
IEA-ETSAP Technology Collaboration Programme and Modelling Tools

Annex XIV: Understanding & Facilitating the Energy Transition
to Achieve the 'Well Below 2°C' Goal

Prof. Brian Ó Gallachóir

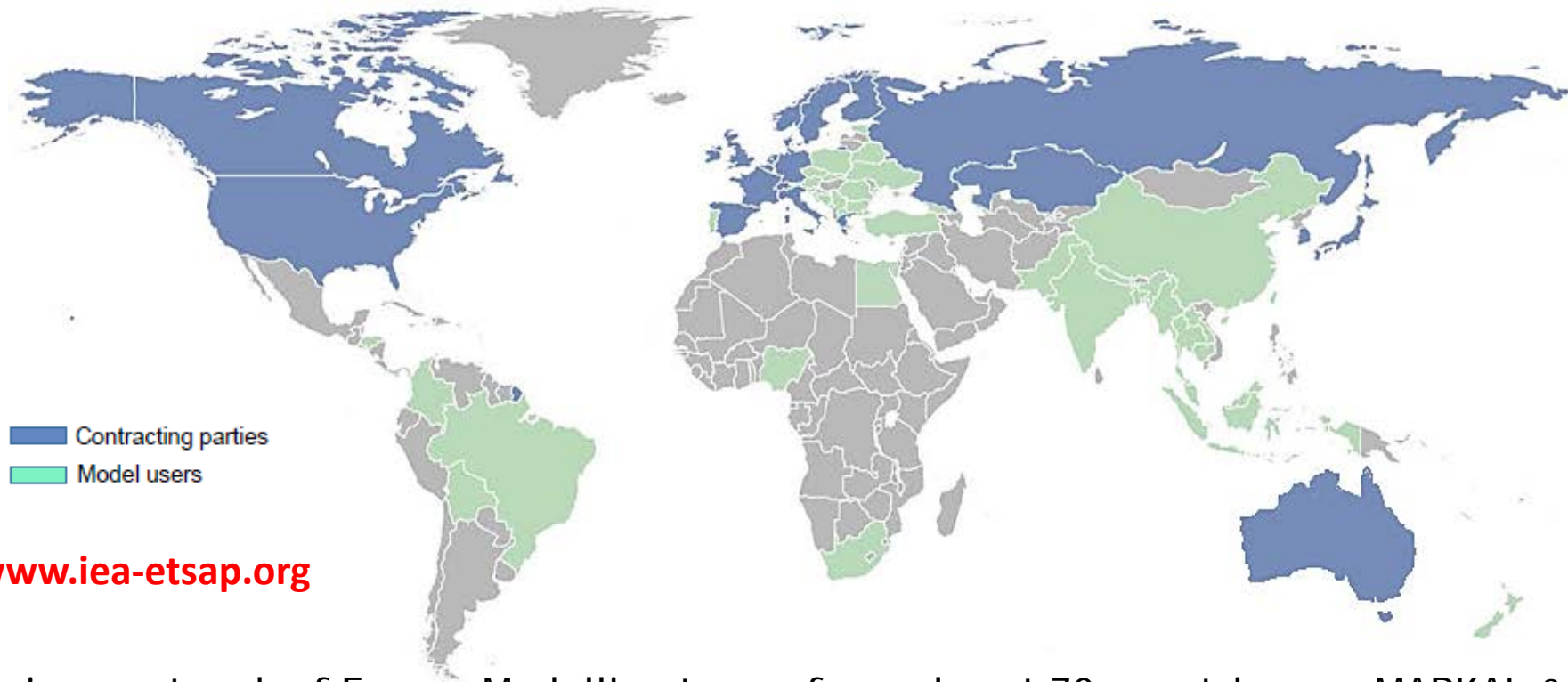
Chair IEA ETSAP TCP Executive Committee

IEA ETSAP Workshop on Energy Models & Applications

Research Centre for Gas Innovation, Universidade de São Paulo, Brazil

Jan 30 2017

- One of 39 **IEA Technology Collaboration Programmes**
www.iea.org/tcp/
- 40 years international **cooperation** on energy **systems** modelling (since first oil crisis)
- **Developing and maintaining** (MARKAL and TIMES) tools
- **Assisting policy decisions** by modelling possible future **energy pathways**
- Focus on key role of **technology** to meet goals
- Biannual **workshops** and **training**



www.iea-etsap.org

Unique network of Energy Modelling teams from almost 70 countries use MARKAL & TIMES models analyse energy systems and support decision making in energy policy.

Participants

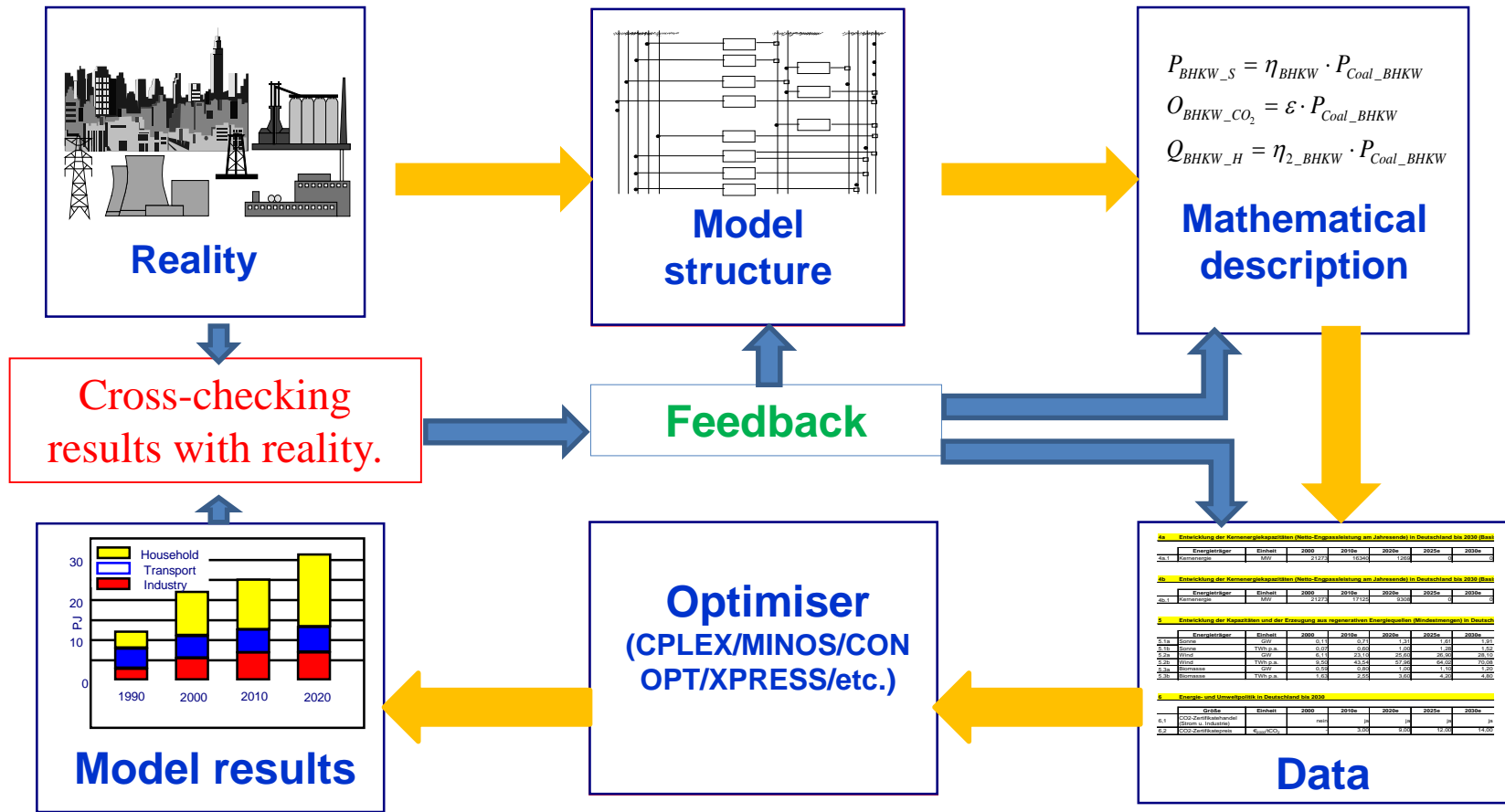
Australia	CSIRO	Japan	IEEJ
Belgium	VITO/SPW/Brussels	Kazakhstan	NURIS
Denmark	DEA	Korea	KEA
EC	JRC	Netherlands	ECN
Finland	TEKES/VTT	Norway	IFE
France	ADEME/DGEMPEDAD/EDMP	Russia	ERI-RAS
Germany	IER	Spain	CIEMAT
Greece	CRES	Sweden	STEM
Ireland	SEAI	Switzerland	PSI
Italy	ENEA	UK	DBEIS
Sponsor	Enel Foundation	US	DOE/BNL
Sponsor	GE Global Research		

XIV	2017-19	Understanding & Facilitating the Energy Transition to Achieve the well below 2°C Goal
XIII	2014-16	Tools for Analysis of a Future Energy Revolution
XII	2011-13	Policy Analyses Tools for Global Sustainability
XI	2008-11	JOint STudies for New & Mitigated Energy Systems
X	2005-07	Global Energy Systems and Common Analyses
IX	2003-05	Energy Models User's Group
VIII	2002-05	Exploring Energy Technology Perspectives
VII	1999-01	Contributing to the KYOTO Protocol
VI	1996-98	Dealing with uncertainty together
V	1993-95	Energy options for sustainable development
IV	1990-92	Greenhouse gases and national energy options
III	1987-89	International forum on energy environment studies
II	1984-86	Information exchange project
I	1981-83	Energy technology systems analysis programme
	1978-80	MARKAL Model generator development (BNL, KFA)
	1976-77	Analysis of tools for evaluating R&D strategies

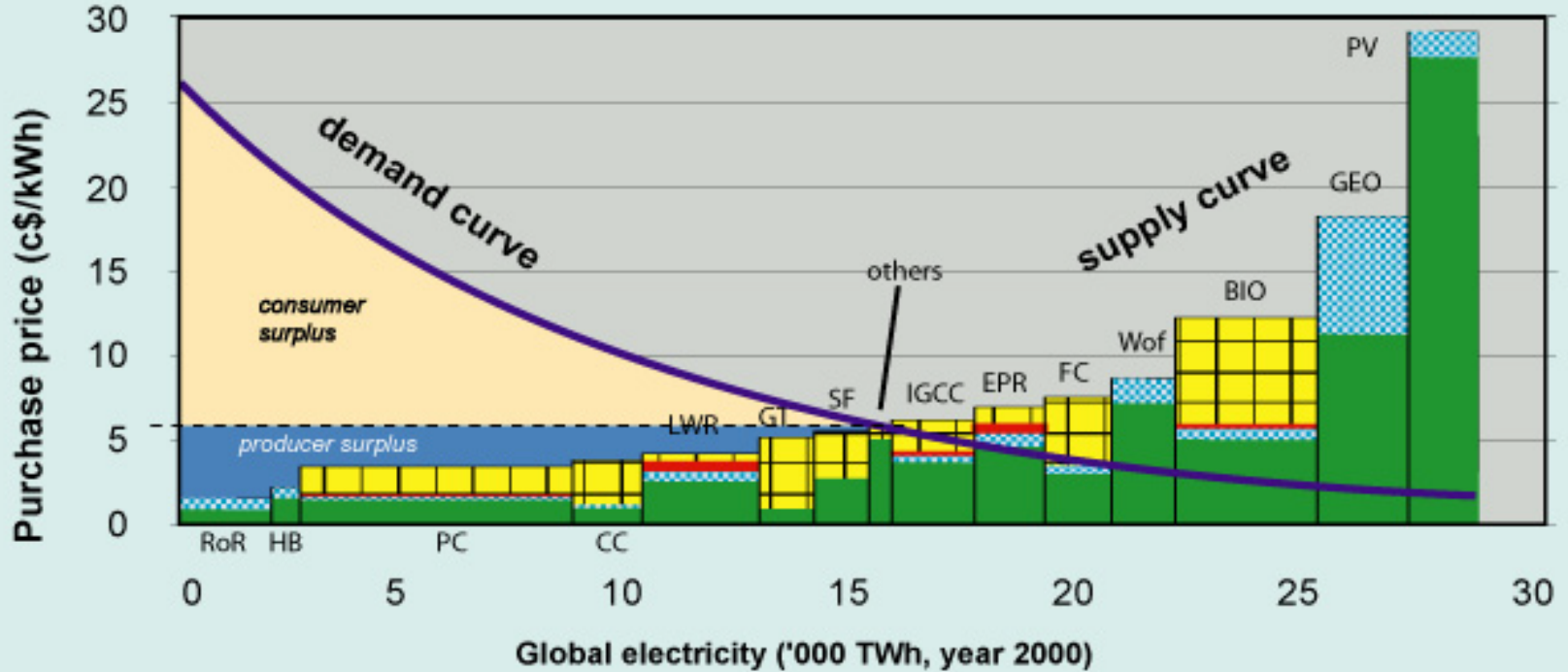
Research and Development

ETSAP will support research and development activities in order to advance the state-of the art of energy systems analysis. A non-exhaustive list of topics includes:

1. Climate **mitigation** responding to the policy ambition aiming for “well below 2° C”;
2. Incorporating impacts of R&D in TIMES to capture the **role of innovation**;
3. Exploring the interplay between differences in **long term and short term** policy ambition;
4. Energy Technology Data Source (**E-TechDS**) updates;
5. Improved modelling of **variable renewables** and short term system operational issues in long term energy systems modelling;
6. New approaches for integrating **human behaviour** into energy systems modelling; and
7. Improved modelling of the interactions between the energy system and the **economy**



- linear programming **bottom-up** energy model
- integrated model of the **entire** energy system
- **medium to long term** prospective analysis (20 - 50 years)
 - Demand driven (exogenous) in physical units
- **partial and dynamic** equilibrium (perfect market)
- optimal **technology** selection
- **minimize** the total system **cost**
- environmental **constraints**
- energy and emission permits **trading**
- price-elastic **demands**



Investment

O+M

Waste

Fuel

$$NPV = \sum_{r=1}^R \sum_{y \in YEARS} (1 + d_{r,y})^{REFYR-y} \bullet ANNCOST(r, y)$$

where:

NPV is the net present value of the total cost (the OBJ);

ANNCOST(y) is the total annual cost in year y;

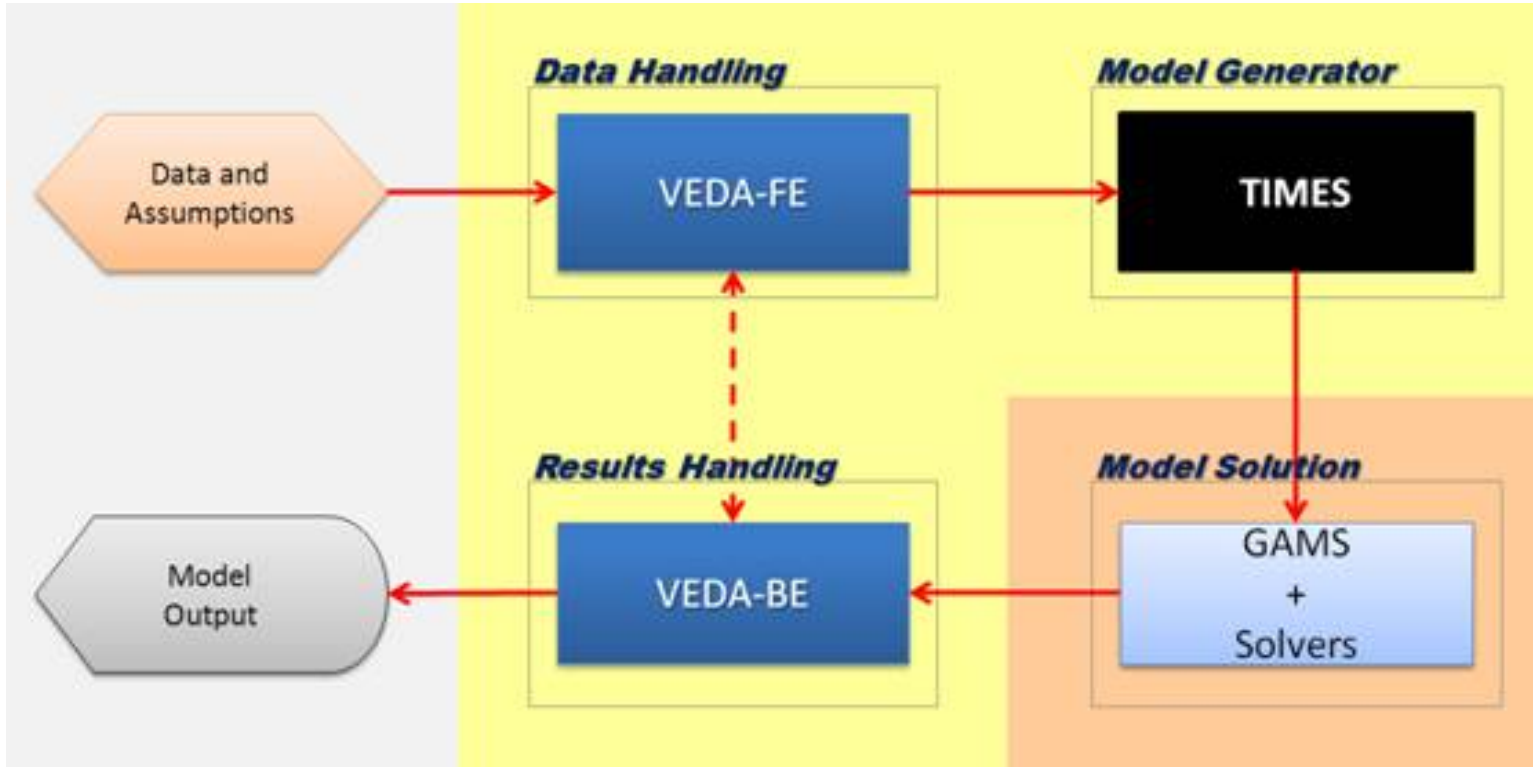
$d_{r,y}$ is the general discount rate;

REFYR is the reference year for discounting (2005);

YEARS is the set of years for which there are costs in the horizon

r is the region

- **Capital Costs** incurred for investing and dismantling plant;
- Fixed and variable Operation and Maintenance (**O&M**) Costs;
- Costs for exogenous **imports** and for **domestic** resource production;
- Revenues from exogenous **exports**;
- **Delivery costs** for required fuels consumed by plant;
- **Taxes** and **subsidies** associated with fuel flows and plant activities;
- **Salvage** value of plant at the end of the planning horizon;
- **Welfare loss** resulting from reduced end-use demands.



Given...

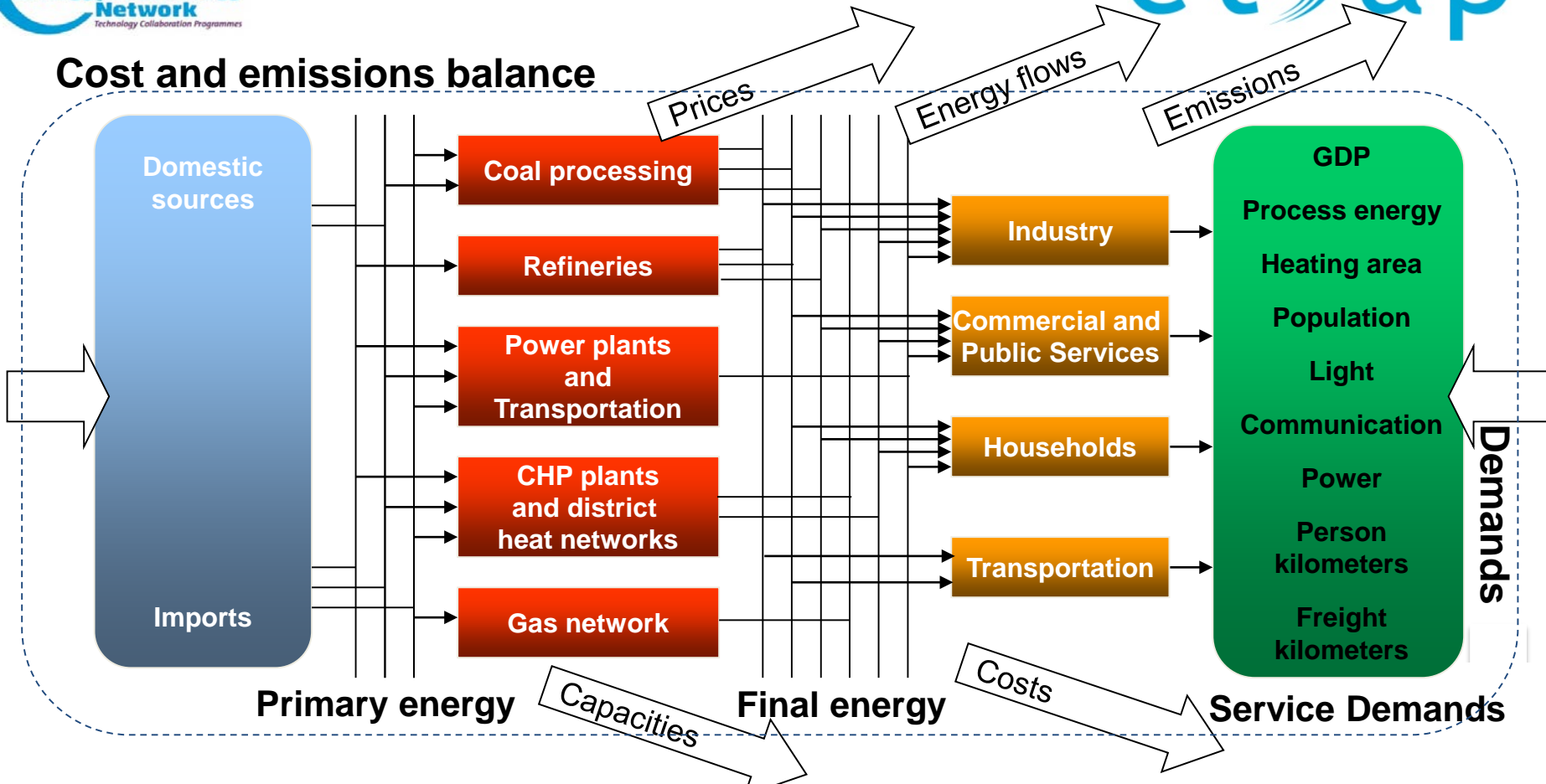
- technology data (e.g. 1300)
- service demands (e.g. 73)
- import fuel prices
- Supply curves
- emission constraints
- other parameters
 - discount rate
 - time horizon definition
 - time slice definition

Models provide...

- technology investments
- technology activities
- emission trajectories
- adjusted demands
- marginal energy prices
- imports/exports
- total system cost

Cost and emissions balance

Energy prices, Resource availability



Annex XII Report > 300 publications 2011-2013 (including 110 peer-review papers) from:

- i) **Global Models:** incl. IEA ETP model, original TIMES Integrated Assessment Model (TIAM), derived TIAM models, ETSAP-TIAM model
- ii) **Regional Models:** Pan-European TIMES model, MARKAL-TIMES Models for Europe, Asia and North America.

Multi-regional models

iii) **National Models** of 32 countries (including China).

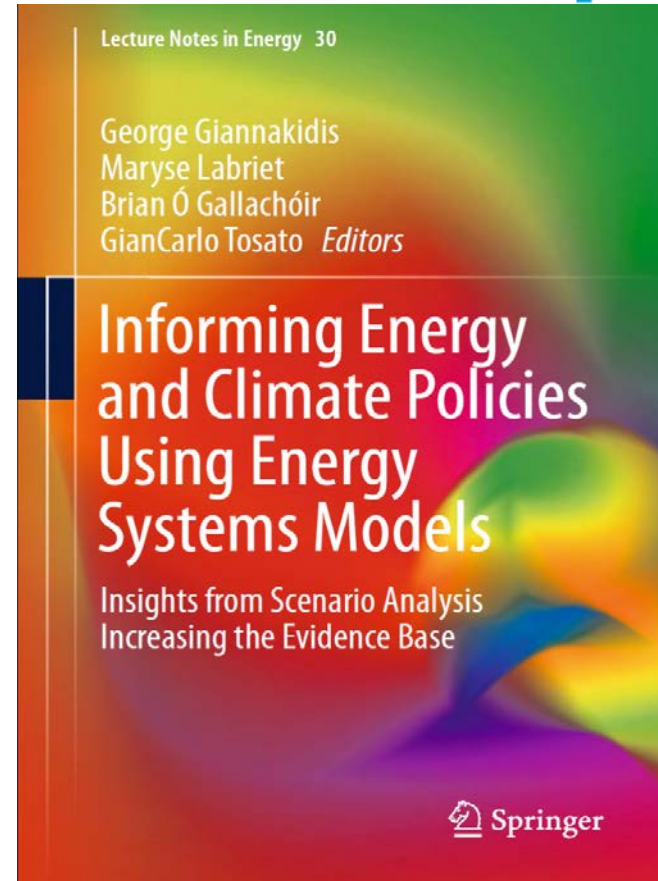
iv) **Sub-National Models:** Western China, Reunion Island (France), Lombardy (Italy), Pavia (Italy), and Kathmandu Valley (Nepal).

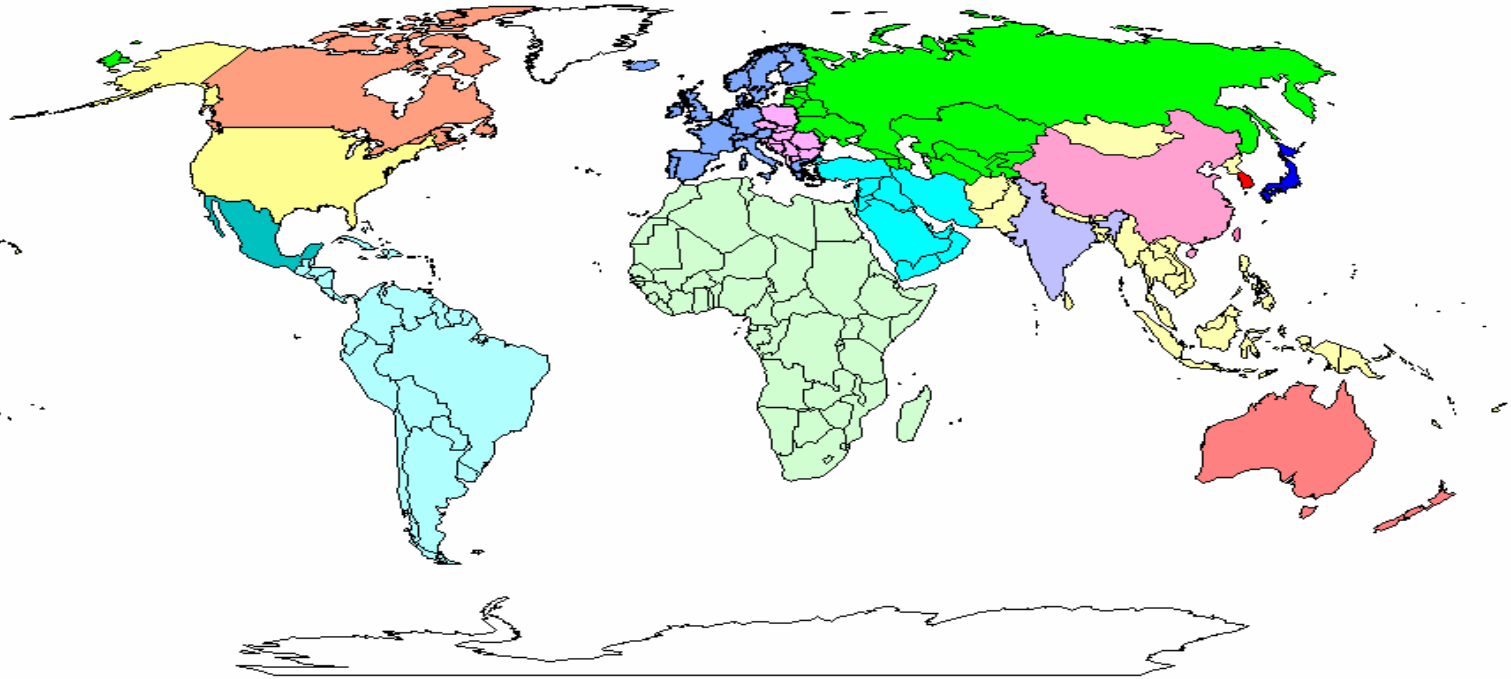
v) **Local Models** for rural areas and cities in Austria, Germany and Italy, other bigger cities such as Madrid (Spain), Beijing, Guangdong and Shanghai (China), Johannesburg (South Africa) and New York City (United States).

http://iea-etsap.org/finreport/ETSAP_Annex_XII_Final%20Report.pdf

- Methodologies and case studies
- Demonstrating use of energy systems models
- Support energy and climate policy
- Critical analysis of rich and varied applications
- Includes diverse global case studies
- Role of technology in energy systems

www.springer.com/gp/book/9783319165394





- Global model (ETSAP-TIAM) now available in addition to modelling tools (TIMES)
- 15 Region global TIMES model available to ETSAP Contracting Parties
- Developed by GERAD and currently updated by ETSAP Collaborative Project
- Includes several thousand technologies and models climate forcing

- distributed to 10 ETSAP Contracting Parties
- available on request by participants
- several projects have used TIAM:
 - EMF-22, EMF-24 (Stanford, US)
 - Low Carbon Society (**NIES, Japan, UK-ERC, ...**)
 - IPCC-IAMC, special report on Renewable Scenarios
 - IEA-RETD, Achieving Climate and Energy Security (ACES)
 - EC-FP7, REACCESS on Energy Corridors for EU
 - Asian Modelling Exercise
- currently being updated and re-calibrated in ETSAP project led by DTU

- \geq two **workshops** per annum on energy systems modelling
 - <http://iea-etsap.org/index.php/workshops>
 - Cork, Ireland May 30-31 2016
 - Madrid, Spain Nov 17-18 2016
 - Tokyo, Japan Dec 14 2016
 - Sao Paulo, Brazil Jan 30 2017
 - Maryland, USA July 10-11 2017
- joint organiser of IEW (International Energy Workshop), Maryland, USA, July 12-14 2017
- Deliver \geq 2 **training courses** for the ETSAP tools biannually
 - Tokyo, Japan Dec 15-16 2016
 - Torino, Italy Jan 2017
 - Sao Paulo, Brazil Jan 31 – Feb 1 2017
 - Maryland, USA July 12-14 2017

- \geq Two workshops per year, one organized together with IEW
- 3-5 TIMES model training sessions around the world
- approx 200 teams involved from the whole world
- access to support and discussion forums
- jobs within TIMES modelling
- new tools and analyses are shared
- close collaboration with IEA, IRENA, Worldbank, etc.
- documentation:
 - Annex report - http://www.iea-etsap.org/finreport/ETSAP_Annex_XII_Final%20Report.pdf
 - Meetings - <http://www.iea-etsap.org/index.php/community/official-documents>
 - Projects - <http://www.iea-etsap.org/index.php/etsap-projects>
 - Model generator & user interface - <http://www.iea-etsap.org/index.php/documentation>
 - Technologies - <http://www.iea-etsap.org/index.php/energy-technology-data>

Advantages:

- have the right to be **represented** at the **Executive Committee** and to participate with one vote the all decisions;
- **free access** to the ANSWER, VEDA-FE, VEDA-BE users' interfaces, updates and related preferential assistance to the IEA-ETSAP members;
- **access** to the annual calls for proposals of IEA-ETSAP **funded** research projects;
- **access** to the global multi-regional TIMES Integrated Assessment Model - **TIAM** (with endogenous trade of energy and CO₂ permits, stochastic variables and climate equations) and continuous updates;
- **free access** to the **training** courses (offered at least twice a year);
- increased chances to be part of **consortia coordinated by IEA-ETSAP** members for submitting projects to International Funding Agencies (USAID, EC, etc.)

Cost: €20 000 per annum

- Ministry of Mines and Energy (MME) participates in three TCPs focusing on renewables (bioenergy, concentrated solar and hydropower)
- Petrobras participates in IEA-GHG TCP (as a Sponsor)
- Further TCPs are in dialogue with MME, the Funding Authority for Studies and Projects (FINEP) and technology-specific research organisations (e.g. involved in CCS, HEV, etc.)
- Prospects for Brazil to join IEA-ETSAP?

IEA-ETSAP Technology Collaboration Programme and Modelling Tools

Annex XIV: Understanding & Facilitating the Energy Transition
to Achieve the 'Well Below 2°C' Goal

Prof. Brian Ó Gallachóir

Chair IEA ETSAP TCP Executive Committee

IEA ETSAP Workshop on Energy Models & Applications

Research Centre for Gas Innovation, Universidade de São Paulo, Brazil

Jan 30 2017