Decarbonisation and the transport sector: A socio-economic analysis of transport sector futures in South Africa

Tara Caetano, Bruno Merven, Faaiqa Hartley, Fadiel Ahjum

International Energy Workshop 2018
Gothenburg, Sweden
20 June 2018

ERC
ENERGY RESEARCH CENTRE
University of Cape Town

sanedi
South African National Energy Development Institute.

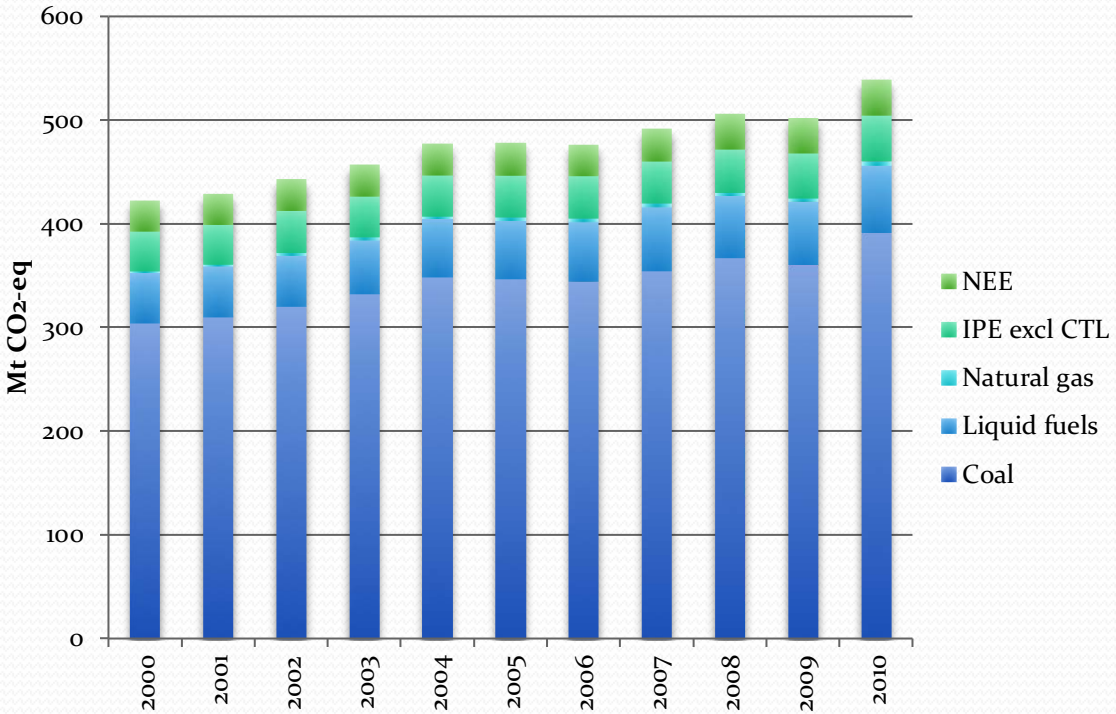
Context

South Africa's NDC

"South Africa's climate change response is that of a developmental state in the context of a sustainable development approach to address global climate change."

- High priority is given to poverty alleviation, reduced inequality and employment
- Mindful of a "*just transition* to a low carbon future"
- Support: finance, technology and capacity building
- Firm commitment to peak in 2025 at 42% below BAU
  - Consistent with a range from 16-20Gt CO_2-eq between 2016 and 2050
  - 2030 (indicative) and 2050 (aspirational)

Emissions: it's an energy problem



Why the transport sector?

- Transport, the second-highest GHG contributing sector - 15%, in 2010, excluding refinery and process emissions, (RSA, 2013b)
- Electricity has been the focus of decarbonisation research in South Africa
  - With increased ambition?
  - DDPP
- Globally, **technology** and **behaviour change** has been part of the focus of literature about climate change mitigation in transport options (Schwanen et al., 2011). Transport technology options that use electricity and hydrogen fuel cells have the potential to play a major role in decarbonising the transport sector (Anandarajah et al., 2013)

- Aim of the study

To analyse the potential socio-economic impacts of decarbonisation, with a focus on South Africa's potential transport futures, as departures from the Integrated Energy Plan.

Methodology

Bottom up Engineering models

Represent the energy system in great detail

Ignore the full macroeconomic feedbacks of different energy system pathways

Top down Economic models

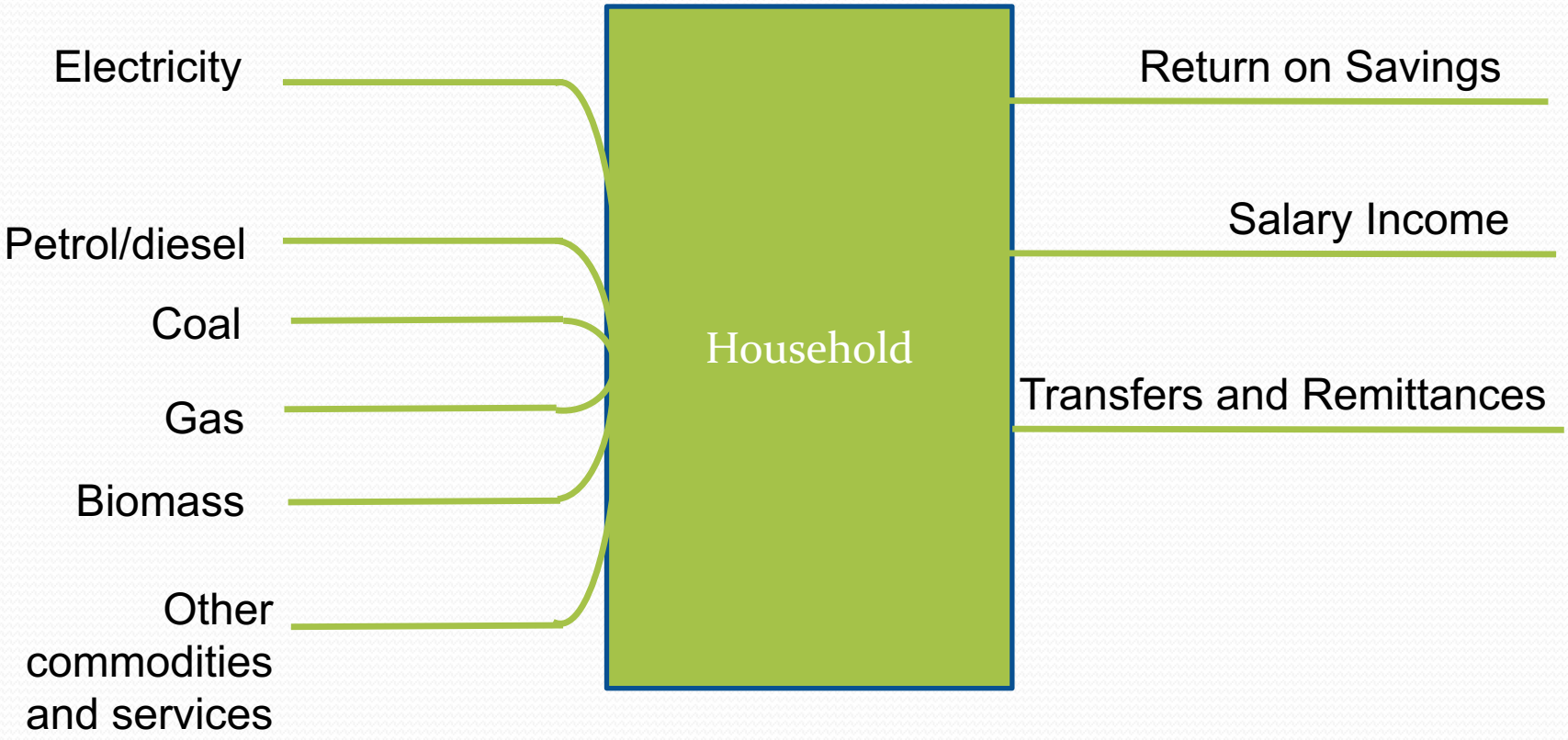
Do not contain technological detail representing the energy sector in aggregate form

Describe the interaction between the energy system and the economy as a whole

Description of economic model (eSAGE)

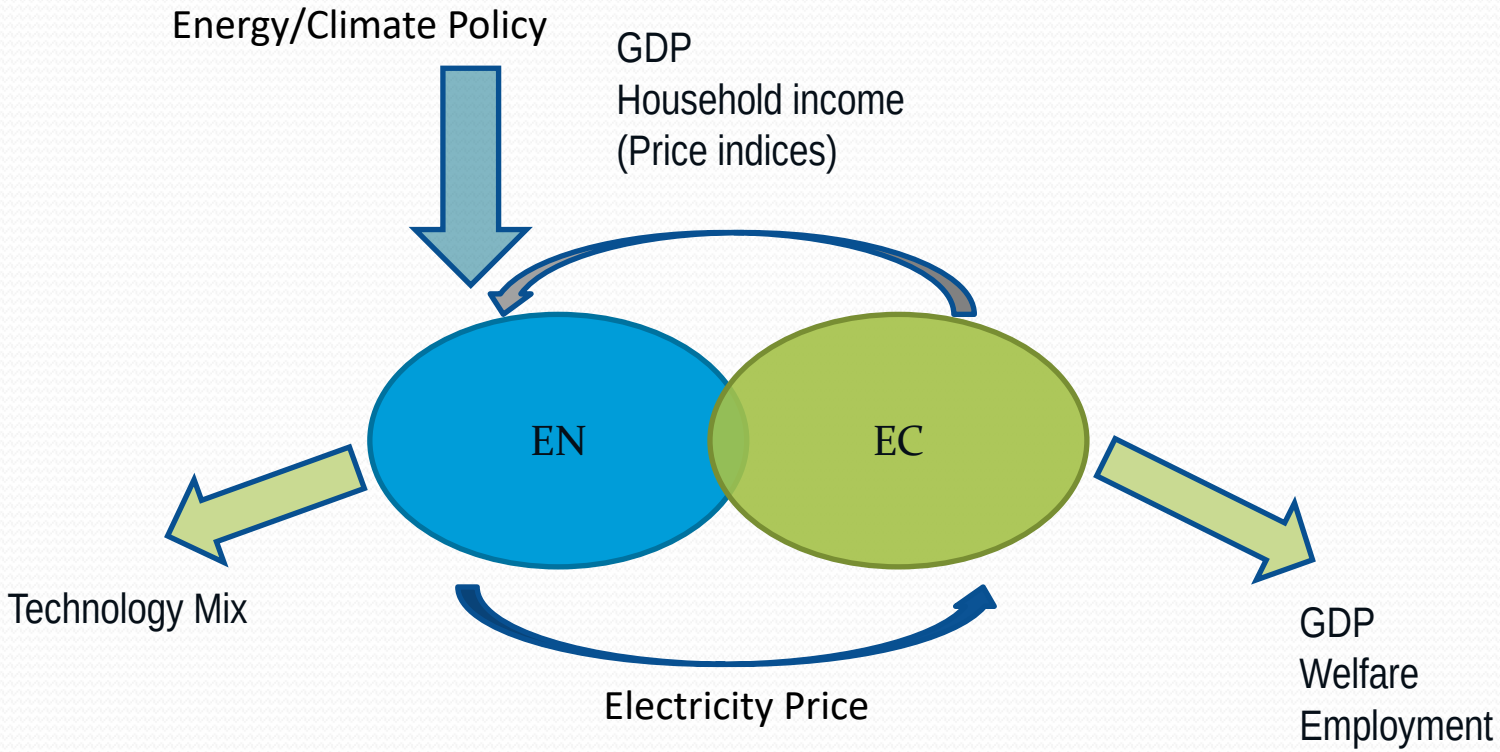
- 2007 social accounting matrix
  - 61 activities and 49 commodities
    - 4 × agriculture, 49 × industry, 8 × services
  - 6 factors of production
    - 4 × education-based labor groups
    - 1 × non-energy capital
    - 1 × energy capital: ESKOM, PetroSA, SASOL
  - 14 household groups based on per capita expenditures
    - 10 deciles with top decile divided in 5 sub-groups
- Energy commodity flows are calibrated to 2007 energy balance

Description of Economic Model: eSAGE Demand function



LES: $D_{elc} = Dmin_{elc} + marg.share_{elc} \frac{(Budget - expend_{min})}{price_{elc}}$

The linked model



Electricity Production function

Expenditure on expansion plan

Production function of all activities (energy)

Consumption function of households (energy)

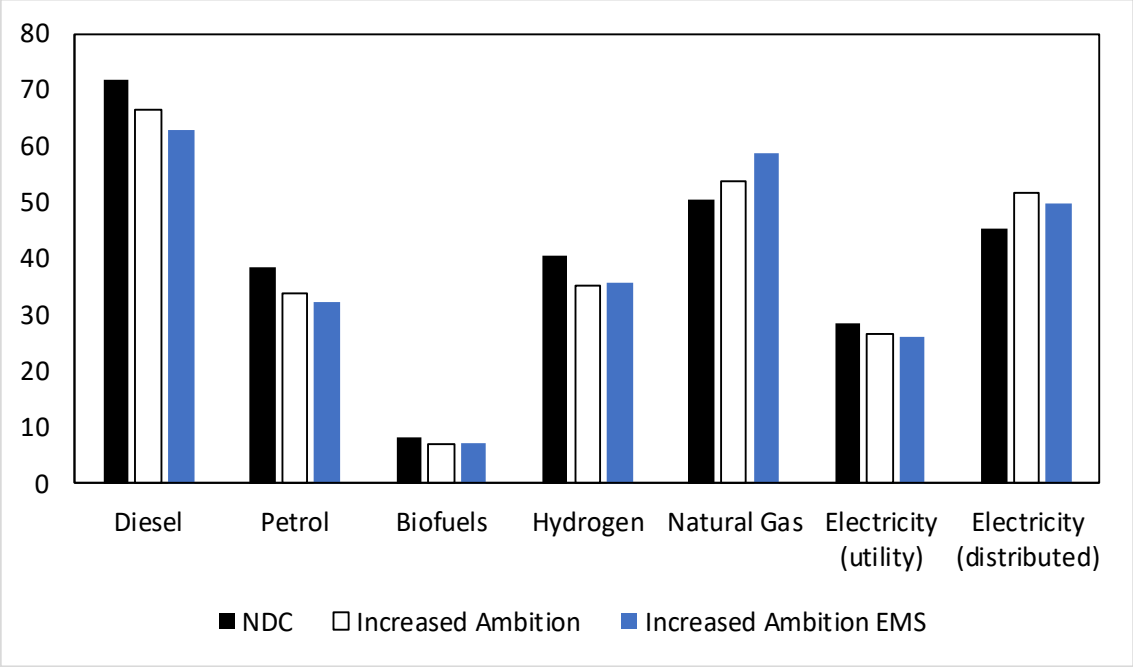
Transport scenarios

	NDC (reference) (Ref_14)	Increased ambition (Ref_10)	Increased ambition EMS (EMS_10)
Carbon constraint	14 Gt	10 Gt	10 Gt
Efficiency	No	No	Yes
Mode switching	No	No	Yes

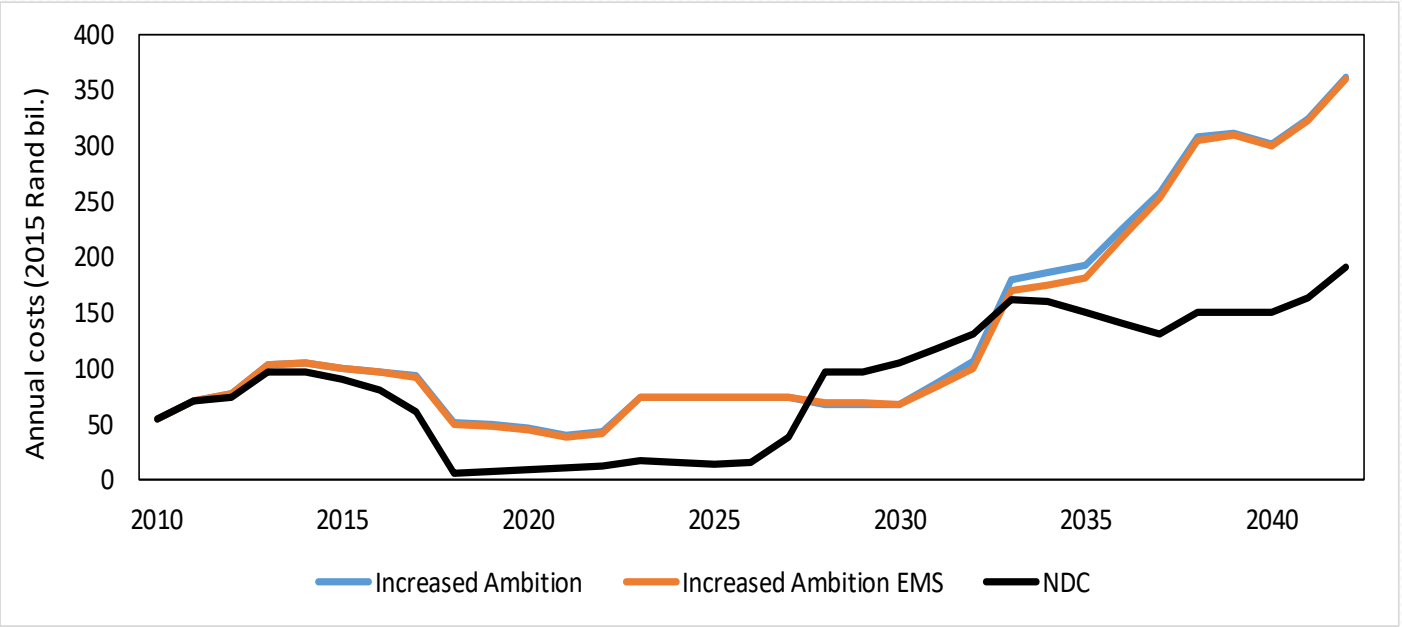
NDC = Nationally Determined Contribution and EMS = Efficiency and mode-switching (Ahjum et al, 2017)

Results

Transport sector energy mix



Electricity sector



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

Aggregate GDP

Total gross domestic product as a deviation from the nationally determined contribution (NDC).

	Deviation from NDC in 2045	
Year	Increased ambition (%)	Increased ambition EMS (%)
2025	-1.0	-0.8
2035	-1.2	-0.8
2045	-2.4	-1.5

Conclusions

- The focus was on a rapid decarbonisation of the South African economy and the potential impacts of implementing efficiency improvements in the transport sector including mode switching.
- The results showed that battery electric vehicles could play a significant role in providing a private transport solution that is also low carbon, subject to certain considerations. Generally, a rapid decarbonisation of the South African economy would have a slightly negative impact on it relative to a less ambitious decarbonisation target.
- Similar to the findings in international literature, the implementation of efficiency improvements in the transport sector and changes in behaviour (decreased mileage, increased occupancy, increased rail use and increased use of public transport) could significantly reduce the burden on the economy of stringent emissions reductions.
- Implications of this study are that mitigation policies must consider energy efficiency improvements and behavioural change in conjunction with a national carbon budget if it is to reduce costs of mitigation.

Thank you!

tara.caetano@gmail.com

Journal of Energy in Southern Africa 28(4): 9–18
DOI: http://dx.doi.org/10.17159/2413-3051/2017/v28i4a2945

Kindly supported by SANEDI (www.sanedi.org.za)

sanedi
South African National Energy Development Institute.

ERC
ENERGY RESEARCH CENTRE
University of Cape Town