DECARBONISATION AND THE TRANSPORT SECTOR: A SOCIO-ECONOMIC ANALYSIS OF TRANSPORT SECTOR FUTURES IN SOUTH AFRICA

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Tara Caetano, *Bruno Merven, Faaiqa Hartley and Fadiel Ahjum*
University of Cape Town

ERC
ENERGY RESEARCH CENTRE
University of Cape Town

Transport Project

The key question is how transport sector energy needs will be met in the future considering the uncertainty of future fuel prices, technology costs and options, as well as efficiency gains.

* The Integrated Energy Plan (IEP) – integrated full-sector study that notes the "lack of coordinated and integrated planning in the energy sector"
* National Transport Master Plan 2050 (NATMAP 2050) discusses sectoral energy demand to contextualise the impact of transport
* Numerous sector specific studies, but integrated full sector models are lacking

Transport Project

* Series of four papers:
  * Maseela et al., (2017) – vehicle-parc model calibration and description,
  * Merven et al., (2017) – demand modelling method for road transport (private vehicle ownership, public transport preferencec, and freight transport demand),
  * Ahjum et al. (2017) uses the SATIM model to analyse potential transport sector energy futures,
  * The fourth paper draws on scenarios from Ahjum et al. (2017), and analyses the socio-economic implications of these transport futures using the linked SATIM-eSAGE energy-economic transport model (Caetano et al., 2017).

Motivation

National Transport Master Plan 2050 (NATMAP 2050) states that: "transport in South Africa will also promote a low-carbon economy by offering transport alternatives that minimise environmental harm" (DoT, 2016).

* Focus of mitigation research → decarbonising the electricity sector

* Urgent and growing need for countries to ramp up their ambition when it comes to their climate change response
  * Efforts need to be made to reduce if not eradicate the use of carbon-intensive fossil fuels (coal, petroleum products, crude oil)
  * With transport accounting for over 30% of national energy demand and currently dominated by these fuels, interventions in this sector are key and their greater impacts need to be well understood

Motivation

* Altieri et al. (2016)
  * Found that a the rapid and relatively lower cost decarbonisation of the electricity system encourages demand sectors to increase their dependence on electricity
  * In the transport sector, this provides an opportunity for a large-scale switch to electro-mobility technologies including battery electric (BEV), hydrogen fuel cell and hybrid vehicles

Such a transition would address one of the main concerns about plug-in vehicles: that the carbon emissions simply move from the vehicle's exhaust to the power station

Transport Sector Futures

- The baseline, or ***NDC scenario***
  - Carbon cap of 14 Gt $CO_{2\text{-eq}}$ from 2015 to 2050
  - No exogenous behavioural changes
  - Passenger transport – vehicle ownership highly correlated with income
  - Freight - transport mode share kept constant
- ***Increased Ambition***
  - Carbon cap of 10 Gt $CO_{2\text{-eq}}$
- ***Increased Ambition Efficiency and Mode Switching (EMS)***
  - Carbon cap of 10 Gt $CO_{2\text{-eq}}$
  - Exogenous technology-based efficiency improvements
  - Exogenous mode switching

Methodology

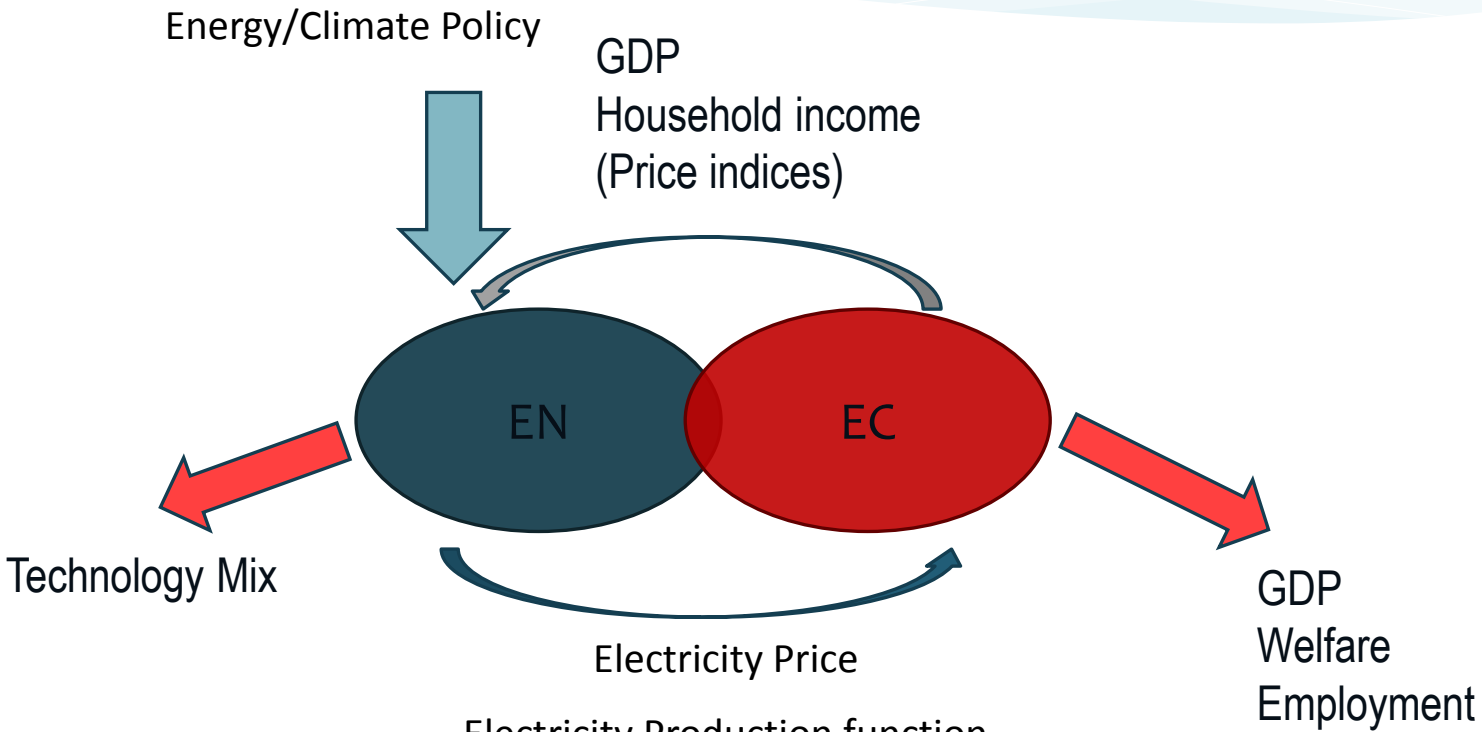
Linked SATIM and e-SAGE model

* **Motivation:** Need tool that can measure the macro- and socio-economic impacts of energy and climate policy

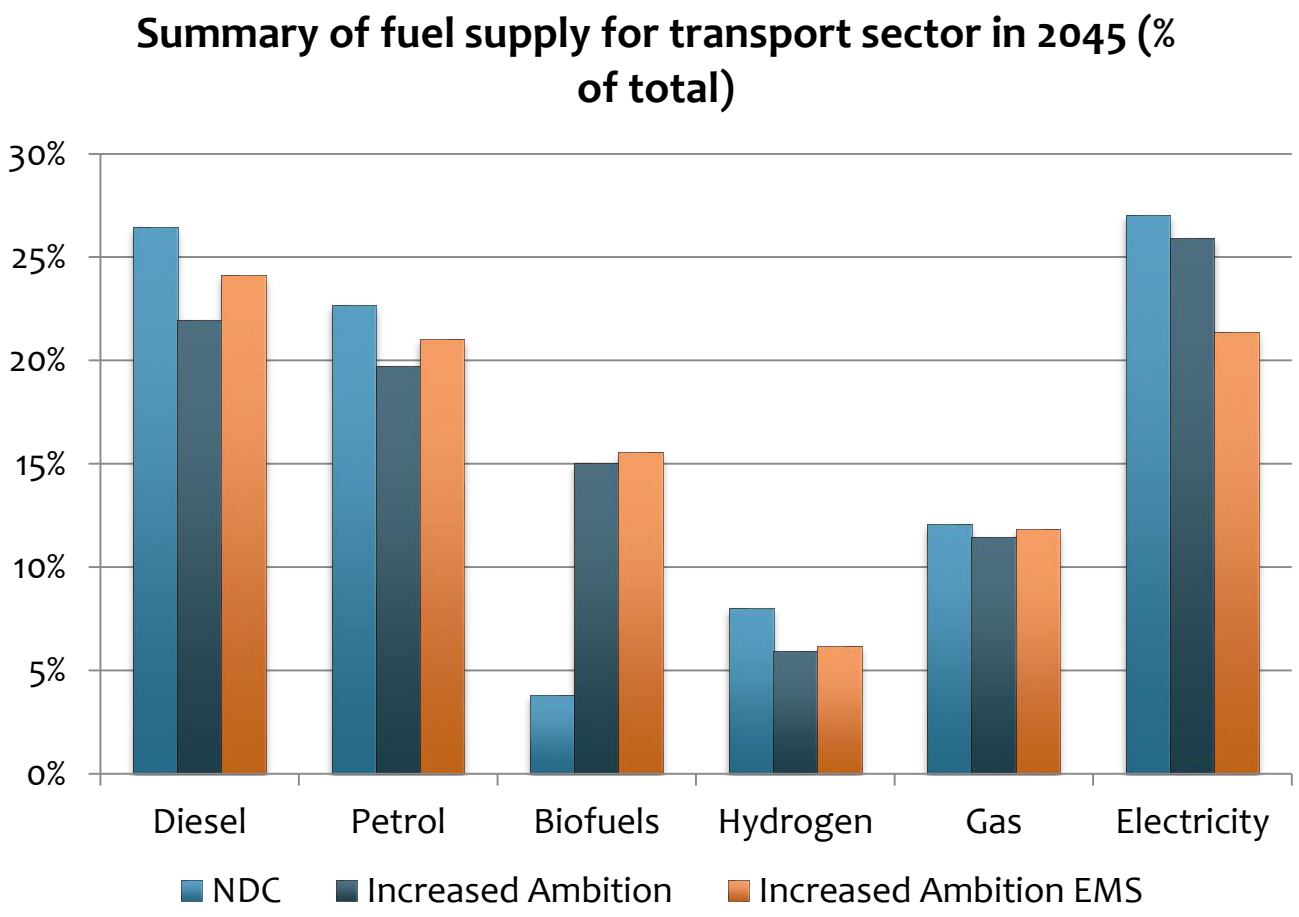
* **Optimization Energy System Models:** no/little economy and energy system feed-back
* **Economic Model (CGE):** over-simplification of the energy system

  * We choose the linked iterative approach over full integration:
  * Full inter-temporal integration constrains the level of detail
  * Stakeholders like to see detail they can relate to

Methodology

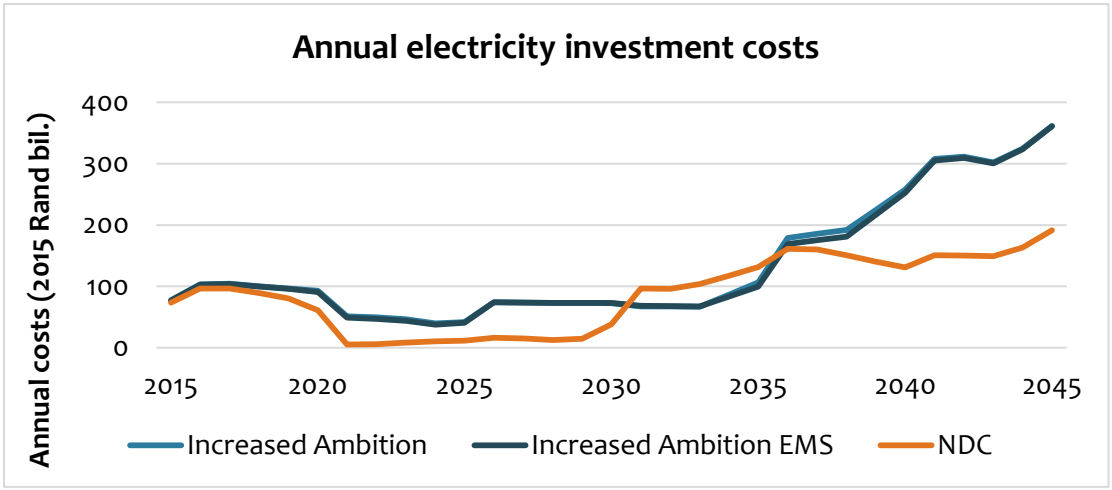


Results - Energy System



* EMS scenario requires *15% less fuel supply* than NDC scenario
* *Electricity* is a prevalent fuel in all scenarios
* *Biofuel vs HFCV* depends on emissions during production
* *Distributed PV* is key

Results - Electricity Sector



Stranded assets in the earlier period

2015 cents/kWh	NDC	Increased Ambition	Increased Ambition EMS
2015	101,8	0%	0%
2025	128,0	24%	24%
2035	136,4	12%	12%
2045	166,7	16%	16%

Results - GDP

	Deviation from NDC	
	Increased Ambition	Increased Ambition EMS
2025	-1,0%	-0,8%
2035	-1,2%	-0,8%
2045	-2,4%	-1,5%

* EMS reduces negative impact of the more stringent carbon constraint
* The electricity sector and service sector grow in both Increased Ambition scenarios compared to the NDC
* Coal mining and petroleum products are notably worse off

Results - Employment

Number of workers (FTE)	2010	2045	Deviation from NDC	
		NDC	Increased Ambition	Increased Ambition EMS
LABOUR	12 182 104	19 083 411	-925 127	-611 926
Unskilled labor	5 703 840	11 497 006	-925 127	-611 926
Primary	1 932 654	3 858 755	-302 910	-200 931
Middle	3 771 186	7 638 251	-622 217	-410 995
Skilled labor	6 478 264	7 586 404	-	-
Secondary	3 541 282	4 262 654	-	-
Tertiary	2 936 982	3 323 750	-	-

Caveats and Future Work

* The **value chains** for transport sector fuels, namely **hydrogen and biofules**, are not yet captured in the linked model,
* The **vehicle ownership information** from SATIM is not yet passed through to the eSAGE model,
* **Infrastructure requirements** for electric vehicles, the cost of this infrastructure, and the potential benefits for localisation are not yet captured in the eSAGE model,
* The **implementation of policies** for electric vehicle penetration as well as **incentives** that could be used to enable this, e.g. reduce import tariff on electric vehicles (Venter, 2017).

Conclusions

Electric Vehicles

- Significant role in private transport and LCV solutions
- 80% of new vehicle sales by 2045
- Key uncertainties – vehicle cost and crude oil prices

EMS

- Implementation of efficiency improvements and behavioural change could significantly reduce the burden of stringent emissions reductions
- Mitigation policy must take this into account to reduce costs of mitigation

Electricity as a transport fuel

- ~ 30% of transport sector fuel supply
- Could reduce emissions by half of present day emissions

Conclusions

Hydrogen

- HFCVs could play a dominant role in freight transport, however the production process is carbon intensive

Coal mining and petroleum products

- The jobs lost in these sectors could be channeled into other industries, but thought must be given to this in order to achieve a just transition

Future Work

- The economic impact of infrastructure demand
- Localisation potential and a deeper look at the value chains (biofuels and hydrogen)
- Implementation of policies to incentivise the uptake of low carbon solutions

Thank you

tara.caetano@uct.ac.za

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