Improving the Energy-Water-Material Nexus toward sustainable future in East Asia

E3ME-FTT modelling: Part 2 - Chapter 8* and Chapter10*

Unnada Chewpreecha

*Jean-Francois Mercure (lead author)

uc@camecon.com

5 August 2016

Outline of the presentation

- E3ME Overview
- Methodology Part 2 Chapter 10
- FTT Transport
- Methodology Part 2 Chapter 8
- FTT Industry

cambridge econometrics

E3ME Overview

Detailed Coverage

- 59 regions (33 European, 26 World)
- 70/44 economic sectors and 42/28 consumption categories
- 23 fuel users of 12 fuels

Comprehensive

- whole energy, environment and economy system
- two ways feedbacks between each module
- many policy instruments

Highly Empirical

- 1970-2014 database
- 23 stochastic equations
- no prior assumptions
- econometrics specification allows for short-medium and long term analysis

Consistent

- based on system of national accounting
- input-output tables
- bilateral trade

Forward Looking

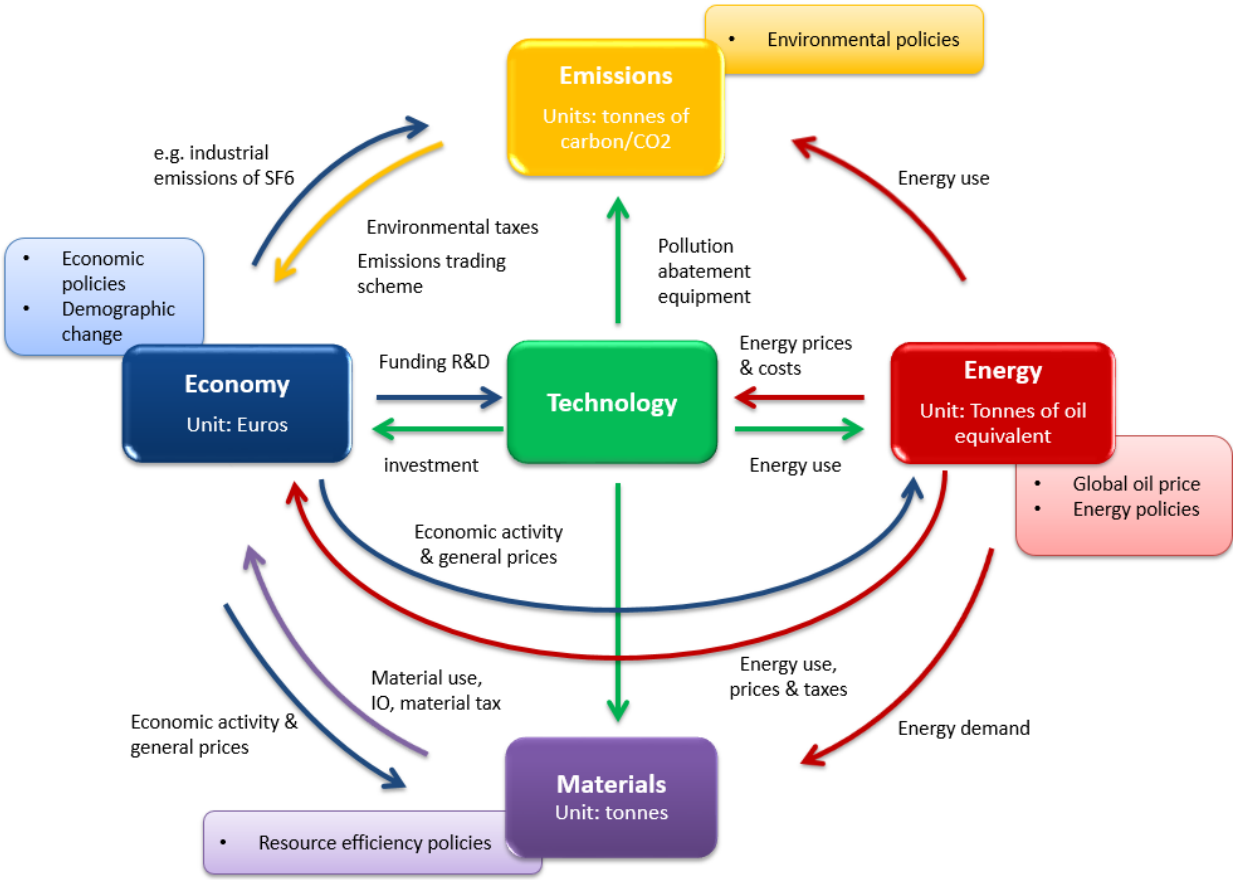
- annual projections to 2050
- behavioural equations with effects from previous outcomes
- ex-ante scenario analysis (ex-post is also feasible)

Modular

- E3: Energy, Environment, Economy and material modules
- power generation and transport sub-modules
- research can be decentralised

cambridge econometrics

E3ME E3 Linkages



E3ME Latest Developments

- New regions (Africa and Middle East regions)
- Endogenous energy price – global resources database
- FTT-Transport
- Gender specific employment demand (Europe only)
- WEO 2015 baseline

cambridge econometrics

Part 2: Chapter 10

Decarbonising transport systems

E3ME-FTT Transport

- FTT: Future Technologies Diffusions
  - a group of sectoral models of technological change to calculate global emissions, using diffusion theory
  - micro-model of technology choice and substitution, given economic/policy context
- E3ME 'top-down' approach is supplemented by a set of 'bottom-up' engineering sub-models (FTT)
  - the current model version includes a detailed treatment of the electricity supply industry and road transport (FTT)
- Well-established E3ME-FTT-Power

cambridge econometrics

Private passenger transport model

FTT:Transport -- Global transport sector model

-Endogenous technology diffusion

25 technologies, 53 world regions
J-F Mercure, *Energy Policy*, 48 799-811 (2012)
(Theory forthcoming in Mercure, *J. Evolutionary Economics*, 2015)

-Parameterised on price distribution and historical diffusion

Large price distribution database
J.-F. Mercure & A. Lam, Environ. Res. Lett. 10 (2015) 064008
Diffusion trend calibrated against history
Model description forthcoming

-Current version covers personal transport, freight work is ongoing

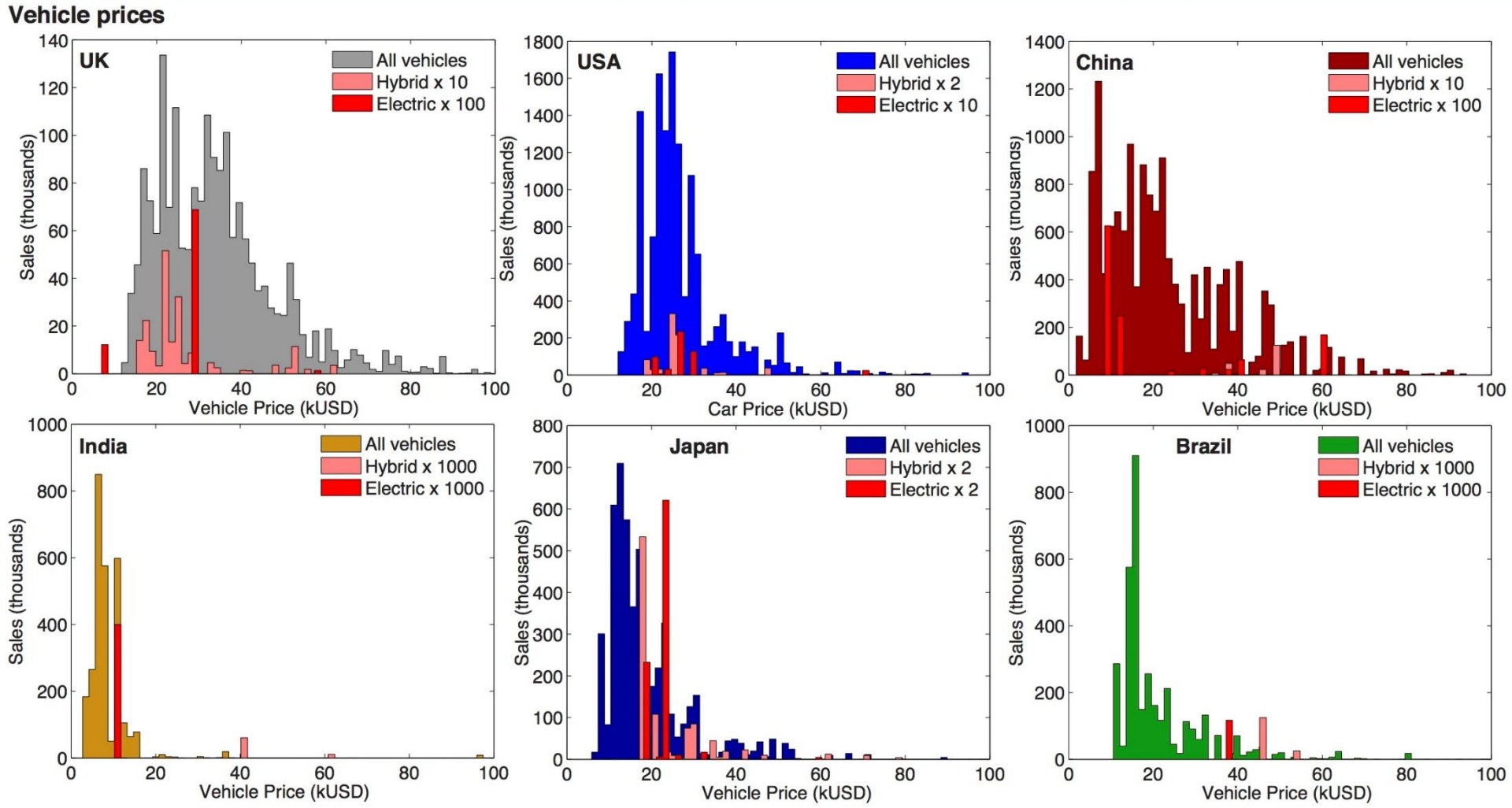
Diffusion: technology choices

The uptake of new technology:
Innovation – Selection – Diffusion

t → $t + \Delta t$

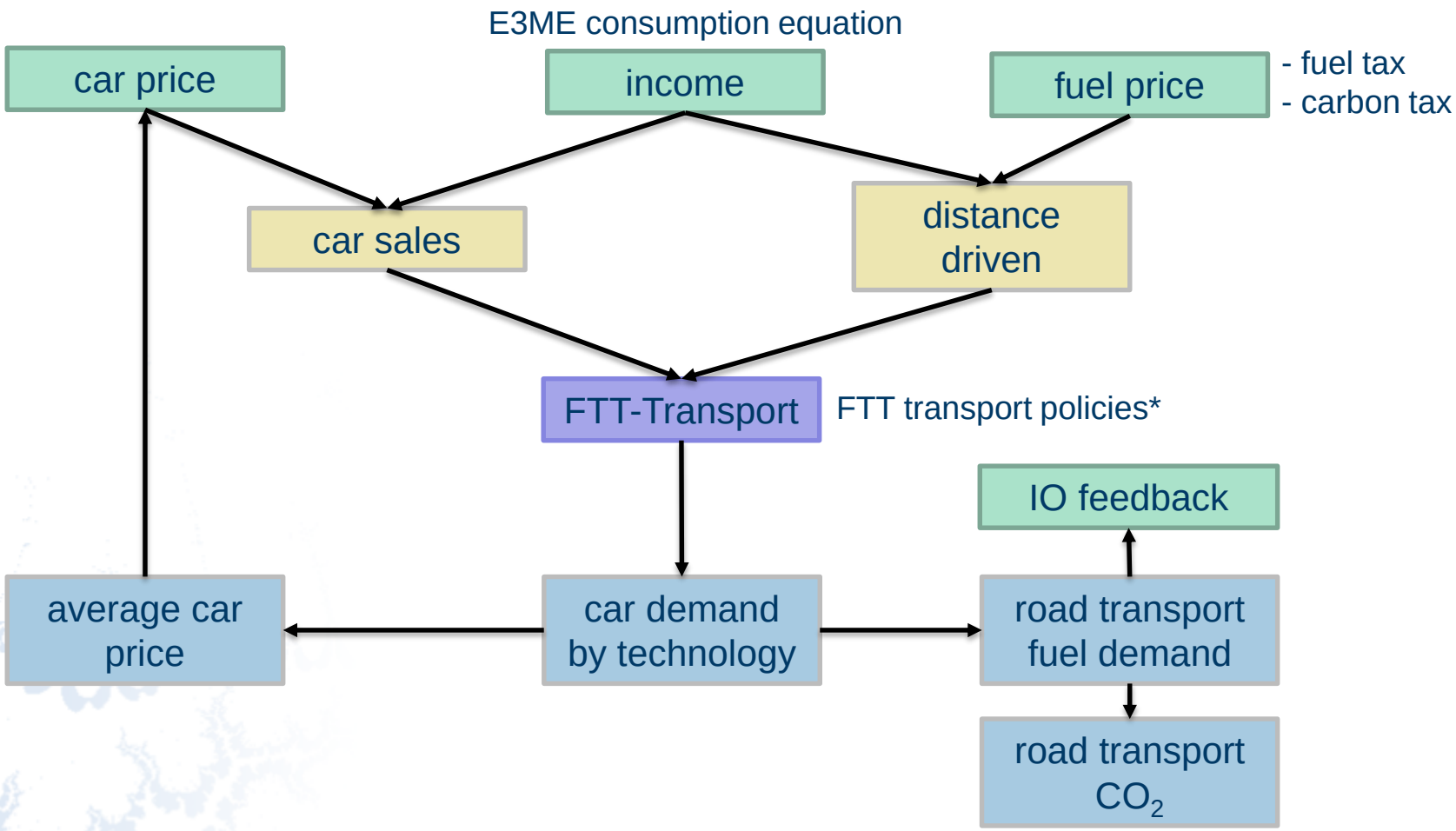
J.-F. Mercure, *Energy Policy* 48, 799-811 (2012)

Agent diversity in car markets across the globe



J.-F. Mercure & A. Lam, *Environ. Res. Lett.* 10 (2015) 064008

E3ME-FTT Transport



cambridge econometrics

E3ME-FTT Transport

* Policies available

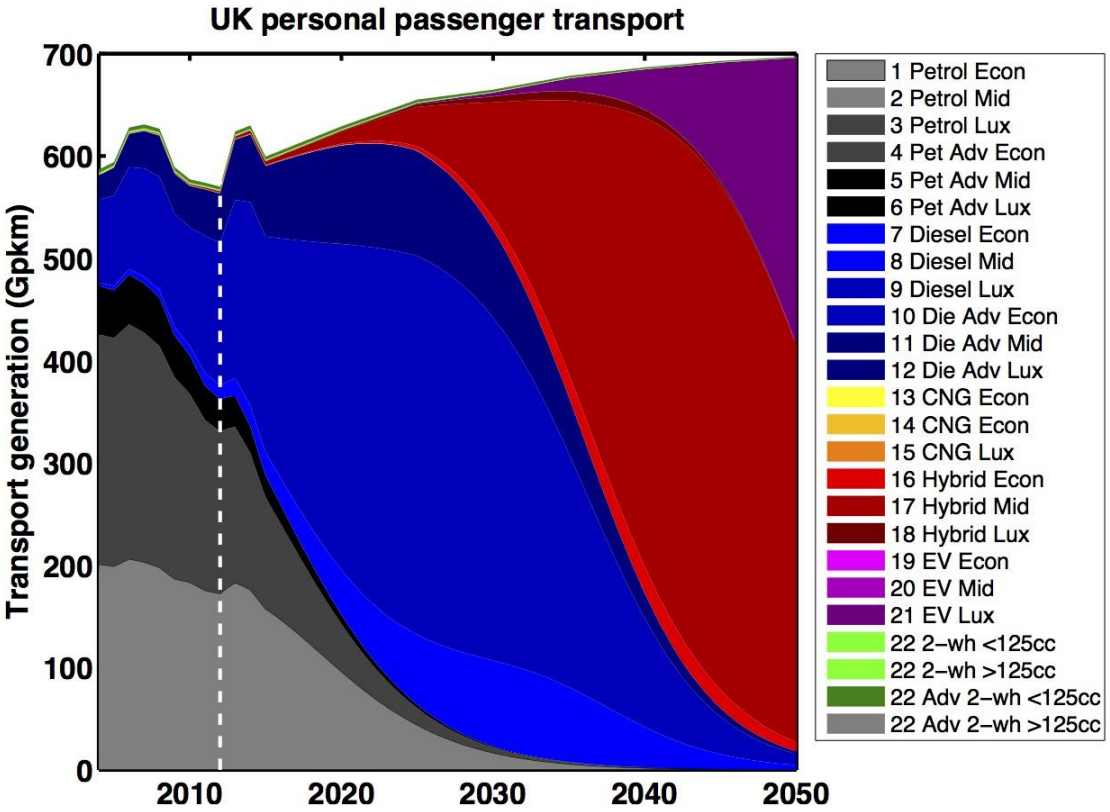
- vehicle tax
- road tax
- fuel tax (on road transport – standard E3ME)
- carbon tax (on road transport – standard E3ME)
- biofuel mandate
- regulations
- exogenous share

cambridge econometrics

The diffusion of vehicle technology

53 regions, 25 technologies

15.$UK	Prices'of'cars'(	Std'of'price"	fuel'cost'(USD	std'fuel'cost	O&M'costs'(UO&
Petrol$Econ	18683.00	4396.00	0.095	0.013	0.038
Petrol$Mid	32185.00	8164.00	0.123	0.014	0.051
Petrol$Lux	99538.00	49455.00	0.202	0.057	0.064
Advance$Petrol$Econ	18683.00	4396.00	0.076	0.013	0.038
Advance$Petrol$Mid	32185.00	8164.00	0.110	0.014	0.051
Advance$Petrol$Lux	99538.00	49455.00	0.161	0.057	0.064
Diesel$Econ	22608.00	3297.00	0.069	0.010	0.038
DieselMid	33755.00	7065.00	0.077	0.015	0.051
Diesel$Large	54793.00	14601.00	0.118	0.025	0.064
Advance$Diesel$Econ	22608.00	3297.00	0.084	0.010	0.038
Advance$Diesel$Mid$	33755.00	7065.00	0.095	0.015	0.051
Advance$Diesel$Large	54793.00	14601.00	0.095	0.025	0.064
CNG$Econ	21485.45	1000.00	0.048	0.055	0.039
CNG$Mid	37012.75	3000.00	0.071	0.069	0.056
CNG$arge	114468.70	5000.00	0.082	0.076	0.066
Hybrid$Econ	29202.00	2826.00	0.084	0.003	0.039
Hybrid$Mid	34540.00	6594.00	0.073	0.009	0.056
HybridLux	78343.00	9263.00	0.124	0.017	0.066
EV$Econ	10990.00	157.00	0.000	0.000	0.046
EV$Mid	44745.00	1256.00	0.000	0.000	0.065
EV$Lux	89961.00	2355.00	0.000	0.000	0.080
2$Wheelers$Motorcycle$Econ$	3808.00	1326.00	0.040	0.003	0.030
2$Wheelers$MotorcycleLux(>	14932.00	5760.00	0.127	0.039	0.030
Adv$Mot	3808.00	1326.00	0.040	0.095	0.030
AdvMot	14932.00	5760.00	0.095	0.095	0.030



Mercure & Lam, *In preparation* (2016)

E3ME-FTT Transport

Decarbonising road transport (Part 2 Chapter 10)

- using combination of policies
- ongoing joint paper: the 1.5°C scenario

Initial findings so far (preliminary and confidential) …

- Share of electric vehicle do not rise to high percentage by 2050 (except in few countries)
- hybrid come in between 30-40 and high efficiency ICE → possible reason for slow electric car uptake
- high efficiency ICE vehicle come into the mix → reduce fuel use but not fast enough
- decarbonisation takes time
- CNG also increase in countries with existing use of technology
- decarbonisation of remaining non-electric can be done using biofuels mandates but need to be careful
- global electricity consumption doesn't become too large (efficiency)
- impact on global oil price

* policy refinement and various issues still to be looked at. Freight transport is not included.

cambridge econometrics

Part 2: Chapter 8

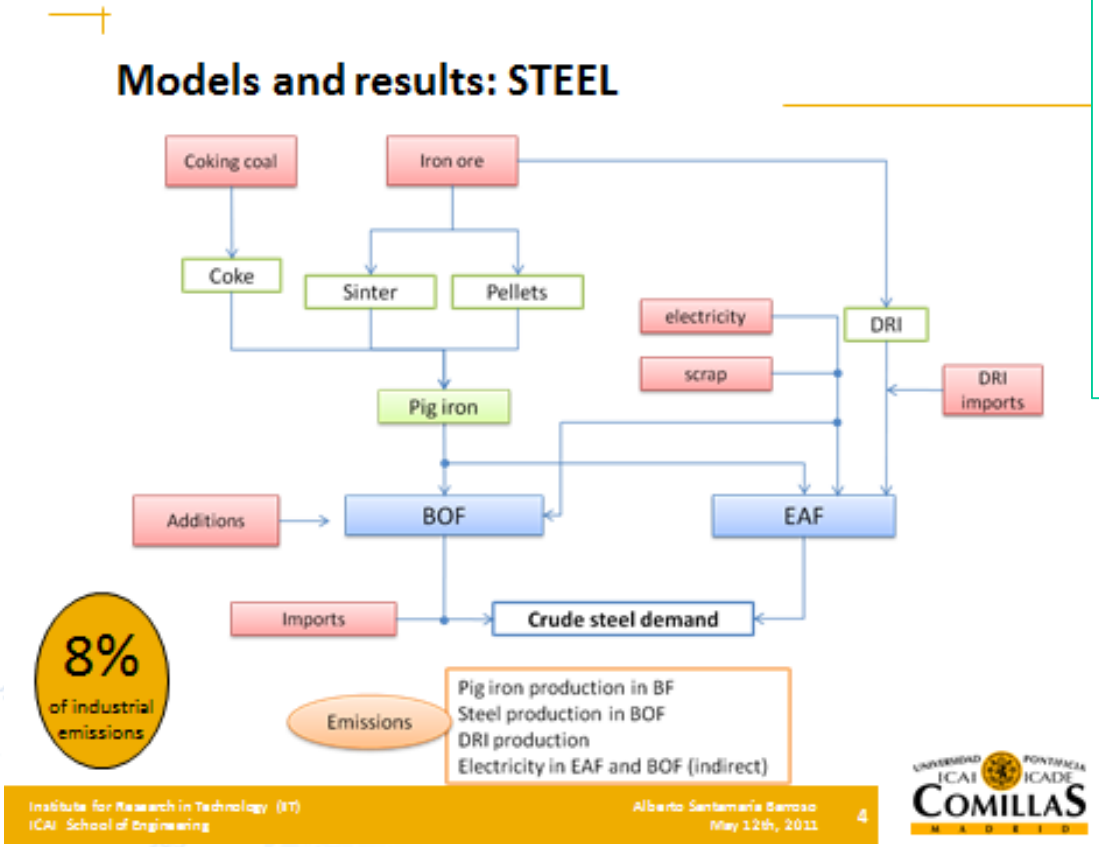
Economic impact and transition of industry under decarbonisation: under GHG emission reduction target and energy mix in 2030,2050

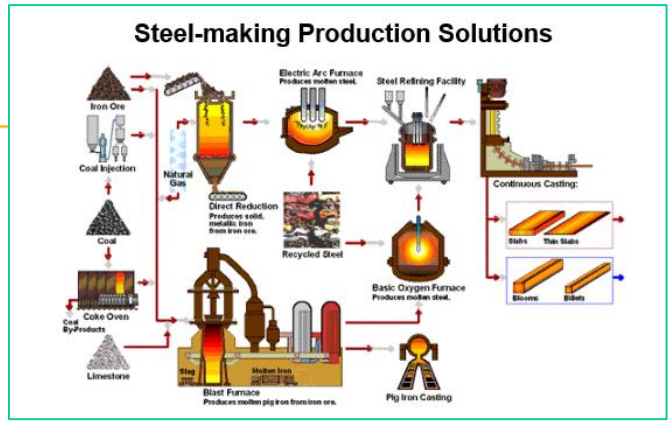
E3ME-FTT Industry

- Similar concept as FTT-Power and FTT-Transport – technology diffusions
- More complex because different industries use different production technologies

cambridge econometrics

E3ME-FTT Industry - example





© Xi'an Abundance Electric Technology Co.,Ltd

Santamaria and Linares (2011) http://www.iit.upcomillas.es/docs/IIT-11-090A.pdf

cambridge econometrics

E3ME-FTT Industry

Development stage:

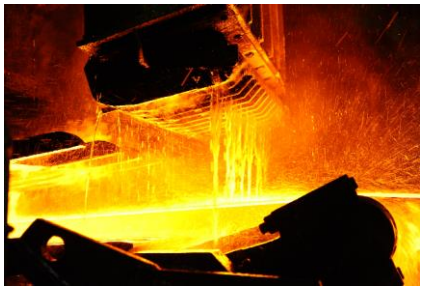
- which industries to include?
- defining technologies
- defining policy options
- data collection
- link to E3ME – inputs and feedback
  - link to E3ME raw material demand?

cambridge econometrics

E3ME-FTT Industry

Choosing sectors:

- clear distinction between different technologies
- data availability
- energy intensive



Possible sectors:

- chemical
- steel
- petroleum
- pulp and paper

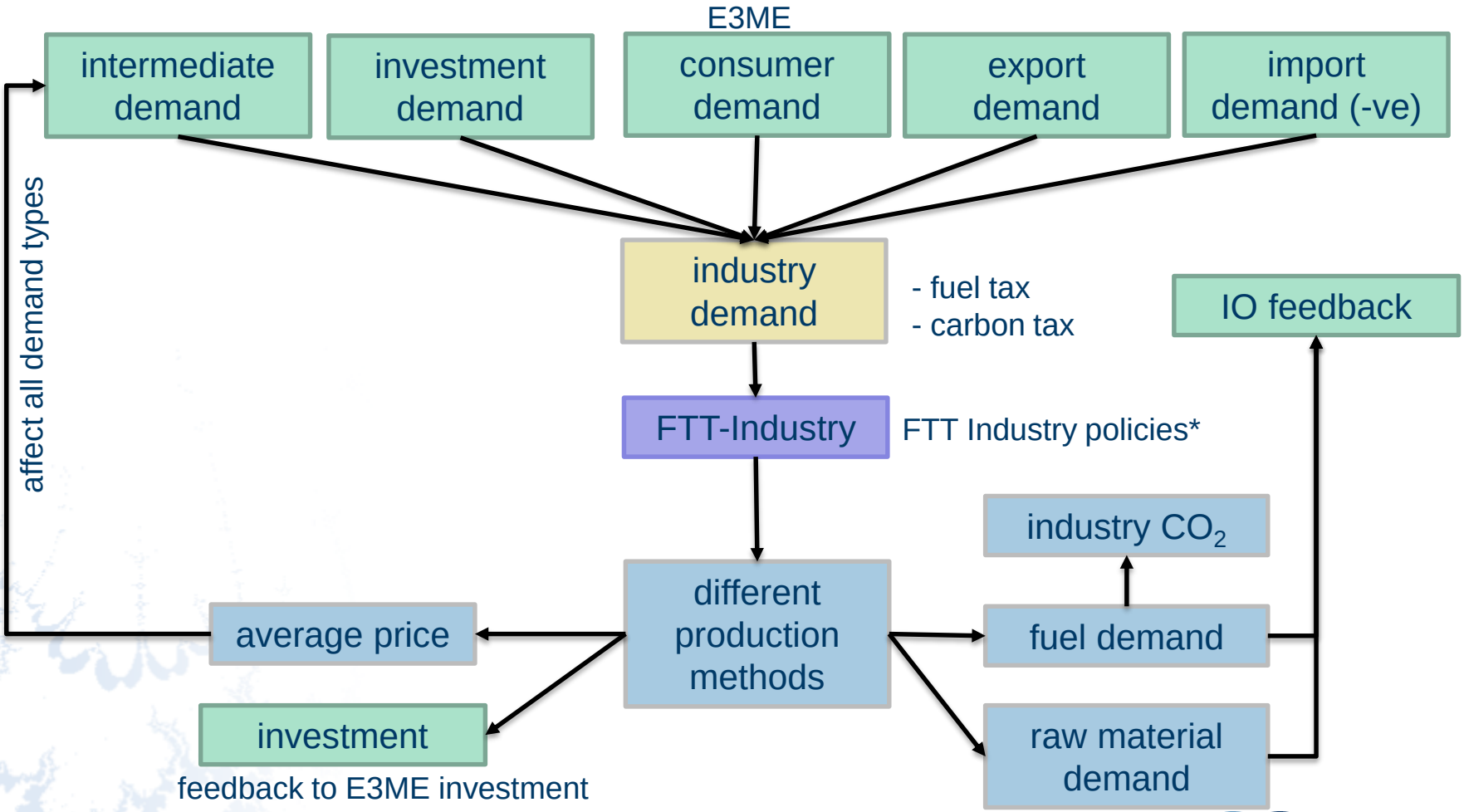
cambridge econometrics

E3ME-FTT Industry

Possible policy options:

- production tax
- energy tax (on Industries – standard E3ME)
- carbon tax (on Industries – standard E3ME)
- regulations
- exogenous share

E3ME-FTT Industry Linkages



Preliminary – subject to change

cambridge econometrics

E3ME-FTT Industry

Decarbonising industry (Part 2 Chapter 8)

- using combination of policies
- linkage to E3ME provide economic and employment impacts
  - capture rebound effects
  - two-ways interactions between energy, emissions, economy and materials

cambridge econometrics