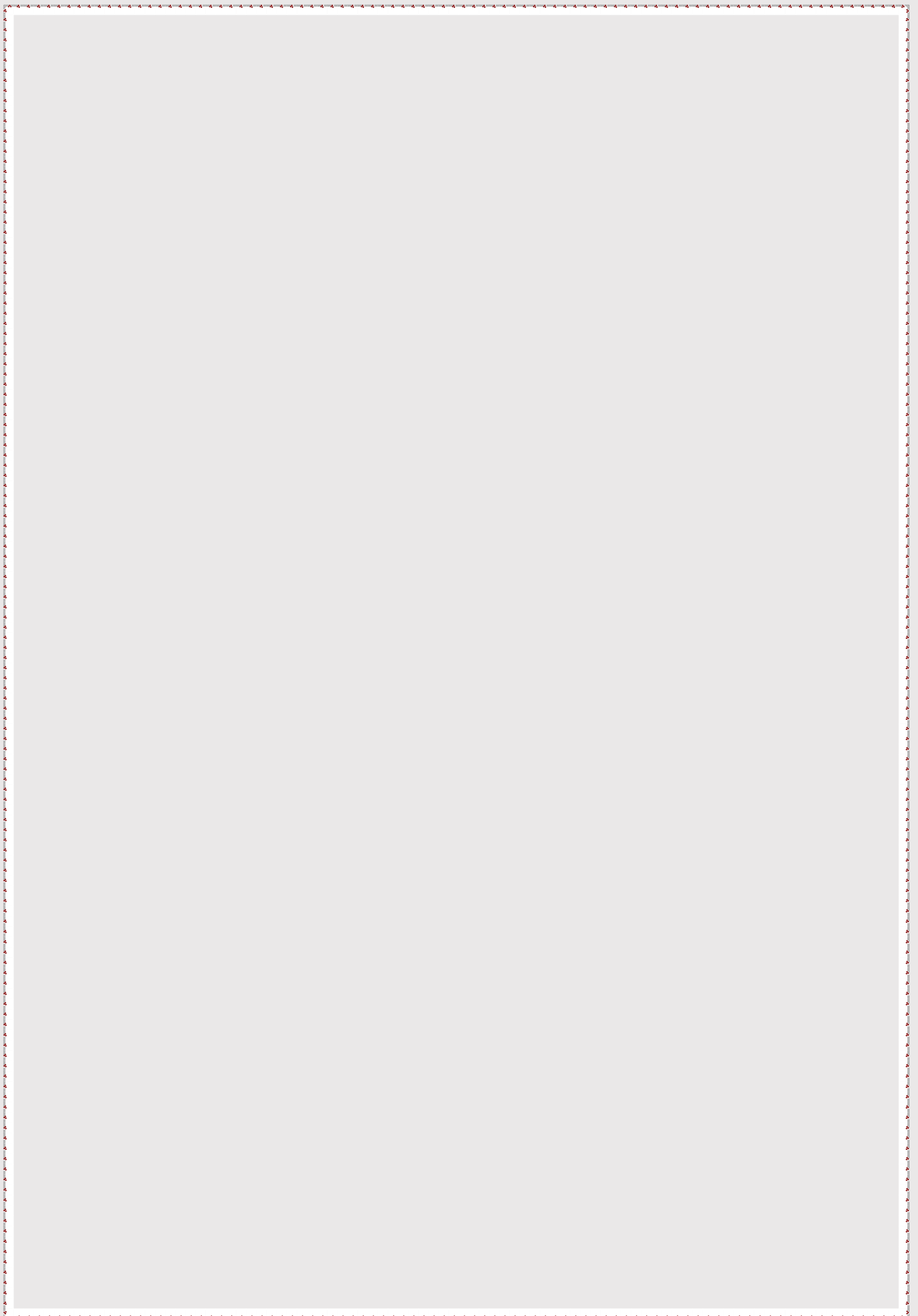


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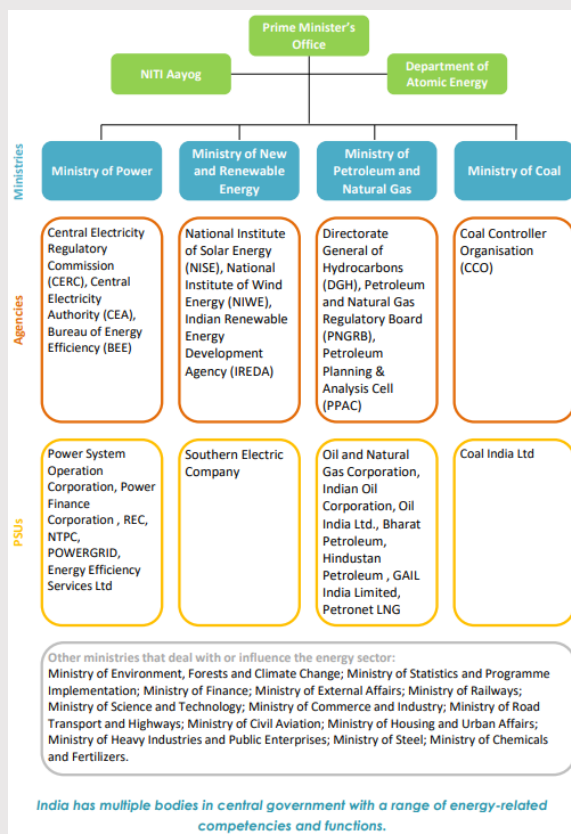


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9.1 India's Energy Scenario

India is a major force in the global energy economy. There has been a rapid increase in energy consumption due to a growing population and rapid economic growth. The growing demand is met through various energy sources, such as coal, oil and solid biomass. Coal¹ has underpinned the expansion of electricity generation and industry, and remains the largest single fuel in the energy mix. Oil consumption² and imports have grown rapidly on account of rising vehicle ownership and road transport use. Natural gas and modern renewable sources of energy have started to gain ground, and the rise of solar photovoltaic (PV), in particular, has been spectacular. India is currently the world's 3rd largest consumer of oil, 3rd largest LPG consumer, 4th largest LNG importer, 4th largest refiner and 4th largest automobile market³. As far as the governance of the energy sector by the central government is concerned, the following figure provides a snapshot.



India's announcement⁴ that it aims to reach net-zero emissions by 2070 and to meet fifty percent of its electricity requirements from renewable energy sources by 2030 is a significant moment for the global fight against climate change. India is pioneering a new model of economic development that could avoid the carbon-intensive approaches.

India is constantly endeavoring towards sustainable and clean energy. In line with the Prime Minister's announcement at COP-26⁵, M/o New and Renewable Energy is working towards achieving 500 GW of Non-Fossil based electricity generation capacity by 2030. India stands 4th globally in Renewable Energy Installed capacity, 4th in Wind Power capacity and 5th in Solar Power capacity (as per the International Renewable Energy Agency – Renewable Capacity Statistics 2024).

¹ <https://www.iea.org/countries/india>

² https://iea.blob.core.windows.net/assets/1de6d91e-e23f-4e02-b1fb-51fdd6283b22/India_Energy_Outlook_2021.pdf

³ <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1992767>

⁴ <https://www.iea.org/commentaries/india-s-clean-energy-transition-is-rapidly-underway-benefiting-the-entire-world>

⁵ <https://pib.gov.in/PressReleasePage.aspx?PRID=1992732>

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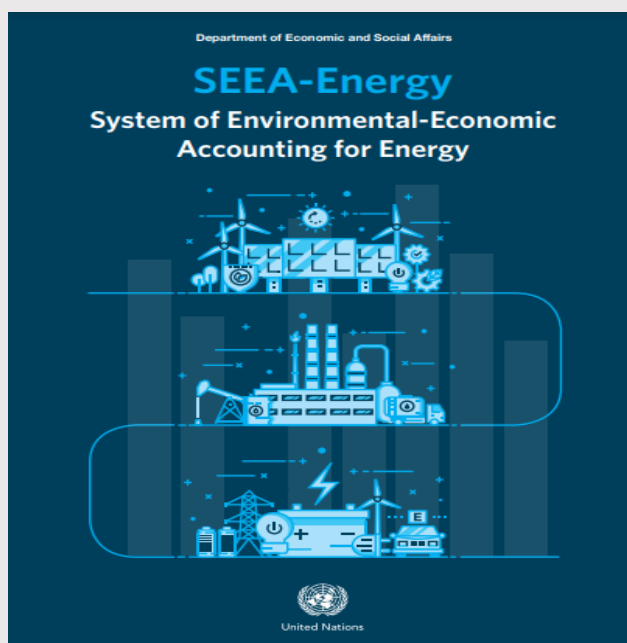
In addition, some of other program/schemes that are also being implemented are:

- i. National Green Hydrogen Mission
- ii. Green Energy Corridor-Inter State Transmission System for 13 GW RE Projects in Ladakh
- iii. Production Linked Incentive (PLI) Scheme for High Efficiency Solar PV Modules
- iv. Offshore Wind Energy, Bioenergy
- v. Solar Parks, Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM), Rooftop Solar etc.

Energy is the most important sector for adaptation as it is responsible for 75-80% of the emissions. India has emerged as a world leader in energy transition. Solar energy contributes to more than 45% in the total renewable energy segment, making it the largest contributor amongst all RE sources (excluding large hydro projects). Installed capacity of solar energy in India has increased by more than 30 times from 2.82 GW in March 2014 to 97.86 GW in December 2024⁶.

9.2 SEEA-Energy

With the enormous potential of India's energy sector, comes a sense of responsibility towards the nation and the globe, at large. Tapping into energy resources while ignoring the environmental concerns will serve good to none. Therefore, the effect of energy supply and use on the environment has emerged as a critical policy issue. Hence, it becomes pertinent to know the proper supply and usage of energy especially in the context of sustainable development. The SEEA-Energy provides the framework for the compilation of the physical and monetary supply and use tables and also for having an idea about the stock of energy available in the country at a particular point of time.



⁶ <https://pib.gov.in/PressReleaselframePage.aspx?PRID=2092429>

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For the purpose of compiling Energy Accounts for the country, the standard framework accepted internationally is the SEEA-Energy Framework. It is entirely consistent with the SEEA Central Framework and follows a similar accounting structure to the System of National Accounts (SNA). By doing so, the SEEA-Energy allows us to develop indicators and conduct analysis on the economy-environment nexus, with a focus on energy.

The System of Environmental Economic Accounting for Energy (SEEA-Energy⁷) is a multipurpose conceptual framework for organizing energy-related statistical information. It supports analysis of both the role of energy within the economy and the relationship between energy-related activities and the environment. At the core of SEEA-Energy is an accounting approach that records the stocks and flows of energy within the territory of reference. The value added of SEEA-Energy lies in its ability to bring a broader and more structured perspective to bear on the already available energy related information. Through their coherence with the SNA, the data in the Energy Accounts can be easily linked with other information collected for national accounts, which allows for a more detailed and policy-relevant analysis of energy information.

The capacity of SEEA-Energy to link energy accounts with economic and other environmental accounts underlines its power. Essential to the formulation of a policy response to an environmental issue such as climate change, which is affected by energy-related emissions of carbon into the air, is understanding both human impacts on the physical environment (through determining, for example, which industry is generating the carbon emissions and the energy products involved and energy needs and possible constraints and solutions (through determining, for example, ongoing energy requirements and what kind of low-carbon energy sources can be utilized). Indicators/statistics generated from SEEA-Energy Accounts can also enhance the understanding of issues related to the effects of using economic instruments (such as tradable carbon emission permits) on both the economy and the environment. Those effects may include impacts on energy prices, household spending and business profitability and, crucially, on emissions of carbon generated by domestic producers and as embodied in imports.

SEEA-Energy has a close relationship with IRES (International Recommendation on Energy Statistics)⁷, which contributes valuable inputs into the production of the tables and accounts of SEEA-Energy. In particular, IRES supports the use of the harmonized definitions of energy products in accordance with the Standard International Energy Product Classification (SIEC)⁸ and offer guidance regarding data sources and data compilation.

⁷ <https://unstats.un.org/unsd/energystats/methodology/documents/IRES-web.pdf>

⁸ <https://unstats.un.org/unsd/classifications/Family/Detail/2007>

Chapter 9: Energy Accounts

The Energy Accounts, as described in SEEA, comprise three types of accounts, namely: Asset Accounts, Physical Supply and Use Tables (PSUT) and Monetary Supply and Use Tables (MSUT).

9.2.1 Asset Accounts for Energy

The purpose of an asset account is to record the opening and closing stock of the assets and the various types of changes in stock over an accounting period. The asset accounts in SEEA-Energy are compiled only for minerals and energy resources. These accounts provide valuable information to assess the fact whether the current patterns of economic activity are depleting and/or degrading the available mineral and energy resources. In addition, the information on the asset accounts can help in the management of mineral and energy resources.

Mineral and energy resources within SEEA-Energy include known deposits of oil resources, natural gas resources, coal and peat resources, and uranium and thorium resources, including those with no current economic value. These resources are defined more broadly than in the SNA 2008, which includes only those inputs that meet the definition of an economic asset. In the SEEA Central Framework, mineral and energy resources include known deposits of oil resources, natural gas resources, coal and peat resources, non-metallic minerals and metallic minerals. In SEEA-Energy, mineral and energy resources are restricted to those resources that can become energy products.

Known deposits of minerals and energy resources are categorized into three classes, based on criteria from the United Nations Framework Classification (UNFC) 2009⁹:

- (a) **Class A:** Commercially Recoverable Resources which includes on-production projects, projects approved for development and projects justified for development;
- (b) **Class B:** Potentially Commercially Recoverable Resources which includes economic and marginal development projects pending and development projects on hold; and
- (c) **Class C:** Non-Commercial and other known deposits which includes unclarified development projects, non-viable development projects, additional quantities in place.

The basic form of the Asset Account is shown in Figure 9.1. It begins with the opening stock of resources and ends with the closing stock of resources. In physical terms, the changes between the beginning and the end of the accounting period are recorded either as additions to or as reductions in the stock. Wherever possible, the nature of the addition or reduction is recorded.

⁹ https://unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/unfc2009/UNFC2009_ES39_e.pdf

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Fig 9.1: Basic Form of an Asset Account

Basic Form of Asset Account
Opening stock of resources
Additions to the stock of resources
Growth in stock
Discoveries of new stock
Upward reappraisals
Reclassifications
<i>Total additions to stock</i>
Reductions in the stock of resources
Extractions
Normal loss of stock
Catastrophic losses
Downward reappraisals
Reclassifications
<i>Total reductions in stock</i>
Revaluation of the stock of resources*
Closing stock of resources

*Applicable only for Asset Accounts in monetary terms. Source: SEEA-Energy

According to SEEA-Energy, there are three types of additions to the stock of the Energy Assets:

- **Discoveries:** Discoveries should incorporate estimates of the quantity of new deposits found during an accounting period. To be regarded as a discovery, the new deposit must be a known deposit – i.e., in Class A, B or C. In situations, in which a quantity of potential deposits becomes known to a higher degree of confidence, this increase should be treated as discoveries. Discoveries should be recorded by type of resource and by category of resource.
- **Upward reappraisals:** Reappraisals should only pertain to known deposits. They will relate to additions in the estimated available stock of a specific deposit, or to changes in the categorization of specific deposits between Class A, B or C based on changes in geological information, technology, resource price or a combination of these factors.
- **Reclassifications:** Reclassifications may occur if certain deposits are opened or closed to mining operations due to a government decision concerning the access rights to a deposit. All other changes in the quantity of known deposits should be treated as

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reappraisals. Reclassifications may conceivably be recorded if asset accounts for energy resources are being compiled by institutional sector.

There are four types of reductions in the stock of energy assets:

- **Extraction:** Estimates of extraction should reflect the quantity of the resource physically removed from the deposit. It should exclude mining overburden, i.e., the quantity of soil and other material moved in order to extract the resource. The quantity should also be estimated before any refinement or processing of the resource is undertaken. Estimates of extraction should include estimates of illegal extraction, either by residents or non-residents, as these amounts reduce the availability of the resource.
- **Catastrophic losses:** Catastrophic losses are rare for most energy resources. While flooding and collapsing of mines do occur, the deposits continue to exist and can, in principle, be recovered. The issue in this case is one of economic viability of extraction rather than of actual loss of the resource itself. An exception to this general principle concerns oil wells that can be destroyed by fire or become unstable for other reasons, resulting in significant losses of oil resources. Losses of oil and related resources in this situation should be treated as catastrophic losses.
- **Downward reappraisals:** Reappraisals should only pertain to known deposits. They will relate to reductions in the estimated available stock of a specific deposit, or to changes in the categorization of specific deposits between Class A, B or C based on changes in geological information, technology, resource price or a combination of these factors; and
- **Reclassifications:** Reclassifications may occur if certain deposits are opened or closed to mining operations due to a government decision concerning the access rights to a deposit. All other changes in the quantity of known deposits should be treated as reappraisals. Reclassifications may conceivably be recorded if asset accounts for energy resources are being compiled by institutional sector.

Monetary asset accounts for mineral and energy resources provide a market-based valuation of the physical stock of mineral and energy resources and the changes in the value of these stocks over time. The same entries are made in monetary terms, although an additional entry recording revaluations of resource stocks is included. This entry accounts for changes in the value of assets over an accounting period due to movements in the price of the resources.

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9.2.2 Physical Supply and Use Tables (PSUT)

SEEA-Energy records the physical flows, measured in physical units of energy content, through the compilation of Supply and Use tables. These tables are used to assess how an economy supplies and uses energy products, as well as to examine the changes in production and consumption patterns over time. These tables help in the presentation of how energy flows into the economy, how they are used within, and how they leave a country's national economy for a given period of time. The PSUT are expressed in a common energy unit such as joules and expresses the relationship between inputs to and outputs from energy transformation processes. The general structure of the PSUT is shown in the Figure 9.2.

Fig 9.2: Basic Form of a Physical Supply and Use Table for Energy

Basic form of a physical supply and use table for energy (joules)						
Supply table						
	Industries	Households	Accumulation	Rest of the world	Environment	Total
Energy from natural inputs					A. Energy inputs from the environment	Total supply of energy from natural inputs
Energy products	C. Output			D. Imports		Total supply of energy products
Energy residuals	I. Energy residuals generated by industry	J. Energy residuals generated by household consumption	K. Energy residuals from accumulation	L. Energy residuals received from the rest of the world	M. Energy residuals recovered from the environment	Total supply of energy residuals

Use table						
	Industries	Households	Accumulation	Rest of the world	Environment	Total
Energy from natural inputs	B. Extraction of energy from natural inputs					Total use of energy from natural inputs
Energy products	E. Intermediate Consumption	F. Household Consumption	G. Change in inventories	H. Exports		Total use of energy products
Energy residuals	N. Collection and treatment of energy residuals		O. Accumulation of energy residuals	P. Energy residuals sent to the rest of the world	Q. Energy residual flows direct to environment	Total use of energy residuals

Note: Dark grey cells are null by definition.

Source: SEEA-Energy

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9.2.3 Monetary Supply and Use Tables (MSUT)

MSUT fully articulates, in monetary terms, the flows of energy products in an economy between different economic units. MSUT for energy provides information on the energy sector and the level of activity in this sector. They also provide detailed information on the industries within the economy that are using these energy products. Monetary supply and use tables for energy can readily be linked with PSUT for energy to create a powerful analytical tool.

Monetary supply and use tables have their roots in economic accounting and utilize the same organizational principles and display the same characteristics as physical supply and use tables. Nevertheless, while the physical supply and use table for energy contains three main types of flows, namely, energy from natural inputs, energy products and energy residuals, the monetary supply and use table for energy records only those flows related to energy products.

Fig 9.3: Basic Form of a Monetary Supply and Use Table for Energy

	Industries	Households	Government	Accumulation	Rest of the world	Total
Supply Table						
Products	Output				Imports	Total Supply
Use table						
Products	Immediate consumption	Household final consumption expenditure	Government final consumption expenditure	Gross capital formation (including changes in inventories)	Exports	Total Use
Value added						

Note: Dark Grey cells are null by definition

9.3 Physical Asset Accounts for Energy for India

The Asset Accounts for the year 2023-24 (P) is provided in Table 9.1. The Opening Stock (Inventory) data as given in the Coal Directory differs from what has been computed in the Asset Accounts. The reason for this is the deduction of the extraction and sterilization loss in the Asset Accounts which is not considered in the geological resources by the GSI.

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Table 9.1: Physical Asset Accounts for Energy: 2023-24(P)

	Types of Energy Resource			
	Coal (Proved Category)	Lignite (Proved Category)	Crude Oil (2P Reserve)	Natural Gas (2P Reserve)
	Million tonnes	Million tonnes	Million BBL	MMSCM
Opening stock of mineral and energy resources (Closing for last FY)	110,776	2,138	3,295	650,626
Additions in stock:				
Discoveries	12,303	453	104	35,600
Upward appraisals				
TOTAL ADDITION TO THE STOCK	12,303	453	104	35,600
Reduction in Stock:				
Extraction	998	41	215	36,438
Sterilization Loss	3,693	142		
Downwards reappraisals			0	6,387
TOTAL REDUCTION IN STOCK	4,691	183	216	42,825
Closing Stock of mineral and energy resources	118,388	2,408	3,183	643,401
<i>Source: Geological Survey of India, Ministry of Petroleum and Natural Gas</i>				
<i>Sterilization Loss for Coal = Extraction*3.7</i>				
<i>Sterilization Loss for Lignite = Extraction*3.46</i>				
<i>2P is the sum of proved and probable reserves.</i>				

9.4 Physical Supply and Use Table for Energy

'Physical Supply and Use Tables for Energy' aims at comprehensiveness that entails recording all energy flows both within the economy, between the economy and the environment. These accounts along with the Asset accounts, provide necessary granular level information to help identifying the policy concern areas.

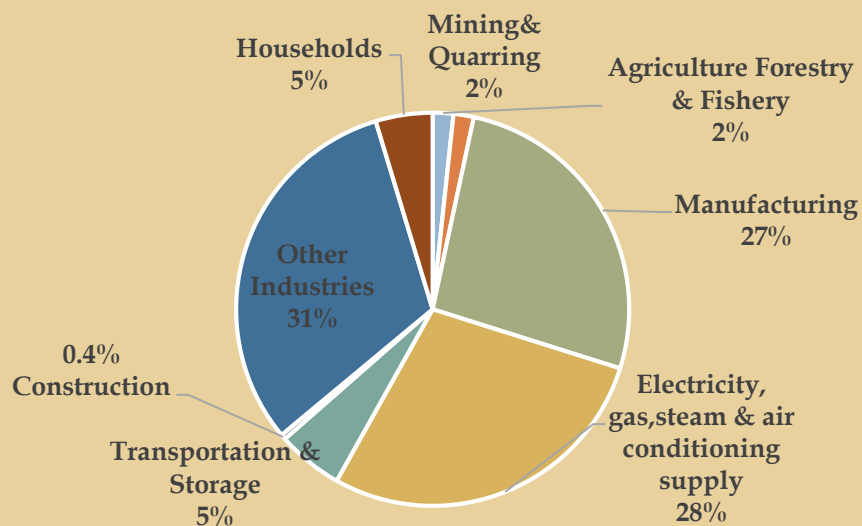
In the chapter, the PSUT for Energy has been compiled following the structure of SEEA-Energy. Following accounting identities have been adhered to while compiling the PSUT for Energy.

- (i) **Total Supply of Energy from Natural Inputs = Total Use of Energy from Natural Inputs**
- (ii) **Total Supply of Energy Products = Total Use of Energy Products (Transformation + End Use)**
- (iii) **Total Supply of Energy Residuals = Total Use of Energy Residual**

The PSUT for energy for the year 2023-24(P) has been presented in **Tables 9.3 (A)** and **9.3 (B)**. The Energy Accounts compiled in the current publication is at a preliminary stage and has scope for further improvement with the availability of granular information from the source agencies, especially NIC-wise disaggregated data, data on residuals and losses, data on the accumulations, etc.

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Fig 9.4: Industry-wise use (Transformation and End Use) of Energy for 2023-24 (P)



Based on the available data, **Figure 9.4** shows the industry-wise use of energy for the year 2023-24 (P). The highest share of use can be seen in the other industries, Manufacturing and the Electricity sector for the year 2023-24 (P).

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Table 9.2 (A) Physical Supply Table for Energy for the year 2022-23

PHYSICAL SUPPLY TABLE (Unit:PJ)	Production (Incl. household own account) & generaion of residuals										
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining & Quarring	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries		Accumulation	Flows from the rest of the world (Imports)	Flows from the Environment	Total
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Energy from natural inputs:											
Natural resource inputs											
Coal										15064	15064
Lignite										420	420
Crude Oil										1249	1249
Natural Gas										1334	1334
Nuclear										500	500
Inputs from RES										764	764
Hydro										585	585
Total										19916	19916
Energy Products:											
<i>Production of energy products by SIEC class:</i>											
Coal		15064							5290		20354
Lignite		420							0		421
Crude Oil		1249							9957		11206
Oil Products			11387						1872		13258
Natural Gas		1334							1019		2353
Electricity				6589					28		6616
Total	0	18067	11387	6589	0	0			18165		54207
Energy Residuals:											
Distribution		1118		978							2096
Extraction											0
Other Losses (Coal Reject/other residuals)											0
Other Energy Residuals	901	745	3199	336	2721	15966	2486				26354
Total energy residuals	901	1864	3199	1314	2721	15966	2486				28450
Other Residual Flows:											
Residuals from end-use for non-energy purposes											0
Energy from solid waste											
TOTAL SUPPLY	901	19931	14586	7903	2721	15966	2486		18165	19916	102574

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Table 9.2 (B) Physical Use Table for Energy for the year 2022-23

PHYSICAL USE TABLE (Unit:PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical diff	Flows to the Environment	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining & Quarring	Manufacturing	Electricity, gas, steam & air conditioning supply (ISIC D)	Transportation & Storage	Construction	Other Industries						
(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)									
Energy from natural inputs:													
Natural resource inputs													
Coal		15064											15064
Lignite		420											420
Crude Oil		1249											1249
Natural Gas		1334											1334
Nuclear				500									500
Inputs from RES				764									764
Hydro				585									585
Total	0	18067	0	1849	0		0						19916
Energy Products:													
Transformation of energy products by SIEC class													
Coal				13304									13304
Lignite				372									372
Crude Oil			10921										10921
Oil Products				37									37
Natural Gas				316									316
Electricity													0
Total Transformed Energy	0	0	10921	14029	0		0						24950
End-use of energy products by SIEC class:													
Coal	0	0	1744		0	206	5265	0	-272	33	73		7050
Lignite	0	0	27		0	14	34	0	17	3	-47		49
Crude Oil							1114				-830		284
Oil Products	17	50	563		2079	16	5570	1214		2665	1047		13221
Natural Gas	6	695	864		534	0	75	0		0	-138		2037
Electricity	878	0	0	336	108	0	3906	1272		50	66		6616
Total End Use for Energy purpose	901	745	3199	336	2721	236	15966	2486	-255	2751	171		29257
End-use of energy products for non-energy purposes													
0													
Energy Residuals:													
Distribution												2096	2096
Extraction												0	0
Other Losses (Coal Reject/other residuals)												0	0
Other Energy Residuals												26354	26354
Total energy residuals												28450	28450
Other Residual Flows:													
Residuals from end-use for non-energy purposes									0				0
Energy from solid waste													0
TOTAL USE	901	18812	14120	16215	2721	236	15966	2486	-255	2751	171	28450	102574

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Table 9.3 (A) Physical Supply Table for Energy for the year 2023-24 (P)

PHYSICAL SUPPLY TABLE (Unit:PJ)	Production (Incl. household own account) & generaion of residuals										
						Households	Accumulation	Flows from the rest of the world (Imports)	Flows from the Environment	Total	
	Industries (by ISIC)										
	Agriculture Forestry & Fishery	Mining & Quarring	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage						Other Industries
(ISICA)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)							
Energy from natural inputs:											
Natural resource inputs											
Coal									16906	16906	
Lignite									410	410	
Crude Oil									1256	1256	
Natural Gas									1411	1411	
Nuclear									523	523	
Inputs from RES									849	849	
Hydro									484	484	
Total									21840	21840	
Energy Products:											
<i>Production of energy products by SIEC class:</i>											
Coal		16906						5930		22836	
Lignite		410						0		410	
Crude Oil		1256						10024		11280	
Oil Products			11810					2018		13828	
Natural Gas		1411						1231		2643	
Electricity				7018				24		7041	
Total	0	19983	11810	7018	0	0		19228		58039	
Energy Residuals:											
Distribution		1145		1013						2158	
Extraction										0	
Other Losses (Coal Reject/other residuals)										0	
Other Energy Residuals	945	928	3547	360	3012	17443	2603			28838	
Total energy residuals	945	2073	3547	1373	3012	17443	2603			30995	
Other Residual Flows:											
Residuals from end-use for non-energy purposes										0	
Energy from solid waste											
TOTAL SUPPLY	945	22056	15357	8391	3012	17443	2603	19228	21840	110874	

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Table 9.3 (B) Physical Use Table for Energy for the year 2023-24 (P)

PHYSICAL USE TABLE (Unit:PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses						Final Consumption Households	Accumulation	Export	Statistical diff	Flows to the Environment	Total	
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioni	Transportation & Storage	Construction							Other Industries
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from natural inputs:													
<i>Natural resource inputs</i>													
Coal		16906										16906	
Lignite		410										410	
Crude Oil		1256										1256	
Natural Gas		1411										1411	
Nuclear				523								523	
Inputs from RES				849								849	
Hydro				484								484	
Total	0	19983	0	1856	0	0						21840	
Energy Products:													
<i>Transformaton of energy products by SIEC class</i>													
Coal				14635								14635	
Lignite				341								341	
Crude Oil			11191									11191	
Oil Products				30								30	
Natural Gas				352								352	
Electricity												0	
Total Transformed Energy	0	0	11191	15357	0	0						26548	
<i>End-use of energy products by SIEC class:</i>													
Coal	0	0	2004		0	206	6203	0	-431	44	176	8202	
Lignite	0	0	20		0	5	41	0	-3	0	6	69	
Crude Oil							1140				-1052	89	
Oil Products	21	63	559		2296	24	5777	1253		2735	1070	13798	
Natural Gas	5	865	964		597	0	100	0		0	-240	2291	
Electricity	918	0	0	360	119	0	4182	1350		41	71	7041	
Total End Use for Energy purpose	945	928	3547	360	3012	236	17443	2603	-434	2820	31	31490	
<i>End-use of energy products for non-energy purposes</i>													
Energy Residuals:													
Distribution												2158	2158
Extraction												0	0
Other Losses (Coal Reject/other residuals)												0	0
Other Energy Residuals												28838	28838
Total energy residuals												30995	30995
Other Residual Flows:													
Residuals from end-use for non-energy purposes									0				0
Energy from solid waste													0
TOTAL USE	945	20911	14738	17574	3012	236	17443	2603	-434	2820	31	30995	110874