83**	**48.55**	**49.88**	**51.88**	**51.33**	**54.06**	**56.34**	**56.73**	**55.26**	**100**	**-0.36**	**-0.14**	**4.27**	**1.69**	**2.07**

Annex 14. Electricity Sales Forecast, 2022-2050, in GWh

Year	REF				CES			
	Philippines	Luzon	Visayas	Mindanao	Philippines	Luzon	Visayas	Mindanao
2021	87,417	64,420	11,555	11,442	87,417	64,420	11,555	11,442
2022	91,333	67,536	11,866	11,931	91,333	67,536	11,866	11,931
2023	96,075	70,952	12,537	12,586	96,040	70,903	12,537	12,600
2024	100,155	73,780	13,127	13,249	100,182	73,745	13,141	13,296
2025	105,220	77,286	13,896	14,038	105,345	77,291	13,931	14,124
2026	111,109	81,377	14,832	14,900	111,366	81,428	14,893	15,045
2027	117,653	85,927	15,900	15,826	118,041	86,025	15,988	16,028
2028	124,797	90,901	17,085	16,811	125,302	91,024	17,199	17,078
2029	132,399	96,183	18,358	17,858	132,973	96,293	18,491	18,188
2030	140,459	101,777	19,710	18,973	141,039	101,825	19,853	19,361
2031	149,027	107,735	21,148	20,145	149,485	107,650	21,280	20,555
2032	158,062	114,024	22,664	21,375	158,332	113,756	22,775	21,801
2033	167,588	120,660	24,259	22,670	167,637	120,174	24,346	23,117
2034	177,624	127,655	25,934	24,036	177,417	126,922	25,992	24,503
2035	188,188	135,023	27,689	25,476	187,694	134,016	27,714	25,964
2036	199,260	142,766	29,526	26,968	198,439	141,449	29,512	27,478
2037	210,870	150,901	31,445	28,524	209,678	149,236	31,388	29,054
2038	223,045	159,444	33,450	30,150	221,505	157,436	33,354	30,714
2039	235,809	168,407	35,544	31,857	233,863	166,011	35,402	32,450
2040	249,186	177,810	37,729	33,647	246,816	175,005	37,539	34,272
2041	262,514	187,196	39,908	35,411	260,044	184,269	39,712	36,064
2042	276,378	196,978	42,166	37,234	273,781	193,913	41,960	37,909
2043	290,798	207,169	44,506	39,123	288,048	203,944	44,286	39,818
2044	305,794	217,779	46,929	41,086	302,863	214,374	46,692	41,797
2045	321,381	228,817	49,436	43,127	318,241	225,211	49,178	43,852
2046	337,524	240,280	52,027	45,218	334,150	236,450	51,745	45,954
2047	354,247	252,176	54,703	47,367	350,610	248,103	54,394	48,113
2048	371,567	264,516	57,467	49,583	367,640	260,177	57,127	50,336
2049	389,499	277,307	60,319	51,873	385,254	272,680	59,944	52,630
2050	408,057	290,557	63,260	54,240	403,465	285,619	62,847	54,999

Annex 15. Peak Demand Forecast, 2022-2050, in MW

Year	Final Peak Demand			
	Philippines	Luzon	Visayas	Mindanao
2021	16,036	11,640	2,252	2,144
2022	16,596	12,113	2,316	2,167
2023	17,338	12,559	2,464	2,315
2024	18,056	13,092	2,538	2,425
2025	19,003	13,728	2,687	2,588
2026	20,097	14,466	2,864	2,766
2027	21,291	15,274	3,063	2,954
2028	22,582	16,149	3,280	3,153
2029	23,944	17,070	3,511	3,363
2030	25,376	18,038	3,753	3,585
2031	26,765	18,985	3,990	3,790
2032	28,224	19,982	4,238	4,004
2033	29,757	21,031	4,496	4,229
2034	31,367	22,134	4,766	4,467
2035	33,056	23,293	5,047	4,717
2036	34,821	24,506	5,340	4,975
2037	36,666	25,778	5,643	5,245
2038	38,606	27,116	5,961	5,529
2039	40,634	28,516	6,291	5,827
2040	42,759	29,984	6,634	6,140
2041	44,936	31,496	6,985	6,455
2042	47,196	33,069	7,347	6,780
2043	49,542	34,705	7,720	7,117
2044	51,977	36,405	8,106	7,466
2045	54,503	38,172	8,503	7,828
2046	57,115	40,003	8,913	8,198
2047	59,816	41,902	9,335	8,579
2048	62,609	43,869	9,770	8,970
2049	65,497	45,906	10,218	9,374
2050	68,483	48,014	10,678	9,791

Annex 16. Power Generation, Reference Scenario (In Terawatt-Hour, TWh)

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**2.55**	**1.07**	**1.07**	**1.07**	**1.07**	**1.07**	**1.07**	**1.07**	**1.07**	**1.07**	**1.07**	**1.07**	**1.06**	**1.06**	**1.07**	**1.06**	**1.06**	**1.06**	**1.06**	**1.06**	**1.07**	**1.07**	**1.06**	**1.06**	**1.06**	**1.07**	**1.07**	**1.06**	0.69	-13.33	-10.18	-0.03	-0.01	-3.03
Natural Gas	**18.04**	**22.90**	**23.38**	**23.95**	**23.17**	**22.54**	**27.30**	**31.48**	**35.49**	**38.99**	**43.11**	**46.88**	**51.04**	**54.58**	**59.10**	**62.86**	**65.97**	**69.26**	**76.99**	**85.29**	**93.24**	**101.11**	**110.49**	**119.53**	**129.01**	**140.37**	**148.55**	**158.76**	23.40	3.93	7.32	8.20	8.65	8.11
Coal	**66.42**	**66.78**	**68.95**	**71.46**	**75.58**	**79.84**	**78.90**	**78.18**	**77.46**	**76.95**	**76.02**	**75.30**	**74.58**	**74.06**	**73.14**	**72.42**	**71.69**	**71.17**	**70.25**	**69.53**	**68.81**	**68.28**	**67.37**	**66.65**	**65.93**	**65.39**	**64.49**	**63.77**	35.85	3.11	2.06	-0.94	-1.09	-0.15
Renewable	**27.37**	**31.27**	**34.87**	**38.93**	**43.42**	**48.40**	**53.88**	**59.62**	**65.54**	**71.70**	**78.43**	**85.61**	**93.60**	**101.87**	**111.26**	**120.86**	**130.59**	**144.82**	**152.25**	**158.70**	**167.81**	**175.27**	**184.73**	**194.54**	**203.81**	**211.11**	**222.10**	**230.23**	**40.06**	**11.88**	**11.65**	**9.28**	**4.75**	**8.30**
Geothermal	11.89	11.49	11.91	12.77	13.22	13.93	13.86	14.38	14.43	14.67	14.91	15.12	15.24	15.22	15.37	15.43	15.41	18.88	18.58	18.67	18.52	18.77	19.76	19.47	20.41	20.40	20.58	21.29	7.26	4.95	4.10	2.76	1.21	2.58
Hydro	9.41	9.96	9.86	6.16	9.80	9.22	9.64	10.53	11.64	12.03	11.89	14.21	15.61	18.56	19.42	22.00	23.93	25.95	28.87	28.71	28.47	28.55	33.10	32.07	41.60	41.45	41.80	41.30	7.93	-1.49	0.55	9.44	4.76	5.16
Onshore Wind	1.09	3.29	4.90	8.48	9.44	10.06	12.07	15.63	18.16	21.76	24.79	25.05	28.11	30.65	32.18	39.85	40.11	39.81	41.08	50.98	51.46	62.46	54.76	60.47	53.30	60.63	70.65	67.49	10.63	46.21	40.49	9.80	5.42	16.11
Offshore Wind	-	-	-	-	-	-	-	-	-	-	-	-	-	3.01	3.00	3.38	5.63	9.19	10.51	10.51	10.51	10.54	13.53	14.27	18.02	18.07	18.02	25.27	1.66	-	-	-	10.65	-
Solar	2.65	5.45	7.02	10.71	10.17	14.23	17.23	17.96	20.30	22.21	25.82	30.18	33.67	33.39	40.28	39.16	44.49	49.99	52.15	48.82	57.84	53.90	62.33	67.09	69.26	69.39	69.83	73.72	12.10	40.86	33.11	10.78	3.96	14.13
Biomass	2.32	1.06	1.19	0.80	0.78	0.96	1.09	1.12	1.00	1.03	1.02	1.04	0.97	1.04	1.00	1.03	1.02	1.00	1.06	1.01	1.00	1.05	1.25	1.18	1.21	1.17	1.21	1.16	0.59	-5.18	-2.01	-1.15	1.48	-0.47
Nuclear and Other Technologies	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total Generation	**114.39**	**122.02**	**128.26**	**135.40**	**143.23**	**151.85**	**161.15**	**170.35**	**179.56**	**188.70**	**198.63**	**208.85**	**220.29**	**231.57**	**244.56**	**257.20**	**269.31**	**286.31**	**300.56**	**314.59**	**330.93**	**345.72**	**363.65**	**381.78**	**399.81**	**417.93**	**436.19**	**453.81**	**100**	**5.28**	**5.44**	**5.33**	**4.71**	**5.14**
BESS	0.07	-	0.03	0.01	0.01	0.04	0.12	0.06	0.05	0.23	0.59	0.51	0.44	0.42	0.33	0.43	0.53	0.47	0.55	0.36	0.85	1.19	1.65	1.49	1.46	0.96	1.17	1.02	-	-8.90	-0.65	21.84	8.15	11.00

Annex 17. Power Generation, Clean Energy Scenario - 1 (In Terawatt-Hour, TWh)

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**2.55**	**0.88**	**0.88**	**0.88**	**0.88**	**0.88**	**0.88**	**0.88**	**0.87**	**0.88**	**0.88**	**0.87**	**0.88**	**0.87**	**0.88**	**0.88**	**0.88**	**0.88**	**0.88**	**0.87**	**0.94**	**0.86**	**0.87**	**0.90**	**0.88**	**0.98**	**0.86**	**0.88**	0.62	-16.08	-12.32	-	-	-3.69
Natural Gas	**18.04**	**19.92**	**27.36**	**27.36**	**33.90**	**34.00**	**33.90**	**33.90**	**33.90**	**34.00**	**33.90**	**33.90**	**33.90**	**34.00**	**36.52**	**41.43**	**41.49**	**41.59**	**41.37**	**41.70**	**47.39**	**46.19**	**49.43**	**48.10**	**46.18**	**65.24**	**73.96**	**67.87**	16.84	11.30	8.32	2.07	5.02	4.88
Coal	**66.42**	**67.08**	**61.67**	**59.80**	**58.70**	**56.48**	**63.99**	**64.08**	**63.50**	**61.38**	**62.34**	**61.76**	**59.08**	**60.77**	**60.03**	**59.47**	**58.86**	**58.45**	**57.71**	**50.90**	**56.55**	**56.11**	**55.37**	**54.78**	**54.18**	**49.95**	**53.00**	**48.64**	31.10	-2.67	-0.45	-0.91	-1.82	-1.11
Renewable	**27.37**	**34.13**	**37.88**	**46.55**	**48.71**	**58.96**	**60.82**	**70.00**	**79.30**	**80.51**	**89.44**	**100.30**	**103.71**	**113.31**	**123.46**	**131.46**	**145.07**	**158.90**	**173.83**	**194.21**	**198.61**	**215.73**	**229.87**	**248.23**	**267.62**	**271.08**	**277.85**	**287.90**	**47.56**	**15.62**	**13.92**	**8.54**	**6.12**	**9.17**
Geothermal	11.89	12.22	12.69	13.70	14.09	15.08	15.22	15.35	15.53	15.43	15.76	16.09	16.25	16.33	17.26	17.71	18.46	18.40	18.89	18.71	19.74	19.73	19.09	19.57	20.09	19.30	19.91	19.25	7.67	6.34	4.95	1.83	0.45	2.22
Hydro	9.41	9.35	9.70	9.69	10.94	10.70	10.71	12.82	13.69	12.52	13.30	15.79	15.43	18.65	20.68	21.79	22.48	25.22	26.76	26.56	27.58	28.26	28.81	30.63	32.53	31.03	32.83	32.79	7.92	1.00	3.04	7.00	2.66	4.30
Onshore Wind	1.09	3.65	5.48	9.42	9.92	11.52	12.41	16.28	18.04	20.82	23.22	25.95	28.62	33.00	31.96	32.76	37.63	39.83	46.54	53.78	52.56	53.02	53.83	60.53	71.38	66.27	69.54	69.80	11.04	49.55	41.20	9.36	5.77	16.25
Offshore Wind	-	-	-	-	-	6.89	6.37	7.67	7.67	7.69	7.67	6.86	7.67	8.07	9.58	9.58	12.65	16.49	26.06	36.79	36.79	43.43	50.93	53.66	68.22	68.79	73.58	74.73	6.35	-	-	7.96	16.31	-
Solar	2.65	6.55	7.47	11.33	11.31	12.35	13.63	15.08	21.58	21.52	27.01	33.10	33.28	34.59	41.33	47.19	51.43	56.52	52.93	55.99	59.52	68.87	74.88	81.45	72.80	83.37	79.53	88.99	13.41	37.56	30.23	14.13	4.64	14.90
Biomass	2.32	2.36	2.55	2.42	2.46	2.42	2.48	2.81	2.79	2.53	2.49	2.50	2.46	2.66	2.65	2.43	2.43	2.45	2.65	2.38	2.42	2.42	2.34	2.39	2.61	2.31	2.44	2.33	1.18	10.58	9.90	-1.38	-0.50	2.04
Nuclear and Other Technologies	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**9.68**	**9.65**	**9.65**	**19.31**	**19.36**	**19.31**	**19.31**	**19.31**	**19.36**	**19.31**	**19.31**	**19.31**	**19.36**	**19.31**	**19.31**	**19.31**	**19.36**	**19.31**	**38.62**	**3.88**	**0.00**	**0.00**	**9.05**	**7.15**	**7.99**
Total Generation	**114.39**	**122.00**	**127.79**	**134.59**	**142.20**	**150.31**	**159.59**	**168.86**	**177.57**	**186.44**	**196.21**	**206.49**	**216.88**	**228.31**	**240.19**	**252.55**	**265.62**	**279.19**	**293.10**	**306.98**	**322.81**	**338.26**	**354.84**	**371.32**	**388.17**	**406.61**	**424.98**	**443.90**	**100**	**5.10**	**5.32**	**5.16**	**4.75**	**5.06**
BESS	0.00	0.23	0.37	0.42	0.47	0.46	0.56	0.59	0.53	0.63	0.66	1.76	1.80	1.71	3.61	5.01	6.62	7.78	6.80	7.91	11.22	11.99	17.82	17.00	11.77	22.02	17.67	24.55	-	18.26	16.79	29.34	12.18	19.60

Annex 18. Power Generation, Clean Energy Scenario - 2 (In Terawatt-Hour, TWh)

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**2.55**	**0.88**	**0.87**	**0.88**	**0.88**	**0.88**	**0.88**	**0.88**	**0.87**	**0.87**	**0.87**	**0.87**	**0.83**	**0.97**	**0.86**	**0.86**	**0.88**	**0.89**	**0.88**	**0.97**	**0.99**	**0.88**	**0.95**	**0.91**	**0.88**	**1.18**	**1.14**	**0.88**	0.63	-16.08	-12.32	0.09	-0.09	-3.69
Natural Gas	**18.04**	**19.92**	**24.83**	**24.83**	**30.77**	**30.86**	**30.77**	**30.77**	**30.77**	**30.86**	**30.77**	**30.77**	**30.77**	**30.86**	**32.21**	**33.13**	**32.47**	**36.74**	**31.55**	**34.92**	**44.34**	**41.53**	**53.32**	**44.43**	**50.44**	**67.79**	**64.21**	**48.77**	15.44	9.52	7.02	1.79	2.87	3.65
Coal	**66.42**	**67.08**	**62.85**	**58.38**	**57.64**	**55.68**	**58.33**	**52.65**	**55.12**	**48.10**	**48.45**	**45.80**	**42.15**	**42.27**	**42.18**	**42.17**	**44.90**	**51.96**	**51.30**	**46.78**	**44.36**	**48.05**	**45.02**	**44.78**	**48.17**	**42.20**	**42.07**	**42.05**	27.95	-2.90	-2.86	-0.13	-2.09	-1.62
Renewable	**27.37**	**34.13**	**39.31**	**50.39**	**52.82**	**62.83**	**69.14**	**83.68**	**90.23**	**96.00**	**105.48**	**118.41**	**122.85**	**133.53**	**144.40**	**155.96**	**166.91**	**169.85**	**189.34**	**204.38**	**212.83**	**227.70**	**235.52**	**260.89**	**268.57**	**276.84**	**299.61**	**314.55**	**52.09**	**16.85**	**16.49**	**7.34**	**6.36**	**9.52**
Geothermal	11.89	12.22	12.70	13.71	14.08	15.08	15.24	15.31	15.51	15.48	15.74	15.90	14.97	14.89	14.84	15.54	15.74	15.77	16.34	16.39	17.33	17.68	18.20	18.83	19.42	17.66	17.30	17.21	7.35	6.34	4.93	0.29	0.87	1.81
Hydro	9.41	9.35	9.71	9.70	10.93	10.70	10.71	12.77	13.48	12.34	13.28	15.66	13.54	15.26	17.35	19.77	20.26	23.14	25.96	25.40	25.72	27.38	27.14	28.89	31.38	28.55	28.38	27.15	7.55	0.99	3.00	6.12	1.61	3.60
Onshore Wind	1.09	3.65	6.88	13.22	14.04	15.40	17.68	21.32	21.74	23.45	24.81	26.58	25.27	28.00	26.42	25.57	27.54	28.61	32.40	35.97	34.02	33.66	33.16	36.84	42.27	34.36	37.04	33.39	9.06	56.97	46.05	2.99	1.56	13.23
Offshore Wind	-	-	-	-	-	6.89	6.37	15.33	19.16	23.06	26.83	32.06	42.08	49.96	57.49	65.15	72.82	66.72	80.48	88.15	95.81	103.76	105.99	122.53	126.86	146.03	169.01	186.99	17.53	-	-	15.84	10.86	-
Solar	2.65	6.55	7.47	11.33	11.31	12.35	16.66	16.14	17.55	19.12	22.41	25.75	24.90	23.26	26.14	27.62	28.24	33.15	31.51	36.16	37.69	42.84	48.80	51.52	46.01	48.15	45.75	47.74	9.45	37.56	31.35	7.46	3.71	12.37
Biomass	2.32	2.36	2.55	2.43	2.46	2.42	2.49	2.81	2.79	2.54	2.41	2.45	2.09	2.16	2.16	2.31	2.32	2.45	2.64	2.32	2.26	2.38	2.24	2.28	2.63	2.09	2.12	2.07	1.14	10.57	9.86	-1.34	-1.67	1.62
Nuclear and Other Technologies	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**9.68**	**9.65**	**9.65**	**19.31**	**19.36**	**19.31**	**19.31**	**19.31**	**19.36**	**19.31**	**19.31**	**19.31**	**19.36**	**19.31**	**19.31**	**19.31**	**19.36**	**19.31**	**38.62**	**3.89**	**-**	**-**	**9.05**	**7.15**	**7.99**
Total Generation	**114.39**	**122.00**	**127.87**	**134.48**	**142.11**	**150.24**	**159.12**	**167.99**	**177.00**	**185.51**	**195.23**	**205.50**	**215.91**	**226.99**	**238.96**	**251.43**	**264.47**	**278.80**	**292.38**	**306.36**	**321.82**	**337.52**	**354.11**	**370.32**	**387.36**	**407.37**	**426.33**	**444.87**	**100**	**5.09**	**5.26**	**5.20**	**4.78**	**5.07**
BESS	0.03	0.23	0.32	0.43	0.48	0.46	0.56	0.63	0.43	0.66	0.64	2.68	4.92	2.79	5.06	5.14	4.05	6.48	3.19	3.78	9.15	7.93	14.82	10.80	4.92	29.50	34.11	33.15	-	18.14	17.96	26.25	17.72	20.99

Annex 19. Fuel Input to Power Generation, Reference Scenario (In Million Tons of Oil Equivalent, MTOE)

Energy Source	Outlook																												Average Shares %(2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**0.84**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	0.83	-13.34	-10.19	-0.03	-0.01	-3.04
Natural Gas	**2.82**	**3.58**	**3.65**	**3.74**	**3.62**	**3.52**	**4.27**	**4.92**	**5.55**	**6.10**	**6.74**	**7.33**	**7.98**	**8.53**	**9.24**	**9.83**	**10.31**	**10.83**	**12.04**	**13.33**	**14.58**	**15.81**	**17.27**	**18.69**	**20.17**	**21.94**	**23.22**	**24.82**	16.39	5.69	8.68	8.20	8.65	8.50
Coal	**17.09**	**17.14**	**17.59**	**18.17**	**19.19**	**20.27**	**20.03**	**19.85**	**19.66**	**19.53**	**19.30**	**19.11**	**18.93**	**18.80**	**18.57**	**18.38**	**18.20**	**18.07**	**17.83**	**17.65**	**17.47**	**17.33**	**17.10**	**16.92**	**16.74**	**16.60**	**16.37**	**16.19**	37.16	2.84	1.86	-0.94	-1.09	-0.20
Renewable	**13.85**	**13.60**	**14.25**	**14.52**	**15.86**	**16.80**	**17.32**	**18.38**	**19.09**	**19.87**	**20.61**	**21.79**	**22.79**	**24.01**	**25.07**	**26.39**	**27.54**	**31.78**	**32.70**	**33.28**	**33.91**	**34.77**	**37.17**	**37.60**	**40.76**	**41.34**	**42.50**	**43.64**	**45.61**	**5.42**	**5.22**	**5.63**	**3.22**	**4.65**
Geothermal	10.23	9.88	10.24	10.98	11.37	11.98	11.91	12.36	12.41	12.62	12.82	13.00	13.10	13.09	13.22	13.27	13.25	16.23	15.98	16.05	15.92	16.14	16.99	16.74	17.55	17.54	17.70	18.30	26.06	4.95	4.10	2.76	1.21	2.58
Hydro	2.41	2.55	2.53	1.58	2.51	2.36	2.47	2.70	2.98	3.08	3.05	3.64	4.00	4.76	4.98	5.64	6.14	6.65	7.40	7.36	7.30	7.32	8.49	8.22	10.67	10.63	10.72	10.59	8.93	-1.01	0.92	9.44	4.76	5.27
Wind	0.09	0.28	0.42	0.73	0.81	0.87	1.04	1.34	1.56	1.87	2.13	2.15	2.42	2.89	3.03	3.72	3.93	4.21	4.44	5.29	5.33	6.28	5.87	6.43	6.13	6.77	7.62	7.98	4.92	46.21	40.49	12.11	6.59	17.44
Solar	0.23	0.47	0.60	0.92	0.87	1.22	1.48	1.54	1.75	1.91	2.22	2.60	2.90	2.87	3.46	3.37	3.83	4.30	4.48	4.20	4.97	4.63	5.36	5.77	5.96	5.97	6.00	6.34	4.80	40.86	33.11	10.78	3.96	14.13
Biomass	0.89	0.41	0.45	0.30	0.30	0.37	0.42	0.43	0.38	0.40	0.39	0.40	0.37	0.40	0.38	0.40	0.39	0.38	0.40	0.38	0.38	0.40	0.47	0.44	0.46	0.44	0.46	0.44	0.90	-5.45	-2.22	-1.15	1.30	-0.59
Nuclear and Other Tech	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Fuel Input	**34.59**	**34.67**	**35.84**	**36.78**	**39.02**	**40.94**	**41.97**	**43.49**	**44.65**	**45.85**	**47.00**	**48.59**	**50.05**	**51.69**	**53.22**	**54.95**	**56.40**	**61.02**	**62.92**	**64.62**	**66.30**	**68.26**	**71.90**	**73.55**	**78.01**	**80.23**	**82.44**	**84.99**	**100**	**3.81**	**3.62**	**3.44**	**3.37**	**3.47**

Annex 20. Fuel Input to Power Generation, Clean Energy Scenario - 1 (In Million Tons of Oil Equivalent, MTOE)

Energy Source	Outlook																												Average Shares %(2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**0.84**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.28**	**0.29**	**0.29**	**0.28**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.28**	**0.31**	**0.28**	**0.28**	**0.29**	**0.29**	**0.32**	**0.28**	**0.29**	0.74	-16.09	-12.33	-	-	-3.69
Natural Gas	**2.82**	**3.11**	**4.28**	**4.28**	**5.30**	**5.31**	**5.30**	**5.30**	**5.30**	**5.31**	**5.30**	**5.30**	**5.30**	**5.31**	**5.71**	**6.48**	**6.49**	**6.50**	**6.47**	**6.52**	**7.41**	**7.22**	**7.73**	**7.52**	**7.22**	**10.20**	**11.56**	**10.61**	11.27	13.18	9.69	2.07	5.02	5.26
Coal	**17.09**	**17.22**	**15.70**	**15.13**	**14.83**	**14.26**	**16.16**	**16.18**	**16.04**	**15.50**	**15.74**	**15.60**	**14.92**	**15.35**	**15.16**	**15.02**	**14.87**	**14.76**	**14.58**	**12.85**	**14.28**	**14.17**	**13.98**	**13.83**	**13.68**	**12.62**	**13.38**	**12.28**	32.00	-3.00	-0.71	-0.91	-1.82	-1.18
Renewable	**13.86**	**14.70**	**15.49**	**16.98**	**17.67**	**19.27**	**19.56**	**20.88**	**21.96**	**21.72**	**22.86**	**24.48**	**24.82**	**26.32**	**28.25**	**29.41**	**31.29**	**32.90**	**34.88**	**36.39**	**37.74**	**39.32**	**40.11**	**42.39**	**44.84**	**44.19**	**45.59**	**45.91**	**51.11**	**7.86**	**6.91**	**4.65**	**3.39**	**4.84**
Geothermal	10.23	10.51	10.91	11.78	12.11	12.96	13.09	13.19	13.35	13.26	13.55	13.83	13.97	14.04	14.84	15.23	15.88	15.82	16.25	16.09	16.97	16.96	16.41	16.82	17.27	16.60	17.12	16.56	27.70	6.34	4.95	1.83	0.45	2.22
Hydro	2.41	2.40	2.49	2.48	2.81	2.74	2.75	3.29	3.51	3.21	3.41	4.05	3.96	4.78	5.30	5.59	5.76	6.46	6.86	6.81	7.07	7.24	7.39	7.85	8.34	7.96	8.42	8.41	8.91	1.49	3.42	7.00	2.66	4.41
Wind	0.09	0.31	0.47	0.81	0.85	1.58	1.61	2.06	2.21	2.45	2.66	2.82	3.12	3.53	3.57	3.64	4.32	4.84	6.24	7.79	7.68	8.29	9.01	9.82	12.00	11.61	12.31	12.43	7.23	61.70	48.18	8.93	9.88	19.31
Solar	0.23	0.56	0.64	0.97	0.97	1.06	1.17	1.30	1.86	1.85	2.32	2.85	2.86	2.97	3.55	4.06	4.42	4.86	4.55	4.81	5.12	5.92	6.44	7.00	6.26	7.17	6.84	7.65	5.44	37.56	30.23	14.13	4.64	14.90
Biomass	0.90	0.92	0.98	0.93	0.93	0.91	0.94	1.04	1.03	0.94	0.92	0.93	0.92	0.99	0.99	0.90	0.90	0.91	0.98	0.88	0.90	0.90	0.87	0.89	0.97	0.86	0.90	0.87	1.83	10.04	9.20	-1.32	-0.50	1.88
Nuclear and Other Tech	-	-	-	-	-	-	-	-	-	2.52	2.52	2.52	5.03	5.04	5.03	5.03	5.03	5.04	5.03	5.03	5.03	5.04	5.03	5.03	5.03	5.04	5.03	10.06	4.88	-	-	9.05	7.15	7.99
Total Fuel Input	**34.61**	**35.32**	**35.75**	**36.67**	**38.08**	**39.13**	**41.31**	**42.65**	**43.58**	**45.34**	**46.71**	**48.18**	**50.36**	**52.32**	**54.44**	**56.23**	**57.96**	**59.50**	**61.24**	**61.07**	**64.77**	**66.04**	**67.14**	**69.07**	**71.06**	**72.37**	**75.85**	**79.15**	**100**	**3.03**	**3.37**	**3.39**	**2.90**	**3.21**

Annex 21. Fuel Input to Power Generation, Clean Energy Scenario - 2 (In Million Tons of Oil Equivalent, MTOE)

Energy Source	Outlook																												Average Shares %(2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**0.84**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.28**	**0.27**	**0.32**	**0.28**	**0.28**	**0.29**	**0.29**	**0.29**	**0.32**	**0.32**	**0.29**	**0.31**	**0.30**	**0.29**	**0.39**	**0.37**	**0.29**	0.78	-16.09	-12.33	0.09	-0.09	-3.69
Natural Gas	**2.82**	**3.11**	**3.88**	**3.88**	**4.81**	**4.82**	**4.81**	**4.81**	**4.81**	**4.82**	**4.81**	**4.81**	**4.81**	**4.82**	**5.04**	**5.18**	**5.08**	**5.74**	**4.93**	**5.46**	**6.93**	**6.49**	**8.34**	**6.95**	**7.89**	**10.60**	**10.04**	**7.62**	10.78	11.37	8.37	1.79	2.87	4.02
Coal	**17.09**	**17.22**	**16.00**	**14.76**	**14.52**	**14.03**	**14.70**	**13.27**	**13.89**	**12.12**	**12.21**	**11.54**	**10.62**	**10.65**	**10.63**	**10.62**	**11.31**	**13.09**	**12.92**	**11.79**	**11.17**	**12.10**	**11.34**	**11.28**	**12.13**	**10.63**	**10.60**	**10.59**	29.36	-3.27	-3.14	-0.14	-2.09	-1.70
Renewable	**13.86**	**14.70**	**15.62**	**17.32**	**18.02**	**19.60**	**20.29**	**22.02**	**22.85**	**23.06**	**24.20**	**25.85**	**25.05**	**26.21**	**27.46**	**29.46**	**30.65**	**31.45**	**34.10**	**35.24**	**36.73**	**38.61**	**39.60**	**42.58**	**44.22**	**42.93**	**44.58**	**45.58**	**53.84**	**8.17**	**7.62**	**3.63**	**3.78**	**4.81**
Geothermal	10.23	10.51	10.92	11.79	12.11	12.96	13.10	13.17	13.34	13.31	13.53	13.67	12.87	12.80	12.76	13.36	13.53	13.56	14.05	14.09	14.90	15.20	15.65	16.19	16.70	15.19	14.88	14.79	27.54	6.34	4.93	0.29	0.87	1.81
Hydro	2.41	2.40	2.49	2.49	2.80	2.74	2.75	3.27	3.46	3.16	3.40	4.02	3.47	3.91	4.45	5.07	5.19	5.93	6.66	6.51	6.59	7.02	6.96	7.41	8.04	7.32	7.28	6.96	8.86	1.49	3.38	6.12	1.61	3.71
Wind	0.09	0.31	0.59	1.14	1.21	1.92	2.07	3.15	3.52	4.00	4.44	5.04	5.79	6.70	7.22	7.80	8.63	8.20	9.71	10.67	11.16	11.82	11.96	13.70	14.54	15.51	17.72	18.95	11.66	66.94	56.28	10.03	8.74	21.12
Solar	0.23	0.56	0.64	0.97	0.97	1.06	1.43	1.39	1.51	1.64	1.93	2.21	2.14	2.00	2.25	2.37	2.43	2.85	2.71	3.11	3.24	3.68	4.20	4.43	3.96	4.14	3.93	4.10	3.95	37.56	31.35	7.46	3.71	12.37
Biomass	0.90	0.92	0.98	0.93	0.93	0.91	0.94	1.04	1.03	0.94	0.89	0.91	0.77	0.80	0.79	0.86	0.86	0.91	0.98	0.86	0.84	0.88	0.83	0.85	0.98	0.77	0.78	0.77	1.84	10.03	9.17	-1.28	-1.72	1.44
Nuclear and Other Tech	-	-	-	-	-	-	-	-	-	2.52	2.52	2.52	5.03	5.04	5.03	5.03	5.03	5.04	5.03	5.03	5.03	5.04	5.03	5.03	5.03	5.04	5.03	10.06	5.24	-	-	9.05	7.15	7.99
Total Fuel Input	**34.61**	**35.32**	**35.79**	**36.24**	**37.64**	**38.74**	**40.08**	**40.39**	**41.84**	**42.81**	**44.02**	**45.01**	**45.78**	**47.05**	**48.44**	**50.58**	**52.35**	**55.62**	**57.28**	**57.84**	**60.19**	**62.54**	**64.61**	**66.13**	**69.56**	**69.59**	**70.62**	**74.14**	**100**	**2.86**	**2.67**	**3.25**	**2.92**	**2.97**

Annex 22. Installed Generating Capacity, Reference Scenario (In Gigawatt, GW)

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**6.62**	**0.08**	**0.06**	**0.00**	**0.00**	**0.02**
Natural Gas	**3.73**	**5.04**	**5.04**	**5.04**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.74**	**7.58**	**8.00**	**9.25**	**9.67**	**10.50**	**11.34**	**12.59**	**13.85**	**15.52**	**17.19**	**18.86**	**20.60**	**22.27**	**23.94**	**25.61**	**25.61**	**13.08**	**8.67**	**6.43**	**6.32**	**8.49**	**7.12**
Coal	**12.73**	**13.03**	**13.88**	**14.46**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**14.73**	**23.57**	**2.88**	**2.15**	**0.00**	**0.00**	**0.61**
Renewable	**8.92**	**12.04**	**15.64**	**18.06**	**18.19**	**22.06**	**23.33**	**26.63**	**31.64**	**32.33**	**36.41**	**41.19**	**44.14**	**48.44**	**52.28**	**55.83**	**60.91**	**66.92**	**73.75**	**78.11**	**78.74**	**79.52**	**88.41**	**89.86**	**98.53**	**100.12**	**101.88**	**106.77**	**56.74**	**17.77**	**15.75**	**9.65**	**4.78**	**9.57**
Geothermal	2.00	2.07	2.19	2.25	2.38	2.38	2.38	2.42	2.42	2.46	2.46	2.53	2.53	2.53	2.53	2.53	2.53	2.98	2.98	2.98	2.98	2.98	3.09	3.09	3.20	3.20	3.20	3.31	4.05	3.34	2.71	2.11	1.06	1.90
Hydro	3.87	3.89	4.02	4.02	4.02	4.04	4.04	4.04	4.46	4.46	4.46	5.01	5.56	6.11	6.33	6.88	7.43	7.98	8.49	8.49	8.49	8.49	9.89	9.91	13.51	13.51	13.51	14.01	9.15	1.28	0.95	7.04	5.80	4.83
Onshore Wind	0.43	1.19	1.97	3.20	3.20	4.13	4.57	5.76	6.95	7.43	8.62	9.70	10.79	11.87	12.95	14.04	15.12	16.20	18.35	20.43	20.96	21.33	22.68	23.27	23.82	24.37	24.92	25.47	12.53	45.95	38.44	10.89	4.63	15.72
Offshore Wind	-	-	-	-	-	-	-	-	-	-	-	-	-	0.80	0.80	0.90	1.50	2.50	2.80	2.80	2.80	2.80	3.80	3.80	4.80	4.80	4.80	6.80	1.23	-	-	-	10.52	-
Solar	1.98	4.23	6.81	7.94	7.94	10.86	11.69	13.76	17.16	17.33	20.22	23.29	24.61	26.48	29.03	30.84	33.69	36.62	40.48	42.76	42.86	43.27	48.25	49.09	52.50	53.54	54.75	56.48	28.70	38.63	31.59	10.29	4.43	13.76
Biomass	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.70	0.70	0.70	0.70	0.70	0.70	1.07	1.11	0.83	0.00	0.74	0.50
Nuclear and Other Technologies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capacity	**29.23**	**33.97**	**38.41**	**41.42**	**42.92**	**46.79**	**48.07**	**51.36**	**56.37**	**57.07**	**61.14**	**66.52**	**70.31**	**75.02**	**80.12**	**84.08**	**90.00**	**96.85**	**104.93**	**110.55**	**112.85**	**115.30**	**125.86**	**129.05**	**139.39**	**142.64**	**146.08**	**150.97**	**100**	**8.77**	**7.75**	**6.55**	**4.54**	**6.17**
BESS	1.24	1.72	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	3.13	3.58	3.78	3.78	3.78	3.78	3.78	3.78	-	12.59	8.84	0.00	5.39	4.39

Annex 23. Installed Generating Capacity, Clean Energy Scenario - 1 (In Gigawatt, GW)

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**6.88**	**0.08**	**0.06**	**0.00**	**0.00**	**0.02**
Natural Gas	**3.73**	**5.04**	**5.04**	**5.04**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.62**	**7.46**	**7.60**	**7.60**	**7.60**	**7.94**	**10.36**	**10.36**	**11.94**	**11.94**	**11.94**	**16.37**	**19.72**	**19.72**	**11.16**	**8.67**	**6.43**	**2.15**	**10.01**	**6.13**
Coal	**12.73**	**13.03**	**11.12**	**10.84**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**11.11**	**20.25**	**-1.85**	**-1.39**	**0.00**	**0.00**	**-0.40**
Renewable	**8.92**	**12.07**	**15.48**	**17.90**	**18.89**	**21.72**	**22.72**	**26.07**	**30.80**	**31.89**	**36.38**	**41.08**	**42.03**	**46.95**	**52.04**	**56.51**	**60.70**	**66.16**	**72.49**	**77.32**	**82.40**	**90.25**	**95.88**	**101.02**	**107.99**	**111.39**	**114.42**	**114.83**	**60.24**	**17.48**	**15.44**	**9.76**	**5.67**	**9.85**
Geothermal	2.00	2.07	2.19	2.25	2.38	2.38	2.38	2.42	2.42	2.46	2.46	2.51	2.51	2.51	2.62	2.73	2.83	2.83	2.83	2.83	2.94	2.96	2.96	2.96	2.96	2.96	2.96	2.96	4.19	3.34	2.71	1.58	0.45	1.49
Hydro	3.87	3.89	4.02	4.02	4.52	4.52	4.52	5.12	5.47	5.47	5.63	6.18	6.18	6.73	7.28	7.81	8.01	8.51	8.51	8.83	9.03	9.23	9.43	9.63	9.83	10.23	10.43	10.55	9.81	3.17	3.98	5.22	2.17	3.77
Onshore Wind	0.43	1.33	2.23	3.46	3.80	4.34	4.74	5.69	6.64	7.59	8.54	9.49	10.44	11.39	12.34	13.29	14.24	15.19	16.59	17.99	19.39	20.79	22.19	23.59	24.99	26.39	26.39	26.39	12.87	47.16	38.22	10.32	5.68	15.87
Offshore Wind	-	-	-	-	-	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.10	2.50	2.50	3.30	5.30	6.80	9.60	9.60	11.30	14.00	14.00	17.80	17.90	19.20	19.50	5.06	-	-	10.24	13.91	-
Solar	1.98	4.07	6.33	7.46	7.46	7.76	8.36	10.10	13.53	13.63	17.01	20.15	20.15	23.47	26.55	29.44	31.58	33.59	37.02	37.33	40.69	45.22	46.56	50.10	51.66	53.16	54.69	54.69	27.09	31.08	26.60	12.77	4.99	13.62
Biomass	0.65	0.70	0.72	0.72	0.73	0.73	0.73	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	1.22	3.08	2.58	0.00	0.00	0.73
Nuclear and Other Technologies	-	-	-	-	-	-	-	-	-	1.20	1.20	1.20	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	4.80	1.47	-	-	9.05	7.18	8.01
Total Capacity	**29.23**	**33.99**	**35.50**	**37.64**	**40.00**	**42.83**	**43.83**	**47.18**	**51.91**	**54.19**	**58.69**	**63.39**	**65.54**	**70.46**	**76.03**	**81.33**	**85.66**	**91.13**	**97.45**	**102.62**	**110.12**	**117.97**	**125.18**	**130.32**	**137.29**	**145.12**	**151.50**	**154.32**	**100**	**7.18**	**6.62**	**6.81**	**5.41**	**6.25**
BESS	1.24	1.72	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	3.08	3.08	3.08	4.58	6.20	7.70	7.70	7.70	9.25	12.16	13.02	15.62	17.12	17.12	20.52	22.02	22.02	-	12.59	8.84	13.16	11.08	11.71

Annex 24. Installed Generating Capacity, Clean Energy Scenario - 2 (In Gigawatt, GW)

Energy Source	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Oil	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**3.85**	**6.86**	**0.08**	**0.06**	**0.00**	**0.00**	**0.02**
Natural Gas	**3.73**	**5.04**	**5.04**	**5.04**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**6.14**	**8.16**	**9.52**	**9.52**	**9.52**	**9.52**	**11.36**	**13.86**	**13.86**	**15.06**	**15.06**	**15.06**	**20.15**	**22.59**	**22.59**	**12.35**	**8.67**	**6.43**	**4.48**	**9.02**	**6.64**
Coal	**12.73**	**13.03**	**11.24**	**10.17**	**10.07**	**10.07**	**10.07**	**10.07**	**10.07**	**10.07**	**10.07**	**10.07**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**9.93**	**19.00**	**-3.44**	**-2.59**	**-0.14**	**0.00**	**-0.80**
Renewable	**8.92**	**12.07**	**15.98**	**19.30**	**20.47**	**23.18**	**26.54**	**30.50**	**32.60**	**35.33**	**39.10**	**43.86**	**45.86**	**48.03**	**52.15**	**55.29**	**57.29**	**62.83**	**65.82**	**70.50**	**75.21**	**79.79**	**84.52**	**90.10**	**93.59**	**100.97**	**109.22**	**115.22**	**60.30**	**18.76**	**17.73**	**7.50**	**6.25**	**9.87**
Geothermal	2.00	2.07	2.19	2.25	2.38	2.38	2.38	2.42	2.42	2.46	2.46	2.50	2.50	2.50	2.50	2.50	2.50	2.51	2.51	2.58	2.71	2.71	2.86	2.86	2.86	2.96	2.96	2.96	4.11	3.34	2.71	0.37	1.66	1.49
Hydro	3.87	3.89	4.02	4.02	4.52	4.52	4.52	5.12	5.42	5.42	5.64	6.19	6.19	6.35	6.90	7.45	7.45	8.00	8.30	8.53	8.73	8.93	9.13	9.33	9.53	9.73	9.93	9.93	9.67	3.17	3.98	4.57	2.18	3.54
Onshore Wind	0.43	1.33	2.73	4.86	5.38	5.80	6.75	7.45	8.00	8.55	9.10	9.65	9.65	9.65	10.20	10.34	10.34	10.89	11.44	11.99	12.54	13.09	13.64	14.19	14.74	15.29	15.84	15.84	11.00	54.46	42.96	3.87	3.82	13.77
Offshore Wind	-	-	-	-	-	2.00	2.00	4.00	5.00	6.00	7.00	9.00	11.00	13.00	15.00	17.00	19.00	21.00	21.00	23.00	25.00	27.00	29.00	32.00	33.10	38.10	44.10	50.10	14.40	-	-	18.04	9.08	-
Solar	1.98	4.07	6.33	7.46	7.46	7.76	10.17	10.77	11.02	12.16	14.16	15.78	15.78	15.78	16.81	17.26	17.26	19.69	21.83	23.66	25.49	27.32	29.15	30.98	32.62	34.15	35.65	35.65	19.90	31.08	27.62	6.22	6.12	11.90
Biomass	0.65	0.70	0.72	0.72	0.73	0.73	0.73	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	1.22	3.08	2.58	-	-	0.73
Nuclear and Other Technologies	-	-	-	-	-	-	-	-	-	1.20	1.20	1.20	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	4.80	1.50	-	-	9.05	7.18	8.01
Total Capacity	**29.23**	**33.99**	**36.12**	**38.37**	**40.54**	**43.25**	**46.61**	**50.57**	**52.67**	**56.60**	**60.37**	**65.13**	**68.19**	**70.35**	**76.50**	**81.00**	**83.00**	**88.54**	**91.53**	**98.04**	**105.25**	**109.83**	**115.76**	**121.34**	**124.83**	**137.30**	**147.99**	**156.39**	**100**	**7.35**	**7.54**	**5.76**	**5.85**	**6.30**
BESS	1.24	1.72	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	3.93	3.93	3.93	6.43	7.00	7.00	7.00	7.00	7.00	12.60	12.60	14.60	17.36	17.36	23.17	24.66	24.66	-	12.59	8.84	12.08	13.43	12.20

Annex 25. Greenhouse Gas Emission (GHG), By Fuel, Reference Scenario (in Million Tons of CO2 equivalent, $MtCO_2e$)

Fuel	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Coal	73.78	74.38	76.60	79.29	83.73	88.43	88.02	87.83	87.66	87.71	87.35	87.22	87.10	87.21	86.94	86.90	86.88	87.07	86.81	86.76	86.71	86.85	86.64	86.62	86.60	86.77	86.59	86.58	45.54	2.75	1.96	-0.09	-0.06	0.51
Natural Gas	6.60	8.37	8.54	8.75	8.47	8.24	9.98	11.50	12.97	14.25	15.76	17.14	18.66	19.95	21.60	22.97	24.11	25.31	28.14	31.17	34.08	36.95	40.38	43.69	47.15	51.30	54.29	58.02	10.82	5.10	8.23	8.20	8.65	8.37
Oil	56.39	56.93	59.23	61.73	64.14	66.51	68.81	71.08	73.40	75.79	78.24	80.76	83.35	86.01	88.74	91.54	94.41	97.37	99.84	102.38	104.99	107.66	110.41	113.24	116.17	119.18	122.29	125.49	43.64	3.41	3.40	3.20	2.57	3.03
Total	**136.76**	**139.68**	**144.38**	**149.77**	**156.34**	**163.18**	**166.81**	**170.41**	**174.03**	**177.74**	**181.34**	**185.11**	**189.11**	**193.17**	**197.28**	**201.41**	**205.40**	**209.75**	**214.80**	**220.31**	**225.77**	**231.47**	**237.43**	**243.55**	**249.92**	**257.25**	**263.17**	**270.09**	**100**	**3.12**	**2.89**	**2.10**	**2.56**	**2.49**

Annex 26. Greenhouse Gas Emission (GHG), By Fuel, Clean Energy Scenario - 1 (in Million Tons of CO2 equivalent, $MtCO_2e$)

Fuel	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Coal	73.74	74.59	69.08	67.28	66.50	64.74	72.57	73.11	73.00	71.38	72.81	72.72	70.58	72.76	72.55	72.55	72.51	72.68	72.54	66.43	72.60	72.78	72.67	72.72	72.77	69.24	72.88	69.24	45.52	-2.46	-0.35	-0.06	-0.48	-0.29
Natural Gas	6.60	7.28	10.00	10.00	12.39	12.42	12.39	12.39	12.39	12.42	12.39	12.39	12.39	12.42	13.35	15.14	15.17	15.20	15.12	15.24	17.32	16.88	18.06	17.58	16.88	23.85	27.03	24.80	8.45	12.55	9.24	2.07	5.02	5.13
Oil	55.93	55.45	56.79	58.22	59.81	61.30	62.73	64.10	65.75	67.45	69.17	70.92	72.73	74.54	76.40	78.26	80.16	82.09	84.13	86.22	88.45	90.60	92.89	95.30	97.72	100.35	102.85	105.56	46.02	2.01	2.07	2.50	2.55	2.40
Total	**136.26**	**137.32**	**135.87**	**135.50**	**138.69**	**138.47**	**147.69**	**149.60**	**151.14**	**151.25**	**154.37**	**156.04**	**155.70**	**159.72**	**162.30**	**165.95**	**167.83**	**169.97**	**171.80**	**167.89**	**178.38**	**180.26**	**183.63**	**185.59**	**187.37**	**193.44**	**202.77**	**199.61**	**100**	**0.34**	**1.23**	**1.28**	**1.62**	**1.39**

Annex 27. Greenhouse Gas Emission (GHG), By Fuel, Clean Energy Scenario - 2 (in Million Tons of CO2 equivalent, $MtCO_2e$)

Fuel	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Coal	73.74	74.59	70.26	65.81	65.32	63.83	66.88	61.76	64.64	58.22	59.04	56.92	53.82	54.45	54.89	55.43	58.66	66.17	66.11	62.27	60.49	64.73	62.38	62.77	66.73	61.51	62.02	62.66	42.97	-2.69	-2.43	0.69	-0.54	-0.65
Natural Gas	6.60	7.28	9.08	9.08	11.25	11.28	11.25	11.25	11.25	11.28	11.25	11.25	11.25	11.28	11.77	12.11	11.87	13.43	11.53	12.76	16.21	15.18	19.49	16.24	18.43	24.78	23.47	17.82	8.16	10.75	7.92	1.79	2.87	3.90
Oil	55.93	55.45	56.53	58.22	59.81	61.30	62.73	64.10	65.75	67.44	69.17	70.92	72.67	74.64	76.39	78.25	80.16	82.09	84.13	86.32	88.50	90.61	92.98	95.30	97.72	100.55	103.12	105.56	48.87	2.01	2.07	2.50	2.55	2.40
Total	**136.26**	**137.32**	**135.87**	**133.11**	**136.37**	**136.41**	**140.85**	**137.10**	**141.64**	**136.94**	**139.45**	**139.09**	**137.74**	**140.37**	**143.05**	**145.78**	**150.69**	**161.69**	**161.77**	**161.35**	**165.20**	**170.52**	**174.84**	**174.31**	**182.89**	**186.84**	**188.61**	**186.05**	**100**	**0.09**	**0.13**	**1.66**	**1.41**	**1.13**

Annex 28. Greenhouse Gas Emission (GHG), By Sector, Reference Scenario (in Million Tons of CO2 equivalent, $MtCO_2e$)

Sector	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Transformation*	75.71	76.22	78.16	80.61	84.29	88.27	89.08	89.90	90.65	91.42	92.01	92.67	93.48	94.26	95.00	95.66	96.08	96.77	98.69	101.01	103.20	105.55	108.08	110.67	113.42	117.04	119.14	122.16	52.18	2.21	1.88	0.74	2.36	1.64
Industry	12.84	13.66	14.55	15.44	16.25	17.05	17.86	18.67	19.51	20.37	21.27	22.19	23.13	24.11	25.13	26.17	27.24	28.35	29.30	30.26	31.24	32.24	33.24	34.27	35.30	36.34	37.39	38.45	11.14	4.70	4.68	4.27	3.10	3.97
Transport	36.97	38.16	39.57	41.15	42.72	44.26	45.74	47.15	48.56	49.98	51.39	52.82	54.27	55.72	57.18	58.66	60.14	61.64	62.80	63.95	65.11	66.26	67.41	68.55	69.69	70.83	71.97	73.11	27.58	3.79	3.64	2.72	1.72	2.62
Others	11.23	11.64	12.09	12.58	13.08	13.59	14.13	14.70	15.31	15.97	16.68	17.43	18.23	19.08	19.98	20.93	21.93	23.00	24.02	25.09	26.22	27.42	28.70	30.06	31.51	33.04	34.66	36.38	9.10	5.47	5.10	4.58	4.69	4.77
Total	**136.76**	**139.68**	**144.38**	**149.77**	**156.34**	**163.18**	**166.81**	**170.41**	**174.03**	**177.74**	**181.34**	**185.11**	**189.11**	**193.17**	**197.28**	**201.41**	**205.40**	**209.75**	**214.80**	**220.31**	**225.77**	**231.47**	**237.43**	**243.55**	**249.92**	**257.25**	**263.17**	**270.09**	**100**	**3.12**	**2.89**	**2.10**	**2.56**	**2.49**

Annex 29. Greenhouse Gas Emission (GHG), By Sector, Clean Energy Scenario - 1 (in Million Tons of CO2 equivalent, $MtCO_2e$)

Sector	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Transformation*	75.71	75.24	72.03	69.84	71.04	68.88	76.24	76.32	75.74	73.70	74.62	74.04	71.41	73.10	73.29	74.54	73.97	73.60	72.79	66.19	73.91	72.96	73.42	72.38	71.08	73.98	80.05	73.55	46.77	-1.93	-0.18	-0.36	-0.01	-0.18
Industry	12.75	13.42	14.16	14.88	15.55	16.21	16.87	17.52	18.19	18.88	19.58	20.30	21.04	21.80	22.57	23.37	24.18	25.02	25.86	26.72	27.60	28.48	29.38	30.29	31.21	32.14	33.08	34.02	13.25	3.83	3.86	3.63	3.12	3.51
Transport	36.62	37.20	37.88	38.62	39.53	40.36	41.13	41.83	42.77	43.69	44.60	45.50	46.39	47.27	48.14	48.97	49.79	50.59	51.45	52.31	53.17	54.03	54.88	55.73	56.58	57.42	58.27	59.11	28.69	2.20	2.10	1.92	1.57	1.85
Others	11.17	11.46	11.80	12.16	12.58	13.01	13.46	13.93	14.44	14.99	15.57	16.20	16.86	17.56	18.30	19.08	19.90	20.77	21.69	22.66	23.69	24.79	25.95	27.19	28.50	29.89	31.37	32.93	11.29	4.70	4.39	4.07	4.72	4.39
Total	**136.26**	**137.32**	**135.87**	**135.50**	**138.69**	**138.47**	**147.69**	**149.60**	**151.14**	**151.25**	**154.37**	**156.04**	**155.70**	**159.72**	**162.30**	**165.95**	**167.83**	**169.97**	**171.80**	**167.89**	**178.38**	**180.26**	**183.63**	**185.59**	**187.37**	**193.44**	**202.77**	**199.61**	**100.00**	**0.34**	**1.23**	**1.28**	**1.62**	**1.39**

Annex 30. Greenhouse Gas Emission (GHG), By Sector, Clean Energy Scenario - 2 (in Million Tons of CO2 equivalent, $MtCO_2e$)

Sector	Outlook																											Average Shares % (2022-2050)	Average Annual Growth Rates (%)				
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		'22-'28	'22-'30	'30-'40	'40-'50	'22-'50
Transformation*	75.71	75.24	72.28	67.45	68.72	66.83	69.40	63.83	66.24	59.38	59.69	57.09	53.45	53.74	54.04	54.37	56.82	65.32	62.77	59.65	60.74	63.22	64.62	61.10	66.60	67.38	65.90	59.98	43.47	-2.43	-2.39	0.23	-0.85	-0.91
Industry	12.75	13.42	14.16	14.88	15.55	16.21	16.87	17.52	18.19	18.88	19.58	20.30	21.04	21.80	22.57	23.37	24.18	25.02	25.86	26.72	27.60	28.48	29.38	30.29	31.21	32.14	33.08	34.02	14.09	3.83	3.86	3.63	3.12	3.51
Transport	36.62	37.20	37.63	38.62	39.53	40.36	41.13	41.83	42.77	43.69	44.60	45.50	46.39	47.27	48.14	48.97	49.79	50.59	51.45	52.31	53.17	54.03	54.88	55.73	56.58	57.42	58.27	59.11	30.44	2.20	2.10	1.92	1.57	1.85
Others	11.17	11.46	11.80	12.16	12.58	13.01	13.46	13.93	14.44	14.99	15.57	16.20	16.86	17.56	18.30	19.08	19.90	20.77	21.69	22.66	23.69	24.79	25.95	27.19	28.50	29.89	31.37	32.93	12.00	4.70	4.39	4.07	4.72	4.39
Total	**136.26**	**137.32**	**135.87**	**133.11**	**136.37**	**136.41**	**140.85**	**137.10**	**141.64**	**136.94**	**139.45**	**139.09**	**137.74**	**140.37**	**143.05**	**145.78**	**150.69**	**161.69**	**161.77**	**161.35**	**165.20**	**170.52**	**174.84**	**174.31**	**182.89**	**186.84**	**188.61**	**186.05**	**100**	**0.09**	**0.13**	**1.66**	**1.41**	**1.13**

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