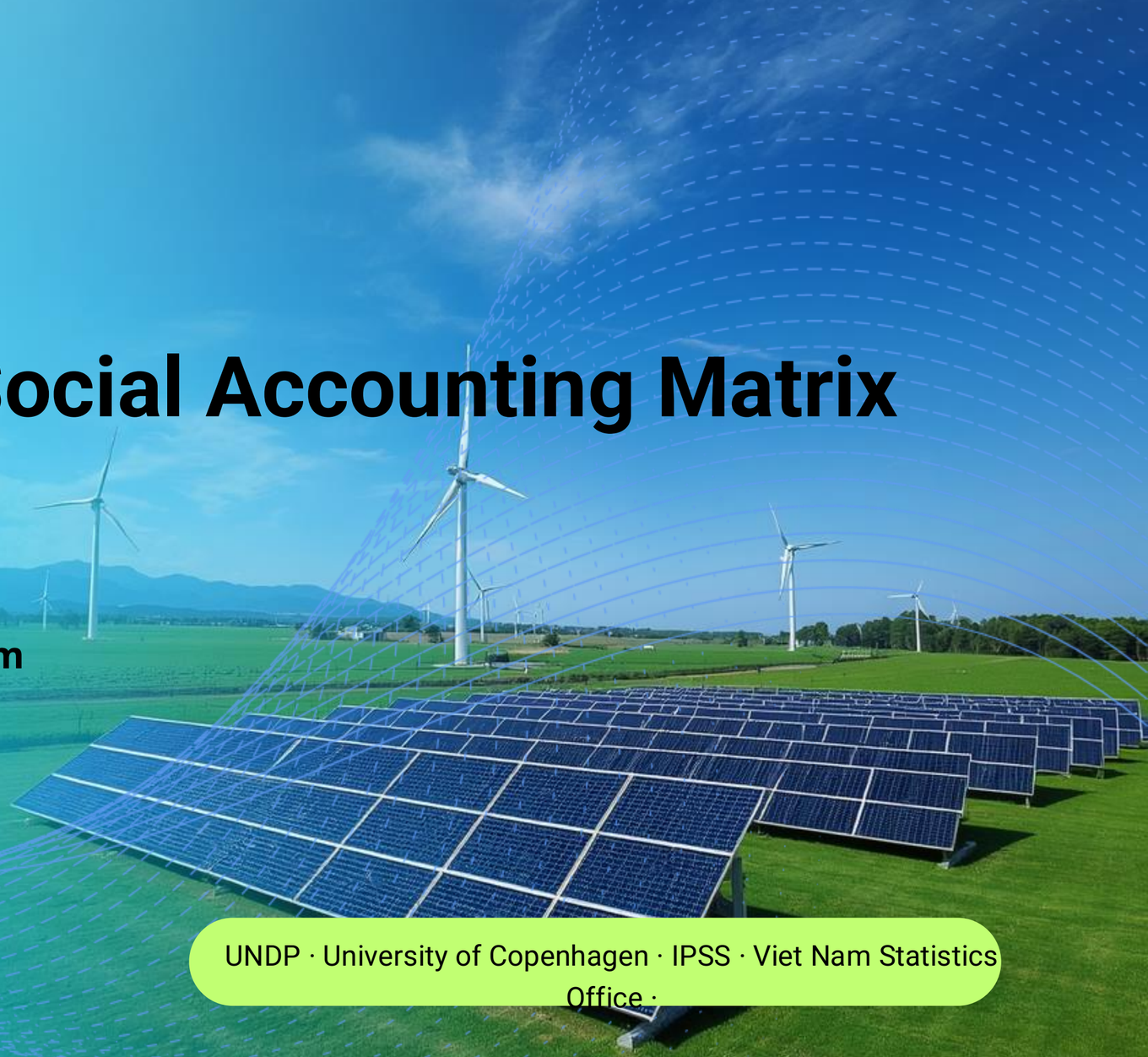
IPSS & UNDP Conference

Building the Energy Social Accounting Matrix (ESAM) for Viet Nam

Dr. Dang Thi Thu Hoai & IPSS Research Team



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Outline

1. Overview of the ESAM project
2. Introduction to data & model outputs
3. Energy–economy patterns from data and multiplier analysis
4. Potential applications for policy analysis



- Result 1: Energy imports vs renewable electricity
- Result 2: Electricity saving and emission reduction
- Results 3–4: Cross-subsidies & impacts of elec price increases
- Potential applications of data and models

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1- Overview

Viet Nam ESAM Project

ESAM (Energy Social Accounting Matrix) is an integrated data tool that extends the traditional SAM with energy and greenhouse-gas emission accounts — supporting analysis of just energy transition policies in Viet Nam.
The project develops the 2019 ESAM dataset and builds SAM multiplier and CGE models to support national energy policy making.

Partners: UNDP • University of Copenhagen • IPSS • Viet Nam Statistics Office
Period: 2024–2026.
Scope: National — Base year 2019

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Projects Objectives

The Viet Nam ESAM project aims to build a comprehensive data and analytical modelling platform to support policy making for a just energy transition and sustainable development in Viet Nam.

Build the 2019 ESAM

Develop the 2019 Energy Social Accounting Matrix (ESAM) for Viet Nam, integrating economic, social and energy data.

Support energy policy analysis

Provide tools to analyse the impacts of just energy transition policies on growth, labour and emissions.

Develop SAM multiplier & CGE models

Develop SAM multiplier and CGE models based on Viet Nam’s 2019 economic structure.

Promote sustainable development

Support Viet Nam in achieving sustainable development goals, reducing greenhouse-gas emissions and ensuring equity in the energy transition.

Partners & Roles



01	**UNDP** **United Nations Development Programme**	Fund and coordinate the overall ESAM project.
02	**University of Copenhagen** **International academic partner**	Support ESAM construction and the development of multiplier and CGE models; provide inputs on data and model use and analysis.
03	**IPSS** **Institute for Policy and Strategy Studies**	Lead emission-account construction, coordinate development of the 2019 Viet Nam ESAM, and conduct policy analysis using the models.
04	**Viet Nam Statistics Office**	Provide SUT data and national energy accounts; coordinate validation and standardisation of ESAM data.

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Project Outputs

The Viet Nam ESAM project produces four core output groups to support energy policy making and just energy transition research in Viet Nam.

2019 ESAM dataset & emission accounts

A fully integrated 2019 Energy Social Accounting Matrix for Viet Nam, including sector, household, energy and GHG emission accounts from energy use.

SAM multiplier & CGE models

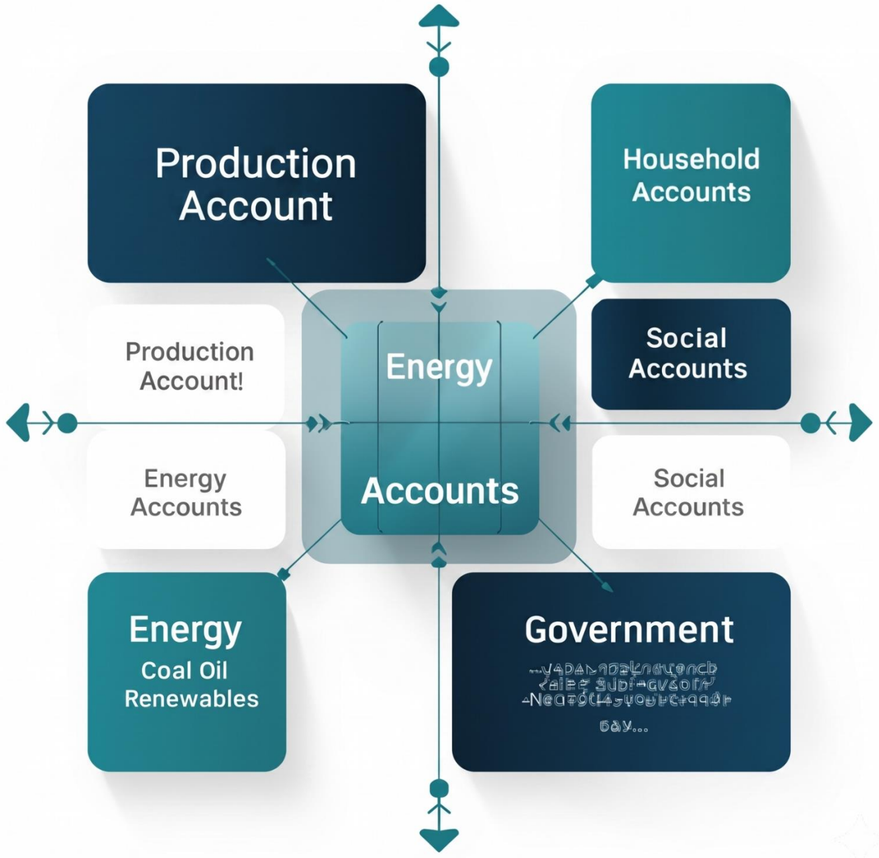
SAM multiplier and static CGE models calibrated to Viet Nam data to support policy scenario simulations.

Technical report

Technical report detailing the methodology, ESAM construction process, energy accounts and emission accounts.

Policy analysis report

Policy analysis report applying ESAM multiplier and CGE models.



2- Products ESAM

ESAM (Energy Social Accounting Matrix) is an extended version of the traditional SAM, integrating energy and greenhouse-gas emission data into the socio-economic accounting framework.

Main accounts: Production sectors, households, government, rest of the world, energy (electricity, coal, oil and gas, renewables), and GHG emissions from energy use.

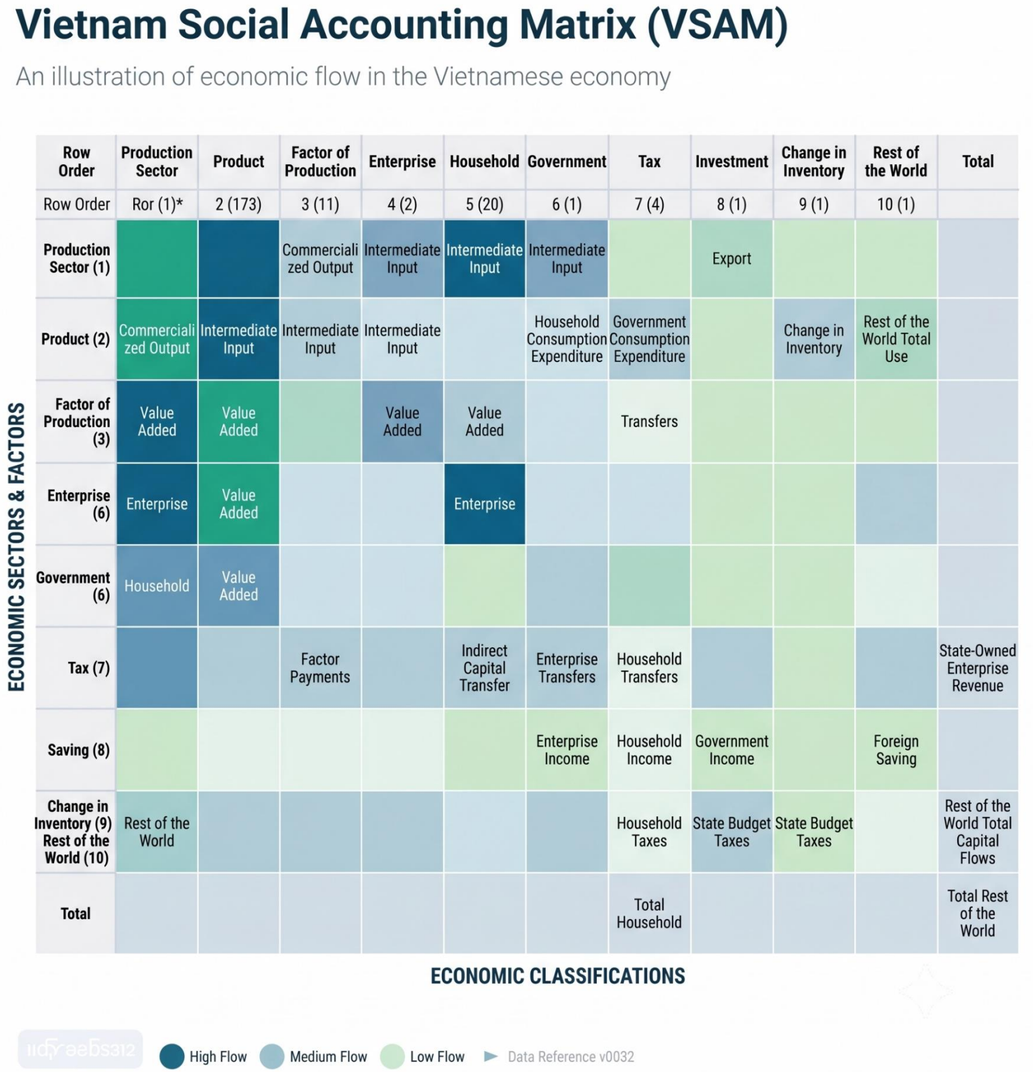
The traditional SAM records monetary flows among economic agents. ESAM adds energy and environmental dimensions, supporting analysis of just energy transition policies.

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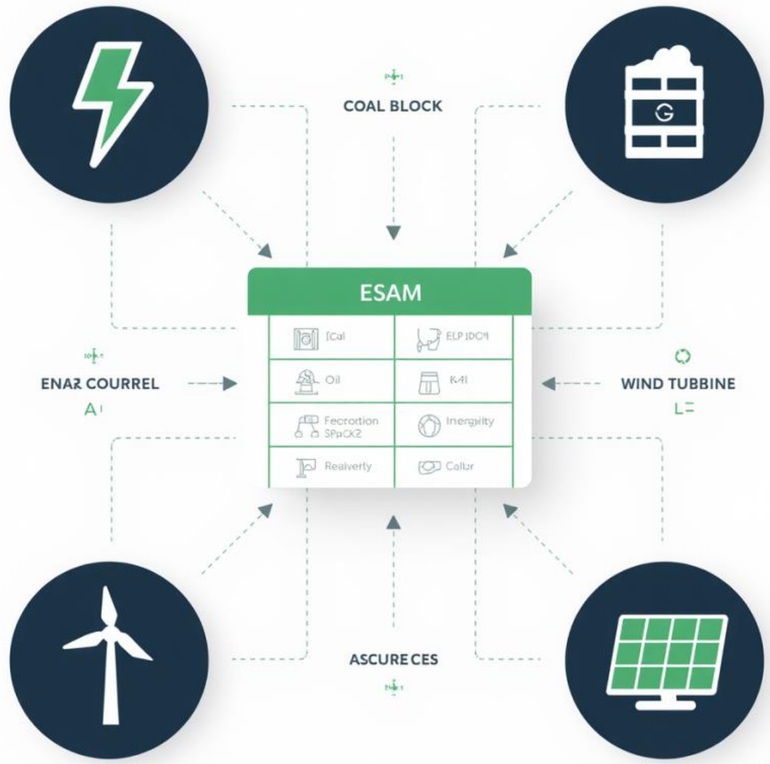
Structure

Viet Nam ESAM 2019

The 2019 ESAM includes the main accounts: 178 economic activities, 173 commodities, 5 energy types (coal, crude oil, oil and gas, petroleum products, electricity: hydro, coal-fired, gas-fired, wind, solar and other electricity), 20 household groups classified by income, location and occupation, government, and the rest of the world.



Row Order	Production Sector	Product	Factor of Production	Enterprise	Household	Government	Tax	Investment	Change in Inventory	Rest of the World	Total
Row Order	Ror (1)*	2 (173)	3 (11)	4 (2)	5 (20)	6 (1)	7 (4)	8 (1)	9 (1)	10 (1)	
Production Sector (1)			Commercialized Output	Intermediate Input	Intermediate Input	Intermediate Input		Export			
Product (2)	Commercialized Output	Intermediate Input	Intermediate Input	Intermediate Input		Household Consumption Expenditure	Government Consumption Expenditure		Change in Inventory	Rest of the World Total Use	
Factor of Production (3)	Value Added	Value Added		Value Added	Value Added		Transfers				
Enterprise (6)	Enterprise	Value Added			Enterprise						
Government (6)	Household	Value Added									
Tax (7)			Factor Payments		Indirect Capital Transfer	Enterprise Transfers	Household Transfers				State-Owned Enterprise Revenue
Saving (8)						Enterprise Income	Household Income	Government Income		Foreign Saving	
Change in Inventory (9) Rest of the World (10)	Rest of the World						Household Taxes	State Budget Taxes	State Budget Taxes		Rest of the World Total Capital Flows
Total							Total Household				Total Rest of the World



Data linkage

Energy in ESAM

Energy data (physical unit: TJ) are integrated from the energy accounts for 46 energy-using sectors that can be linked to the 178 ESAM sectors:

⚡ Electricity: Production, transmission and sectoral consumption

🔲 Coal: Extraction, imports and sectoral consumption

🛢 Oil and gas: Output and sectoral consumption

🌿 Renewable energy: Wind, solar and hydropower

GHG emission accounts from energy consumption

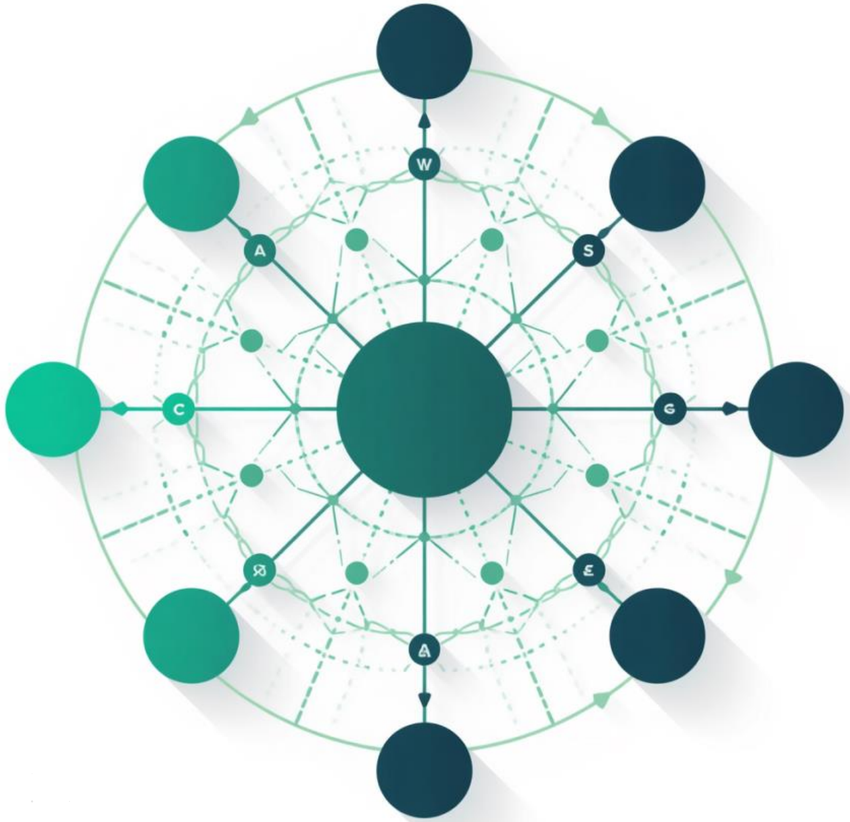
The GHG emission accounts in ESAM are constructed from energy consumption by 46 economic sectors in the energy accounts. The greenhouse gases calculated include CO_2, CH_4 and N_2O — using emission factors under Decision 2626/QD-BTNMT and IPCC guidelines.
This method directly links economic activity with environmental impacts within a single matrix framework.



Khu vực sử dụng năng lượng / Sản phẩm năng lượng	Ngành kinh tế (46)	Hộ gia đình (2)	Chênh lệch tồn kho (1)	Xuất khẩu (1)	TỔNG
Than cứng (1)					
Than non (1)					
Than cốc, than bán cốc, muội bình chưng than đá (1)					
Khí tự nhiên dạng khí hoặc hóa lỏng (2)					
Dầu mỏ thô (1)					
LPG (1)					
Xăng các loại (2)					
Nhiên liệu phản lực (1)					
Dầu hỏa (1)					
Dầu Diesel (2)					
Dầu nhiên liệu (2)					
Dầu nhờn (2)					
Nhựa đường (2)					
Dầu khác (2)					
Nhiên liệu sinh học rắn (1)					
Nhiên liệu sinh học lỏng (1)					
Khí sinh học (1)					
Rác thải (1)					
Điện (9)					
Nhiệt (1)					
TỔNG					

Structure of energy emission accounts

Energy emission accounts in ESAM are disaggregated by 46 economic sectors and 20 energy types. The relationship between energy consumption and CO_2 emissions helps identify high-emitting sectors.



ESAM multiplier model

How it works

The SAM multiplier model measures the economy-wide spillover impact of an exogenous shock through the social accounting matrix. When a sector increases exports, the impact is amplified through rounds of inter-industry production, income and consumption.

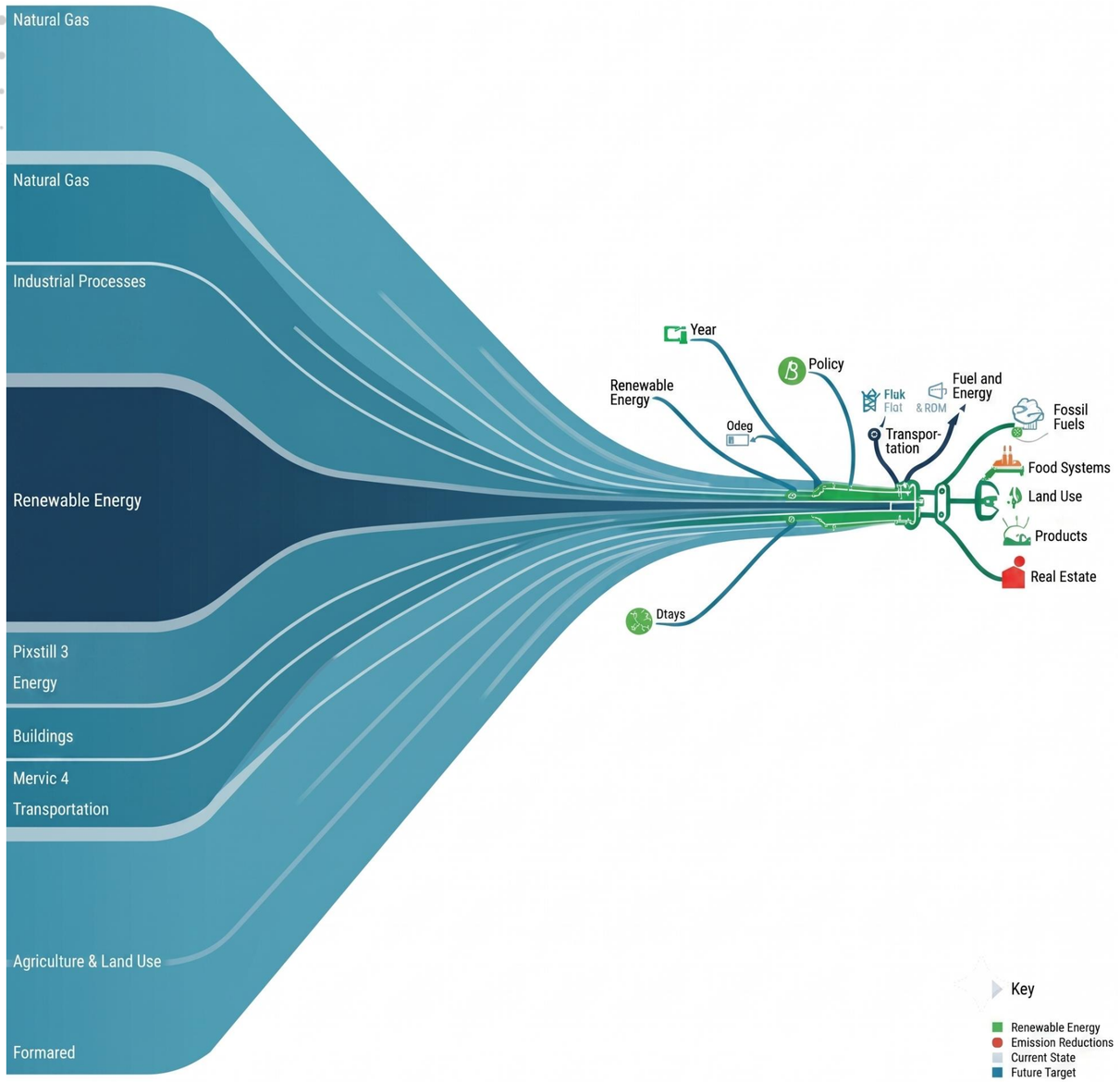
Example: A one-unit increase in renewable-electricity exports → higher output in related sectors → higher labour income → higher household consumption. The overall multiplier reflects the degree of interdependence in the economic structure.

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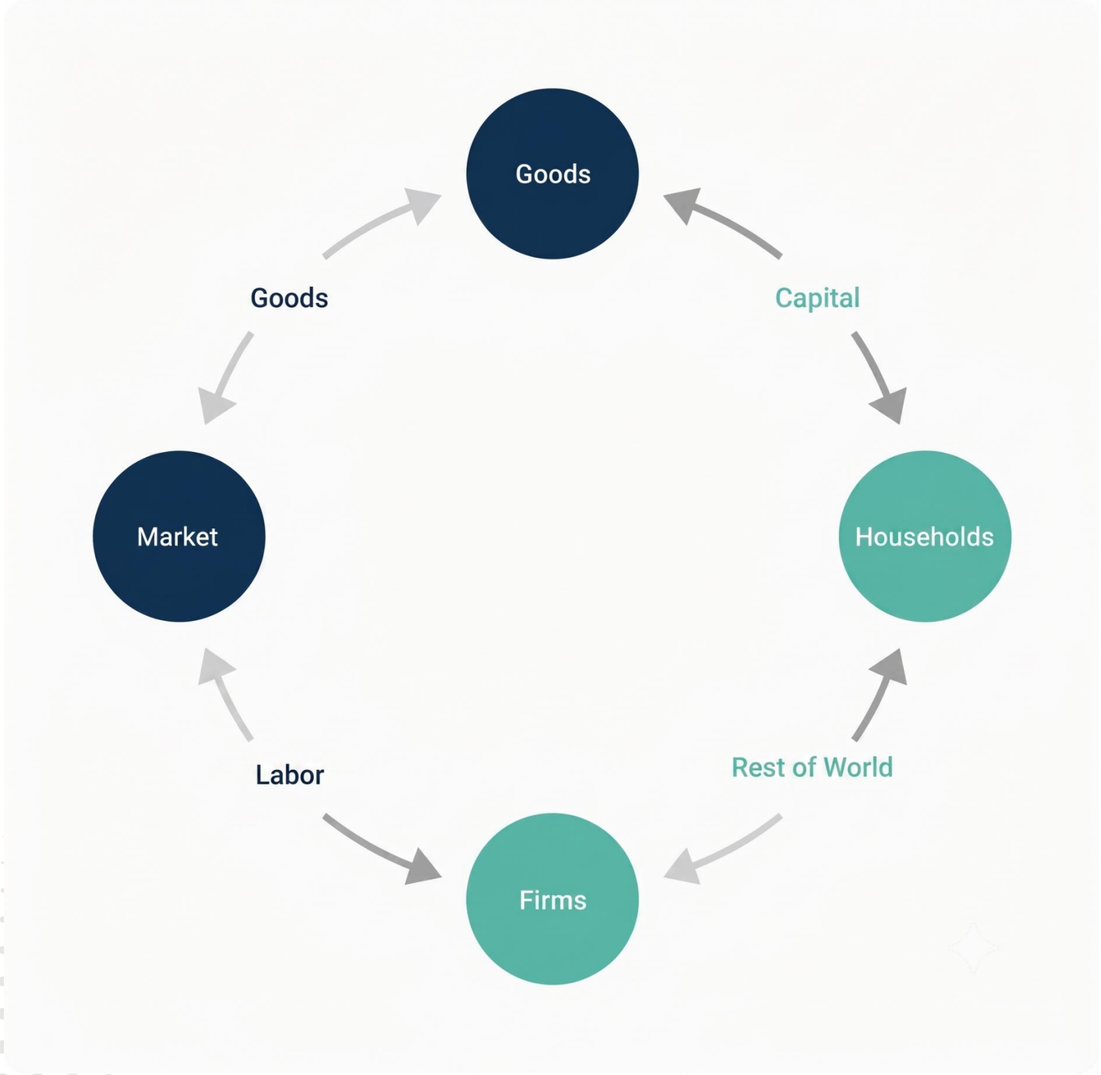
Applications

SAM multiplier model

- Analyse economy-wide impacts of energy policies
- Assess spillover effects of energy sectors on income and labour
- Simulate electricity price increases and renewable energy transition scenarios



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CGE model

The Computable General Equilibrium (CGE) model simulates the whole economy through a system of simultaneous market-clearing equations. Unlike the ESAM multiplier model, CGE allows both prices and quantities to change endogenously, reflecting the behavioural responses of economic agents.

► Markets: goods, labour, capital and energy
► Agents: households, firms, government and the rest of the world
► Mechanism: prices adjust to a Walrasian equilibrium

CGE captures substitution effects and income redistribution that a linear SAM multiplier cannot — especially important for analysing energy transition policies.

The CGE model imports data and exports results through Excel, and runs on GAMS software.

OnLine Course Model

Rob Davies, Dirk van Seventer, Karl Pauw and James Thurlow

Version: Static 1.06 beta

Model Workbook

Worksheet	Comments
Notes	General notes on the model
Index	Information for GAMS where to find CGE model input data in this workbook
Sets	Information for GAMS on the sets used by the CGE model (sector codes, commodity codes etc…)
SAM	SAM used by the CGE model
Demand	Demand elasticities with respect to household income used by the CGE model
Elasticities	Substitution elasticities for production functions and other functional forms in the CGE model
Employment	Employment and capital stock data preparations used by the CGE model
FNest2	Production function nestings 2

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Strengths of SAM multiplier

Simple, transparent and easy to compute. Captures direct inter-sectoral spillovers. Suitable for short-term analysis and quick data checks.

Strengths of CGE

Simulates general equilibrium mechanisms. Reflects optimising behaviour by households, firms and government. Suitable for long-term policy analysis.

Limitations of SAM multiplier

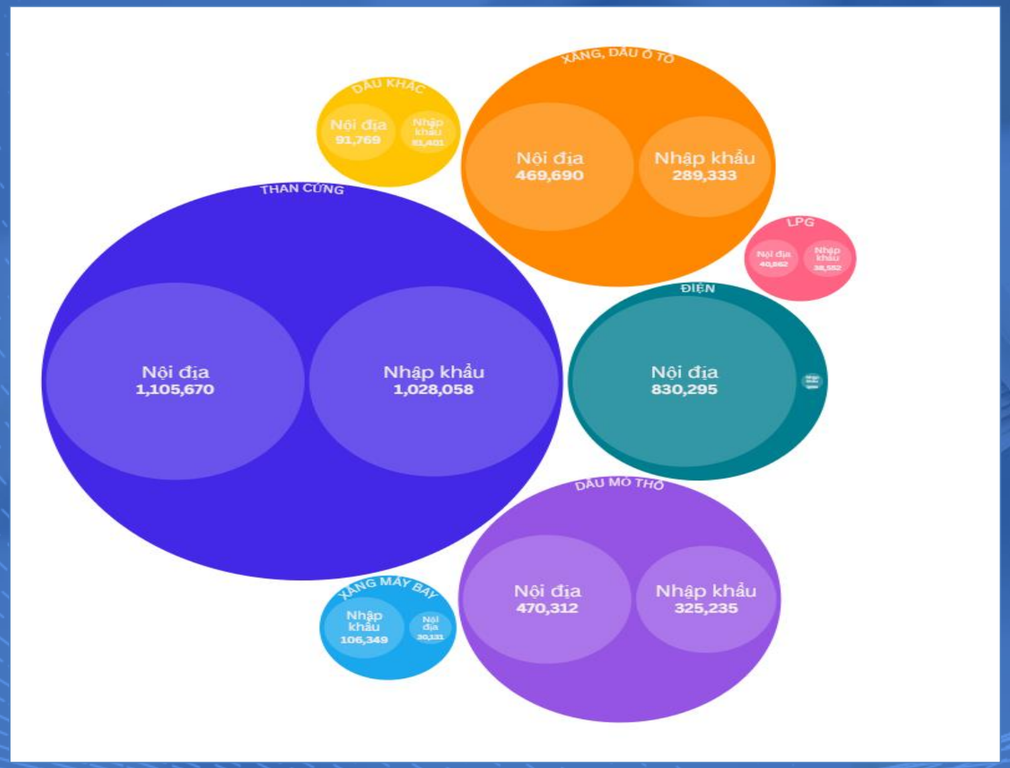
Assumes fixed prices and does not reflect market mechanisms. Cannot simulate behavioural responses of economic agents to policy changes.

Limitations of CGE

Technically complex, requiring detailed data and strong calibration skills. Results are sensitive to parameter assumptions and model structure.

Comparison SAM and CGE

The SAM multiplier and CGE models play complementary roles in analysing energy policy and sustainable structural transformation in Viet Nam.



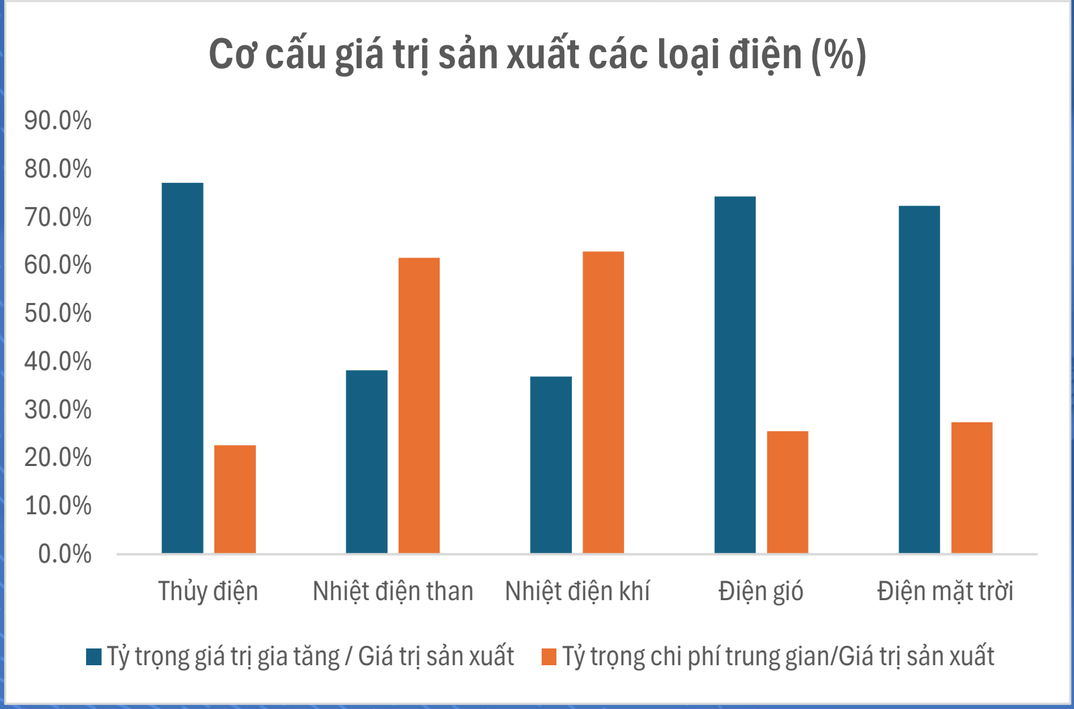
3- Results: (1) Energy imports

Viet Nam is significantly dependent on energy imports, especially coal and oil and gas. The 2019 ESAM analysis shows that high energy import dependence can create energy security risks and production-cost volatility, directly affecting economic competitiveness.

- **Imported coal: ~48% of total consumption**
- **Crude oil: ~41% of demand**
- **High price and energy-security risks**
- **Prioritise domestic energy development**

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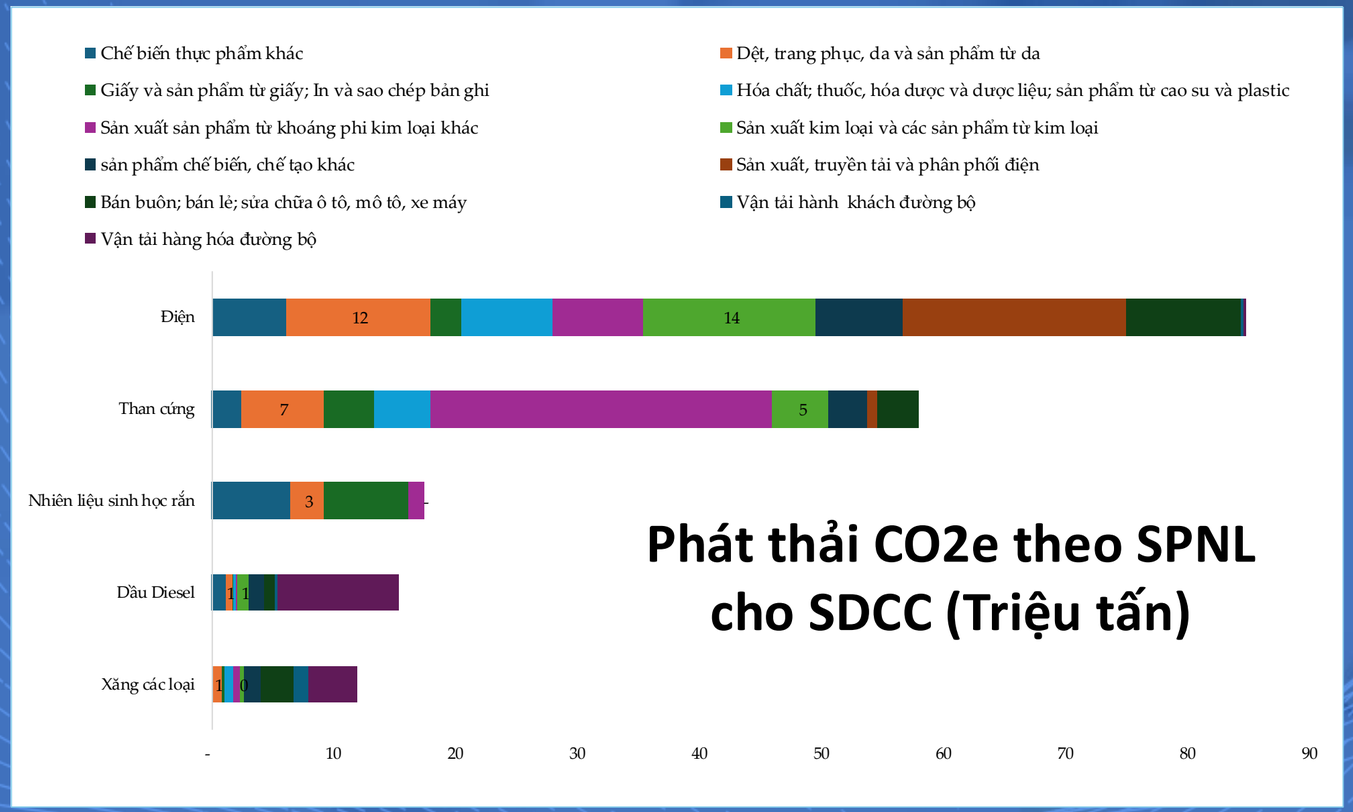
Renewable electricity benefits



VA/GO analysis shows that renewable electricity has a higher domestic value-added ratio than coal-fired and gas-fired electricity. Wind and solar power generate more value added per unit of output while reducing dependence on imported fuels — a dual benefit for Viet Nam's just energy transition.

- **Renewable electricity: highest VA/GO**
- **Coal power: high import costs**
- **Gas power: dependent on imported fuel**
- **Renewables: long-term cost advantage**

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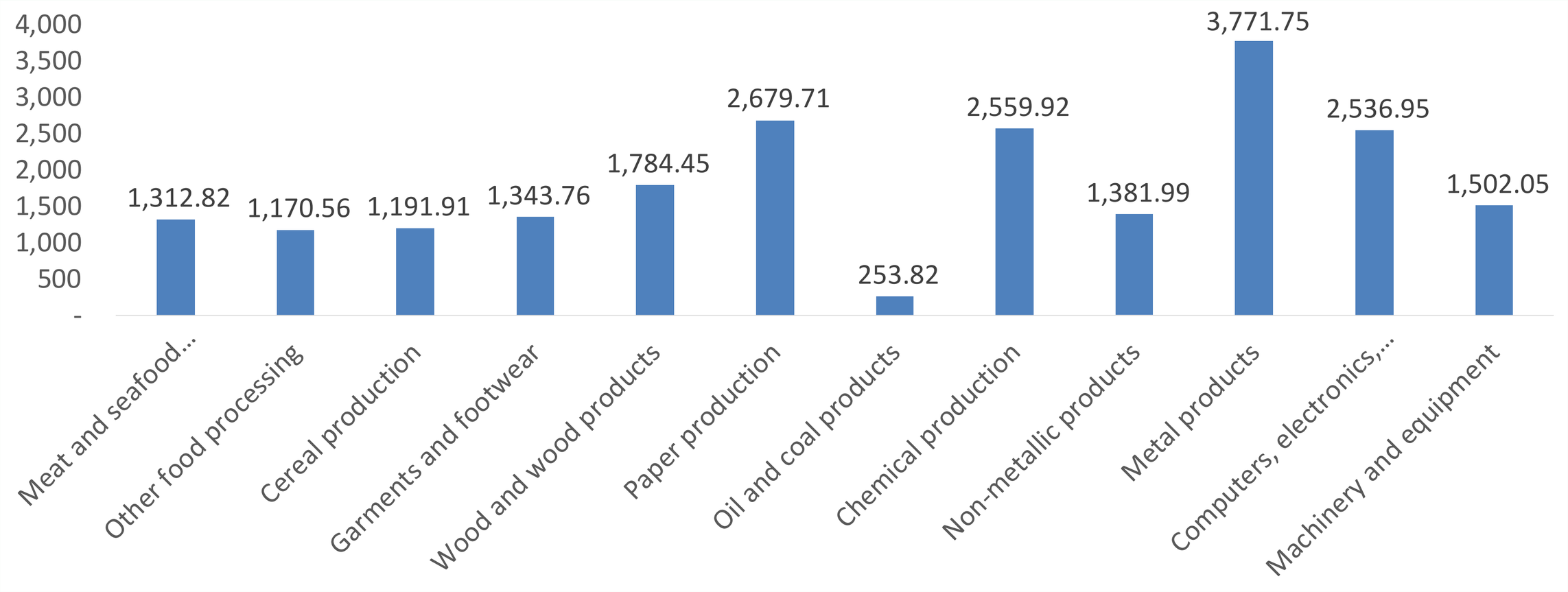


Kết quả (2): Một số ngành phát thải cao và dư địa tiết kiệm năng lượng

Phân tích ESAM 2019 xác định các ngành phát thải khí nhà kính cao nhất. Sản xuất điện; một số ngành công nghiệp chế biến chế tạo; giao thông vận tải; hộ gia đình.

- **Điện: sx điện, kim loại, dệt may**
- **Than cứng: sx kim loại, phi kl**
- **Nhiên liệu: Giao thông & vận tải**
- **Ngành sx (80%) Hộ gia đình (20%)**

Several manufacturing industries face high electricity costs => energy saving can positively reduce costs



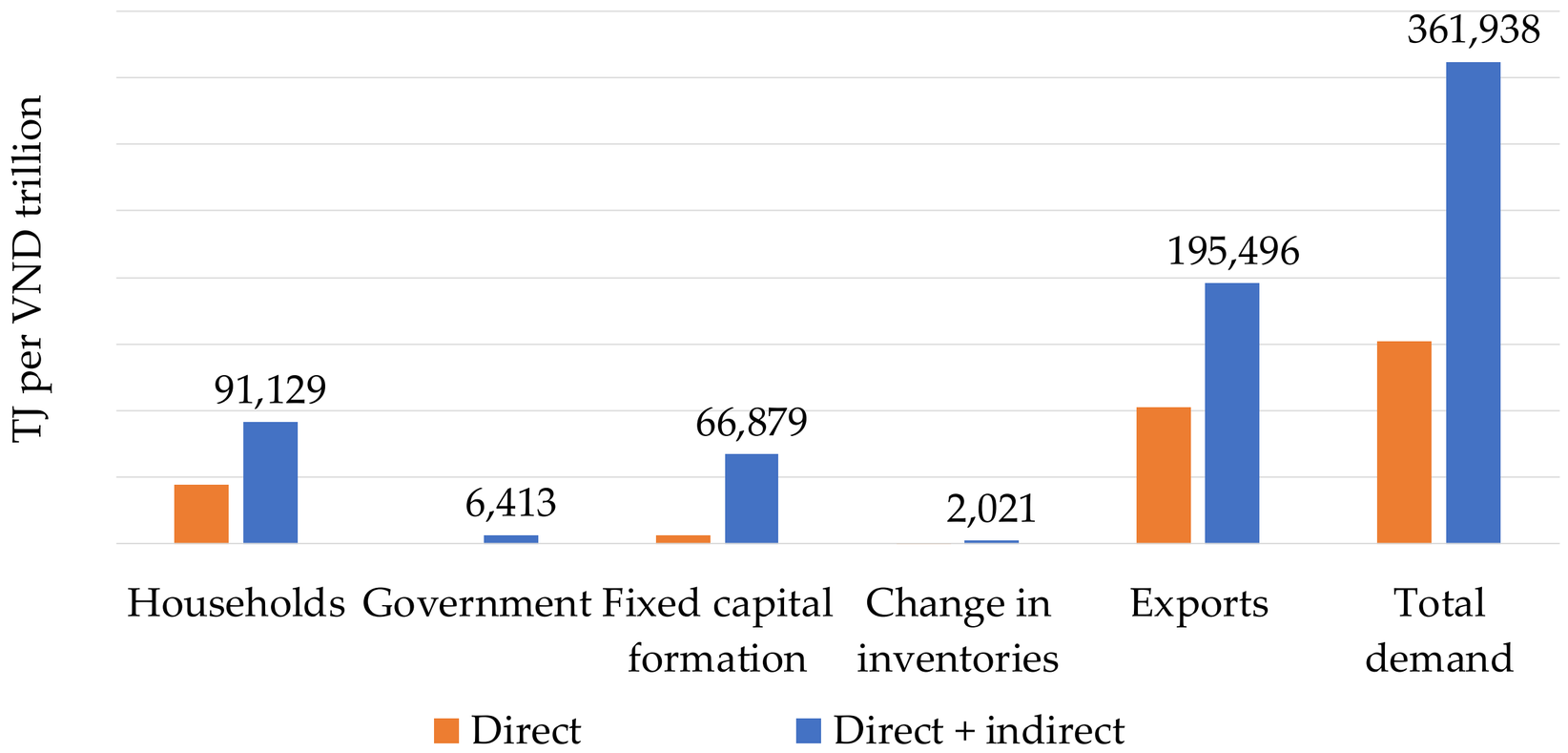
Average electricity cost (VND/kWh)

Manufacturing consumes large amounts of electricity but pays a lower average price than other sectors

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Sector	Electricity (TJ)	Output (kWh)	Cost (VND trillion)	Average price (VND/kWh)	Output share (%)
Agriculture, forestry and fisheries	24.478	6.799.361.770	18,26	2.685	2,90
Industry and construction	**470.171**	**130.603.121.199**	**239,22**	**1.832**	**56,40**
Transport	10.226	2.840.597.264	8,93	3.143	1,20
Services	122.172	33.936.624.316	107,76	3.175	14,70

Multiplier analysis: Increase in electricity consumption by final-demand components for manufacturing products => very large electricity demand unless the structure is adjusted



Multiplier analysis: 10% electricity price increase

Policy / demand
green investment, exports, electricity prices

→

Sectoral impacts through inter-sectoral linkages

→

Direct + indirect impacts

→

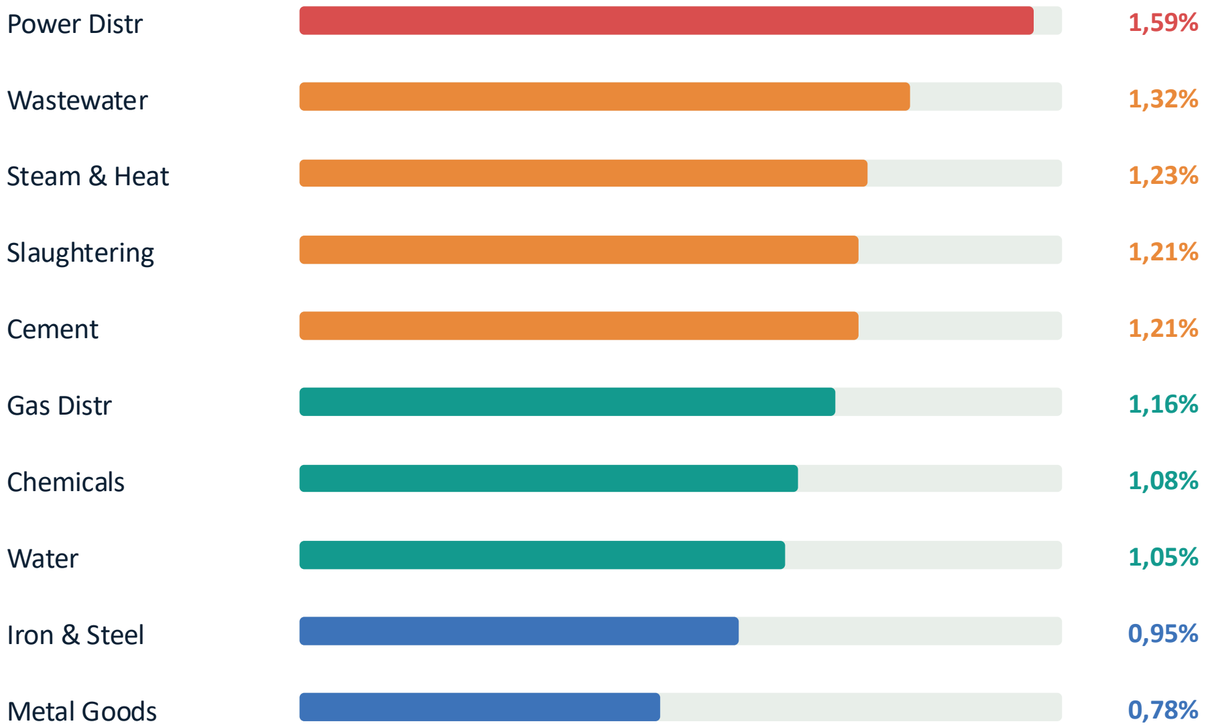
Outputs
GO, VA, employment, income, energy, CO_2e

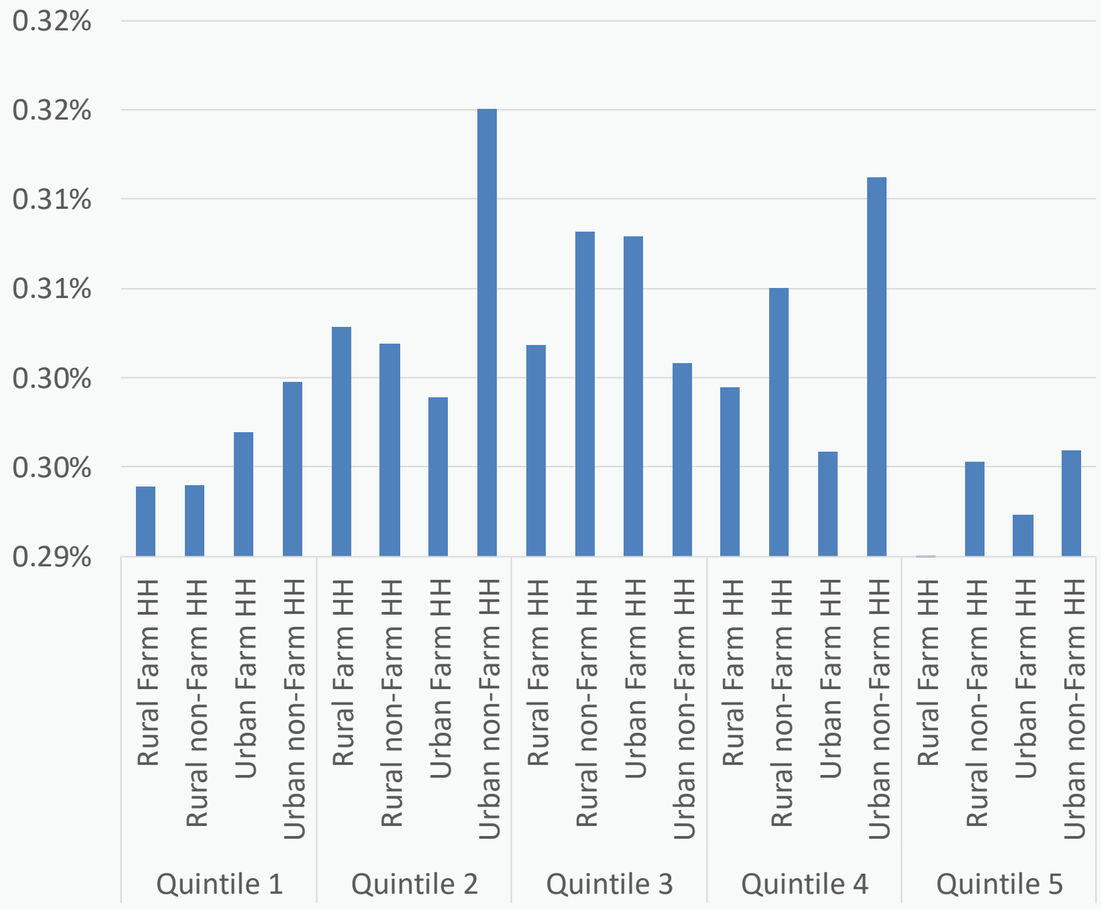
A 10% electricity price increase reduces manufacturing output by 1.8% and raises costs for low-income households by 3.2%. Exports generate strong spillovers to upstream sectors, especially electricity and logistics.

Multiplier results — a 10% electricity price shock raises costs along input supply chains

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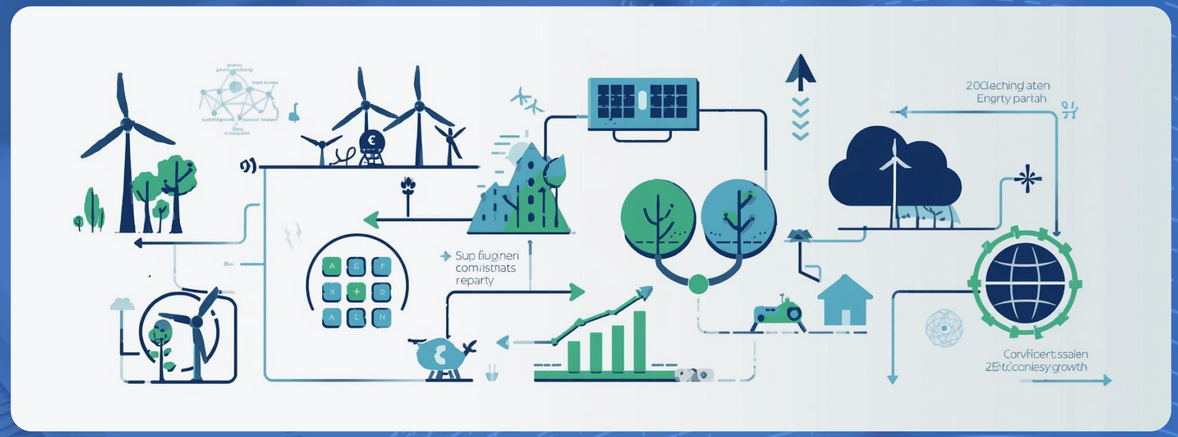
Sectors dependent on electricity and energy inputs are most affected





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Summary of key observations from data and multiplier analysis



- Focus on reducing energy import dependence and developing renewables
- Energy saving in manufacturing
- Electricity prices still involve cross-subsidies
- Electricity price increases may negatively affect some sectors and households

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Potential applications

ESAM, the SAM multiplier model and the CGE model form a comprehensive policy-analysis toolkit, supporting data-driven decisions for Viet Nam’s just energy transition. Linking Energy–Economy–Society–Environment.

Policy impact assessment

Quantitatively simulate the impacts of energy policies on GDP, employment and emissions under each scenario.

Scenario analysis

Compare energy transition scenarios: electricity price increases, oil prices, renewable development and reduced dependence on fossil fuels.

Beyond energy, applicable to many other fields

Trade, taxes, government investment spending, labour-market policies, sectoral productivity, etc.

Support policy making

Integrating economy–society–environment promotes cross-sectoral and interdisciplinary management.

Framework model application



01 **ESAM Foundational data**

The Energy Social Accounting Matrix (ESAM) provides an integrated dataset on monetary flows, energy and emissions — the foundation for the entire analysis.

02 **SAM Multiplier Spillover analysis**

The SAM multiplier model quantifies the economic spillover effects of energy policy shocks on income, labour and production.

03 **CGE model Equilibrium simulation**

The CGE model simulates general equilibrium mechanisms and reflects economic agents' responses to changes in prices and energy policies.

04 **Policy recommendations**

Prof. Finn Tarp's presentation will discuss policy analysis results from the CGE model and draw policy implications for Viet Nam.

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Thank you!

Dr. Dang Thi Thu Hoai
& the IPSS team

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Funding/Partners: UNDP · University of Copenhagen · Viet Nam Statistics Office