CENTRE FOR RESEARCH INTO ENERGY DEMAND SOLUTIONS

Assessing the socio-macroeconomic impacts of the EV transition: UK case study 2020-2050

Jaime Nieto, **Paul Brockway,** Marco Sakai, John Barrett,

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Overview

1. From primary to useful energy
2. MARCO-UK: modelling at the useful stage
3. The EV transition: scenarios and results
4. Discussion

1. From primary to useful energy

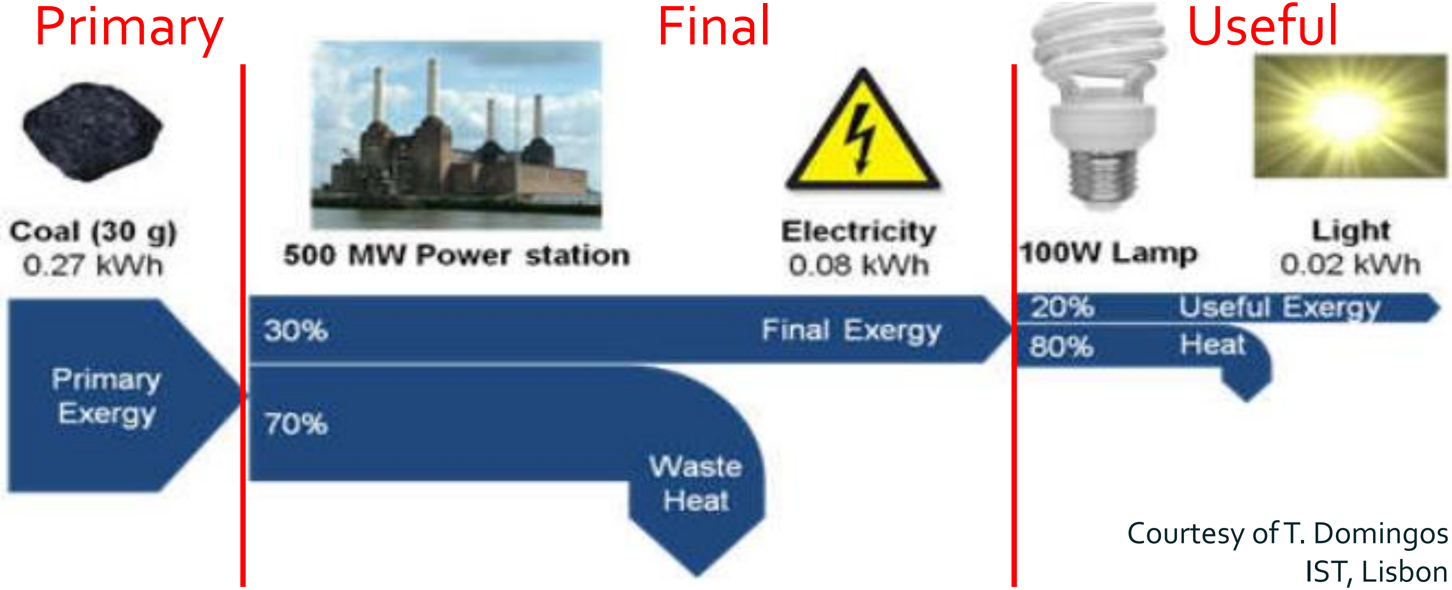
Alternative 'exergy analysis'

Traditional 'energy analysis'

Primary

Final

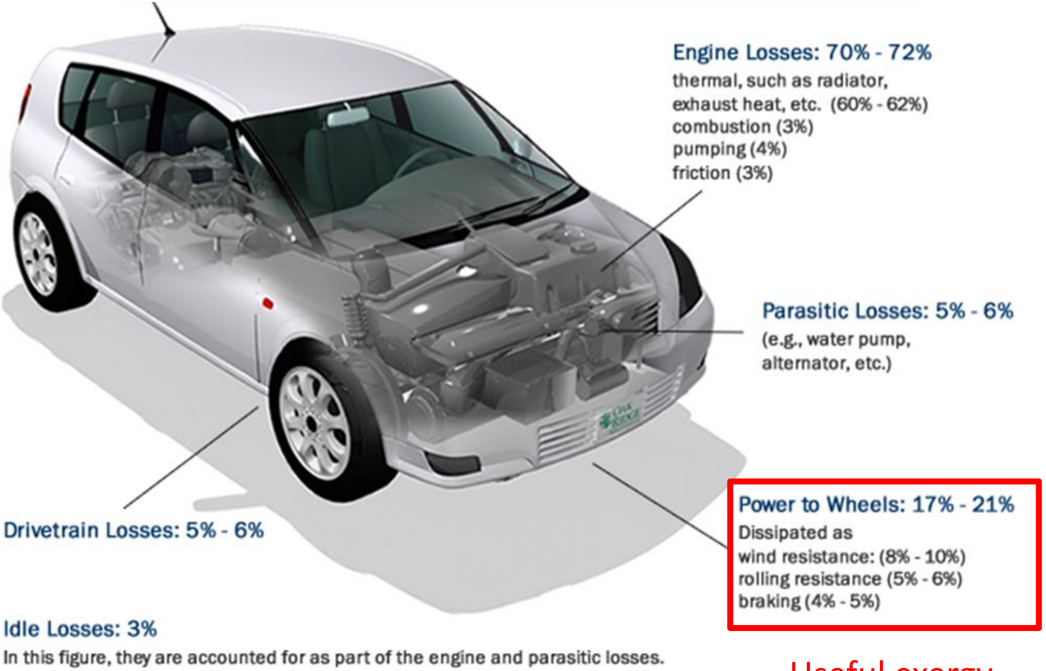
Useful



Energy services

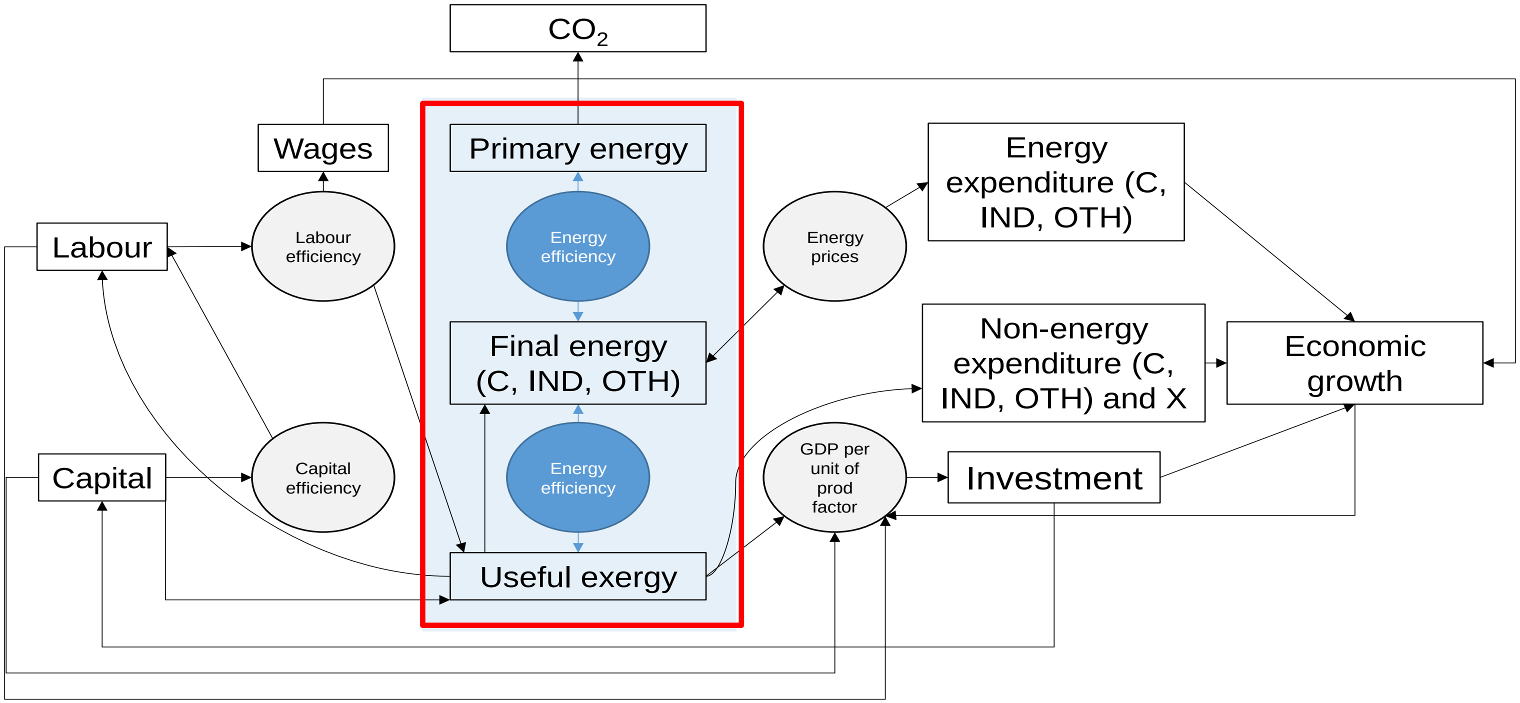
Courtesy of T. Domingos
IST, Lisbon

1. From primary to useful energy



Useful exergy

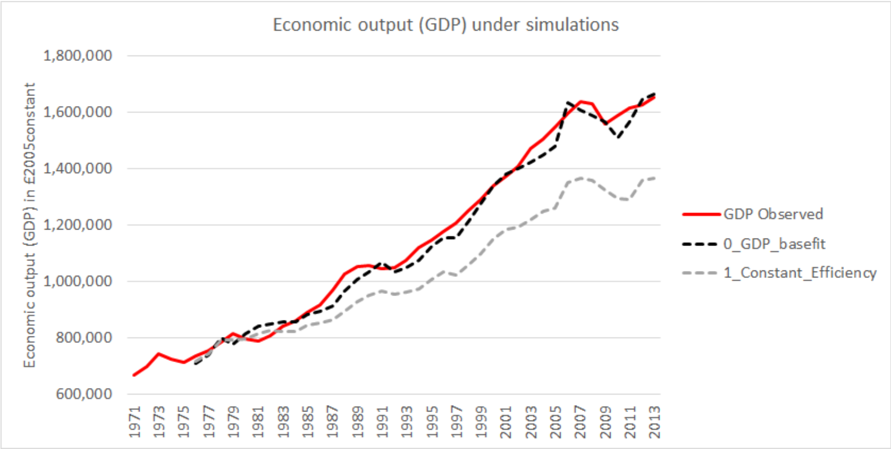
2. MARCO-UK: modelling at the useful stage



Source: Sakai et al. (2019)

2. Some outputs from MARCO-UK model

- Energy efficiency gains explain 25% of UK economic growth (close match to TFP)



Source: Sakai et al (2019)

- Largest socioeconomic benefits (+jobs, +GDP) from tightest energy target

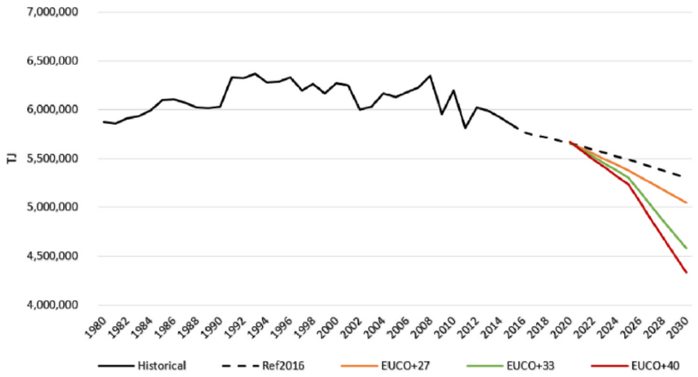


Fig. 2. UK's Total Final Energy Use by EUCO energy reduction targets.

Source: Nieto et al (2021)

3. The EV transition – happening now (at least in our house)

3. The EV transition: Input scenarios

KEY	
NOT APPLIED / BASELINE	APPLIED / LOWER
APPLIED / MEDIUM	APPLIED / HIGHER

Scenario		Code	Electrification of transport				Efficiency of Transport increased		Rebound limits		Additional Expenditure		Electricity Prices	Sectoral change	
			Electricity share in transport (%)		Oil products share in transport (%)		Final to useful efficiency in the Transport sector (%)		Maximum increase in energy services over Baseline (%)		Increase over the Baseline's **Capital Investment** in year "t" (million GBP/year)	Increase over the Baseline's **Households' Consumption** (million GBP/year)	Variation from Base Year (2018=100)	Share of Transport Equipment sector over GDP (%)	
			Base Year	2050	Base Year	2050	Base Year	2050	Base Year	2050	Average (All period)	Average (All period)	2050	Base Year	2050
Baseline	1a	_0	**1.1**	1.1	**94.8**	94.8	**28.9**	Endog	-		-	-	100	1.56	
Additional Expenditure	1b	exp 075* _exp _exp175*	**1.1**	1.1	**94.8**	94.8	**28.9**	Endog	-		+ 5,817 + 6,813 +7,810	+ 7,816	100	1.56	
EV	 2b 2a	_EV_unlim * _EV _EV_ASI	**1.1**	90	**94.8**	5	**28.9**	65.5	- **0** **0**	 **29** **0**	+ 6,813	+ 7,816	100	1.56	
Electricity Prices	2c 2d	EV_lowp EV_highp	**1.1**	90	**94.8**	5	**28.9**	65.5	**0**	**29**	+ 6,813	+ 7,816	75 130	1.56	
Reindustrialise	2e	EV_reind	**1.1**	90	**94.8**	5	**28.9**	65.5	**0**	**29**	+ 6,813	+ 7,816	100	1.56	2.22

3. The EV transition: Input scenarios

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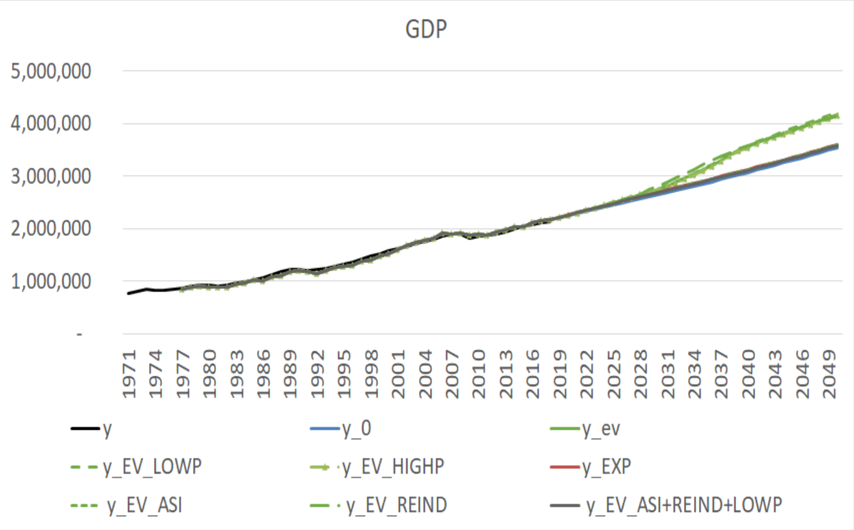
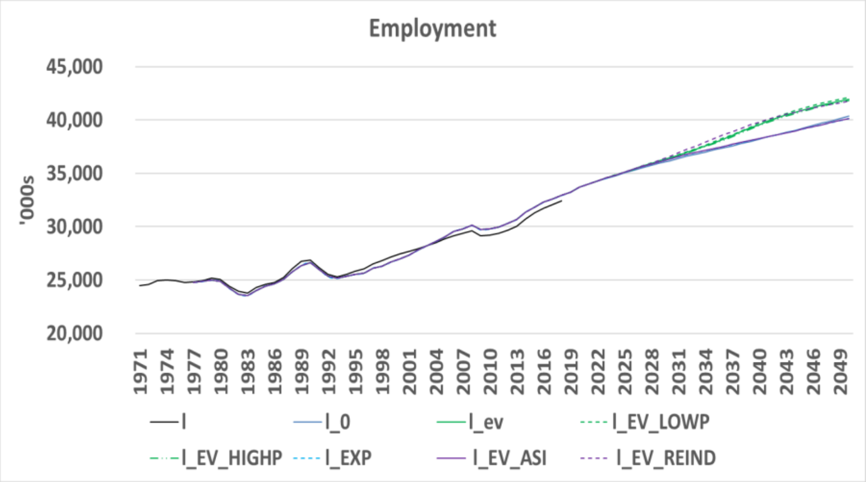
Scenario	Code		Electrification of transport: Electricity share in transport (%)		Electrification of transport: Oil products share in transport (%)		Efficiency of Transport increased: Final to useful efficiency in the Transport sector (%)		Rebound limits: Maximum increase in energy services over Baseline (%)		Additional Expenditure: Increase over the Baseline's **Capital Investment** in year "t" (million GBP/year)	Additional Expenditure: Increase over the Baseline's **Households' Consumption** (million GBP/year)	Electricity Prices: Variation from Base Year (2018=100)	Sectoral change: Share of Transport Equipment sector over GDP (%)	
			Base Year	2050	Base Year	2050	Base Year	2050	Base Year	2050	Average (All period)	Average (All period)	2050	Base Year	2050
Baseline	1a	_0	1.1	1.1	94.8	94.8	28.9	Endog	-		-	-	100	1.56	
Additional Expenditure	1b	exp_075*	1.1	1.1	94.8	94.8	28.9	Endog	-		+ 5,817	+ 7,816	100	1.56	
		_exp									+ 6,813				
		_exp175*									+7,810				
EV		EV_unlim *	1.1	90	94.8	5	28.9	65.5	-		+ 6,813	+ 7,816	100	1.56	
	2b	_EV							0	29					
	2a	_EV_ASI							0	0					
Electricity Prices	2c	EV_lowp	1.1	90	94.8	5	28.9	65.5	0	29	+ 6,813	+ 7,816	75	1.56	
	2d	EV_highp											130		
Reindustrialise	2e	EV_reind	1.1	90	94.8	5	28.9	65.5	0	29	+ 6,813	+ 7,816	100	1.56	2.22

3. The EV transition: scenarios and results

GDP: difference versus (CAAGR 1.7%) baseline in 2050:
- ASI EV scenario: 1.6% higher (+£60Bn)
- All other EV scenarios: 17-20% higher (+£650Bn) 2.1%CAAGR

Employment: versus baseline
- ASI EV scenario: 40,000 average extra jobs 2020-2050
- All other EV scenarios : 1Mn average extra jobs 2020-2050

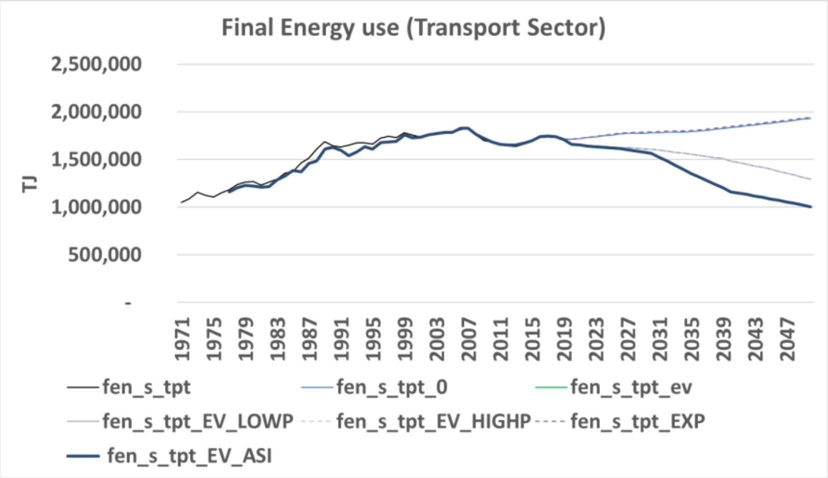


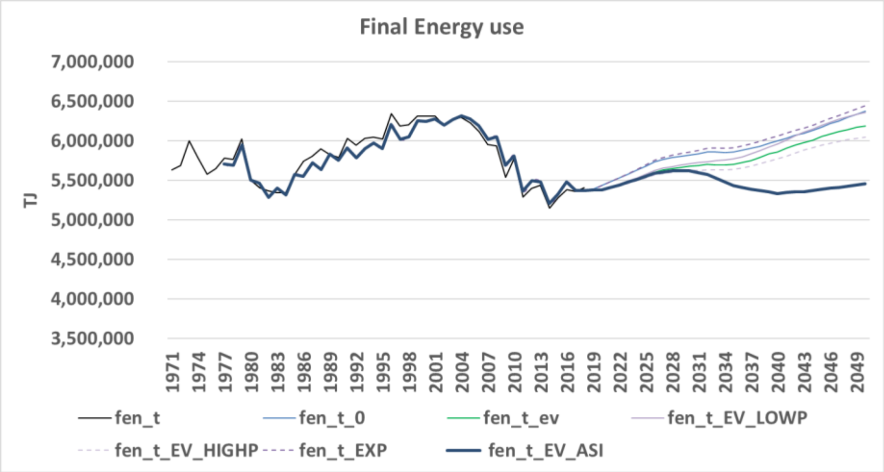


3. The EV transition: scenarios and results

transport: reductions in final energy in 2050 (**vs ICE baseline**)
- 48% reduction in the ASI EV scenario (zero direct rebound)
- 33% reduction in other EV scenarios (29% direct rebound)

Total energy: reductions in final energy in 2050 (**vs ICE baseline**)
- 15% reduction in the ASI EV scenario (zero direct rebound)
- 0-5% reduction in other EV scenarios (55-98% total rebound)





4. Discussion

1. **Economic system changes** only have **small** impacts:

    Capital investment (£11Bn) stimulates only a small GDP impact and jobs, as expected

    Energy prices: only have a small impact on the results (lower prices reinforce rebound effects)

2. **Energy system changes** from the EV transition causes **large** changes on the energy-economic system

    Non-ASI scenarios: Up to 20% increase (+£650Bn/yr) in GDP in 2050 and 1M extra jobs above baseline

    ASI scenario: Up to 50% reduction in transport final energy and 15% overall final energy reduction versus baselines

    ➢ both effects do not occur simultaneously

3. **Energy rebound effects** can be **significant**:

    direct rebound 12% short term and 29% long term included

    overall / total rebound of 75% for central EV scenario

4. **The ASI scenario:** finds an "equilibrium" is possible, to realise energy savings and not harm the economy, through

    economics: keeping an eye on prices, deciding whether to produce or import,

    energy demand management: policies to control rebound, so most of the efficiency gains go to reduced final energy

References

Nieto J., Pollitt H., Brockway P.E., Clements L., Sakai M., Barrett J. (2021) Socio-macroeconomic impacts of implementing different post-Brexit UK energy reduction targets to 2030. Energy Policy, 158, 112556. Available at: https://doi.org/10.1016/j.enpol.2021.112556

Nieto, J., Brockway, P. and Barrett, J. (2020) Socio-macroeconomic impacts of meeting new build and retrofit UK building energy targets to 2030: a MARCO-UK modelling study. Sustainability Research Institute (SRI) Working Paper No. 121. Available at: https://sri-working-papers.leeds.ac.uk/wp-content/uploads/sites/67/2020/01/SRIPs-121.pdf

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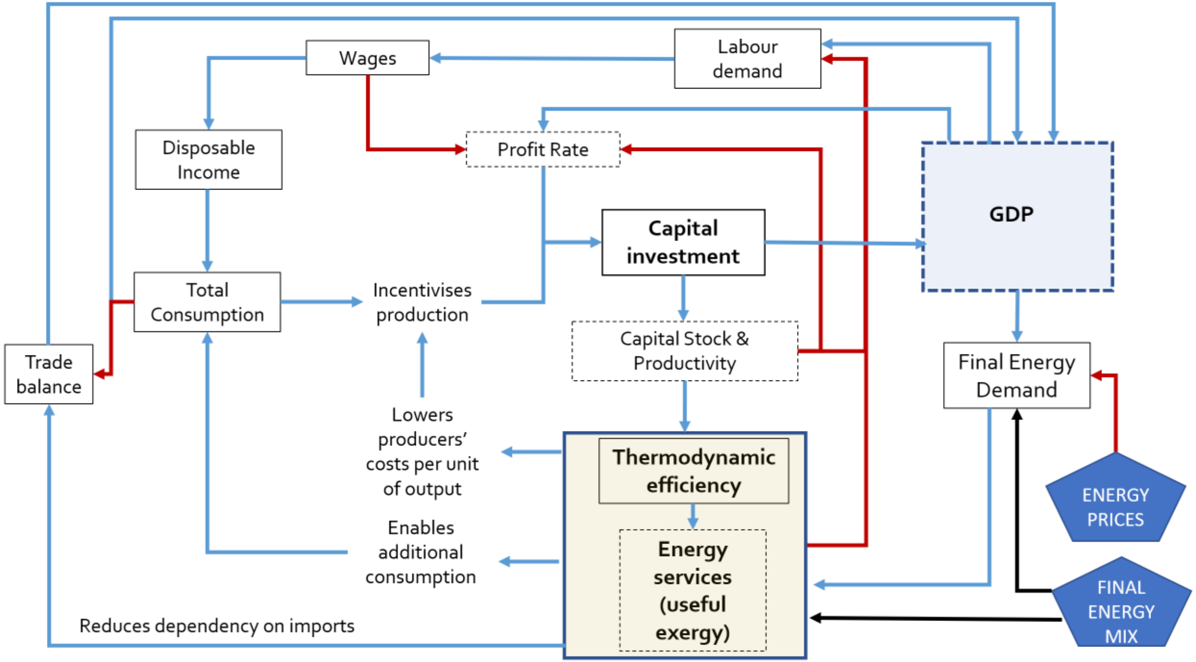
Sakai, M.; Brockway, P.E.; Barrett, J.R.; Taylor, P.G. (2019) Thermodynamic Efficiency Gains and their Role as a Key 'Engine of Economic Growth'. Energies 2019, 12, 110. Available at https://doi.org/10.3390/en12010110

Contact details:
Paul Brockway: p.e.brockway@leeds.ac.uk

BACK UP / ADDITIONAL SLIDES

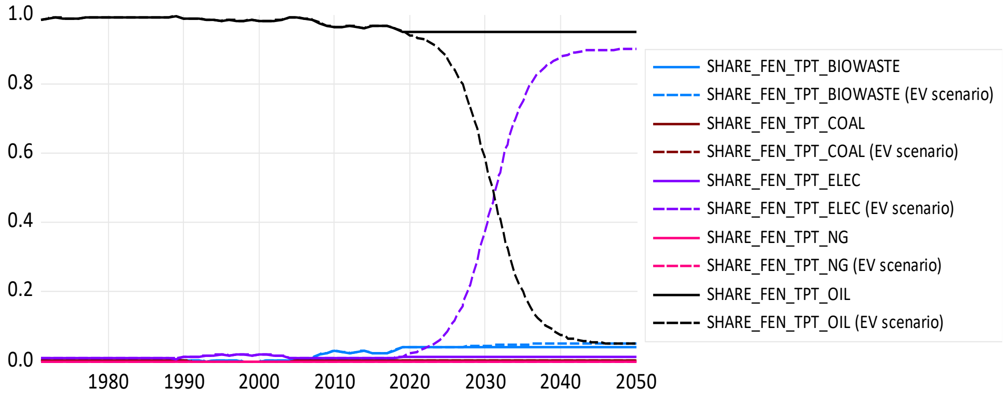
MARCO-UK: modelling at the useful stage



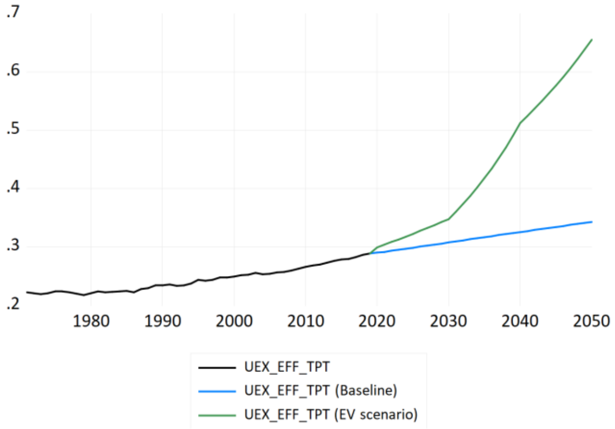
Source: Based on Nieto et al. (2021)

The EV transition: Input scenarios

Fuel shares: switch in EV scenarios to 90% electricity

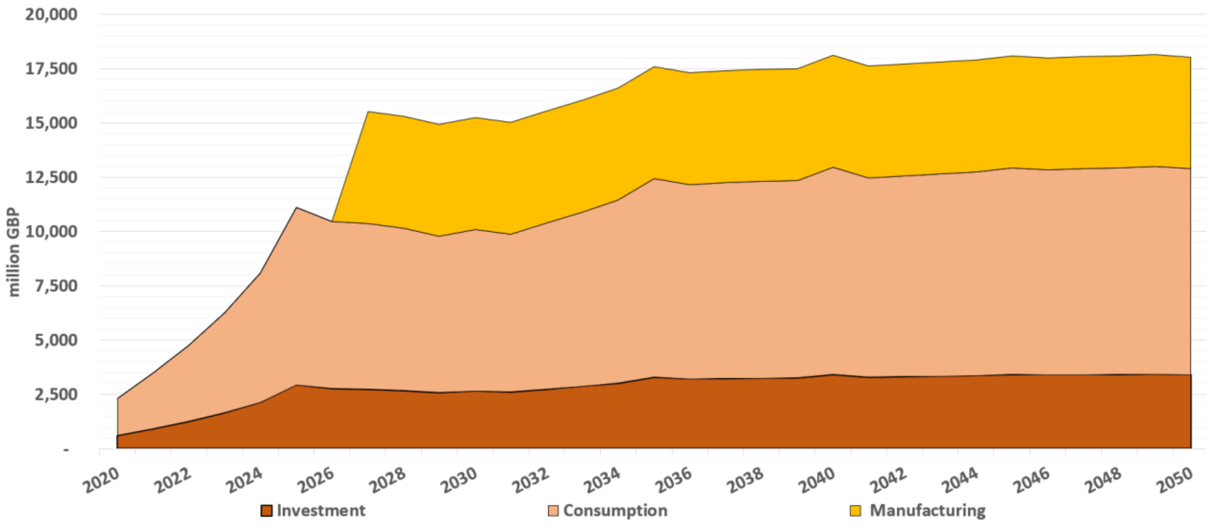


Transport efficiency: EV scenarios 70% efficiency in 2050 = twice ICE efficiency (35%)



The EV transition: Input scenarios

Investment: split between firms and households



The EV transition: Input scenarios

Electricity prices: high/low electricity prices are higher/lower than BEIS projections