START2030

Model Linking

17. November 2021, online

WIFO TU Graz CESAR Centre of Economic Scenario Analysis and Research

General Approach

Approach

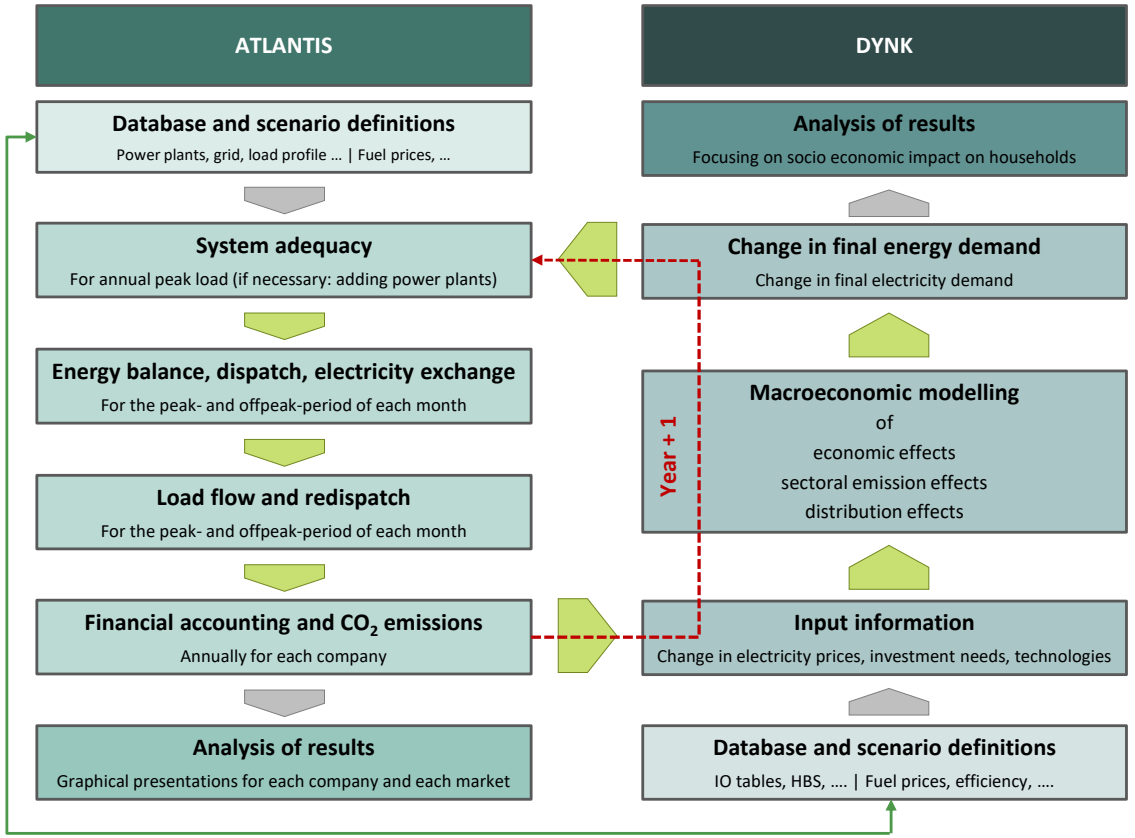
- Link **sectoral macroeconomic model** & **partial model** of energy sector
- **Following** Pan & Köhler 2007 and Köhler 2006
  - Endogenous **learning curves** → change IO coefficients
  - **Hybrid** model (economic and energy technology)
  - Relative production costs as **trigger for investment**
  - **Capital stock** structure → energy production mix
  - Focus on technology switch "tipping points"

Extensions in START2030

- **Economic**: all economic feedback mechanisms
  - Endogenous final demand & investment
  - **Price system** of all 77 commodities & Supply/Use Tables
  - **Labor market** feedback
  - Explicit **electricity commodity** (NACE 35.1)
  - Different household groups & **prosumer**
- **Electricity** generation: Detailed bottom-up model
  - **Regional** aspect (nodes) of AT
  - Detailed **costs**; varying **demand load**; electricity **market**; **learning curves**
  - Explicit depiction of AT **physical** electricity generation & demand
  - Technology specific investments + **Infrastructure** and **storage**

Data Exchange & Convergence

- **Soft-Link** – iterative data exchange
- ATLANTIS → DYNK
  - Electricity generation by technology (GWh)
  - Electricity Generation costs (per GWh)
  - Market price (Whole sale) (€/MW)
  - Employment in electricity sector
  - Investment needs
- DYNK → ATLANTIS
  - Final electricity demand
- Data exchange until convergence is achieved



Data Exchange & Convergence

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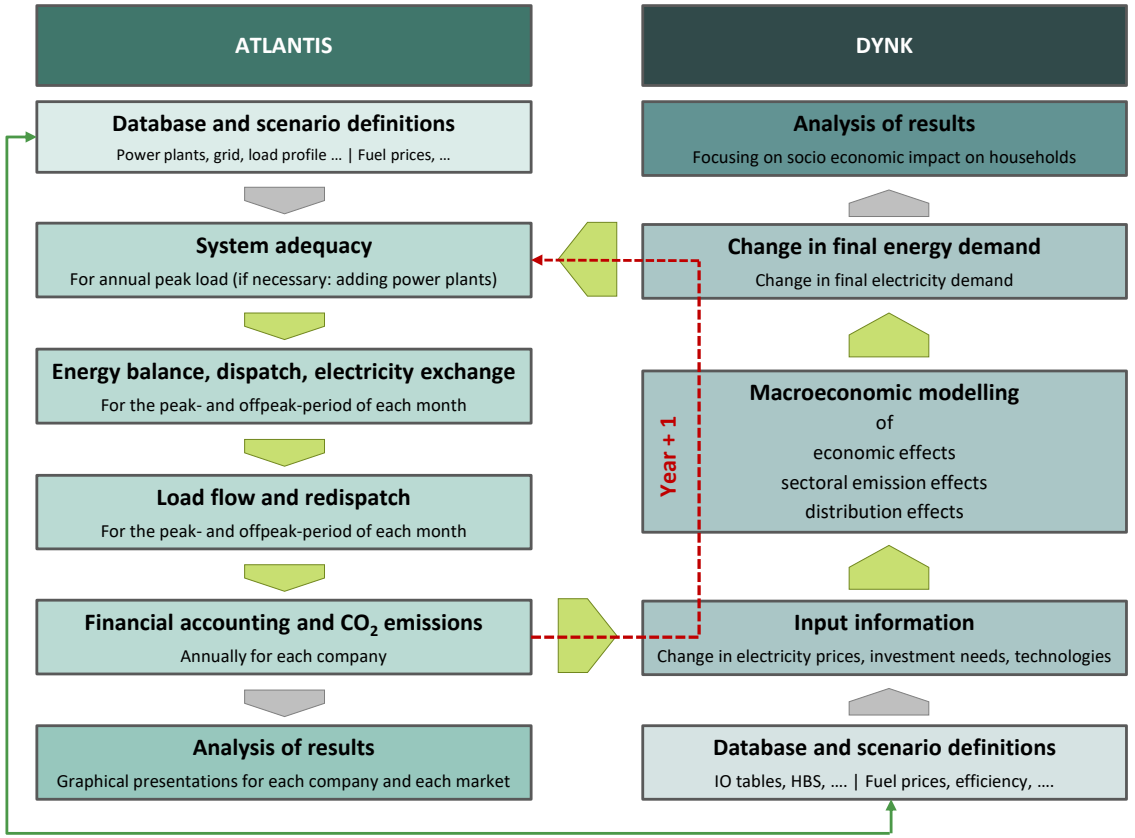
    - Per capacity installed
  - Investment needs (€/MW)
    - Plants, storage and grid
- DYNK → ATLANTIS
  - Final electricity demand
    - Per sector & private households



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Inputs used to change …

IO Coefficients "techswitch"

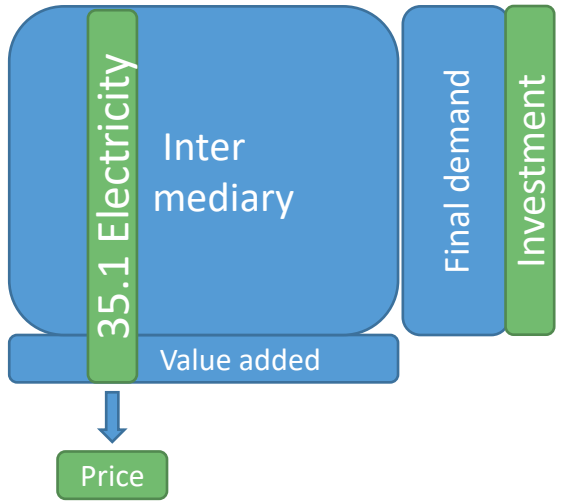
Electricity **Commodity price**

Employment intensity

Investment demand

Regional & temporal distributed **electricity demand**

Figure: Illustrative IO-Tables



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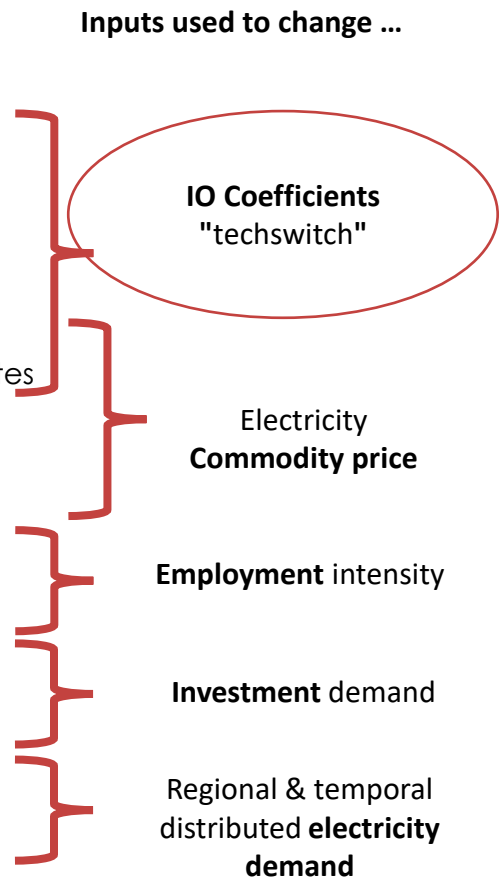

Data Processing – "Techswitch"

- "**Techswitch**"; Aim: Change in IO coefficients based on electricity generation mix
  - Available Data:
    - Technology specific IO-coefficients , based on Exiobase MRIO
    - Calibrated to AT-IOT 2017
  - **Step 1**: Derive **change** in technology costs (by ATLANTIS results)
    - i.e. change in fuel **costs**, O&M etc. & change in **output**
  - **Step 2: Re-weighting** of technology vectors
    - Electricity distribution & trade is constant
  - **Step 3: Aggregation** of vectors to „new" NACE 35.1 sector input coefficients
  - **Step 4:** Adapt coefficients in **IO matrix** & re-run DYNK

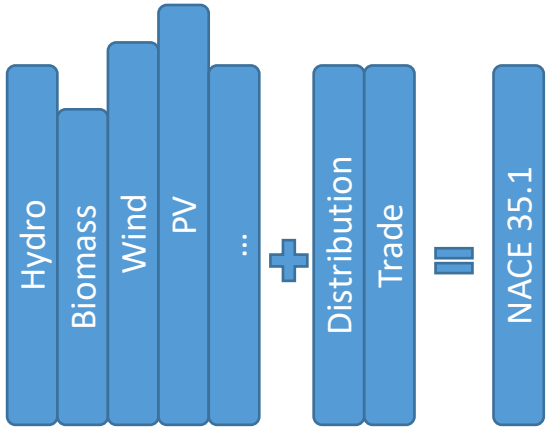

Figure: Illustrative Sub-Sector aggegation

Data Processing

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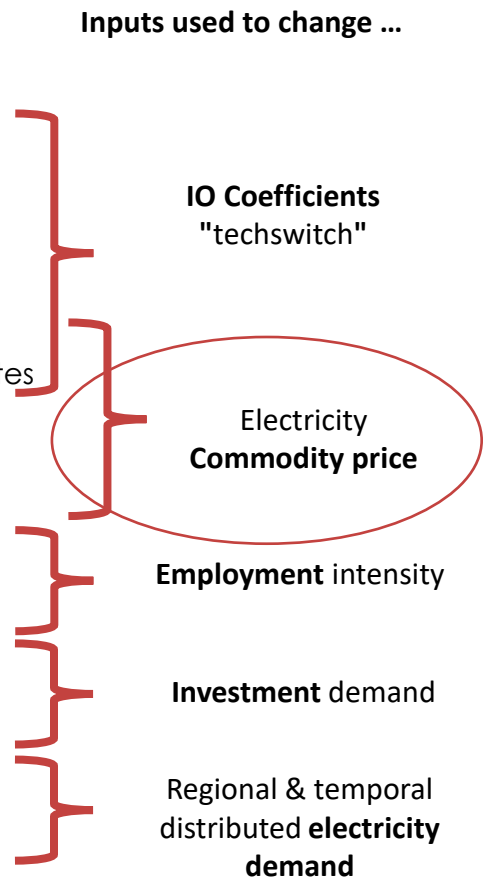
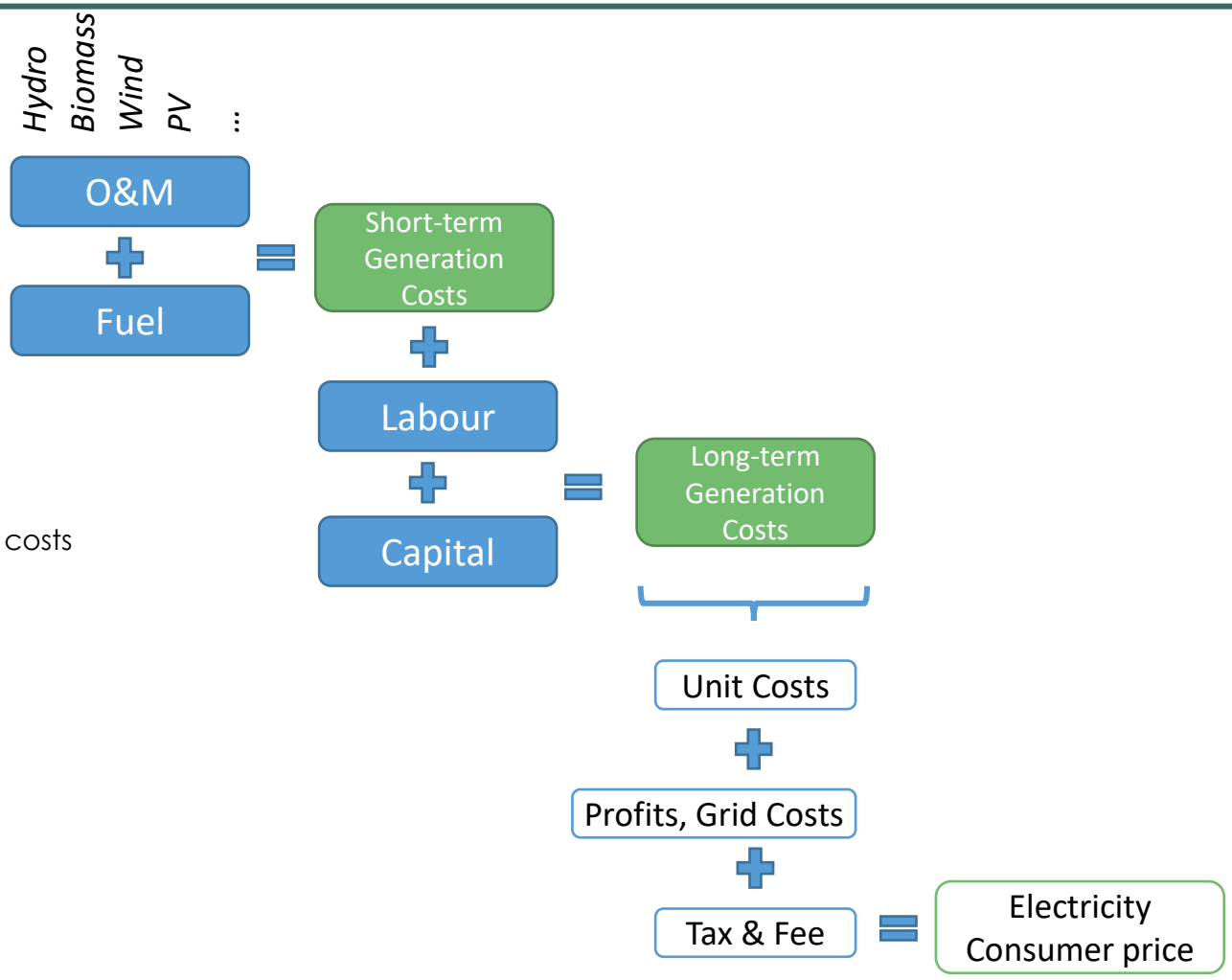


Data Processing – Electricity Price

- "**Price for Electricity**", AIM: Extract consumer price of electricity
  - Available data (ATLANTIS)
    - Generation costs per technology (Mio.€) – including emission certificate costs
    - Grid costs (€/kWh)
  - **Step 1**: derive long-term generation costs
    - Total costs per GWh & Technology produced
    - Includes **capital** costs (depreciation, interest rates) and **labour** costs
  - **Step 2**: Add fixed profit mark-up and grid costs
    - Based on historic shares (%)
    - Grid costs (€/kWh)
  - **Step 3:** Add taxes & fees Derive price index
  - **Step 4**: Derive price index
    - Starting year 2017 = 1



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Inputs used to change …

- **IO Coefficients** "techswitch"
- Electricity **Commodity price**
- **Employment** intensity
- **Investment** demand
- Regional & temporal distributed **electricity demand**

Data Processing – Electricity demand

- "**Demand for electricity**": Aim: Link Electricity demand (physical) to IOT
  - Available data
    - Sectoral electricity consumption (monetary & physical)
  - **Step 1**: Extract **nominal** electricity commodity (CPA 35.1) **consumption (D)**
    - from simulated IOT, current prices
    - Industries & private households
  - **Step 2**: **Deflate** monetary values
    - By **Price** index for commodity CPA35.1 **(P)**
  - **Step 3:** Derive physical **electricity demand (X)**
    - By Energy intensity factor **(Z)**
    - where: Energy intensity factor is extrapolated from historic developments

$$X_{elec} = \frac{D_{35.1}}{P_{35.1}} Z$$

Stylized representation of physical electricity demand derivation

Discussion

- Are essential feedbacks missing?
- Are our assumptions to derive electricity demand plausible? Are there other drivers?
- Are electricity generation technologies represented sufficiently?
  - Costs: O&M, fuel, emission certificates, capital costs
- Do you have any experience with linking B-U & T-D models?
  - Obstacles, good practice, advise