ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT

Linking the TIMES-Italy model with macro-economic models:

Experiments with Social Accounting Matrices and G-E models

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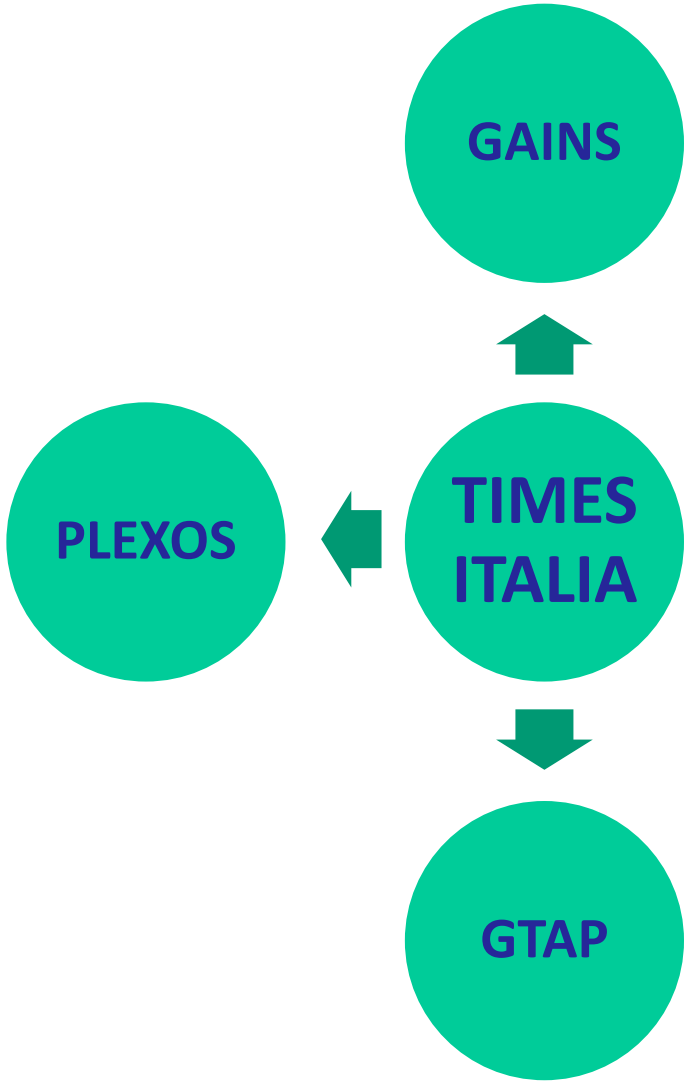
Suite of models used at ENEA



Impacts on emissions of athmospheric pollutants

Impacts on the Electric power systems

Impacts on the economic system

Impacts on internationl trade and competitiveness

Model linkages for integrated assessment

The activity reported here is part of a project funded by the Italian Ministry of Economic Development, aimed at developing an integrated assessment tool that can be used both for impact assessment and for policy simulation and analysis.

The team involved in this project is composed by:

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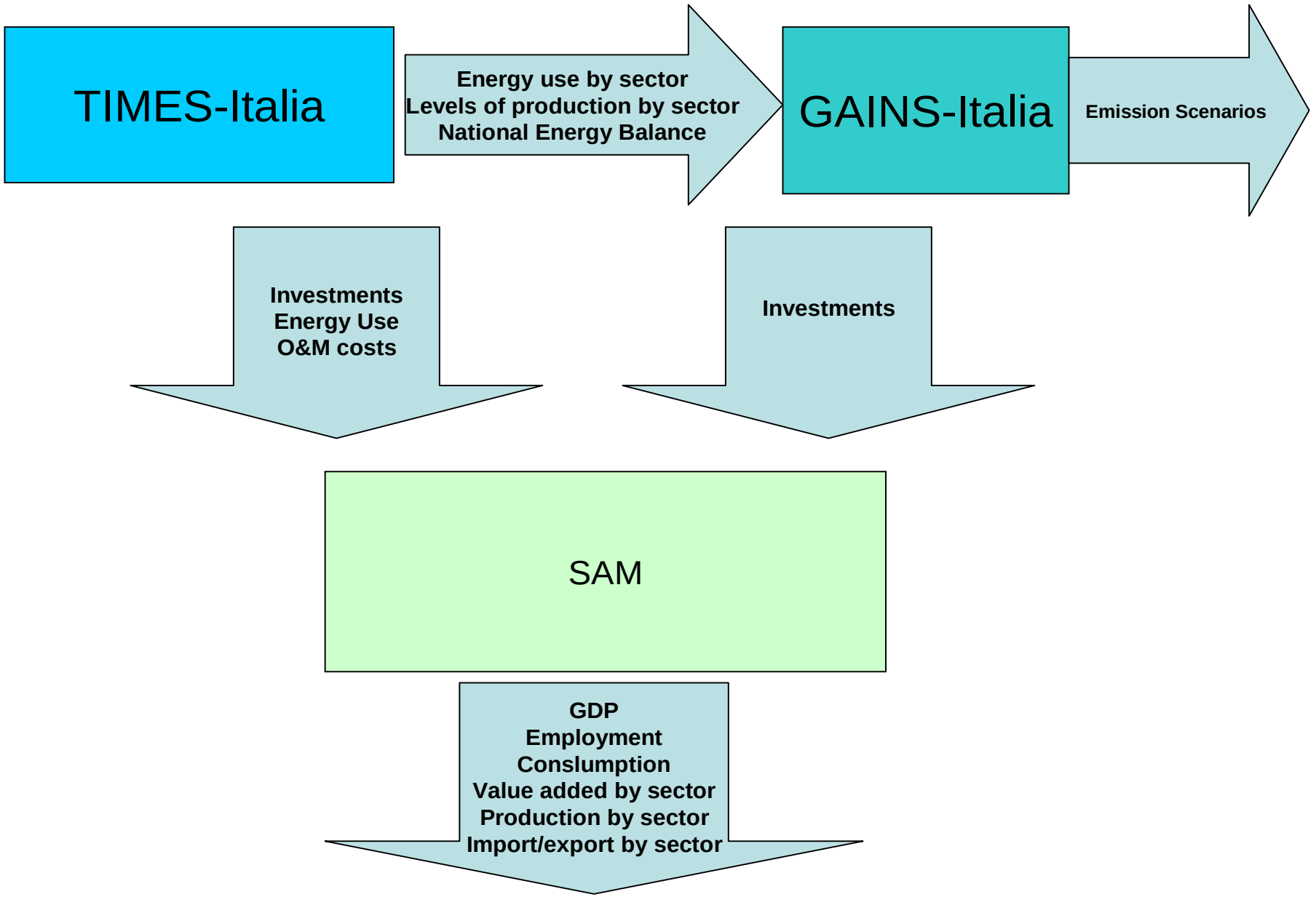
Workflow for integrated analyses



Linking Energy System models with Macroeconomic models

Partial equilibrium approach does not take into account redistribution effects, feedbacks, impact on non energy sectors and prices etc.

Unidirectional Soft-link

Extend B-U models as far as possible w/o hitting technical limit (i.e. keep model linear), preserving technological detail

Supplement B-U results with macroeconomic model, with or without feedback link:

- w/o feedback: simpler implementation, quicker cycle time
- with feedback: iterative scheme is time-consuming

Joint analysis: different models for different needs

Distributional issues between economic agents or countries are better addressed with macroeconomic models

Technological opportunities, interaction between demand and supply in energy markets, better addressed with energy models

Social Accounting Matrix (SAM)

A Social Accounting Matrix is an organized matrix representation of all transactions and transfers between different production activities, factors of production and institutions (like households, firms and government) within the economy and with respect to the rest of the world.

SAM is a comprehensive accounting framework within which the full circular flow of income from production to factor incomes, household income to household consumption and back to production is captured.

In a SAM all the transactions in the economy are presented in the form of a matrix.

Each row gives receipts of an account while the column gives the expenditure. The total of each row is equal to the total of each corresponding column.

SAM structure and content

			Goods and services	Production Activities	Factors		Resident Institutions			Savings-Investments	Rest of the world	Total
					Labour	*Capital Services*	*Households*	*Firms*	*Public sector*			
			(1)	(2)	(3)		(4)			(5)	(6)	
Goods and services	(1)		Trade/transp. marg.	Intermediate consumption			Final cons.hous.		Final cons.of PS	Investment & var.stocks	Exports	Demand of goods
Production Activities	(2)		Domestic production						Subsidies to production			Inflows of activities
Factors	(3)	*Labour*		Wages and Salaries							labour inc. from ROW	Labour incomes
		Capital Serv.		Earn.b.taxes (EBT)								Capital incomes
Resident Institutions	(4)	*House holds*			Wages and Salaries		Intra-hous. transfers	Distributed profits	Transfers to households		Transferts from ROW	Households incomes
		Firms				Earn.b.Taxes (EBT)					Transferts from ROW	Firms incomes
		Public sector	Taxes on goods/serv	Taxes on activities			Taxes/social security	Taxes	Transfers within PS	Budget deficit	Transferts from ROW	PS income
Savings-Investment	(5)		Decreases of stocks	Depreciation of capital			Savings of households	Savings of firms	Budget surplus		Deficit bal.of payments.	Financial resources
Rest of the world	(6)		Imports		Remun.of ext.labour		Transfers to ROW	Transfers to ROW	Transfers to ROW	Surplus bal. of payments		Outlays to ROW

Total	Supply of goods and services	Domestic production	Payments for labour	Payments for capital services	Households expenditure	Use of EBT	Public expenditure	Total investment	Payments of ROW

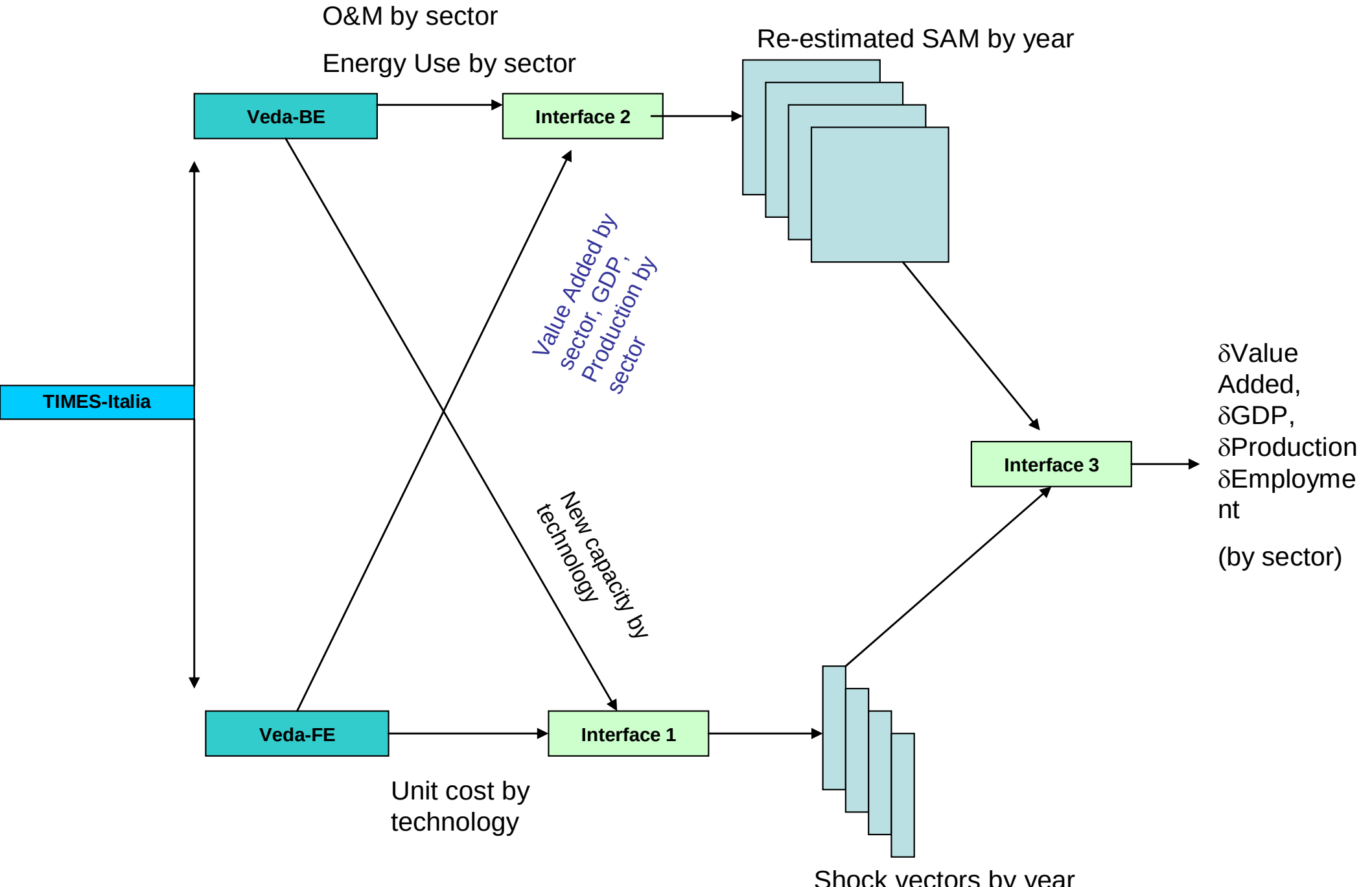
Social Accounting Matrix

Impact assessment using multipliers

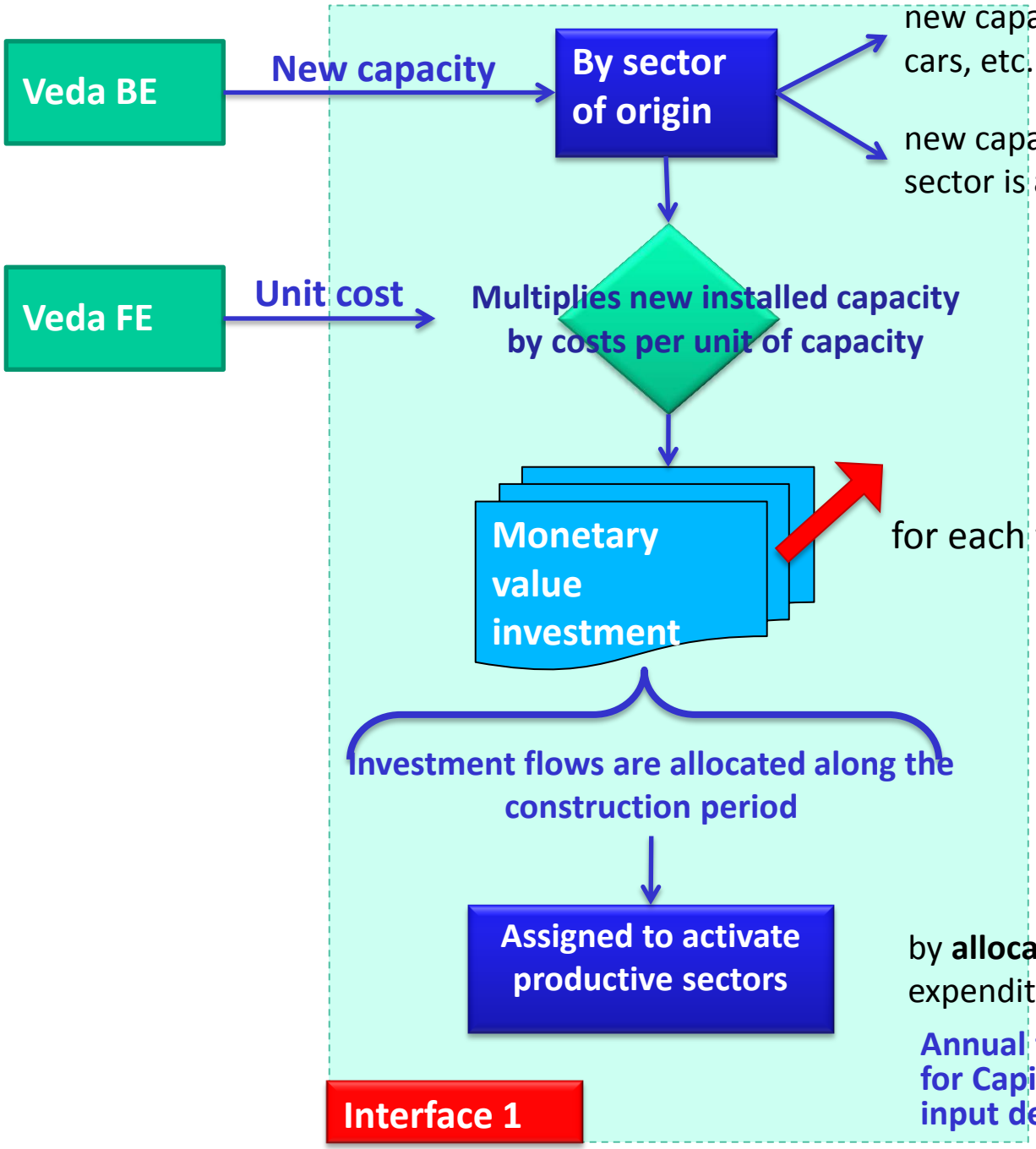
$$X=(I-A)^{-1}Z$$

- **Impact in the costruction period:**
  - The exogeneous sector is the investment sector
  - The investment acts as an exogenoeus shock that is assigned to a sector of final demand (usually Capital formation or Families)
- **Impact during investment's lifetime period:**
  - the Investments generates changes in running expenditures of productive sectors (i.e. increase in O&M, decrease in expenditure for fossil fuels or electricity).
- **These changes are represented by a re-estimation of SAM's coefficient.**

TIMES and SAM linkage



Transformation of TIMES data (interface 1)



new capacity by the residential sector (End use devices, cars, etc.) is attributed to the Household sector.

new capacity by the productive sector or by the energy sector is attributed to the Capital Formation sector.

for each technology for every year

by **allocation factors**= share of input sector in the total expenditure.

Annual total vectors of investment for households and for Capital Formation are calculated by aggregation of input demand by sector.

Transformation of TIMES data (interface 2)

1) Veda FE → GDP and V.A. → SAM GDP & VA growth rate → evolving year after year according to the growth rates of GDP & VA of TIMES-Italy

2) Veda BE → O&M by techs → O&M growth rate by sectors → The SAM sector "Commercial, maintenance and repair services…" follow the path of growth coming from Times results

3) Veda BE → Energy purchases by techs → Energy purchases growth rate by sectors → **The SAM sector** "Power, Gas, Steam", "Coke and oil refining products, etc…" **follow the path of growth defined by Times results**

4) Interface 2 builds for each year a new SAM and rebalances it using a routine based on the RAS with constraints method. It reports the changes in the structure of the economy assuming that most of the structural change is originated in the energy sector

Interface 2

Evaluation of the impact (Interface 3)

The evaluation of the impact of a technological scenario is done through interface 3 as follows :

- for each scenario year the SAM produced by Interface 2 is used;
- the “Capital Formation” sector is made exogenous and the corresponding multipliers matrix is evaluated ;
- for each year, the related “shock” vector of Investment (calculated by Interface 1) is multiplied by the multiplier’s matrix;
- Resulting data on job creation, change of GDP, change of value-added by sector are stored in the Database of results.
- the “Household” sector is made exogenous and the corresponding multipliers’ matrix is evaluated;
- for each year, the related “shock” vector of household expenditure calculated by Interface 1 is multiplied by the multiplier’s matrix;
- Resulting data on job creation, change of GDP, change of value-added by sector are stored in the Database of results.

CGE GTAP Dynamic –Energy Model

We use the **GTAP Dynamic model** GDyn (Ianchovichina and McDougall, 2001) which is a recursive-dynamic extension of the standard GTAP developed for a better treatment of long-run simulations.

We merge it with the last version of the **GTAP-Energy model** (McDougall and Golub, 2007)

- Explicit treatment of energy demand, inter-factor and inter-fuel substitution, in production function and consumption.
- Representation of emissions (CO2) from fuel combustion.
- Possibility of introducing market-based policy instruments such as Carbon Tax or Emission Trading.

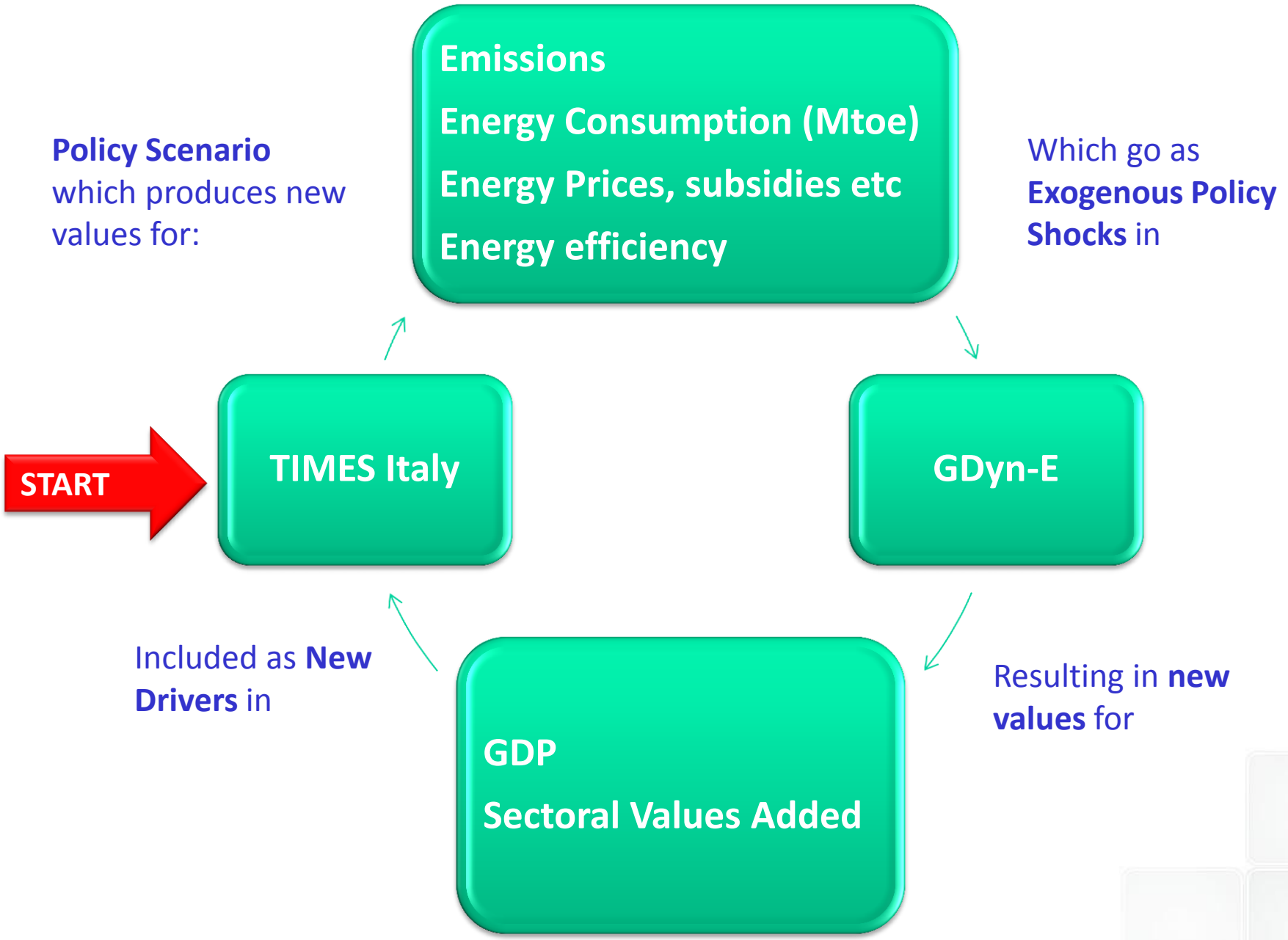
We use the last **GTAP Database 8.1**

The latest version of the **GTAP-Energy data on CO2 emissions**

Linkage – First steps

1. Harmonization of sectors and variables for each model (GTAP and TIMES)
2. Construction of a baseline scenario in Times model
3. Construction of a baseline scenario in GTAP model
   - using the same policy assumptions and the same projections for exogenous variables such as GDP and population
   - replicating the energy system profile defined by TIMES_Italy outcomes (in particular CO_2 emission and energy consumption)

Linkage – Iterative Process



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