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Assessment of investment needs and gaps in relation to the 2030 climate and energy targets

Ingmar Juergens and David Rusnok gbr Advisors
in co-operation with Carlotta Piantieri (IKEM)

OUTCOME

Strengthened skills of the public sector actors and operators of public financial support schemes to address the investment challenge of meeting 2030 energy and climate targets.

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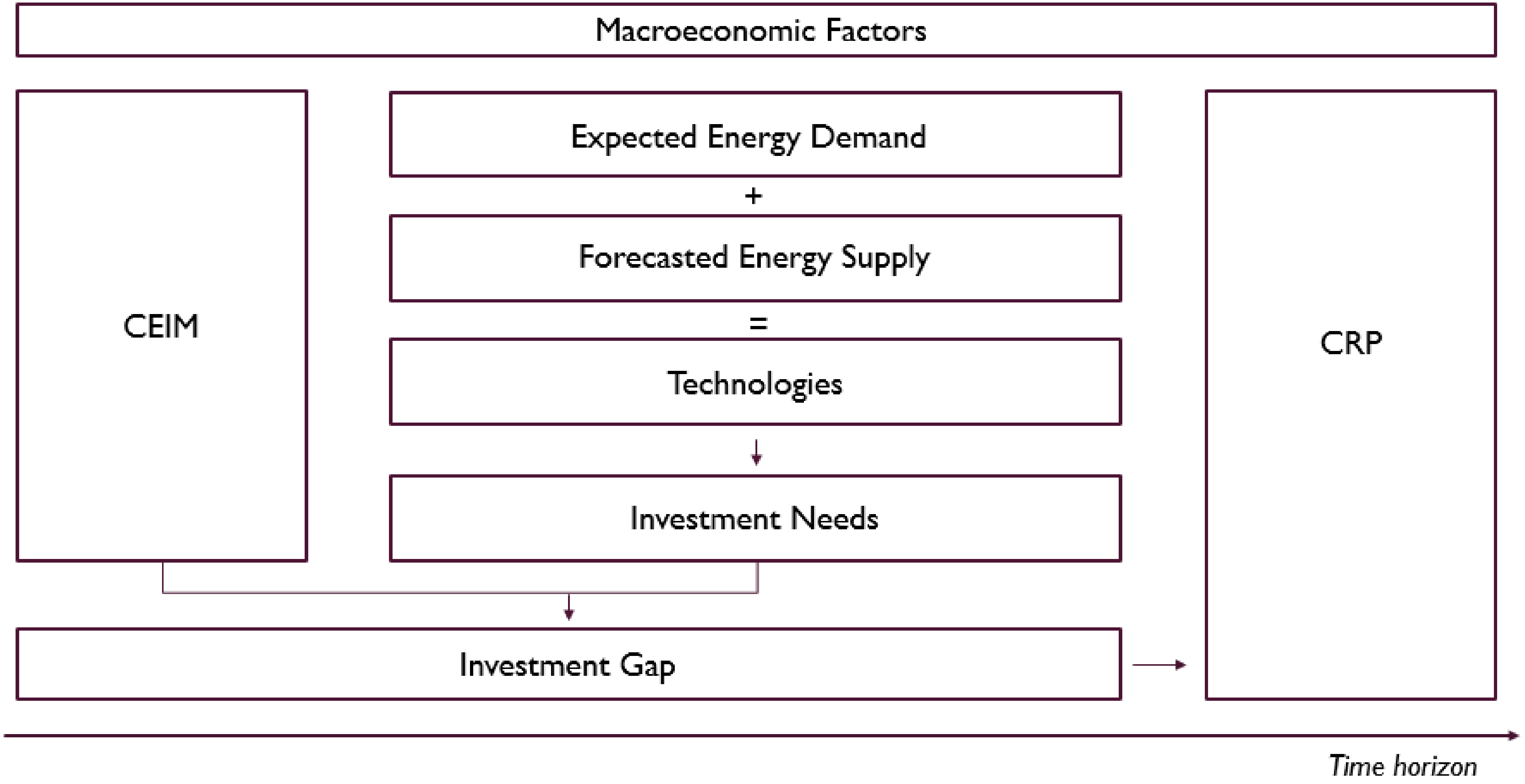
Investment Needs and Gap Analysis (INGA) and the project's analytical framework



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Investment Gap and Need Analyses: Overview, selected Models

Study	Building bocks			Model-specific output features
	Socioeconomic factors	Energy markets	Technologies / Innovation needs	
DENA (2018)	Exogenous	DIMENSION+	Exogenous	GHG emissions per sectors
BCG (2018)	VIEW model by Prognos	Different Prognos models	Bottom-up Substitution Cost Curve	Sectorial cost-efficient and low-carbon technologies and investment needs.
Frauenhofer (2015)	Exogenous	REMod-D	Exogenous	System composition including cost analysis
IEA (2017)	Exogenous	WEM	REmap	Energy flows by fuel, investment needs and costs, carbon dioxide (CO2) and other energy-related GHG emissions, and end-user prices.
OECD (2017)	Yoda model + Oxford GE model	Oxford GE model	Exogenous	SR and LR economic growth, potential output. GEM enables sector-level analysis.
IRENA (2015)	Exogenous	Exogenous	REmap	Supply substitution cost curve. Current cost of technologies .
EC Impact Assessments (2017)	All the economy is modelled endogenously			Investment needs figures and detailed assessment of relative economic impacts.

Investment Gap and Need Analyses: Studies investigating total (additional) costs

Preliminary analysis for illustrative purposes only!

ID	Study	Scenario	Time Period	P.a. Min	P.a. Max	Total Min	Total Max
				Billion€	*Billion€*	*Billion €*	*Billion €*
2050 - 80 per cent scenario							
1	DENA	80%	2018-50	33.3	54.6	1064	1746
2	BCG	80%	2015-50	28.6		1000	
3	Frauenhofer	80%	2015-50	24.9	38.4	873	1343
2050 – 90/95 per cent scenario							
1	DENA	95%	2018-50	34.3	58.3	1098	1866
2	BCG	95%	2015-50	50.6		1770	
3	Frauenhofer	95%	2015-50	49.6		1735	
2030 targets							
4	Prognos	55%	2018-30	20.0	22.5	240	270

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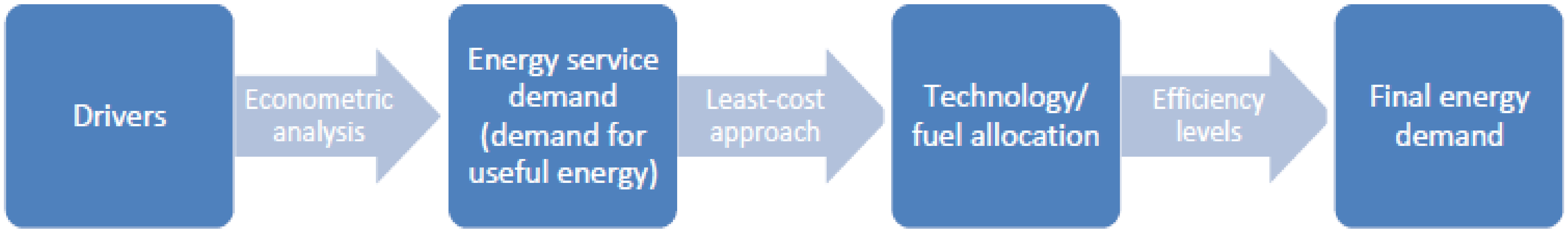
IEA World Energy Model

Determinants of final energy demand



Drivers

- Socio-economic variables
- End-user prices

Activity variables

and related energy services

Technologies

that satisfy specific energy services

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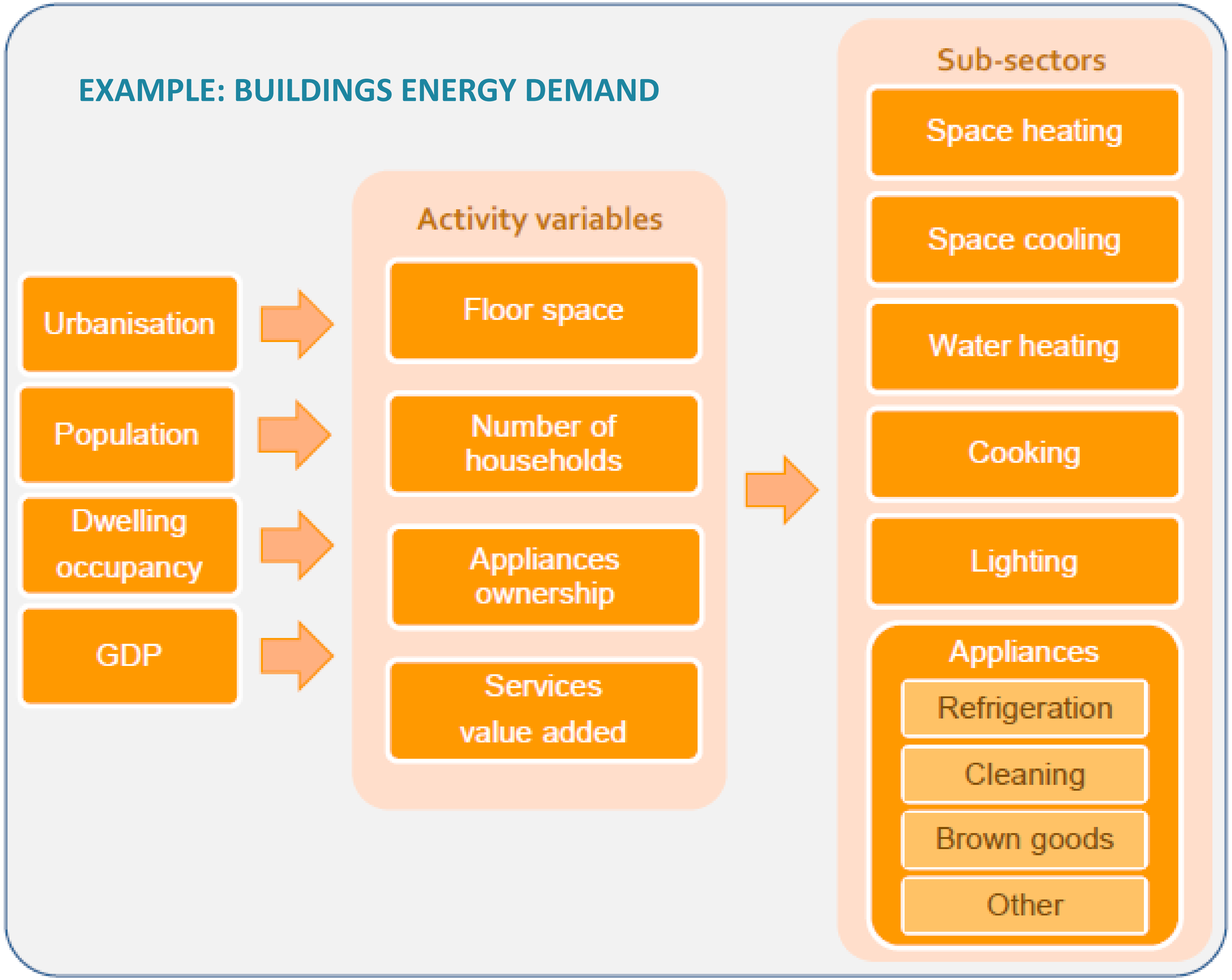
IEA World Energy Model



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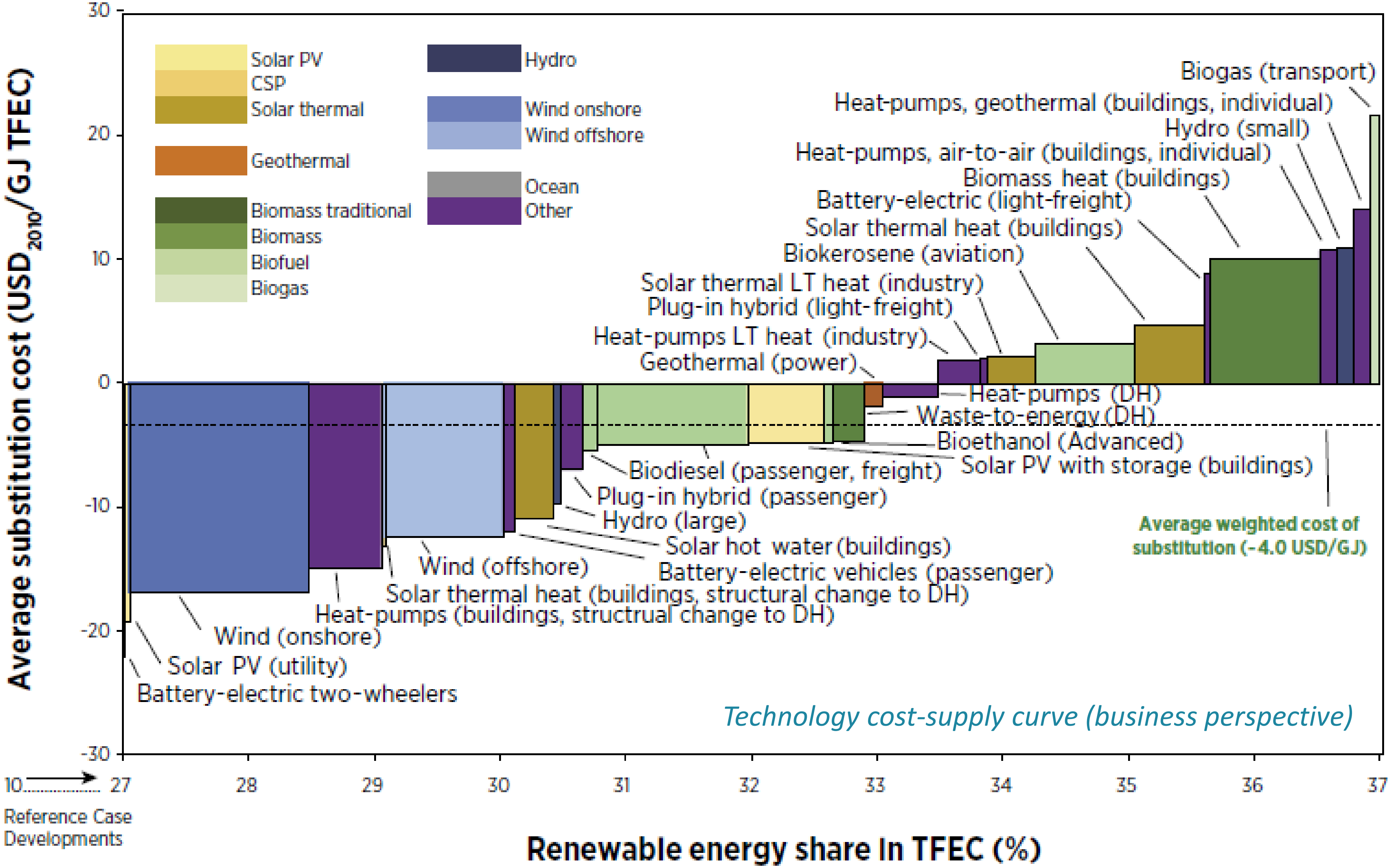
IRENA 2016 REmap

Technology cost difference per unit of final energy consumed if one replaces conventional energy technologies assumed to be in place in 2030 in the Reference Case with renewable energy (RE) technologies.

TECHNOLOGY SUBSTITUTION COST MODEL



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IRENA 2016 REmap

ASSUMPTIONS / INPUTS

- Emissions targets:
  - - 55% GHG emissions compared to 1990
- Energy demand (TFEC)
  - Reference Case: TFEC will decrease yearly to 7.7 EJ in 2030 constrained by emission targets
  - REmap: TFEC will decrease yearly to 7.6 EJ in 2030 (reformed *Erneuerbare-Energien-Gesetz* → accelerated renewables deployment)
- Emissions from energy consumption as share of the carbon budget
  - Reference Case: Renewable energy share of TFEC can increase to 30%
  - REmap: Renewable energy share of TFEC can increase to over 37% through higher uptake of renewable technologies in end-use sectors

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IRENA 2016 REmap

ENERGY SECTOR, ASSUMPTIONS REmap 2030

Scenario 2030

- Total power generation declines from 630 TWh per year to 600 TWh per year in 2030
- Exports to neighbouring European countries increase from 18 TWh per year to 44 TWh per year in 2030

Policies 2030

- Reformed Renewable Energy Act (*Erneuerbare-Energien-Gesetz)*
- Carbon price of USD 40 per tonne of CO_2 by 2030 passed through to all fossil fuel consumers

Technologies 2030

- Renewable energy technologies

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IRENA 2016 REmap

TECHNOLOGY ASSUMPTIONS / INPUTS

- Capital cost projections and learning rates → Source of data: literature
- O&M cost projections → Source of data: National statistics / IRENA / IEA
- Technological performance and capacity constrains

Example: Wind (onshore) technology

	Cumulative value of installed capacity in 2030 (REmap)
Power capacity	72.3 GW
Electricity generation	160.0 TWh

- Deployment level reflects the rate of deployment for onshore wind (2.5 GW per year) of the reformed Renewable Energy Act (*Erneuerbare-Energien-Gesetz)*

- Opportunity cost?

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Discussion (I)

What can we learn from the different models/ tools/approaches?

- How to use these models' outputs for national analysis?
- What are other models already available?
- Sector-specific models
- National-level models for Czech Republic, Germany and Latvia
- Are there „model gaps"?

Corresponding project deliverables driven by client needs

- Do national institutions (ministries, banks, etc.) assess investment needs internally (and have or build their own modeling capacity) or by contracting studies/assessments?
- Model overview and characterisation useful in any case
- Workshops, webinars and self-standing slide decks to understand which models (etc.) are available and can be put to which specific use or address which specific knowledge gap or policy question
- Review of and inputs to national institutions' own analysis

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DISCUSSION (II)

What do governments need from an investment needs and gap analysis?

- What are the 2030 target gaps (GHG, other Energy Union targets)?
- Translation of target gaps into action gaps; which role for (increasing) investment?
- Where are the gaps? Public, private (households, corporates), in which sectors?

Toward capital raising strategies:

- What causes the gaps? Barriers and drivers
- Which barriers and drivers can be addressed by policy?
- Where to focus public financing?

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Capital Raising Plan - Relevance and definition in the context of the EUKI project

- Is required to develop **National Energy and Climate Plans.**
- Is a **strategy** to match financing **demand** *to finance investments to achieve 2030 climate and energy targets in the Czech Republic* with national / international financing **supply** and **to mobilise private capital**.
- Is necessary, because market imperfections (**barriers**) prevent matching financing demand and supply.
- Must be embedded in the **overall country strategy** for reaching the energy and climate goals.

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Capital Raising Plan

At what level of the economy do we define a strategy for the Czech Republic?

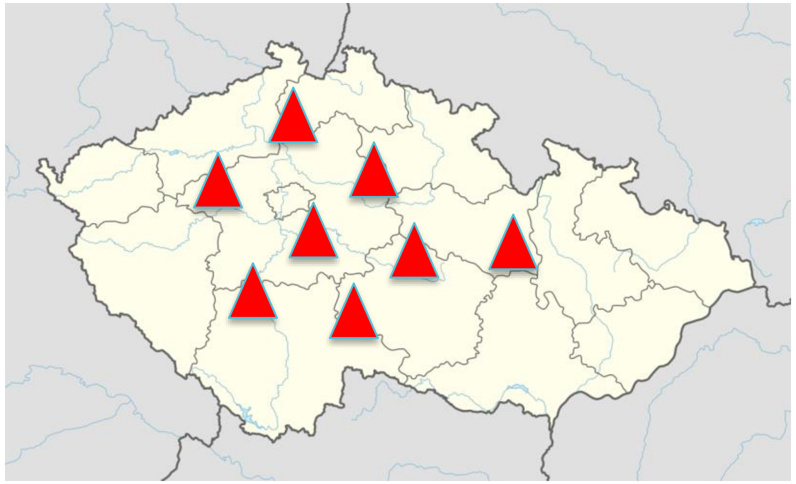
Macro approach

Economy wide CRPs, in order to improve framework conditions e.g. for the private sector

Meso approach

Sector or technology focus CRPs, in order to improve framework conditions for investments in specific sectors / technology

Micro approach



Project specific CRPs, in order to raise capital for a specific project

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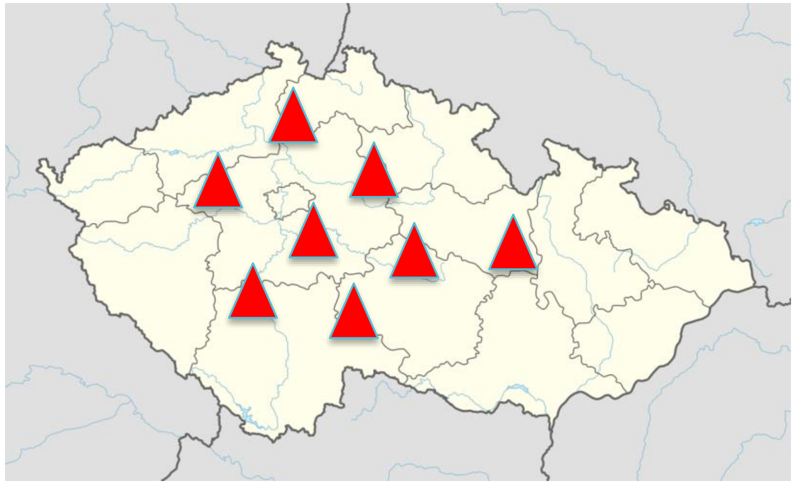
Capital Raising Plan
Possible Protype CPRs

Macro approach	Meso approach	Micro approach
		
Protoype CPR: Recommendations for policy makers in the Czech Republic to augment saving and investment rates	**Protoype CPR:** Handbook and tools for policy makers in CZ to identify relevant barriers and appraise policy instruments to improve framework conditions in selected sectors	**Prototype CPR:** Business-plan and project calculation tool for project developers to present climate friendly project to local / multilateral bank and / or equity investor

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Capital Raising Plan

EUKI approach

Climate investment capacity (CIC2030):
climate finance dynamics & structure for financing the 2030 targets

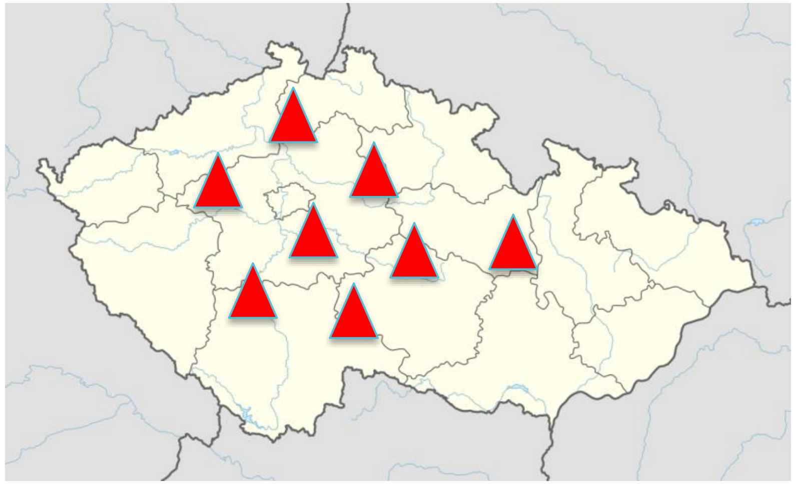
Macro approach

Protoype CPR:
Recommendations for policy makers in CZ to augment saving and investment rates

Meso approach

Protoype CPR:
Handbook and tools for policy makers in CZ to identify relevant barriers and appraise policy instruments to improve framework conditions in selected sectors

Micro approach



Prototype CPR:
Business-plan and project calculation tool for project developers to present climate friendly project to local / multilateral bank and / or equity investor

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Capital Raising Plan - First draft Concept for the Meso-CRP

Step 1
- Identify barriers that prevent especially private sector to invest in climate friendly technologies in selected sectors

Step 2
- Identify Policy Actor & Financial Actor to tackle barrier in sector

Step 3
- Define effective policy and financing instruments to tackle barriers and improving framework conditions for (private) investments in selected sectors

Step 4
- Gather data, combine information and set-up CRPs for selected sectors taking into consideration overall country strategy

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Discussion

1. Focus on meso-level?
2. Relative importance of investment needs and capital raising strategy in the context of the NECP
3. Mix of instruments (financial instruments, market-based policies, regulation and standards) for raising capital differs between sectors
4. Demand versus supply focus also differs!
5. How deep to go in the assessment of policy effectiveness (in terms of private capital mobilisation)?

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THANK YOU!

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- IRENA REmap GERMANY Report 2015 (link);
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ANNEX

DESCRIPTION OF THE STUDIES

CAPITAL RAISING PLANS - RELEVANT ACTORS (DEMAND / SUPPLY)

Strategy 2: Meso approach

Private households

EU Commission

Banks

Ministries

Municipalitys

Regulation

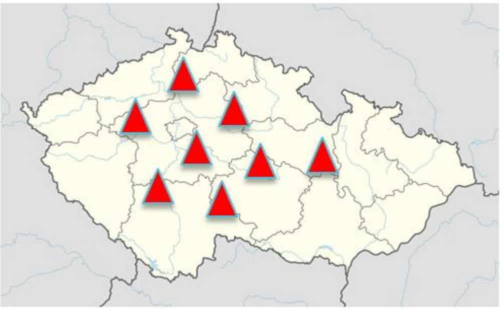
Financing Institutions

State authorities

Industry

Energy producers

Strategy 3: Micro approach



Equity Providers

Project Developers

Banks

Financing Institutions

Rating Agencies

Technology Providers

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OUTPUT I and its investment needs and gaps analysis component

The project's focus is on capacity building. In relation to the national energy and climate plans under the Energy Union 2030 governance regime, **Skills** for preparing and using […] the Energy and Climate Investment Gap and Need Analyses (INGA) **are developed** in Latvia and Czechia based on CEIM and INGA prototypes for at least two sectors per country, **drawing heavily on corresponding analysis in Germany**

Working Package I is implemented through a **learning-by-doing approach** and will draw heavily on […] **the review of INGA-related experience in DE,** transferring expertise and knowhow to the target countries with help of the implementing partners.

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OECD 2017 Yoda Model

SEMI-STRUCTURAL MACROECONOMIC MODEL

INPUTS

- Current state of economies (position in the business cycle)
- Structural variables (ex. hysteresis, impact of credit risks premium faced by governments on public debt)
- International dimensions

1. **Innovation** → captures increase in R&D spending necessary to reach a 2°C scenario (50% scenario) and equivalent to 0.1% GDP (66% scenario)
2. **Regulatory setting** → captures the reduced costs of the transition in a more flexible regulatory environment.

OECD 2017 Oxford Global Economic Model

INTEGRATED GLOBAL (MACROECONOMIC) MODEL

“Most commonly used globally integrated economic model”

Captures:

- economic cycles in the short run
- supply side factors in the long run.

INPUTS

- trade volumes and prices
- competitiveness (labour supply)
- interest/exchange rates
- commodity prices
- capital stock (SR) and capital flows (LR)
- technological progress (LR)

Break down of GDP into 12 high-level sectors

1. manufacturing and industry services
2. energy sector (oil, coal and gas) is extensively detailed for the major economies

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IEA World Energy Model

ITERATIVE ENERGY SUPPLY AND DEMAND MODEL

- Electricity consumption and electricity prices dynamically link the final energy demand and transformation sector

EXOGENOUS ASSUMPTIONS

- economic growth
- demographics
- technological developments

INPUTS

- Demand-side drivers (estimated econometrically)
- Technology cost projections
  - investment costs, O&M costs, fuel costs and CO2 costs
  - learning rates from the literature
- Average end-user prices

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DYNAMIC INPUT-OUTPUT MODEL

- Direct energy demand and indirect energy demand

INPUTS

- interindustry transactions
- 72 economic areas
- business capital and labour demand,
- wage and price dynamics,
- technological progress,
- production capacity and many other variables are modelled separately for each industry.

- RoW environment is provided by Prognos AG's global economic forecasting and simulation model.

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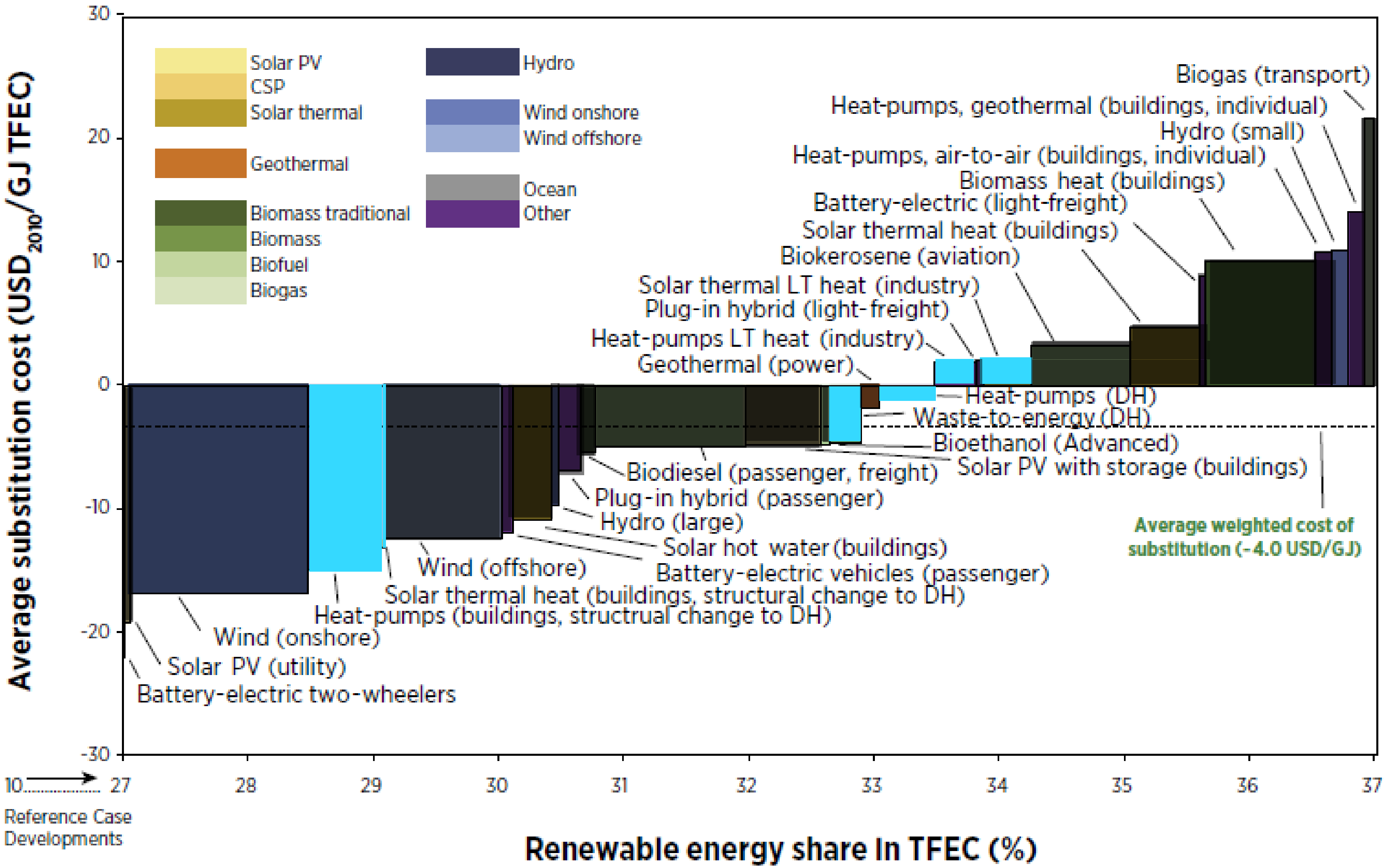
INDUSTRY SECTOR



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INDUSTRY SECTOR, ASSUMPTIONS REmap 2030

Scenario 2030

- By 2030, industry's renewable energy share can increase to
  - 14.4% (31%) excluding (including) electricity and district heat

Policies 2030

- Free allocation of carbon allowances
- EEG policy

Technologies 2030

- Renewable energy technologies other than biomass
  - geothermal, solar thermal and heat pumps
    → potential of 3% of the sector's total energy demand
- Electricity-based heating and cooling (lower cost than end-use market prices)

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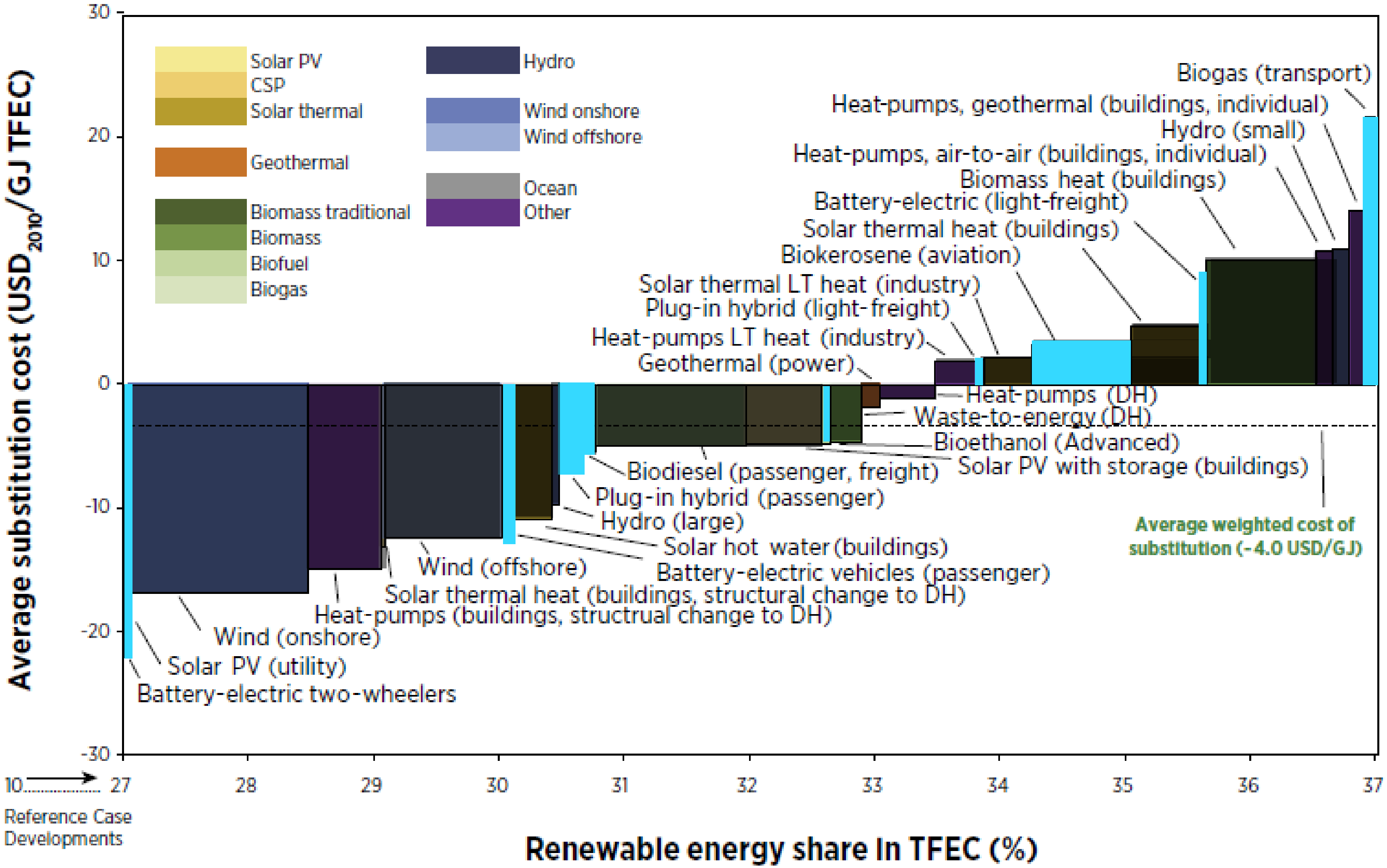
TRANSPORT SECTOR



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TRANSPORT SECTOR, ASSUMPTIONS REmap 2030

Scenario 2030

- 10% growth in biofuel use (motor fuel and aviation fuel)
- Crude oil price = USD 120 per barrel

Policies 2030

- Lower taxes and/or CO_2 price (increase the competitiveness of biofuels)

Technologies 2030

- Deployment of 6 million electric vehicles (EVs)
  - plug-in hybrid vehicles, battery-electric vehicles and light-freight vehicles
- EVs cost is slightly higher than internal combustion engine vehicles, even though battery costs will have declined
- EVs are twice as efficient as internal combustion engine vehicles

  → low contribution to total renewable energy share

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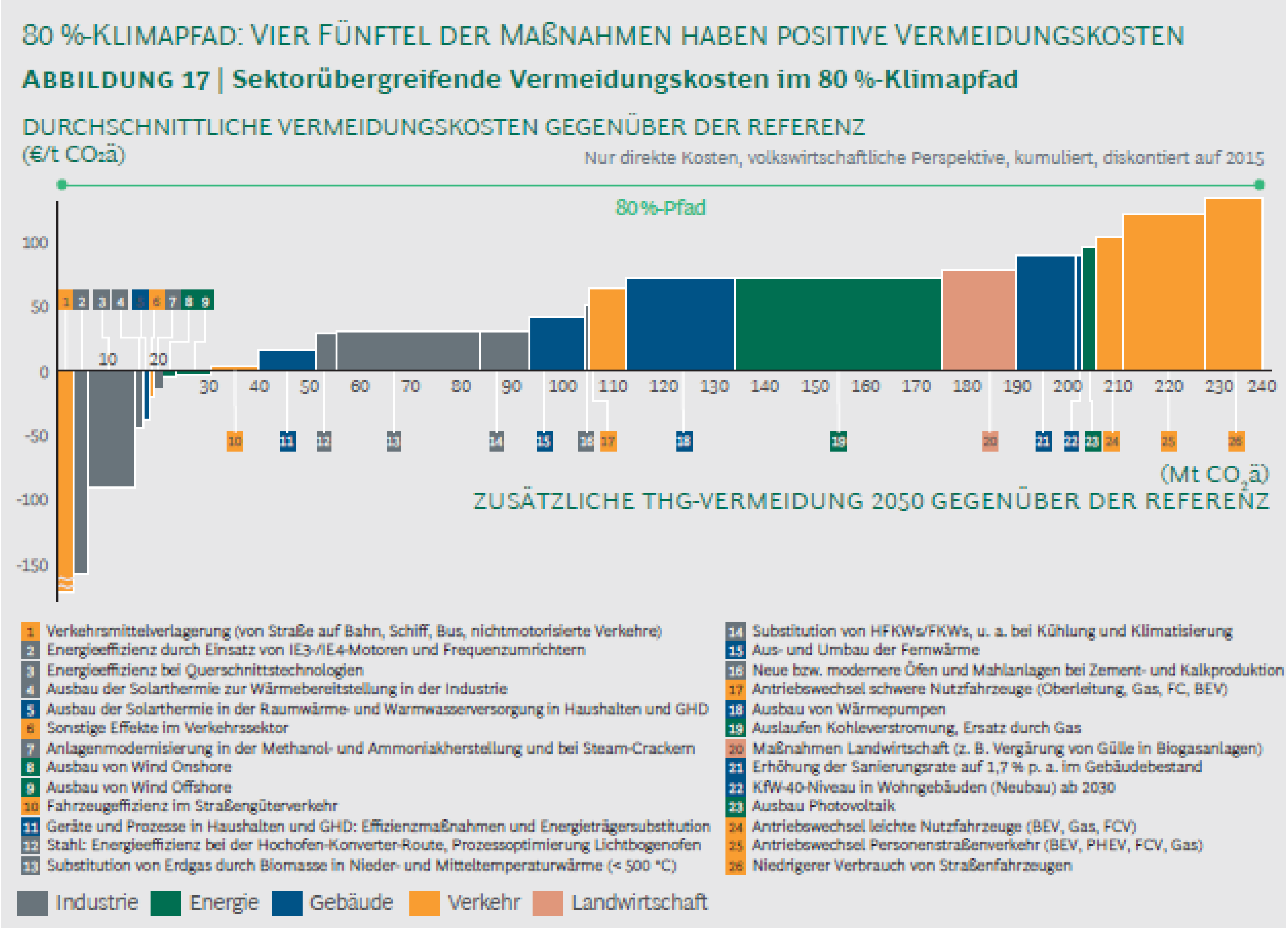
BCG 2018

ABATEMENT COST CURVES

- Bottom-up aggregation of information
- 200 experts
- Discussion of existing findings, new approaches to reducing emissions, assumptions, technology potentials, costs, opportunities and fields of action.



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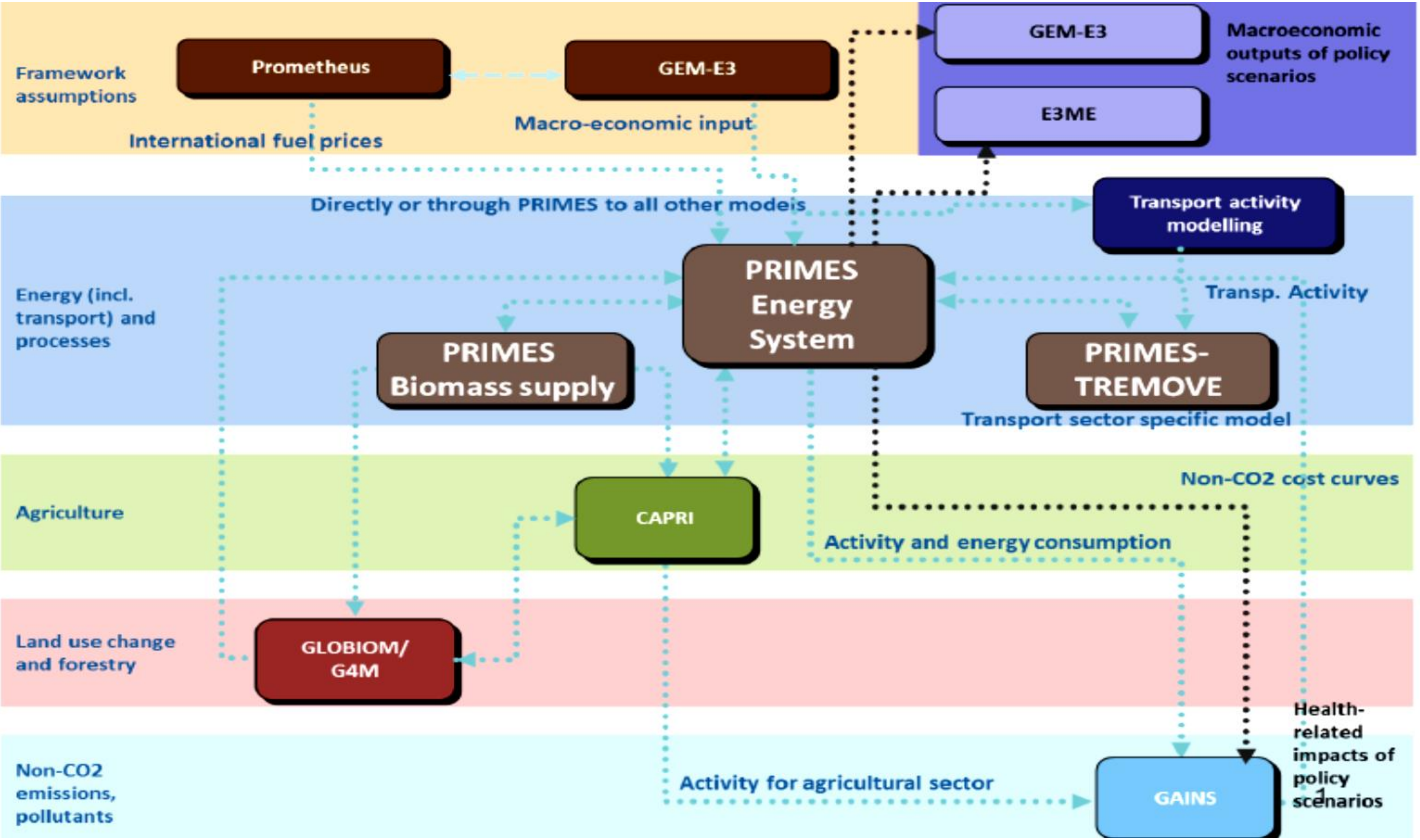
European Commission 2017



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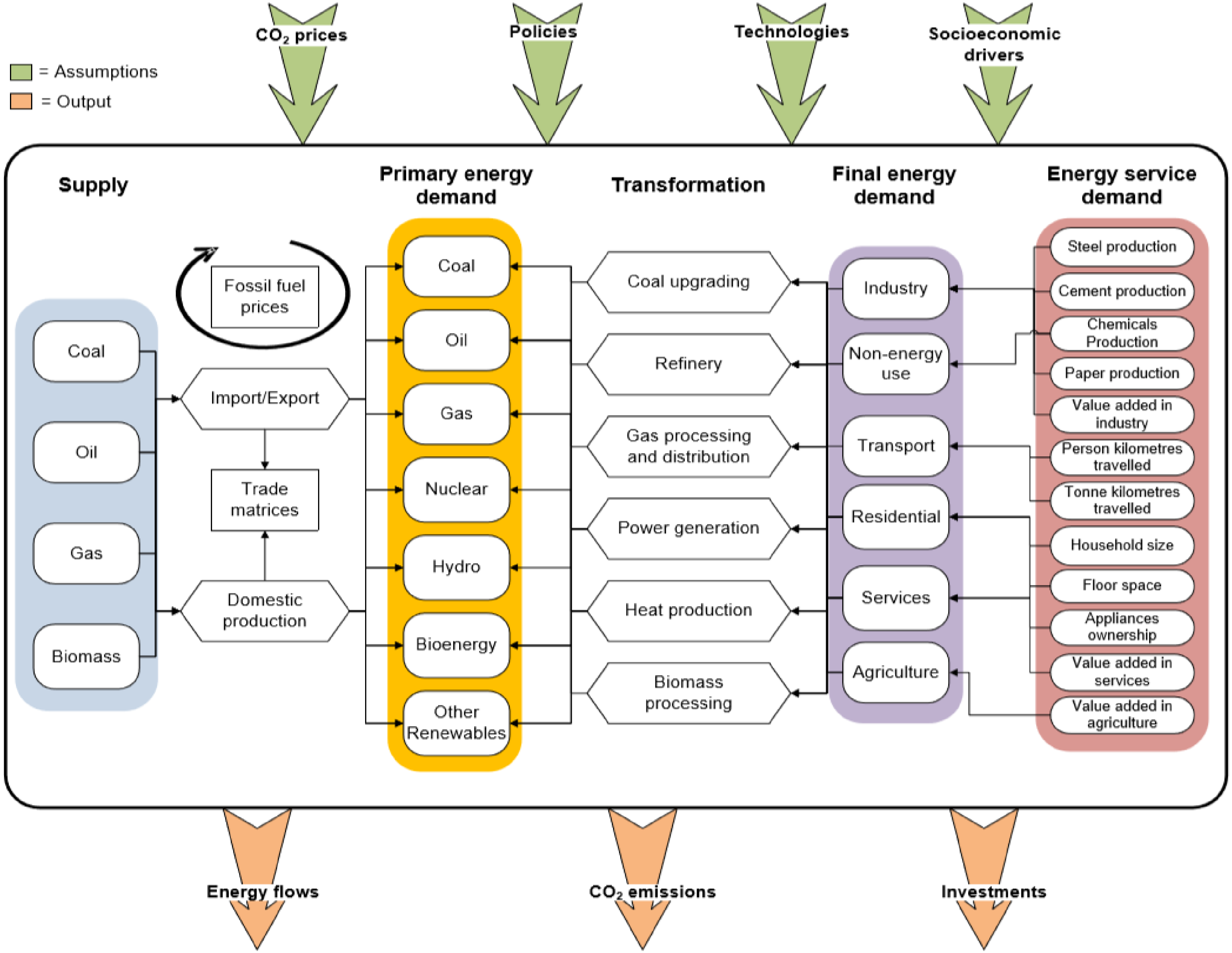
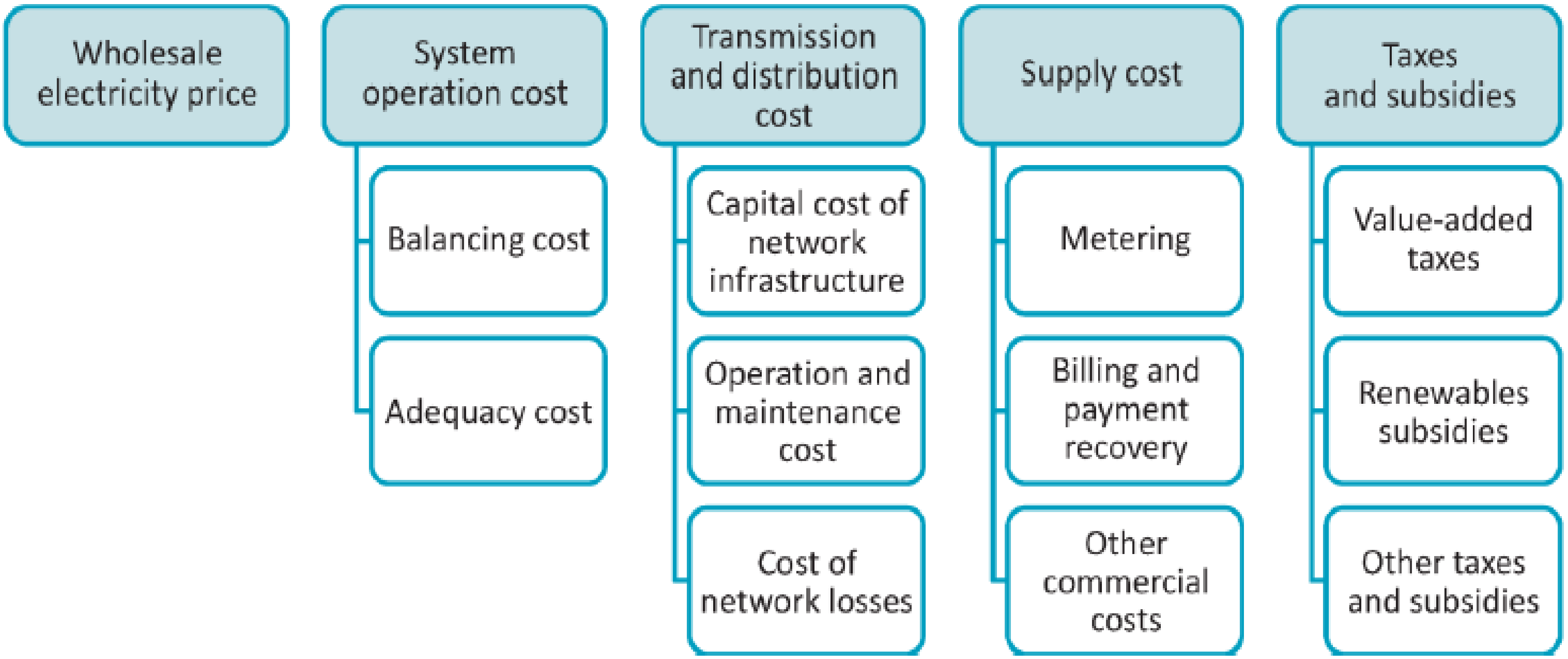

= Assumptions
= Output
CO2 prices
Policies
Technologies
Socioeconomic drivers
Supply
Primary energy demand
Transformation
Final energy demand
Energy service demand
Coal
Oil
Gas
Biomass
Fossil fuel prices
Import/Export
Trade matrices
Domestic production
Coal
Oil
Gas
Nuclear
Hydro
Bioenergy
Other Renewables
Coal upgrading
Refinery
Gas processing and distribution
Power generation
Heat production
Biomass processing
Industry
Non-energy use
Transport
Residential
Services
Agriculture
Steel production
Cement production
Chemicals Production
Paper production
Value added in industry
Person kilometres travelled
Tonne kilometres travelled
Household size
Floor space
Appliances ownership
Value added in services
Value added in agriculture
Energy flows
CO2 emissions
Investments

Determinants of energy supply



Inputs

Capital Cost projections

Capital costs of a technology decrease at learning rates (available from literature) with each doubling of the installed cumulative capacity

Operation & Maintenance Costs projections

Database of RE projects' costs of installing, operating and maintaining RE technologies within a given country

Technological Performance

- Nameplate Capacity VS Capacity factor
- Conversion efficiency of a technology
- Substitution factor (SF) of a technology for another

Intermediate Outputs

Annualized cost of a technology = annuity * overnight capital cost * installed capacity + annual O&M cost + annualized fuel and electricity costs

Annual electricity (MWh) or district Heat (PJ) generation = Total installed capacity * capacity factor

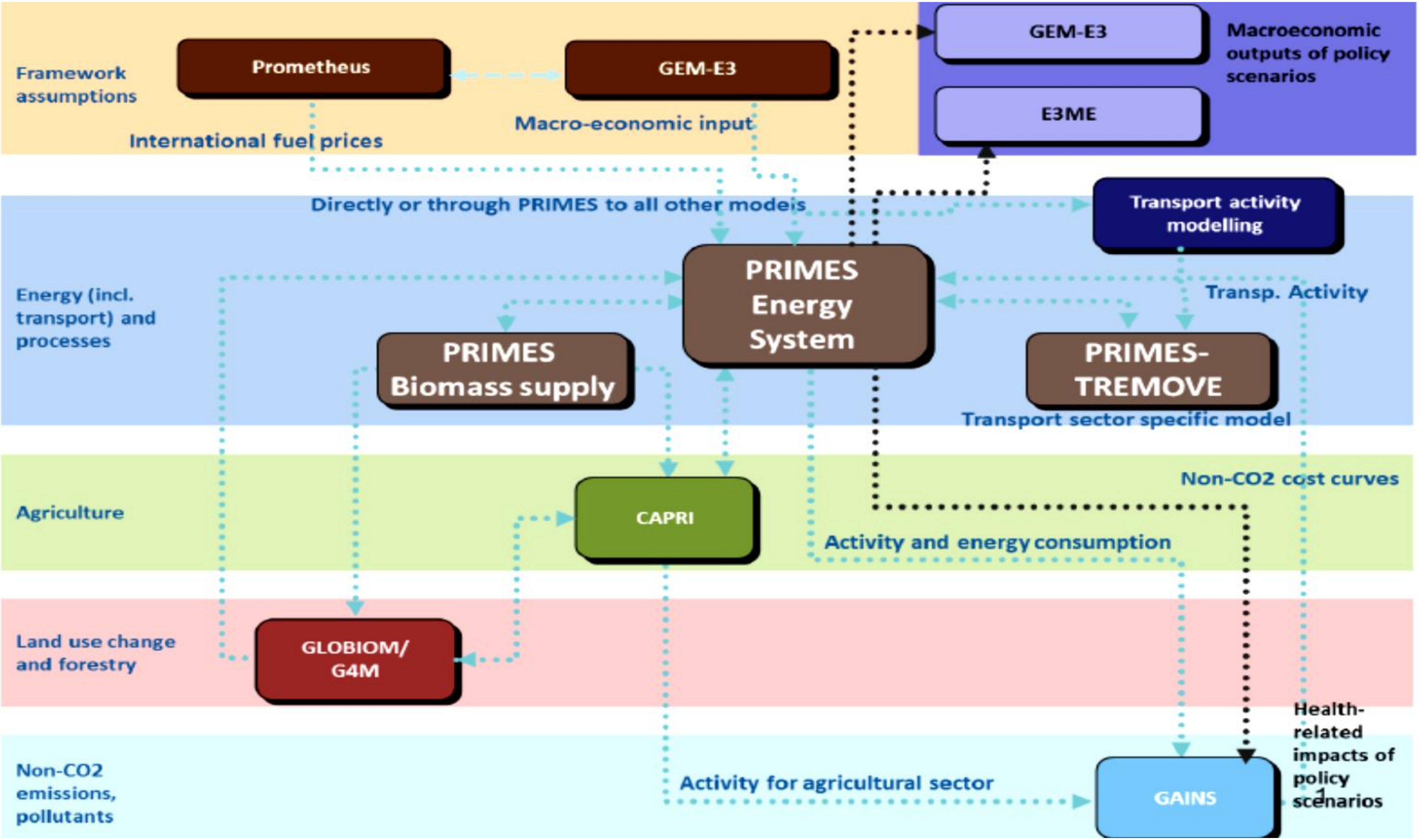
- Substitution cost for energy transformation (end-use) sectors = annualized cost of RE technology to generate 1 PJ of electricity or heat (useful energy) – annualized cost of non-RE technology to generate the same 1 PJ / total RE electricity (final energy used) to generate that 1 PJ

Final Outputs

TECHNOLOGY COST-SUPPLY CURVE: cost difference per unit of final energy consumed if one replaces conventional energy technologies assumed to be in place in 2030 in the Reference Case with renewable energy (RE) technologies.

- Business perspective – energy taxes, subsidies and local cost of capital are included
- Government perspective – taxes, subsidies and cost of capital are not included

EC 2017



Framework assumptions
Prometheus
GEM-E3
International fuel prices
Macro-economic input
GEM-E3
E3ME
Macroeconomic outputs of policy scenarios
Energy (incl. transport) and processes
Directly or through PRIMES to all other models
Transport activity modelling
PRIMES Energy System
PRIMES Biomass supply
Transp. Activity
PRIMES-TREMOVE
Transport sector specific model
Agriculture
CAPRI
Non-CO2 cost curves
Activity and energy consumption
Land use change and forestry
GLOBIOM/ G4M
Non-CO2 emissions, pollutants
Activity for agricultural sector
GAINS
Health-related impacts of policy scenarios

PRIMES Partial equilibrium modelling system:

- energy demand and supply

INPUTS

- Simulation of energy consumption and the energy supply system (both at EU and MSs levels)
- Emission abatement technologies, and technology vintages.
- EU carbon price trajectories
- Forward looking decision making behaviour, grounded in micro economic theory.
- complemented by sub-modules:
    - transport sector module (PRIMES-TREMOVE)
    - PRIMES biomass supply module
    - other modules

PRIMES-TREMOVE Transport Model

- projects the demand for passengers and freight transport (by transport mode and transport mean).
- Interaction of transport demand allocation module and technology choice and equipment operation module.

When coupled with PRIMES energy system model, interaction of the different energy sectors is taken into account in an iterative way.

Dynamic system of multi-agent choices under several constraints.

PRIMES Biomass economic supply model

- optimal use of biomass/waste resources and investment in secondary and final transformation
- consumer prices of final biomass/waste products
- consumption of other energy products in the production, transportation and processing of the biomass/waste products

INPUTS

- the demand of final biomass/waste energy products, given by the rest of the PRIMES model.

GEM-E3 (World and Europe) applied general equilibrium model
- bilateral trade flows
- environmental flows

→Dynamic interactions between the economy, productive sectors, consumption, price formation of commodities, labour and capital, investment and dynamic growth – driven by accumulation of capital and equipment.
- Technology progress is explicitly represented in the production function.
- The model represents also the energy system and the environment.

Prometheus stochastic model
- future world energy prices, supply, demand and emissions
- world fossil fuel price projections are used as import price assumptions for PRIMES.

GAINS - Greenhouse gas and Air Pollution Information and Simulation model
- projection and mitigation of greenhouse gas emissions at detailed sub-sectorial level,
- air pollution impacts on
  human health from fine particulate matter and ground-level ozone,
  vegetation damage caused by ground-level ozone,
  acidification of terrestrial and aquatic ecosystems and excess nitrogen deposition of soils.

GLOBIOM - Global Biosphere Management recursive dynamic partial equilibrium model
- agricultural and forestry production and bioenergy production
  - 28 (or 50) world regions,
  - 20 most important crops,
  - different livestock production activities, forestry commodities and energy transformation pathways.

G4M - geographical agent-based Global Forestry Model
- assessment of afforestation-deforestation-forest management decisions.

CAPRI Economic partial equilibrium model
- projects agricultural activity in the EU.

BCG 2018

1. Dynamic input-output model including 72 economic areas.

2. Bottom-up aggregation of information
   1. Almost 200 experts from BCG, Prognos, BDI, 70 companies and associations were gathered over 7 months in five working groups and more than 40 workshops,
   2. discussing existing findings, new approaches to reducing emissions were developed, assumptions validated and technology potentials, costs, opportunities and fields of action.
   - Advantages: objective and broadly secure basis of facts as of today.

Factors included in the analysis:

- business capital and labour demand,
- wage and price dynamics,
- technological progress,
- production capacity and many other variables are modelled separately for each industry.

• RoW environment is provided by Prognos AG's global economic forecasting and simulation model.

CPI 2017

Energy Supply and Demand factors are based on WEO model

Supply and demand of a country are then matched depending on:

(i) total supply costs;
(ii) expected prices for the different markets (domestic versus import/export);
(iii) changes in expected supply and demand;
(iv) whether or not demand can be met with domestic supply;
(v) whether physical assets (dedicated pipelines, etc.) or contracts/market practice (long-term gas supply contracts indexed on oil prices, etc.) shape future export/import trade.

Once supply and demand have been matched, CPI calculates the value of each country's annual production under each scenario, sum the discounted annual production values to today's money, and assess the magnitude of loss in value to producers because of the change in scenarios (i.e. the stranding).

Output:

- investment needs impact of a switch from fossil fuels to renewable,
- reduction of oil use in the transport sector.