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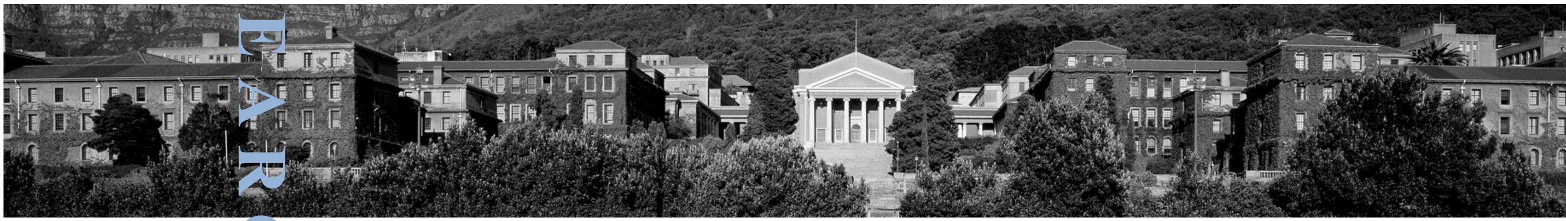

Comments on the draft Integrated Energy Plan issued by the Department of Energy in 2013

Energy Research Centre

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Energy Research Centre
University of Cape Town
Private Bag X3
Rondebosch 7701
South Africa

Tel: +27 (0)21 650 2521
Fax: +27 (0)21 650 2830
Email: erc@erc.uct.ac.za
Website: www.erc.uct.ac.za

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Preface

The Energy Research Centre (ERC) welcomes the publication of South Africa's draft 2012 Integrated Energy Plan (IEP 2012). We offer these comments, in the hope that they may contribute in the process of making the bold, well informed and robust final integrated energy plan whose implementation can see the country's economic, social and environmental goals attained.

Before delving into the comments that should be considered in the final IEP, ERC found it crucial to congratulate the Department of Energy on achieving such a milestone of producing an official energy systems model with supporting database and supporting data input methodologies, more so because its an OPEN source energy model which can be interrogated by all members of the society. A first iteration of results has been produced and this in itself is a significant achievement. From this perspective the IEP 2012 can be considered a success. This shouldn't however discourage constructive criticism on technical problems many of which the IEP modelling team are already aware of.

The comments are made with a clear understanding that the IEP draft document just showed the results of the model thus far and these comments are mainly on the modelling process and assumptions used.

1. Introduction

Since the integrated energy plan (IEP) is such a crucial plan for the country, ERC felt the need to make an input (in the form of written comments) during the process of producing it. Given the ERC's understanding of sub-section 8.3 of the IEP draft document – that comments made towards draft IEP will further improve the modelling process and assumptions – the comments mainly concern the technical modelling process and not public engagement and policy recommendations. The concentration in technical modelling aspect of the IEP comes from the fact that ERC believes that robust modelling is a vital necessity for producing sound energy plans, strategies and policies.

Section one starts by reflecting on our understanding of the IEP plan/process and what the final draft must communicate. The second section will give comments that are mainly concerned with the modelling methodology followed in each sector of the economy.

2. What is the IEP and what does its development process entail?

According to the International Atomic Energy Agency (IAEA, 2008):

> Integrated energy planning is the systematic analysis of all the factors that influence the evolution of energy systems. It facilitates problem solving and makes it possible to explore linkages, evaluate trade-offs and compare consequences, thereby helping countries to develop an effective energy strategy that supports national sustainable development goals".

Thus the main goal of an integrated energy plan is to identify the best ways of utilising different energy sources such that social and economic developments are achieved and at the same time adhering to relevant national policies , and this seems to have been done well in the IEP so far.

3. Modelling methodology and underlying assumptions

3.1 General comments

The results (section 7) are very brief for an IEP (pp. 133-147), this is just 15 pages out of 150 pages of main text. The detailed demand analysis and projections are worth having, but there is surprisingly little detail presented. Hopefully the final draft will have more results included as it was discovered during the public hearing sessions that more vigorous modelling is still underway. Energy demand in the sectors has to be at service levels so that energy efficiency and fuel switching impacts can be quantified.

3.1.1 Discount rate

Discount rate is quite high (11.3% compared to 8% in ERC SATIM model) but has been calculated by a very systematic numerical method – Treasury's EOCK method. It may be interesting to unpack rationale behind EOCK.

3.1.2 Energy efficiency

Unlike the IRP2010, the IEP does not include energy efficiency (demand-side management or integrated demand-side management) as an energy resource. Neglecting the important role that efficiency plays will result into problems of over-investment in energy supply. There have been some interesting discoveries made by the City of Cape Town, where the City's electricity sales (shown in Figure 1) have been dropping since 2007 irrespective of increasing GDP growth during the same time period. Therefore the important role played by energy efficiency measures should somehow feature in energy planning and modelling process.

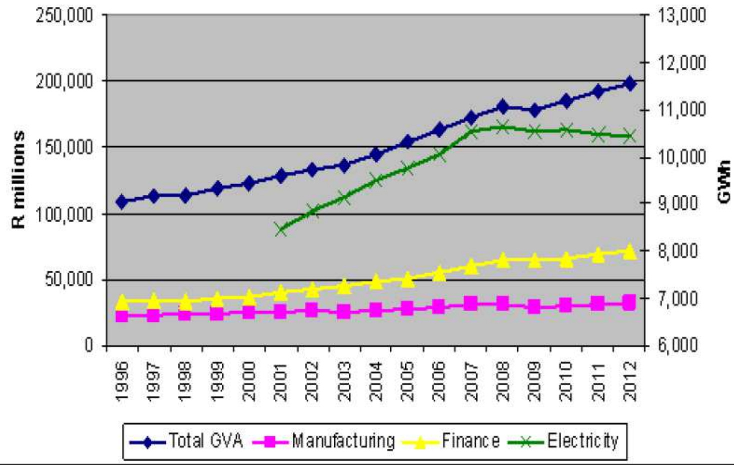

Figure 1: City of Cape Town's electricity sales and GDP growth

3.2 Sectoral issues

In all demand sectors, except for transport, energy demand is very aggregate. The IEP energy demand modelling team opted to use an econometric modelling methodology which uses elasticity between fuel demands and GDP. If econometric modelling is used, it is not possible to include energy efficiency improvements in the modelling process. If bottom-up end use energy demand analysis methodology is adopted, it is easy to incorporate energy efficiency impacts during the modelling process. Besides the possible exclusion of energy efficiency improvements in the modelling process, econometric energy demand modelling should be used with care in planning processes given the historic weaknesses that arose from this methodology in the 1970's after the first oil crisis, where energy demand projections were too high. This over-estimation of energy demand resulted in over investment in energy supply infrastructure more especially in South Africa. To clarify the point of energy over-estimation it is worth referring to transport sector comments on sub-section 3.2.6.1 of this report, where very high freight energy demand was arrived at by 2050 – 1600PJ. To make bottom-up end use energy demand analysis, it is challenging given the paucity of end-use data in South Africa. With respect to electricity, the end use energy data exists, therefore there is definitely a room for improvement on electricity demand.

3.2.1 Power sector (electricity supply)

Comments made in this section are relevant to both IEP and IRP update.

Power plant investment costs

- Why not use information generated in REIPPP for RE and from Medupi/Kusile projects to inform costs to be used in model?
- It is true that these costs include ODC (owners development costs) as well as EPC (engineering and procurement costs), but why not include ODC in the cost boundaries for power plants? This would involve some averaging over projects, but these costs are used in the electricity price calculation, so why not use them in the optimisation as well? The benefit of using these costs is that they are closer to the current reality of constructing those power plants. Learning can then be applied to the EPC component in cost projections.

Inga

- Why limit Grand Inga to only 2.5 GW? (Given that South there could be more than one transmission route to SA connecting to different turbines)

Demand response

- Scenarios where electricity price is impacted (e.g. by CO2 cap/price, RE target, shale gas) relative to a base do not have any demand response. This response would could come from:
  - Efficiency gains
  - Fuel switching
  - Process switching
  - Behaviour change
  - Slow-down in growth

Points relevant to only IEP (as adequately addressed in IRP)

Reliability of system: How is it ensured other than by a reserve margin constraint?

Coal price for power plants: Why is coal price kept constant in IEP given the increase anticipated in MYPD3?

Demand projections

- Would be valuable to have electricity demand (energy and power) and price projections for the different IEP scenarios.
- Power sector has constant coal price assumption. Eskom MYPD and Coal Roadmap assume an increasing price in real terms. This has a big effect on the optimisation results and the thinking here could be reviewed in more detail.
- Wind map used is dated (Diab) – need to use the new one from this year.
- Is the impact of distributed generation on centralised generation modelled? Particularly for the residential, commercial/institutional and industrial sectors.
- Does the IEP least cost modelling account for the marginal cost of water supply and distribution, which could affect the resultant generation portfolio for electricity supply?

3.2.2 Liquid fuels supply

GTL does not compete with CTL and crude refineries in the IEP for the base case and emissions limit case.

- CTL infrastructure is expensive and a high CO_2 emitter relative to GTL but benefits from a *cheap* (excluding the externalities of coal mining) secure feedstock.
- PetroSA suggests that GTL viable at an oil price of > US $100 and a gas price of < US $5 MMBtu.
- The IEP moderate and high oil price scenarios are well above US $100.

The competitiveness and viability of GTL requires further scrutiny, with an emphasis on

1) sensitivity to local gas prices;
2) security of supply concerns;
3) increasing gas consumption across in the economy; and
4) increasing demand for diesel.

3.2.3 Industry

It seems like there is no apparent growth in gas consumption for the iron and steel sector. With the possibility of a growing natural gas market, is this a realistic future outlook. Both The Annexure and the IEP report do not give detailed assumptions about the modelling of end uses in this sector. More detail regarding assumptions required: How do the test cases differ on the demand side? Do the energy intensity improvements differ between cases?

Level of disaggregation

Other manufacturing' lumps together sectors with very different characteristics. We suggestion that 'other manufacturing' to be divided into two groups: highly energy-intensive manufacturing, and less energy-intensive manufacturing

Energy data

- Lack of data on petroleum-based fuels in industry
- Understand biomass/waste consumption in industry (currently lumped into 'other manufacturing' in the energy balance
- Inconsistency of the energy balance with other sources such as the IEA. This will be a future consideration.

Demand drivers

- Shift from high energy intensity, primary manufacturing to less energy intensive, secondary manufacturing is an important driver that is masked by lumped 'other manufacturing sector'

Technological details and assumptions

- Lack of technological detail makes it difficult to say whether energy intensity improvements are feasible.
- At current coal price increases appear electric arc furnaces will be uncompetive by 2016 but seem to grow at 1% continuous in model (dependent on scrap availability) [*from Cohen et al NPC work*]

3.2.4 Commercial

In general there appears to be some information about the commercial sector missing from the IEP report, which needs to be included for reader clarity and future reference. There is coal consumption depicted in the commercial sector (Figure 6-1 of Annexure A part 1) shown below, but there is no depiction of the coal consumption in figure 6-2 of the Annexure showing the projected demand for coal.

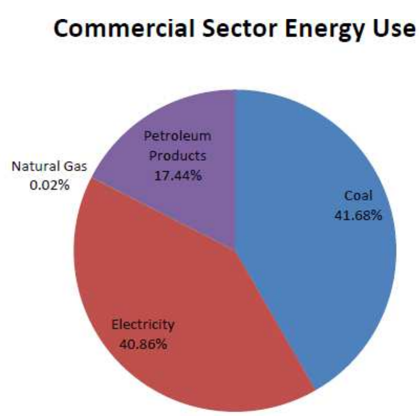

Figure 2: Fuel consumption in the commercial sector, figure 6-1 of the IEP Annexure A part 1

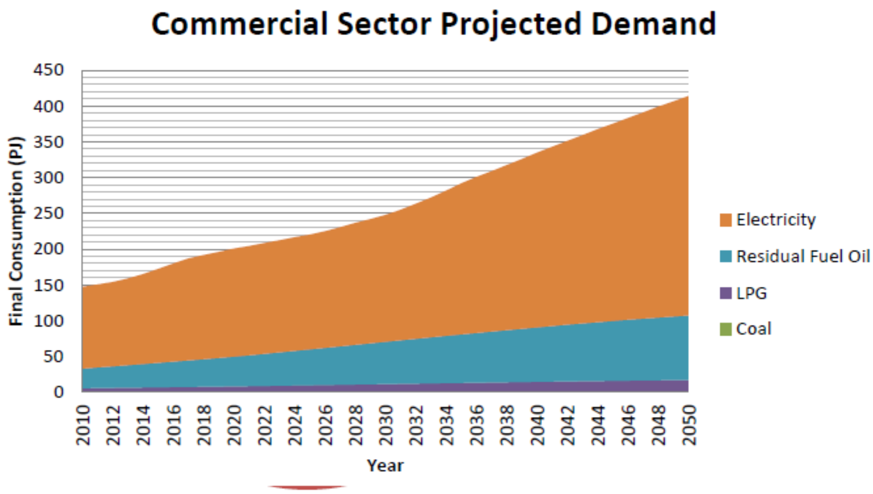

Figure 3: fuel consumption projection of the model of the IEP. This is figure 6-2 from the IEP Annexure A part 1.

Figure 2 shows the composition of the fuel consumed in the commercial sector which includes coal. But the energy projections of the IEP do not show any coal consumption. The second paragraph of section 6.1 of the IEP Annexure A part 1, indicates the assumptions of the fuel projections, yet there appears to be no further reason for these numbers. There needs to be background information provided that helps indicate the rationale for these assumptions. The last section of the paragraph of section 6.1 of the IEP Annexure A part 1 reportS: "The share in LP Gas increases marginally from 3% to 4% over the same time period [2010 -2050], while the residual fuel oil which is mostly used in boilers increases from 18% to 22%." The fact that gas usage only increases marginally needs to be justified in the face of increasing gas interest in the country. Also justification for the large shift to residual fuel oil needs clarification.

3.2.5 Residential

The diversity of this sector is not well represented in the model. If possible disaggregating households will prove to be essential because low and high income households needs differing energy policies. There are two types of energy policies that are considered in this sector – policies lowering energy poverty and policies that reduce emissions and pollution. Therefore households dissagregation will help in costing the implementations of some energy policies or strategies.

Although there are no classfications of households, the IEP report on pages 7 and 92 refers to households being classified into differing household types: "Energy demand in the residential sector is determined by estimating the average energy consumption by different household types." But on page 92 (Table 5-1), no households sub-sectors are included, which contradicts what the above statement said. If household types or sub-sectors are modelled, they have to be explained thoroughly and well represented so that relevant policies that affect each sub-sector will be clearly defined.

ERC suggests that households be classified into three income household types: low-, middle- and high-income households. Both low- and middle-income households include electrified and non-electrified households. This suggestion is important because appliance ownership (which the IEP report says will increase as income increases) is highly correlated to income and the All Media Products and Surveys (AMPS) from the South African Advertising and Research Foundation (SAARF) has confirmed this correlation. The classification of low-, middle- and high-income households can follow the definitions used in the recent Department of Energy Report on household energy issues, *A survey of energy-related behaviour and perceptions in*

South Africa: The Residential Sector 2012 and 2013. If this classification is followed, the main assumptions will be the mobility of households from one income group to the next, in most cases an upward mobility is assumed. This is the movement of households from low income category to high income category.

Page 111, paragraph 1, states; "In 2006, ~73% of energy consumed by South African households was in the form of electricity, 29% in the form of coal, and 7.4% in the form of petroleum products (mostly illuminating paraffin but also a small amount of LPG)." It seems like there is no use of wood in the residential sector in 2006 despite the fact that the last paragraph on page 70, mentioned that ~ 7 million tonnes of wood was assumed to be used in the sector:

> The domestic use of wood is primarily by poor households, mainly in the remote rural areas, making wood a very important residential fuel in South Africa, as is the case throughout the continent. The exact quantity of residential fuel-wood used in South Africa is unknown, but is estimated at about 86 Petajoules (PJ), which is equivalent to 7 million tons of wood per year.

Besides the exclusion of wood/biomass from the energy mix in the residential sector, the percentages above add to 109% (73%+29%+7.4%) and the wood is not even part of the energy mix.

On page 115, Figure 5-23, the results show a heavy reduction in paraffin use and an ultimate phase out of the fuel by 2022/23. What assumptions underlie the phasing out of paraffin or what methodology was used to phase out the fuel. For example, if optimisation modelling methodology is used, to phase out the fuel, we can assume that it is the most expensive fuel hence households will not buy it. Or the country will stop producing the fuel?

Phasing out paraffin without a clear strategy of how the expensive fuels are going to be made cheaper will only create another dilemma for energy poverty in urban areas where paraffin has played a huge role to alleviate energy poverty, so a strategy or policy for the alternatives in the absence of paraffin must be clear to avoid energy poverty for low income households

Energy planners usually assume that as living standards improve, people will consume more energy (page 116), but there is emerging research which shows that, with trends in technological innovation where the market is flooded with energy efficient appliances, an increase in living standard measure might mean a decrease in energy consumption. May be it will be shown clearly after the analysis if change in economic structure is analysed.

Thank you for considering exploring the response of energy consumption to energy price (highly critical to the residential sector) since proper subsidies or strategies needed to be developed to aid low income households

3.2.6 Transport

The IEP methodology Annex states:

> The demand technology assumptions and methodology for transportation modelling relied heavily on previous work which had been commissioned by the South African National Energy Development Institute (SANEDI) and which had been conducted by the Energy Research Centre (ERC).

As such, the ERC are not in a position to be too critical of the work done in this sector as we will to some extent be reflecting the shortcomings in our own work. The previous work on transport has its flaws of course and some of our comments below may stem from insights into those as well as comments arising from new work such as the Mitigation Potential Study and other general comments on the approach taken in the IEP. Transport as a sector is complex given that liquid fuels are supplied to a spatially highly distributed network supplying diverse agents and technologies that involve almost the entire population. The level of detail in which modelers could indulge is therefore nearly infinite and it is recognised that in a high level IEP this would not be appropriate and a good use of resources. We furthermore note the following statement in the draft IEP report

> For the transport sector, demand was projected for energy end-use (i.e. mobility measured by passenger kilometres or freight tonne kilometres) as opposed to individual fuels (i.e. petrol, diesel, jet fuel, etc.).This second approach makes it possible to quantify the extent to which different fuels can be used to meet the same end-use/need. …The desired approach was therefore only conducted in the transport sector.

It may be, therefore, that other sectors may take preference in further work until such time as they are all modelled on an energy service basis and the approach is consistent. ERC's comments are discussed in more detail below by topic.

3.2.6.1 Road freight energy demand

While ERC model assumptions were widely used in the IEP model there were some notable differences with ERC's SATIM model results, most notably for freight energy demand as seen below:

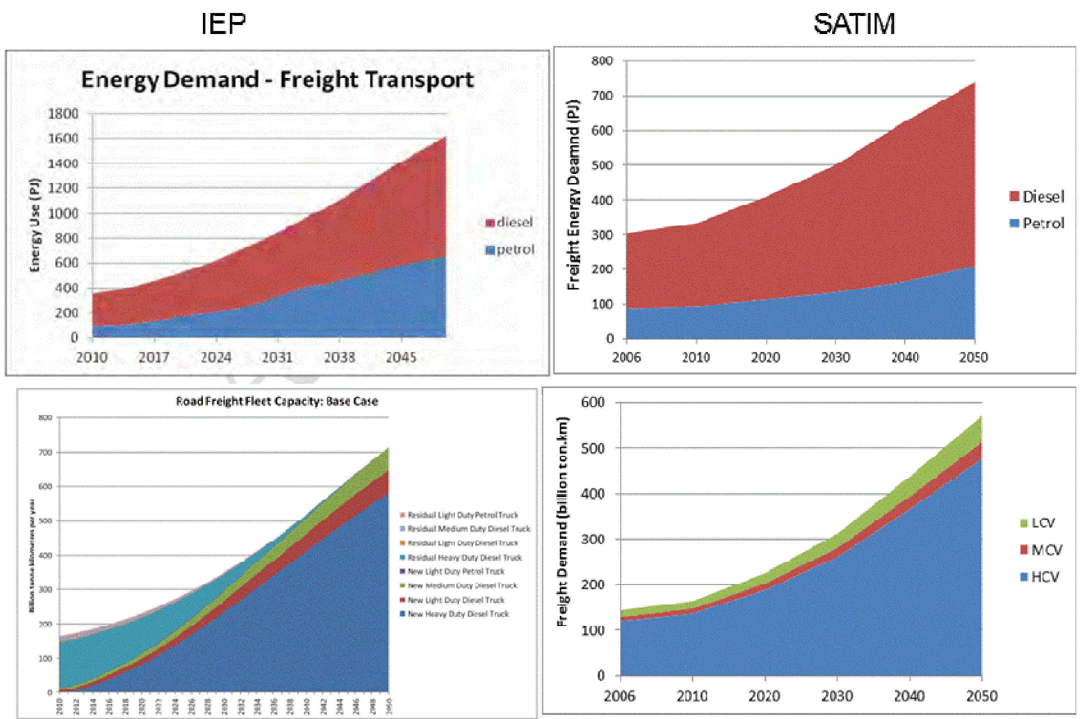

Figure 4: Comparison of freight energy demand for the IEP and ERC SATIM Models

The IEP projected demand for ton.km by 2050 of just over 700 billion tkm was significantly but not greatly larger than that of SATIM at 550 billion tkm but final energy demand for road freight was more than double at 1600 PJ compared to about 730 PJ. This effectively translates into an energy intensity comparison as follows:

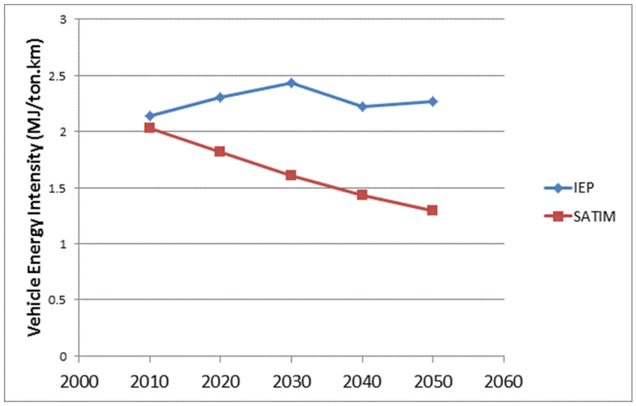

Figure 5: Comparison of road freight energy intensities of the IEP and SATIM models

This suggests that both models require a review with the IEP model showing efficiency deterioration and the SATIM model showing questionable improvements driven by the 1% annual efficiency improvements assumed in that reference case.

The very high growth in freight demand in the IEP model results in a profound dominance of the transport sector in energy demand by 2050 as shown in the extracted figure below:

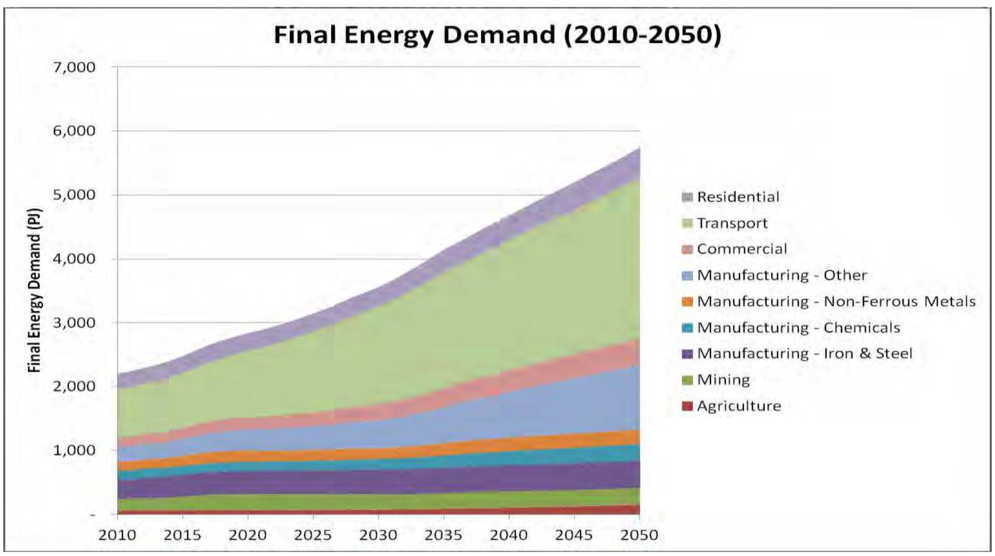

Figure 6: (Figure 5.24 from Draft IEP) Projected demand within different sectors

This figure raised questions from a number of colleagues at ERC and no doubt others and thus a review of freight demand and the underlying assumptions is probably justified as well as an acknowledgement and explanation of the phenomenon in the text.

Other than energy intensity, the assumed relationship of the demand for ton.km in relation to GDP growth is a primary driver of freight demand. ERC assume an elasticity of 0.8 to reflect that the economy will probably become less freight intensive as it diversifies in favour of services but the basis for this exact number remains weak albeit that arguments for the principle may be strong. Given the prominence of freight in evolving energy demand some work on this aspect is likely justified.

3.2.6.2 Road to rail

Switching freight from road to rail is an attractive option for any energy efficiency or emissions mitigation study given the potentially large energy intensity gains and will therefore always be a modelling issue. Clearly this is easiest accomplished for heavy freight particularly bulk goods in reality but improvements in logistics and engineering solutions that facilitate rail and road working together to achieve door-to-door service offer the potential to switch other goods particularly if containerised. Indeed Transnet has recently reported gains in freight share after ceding share to road for many years. While a switch from road to rail is not evident in the model yet the requirement for this has been recognised in the following paragraphs in the IEP report and annexes:

> Road freight transport, which is more reliable, flexible, accessible, and secure and provides shorter transit times by comparison with rail freight transport, is preferred by the industrial sector. However this carries with it negative externalities such as increased and rapid damage to roads, road congestion, air pollution and higher fuel/energy requirements.
>
> However, government has now reviewed its rail investment programme to accelerate the shift from road to rail. This will see an investment of about R63 billion by Transnet in the freight rail system over the next five years. The move should result in a reduction in projected road freight haulage and resultant energy demanded and will therefore require further analysis.
>
> While the shifting of freight from road to rail has significant advantages, including lower costs and fewer externalities, further work and additional consultations are needed to properly assess the impact of the rail expansion plan currently underway by Transnet."

It is reported that stakeholders include the following suggestion for further work:

> Assess the impact of Transnet Freight Rail's rail expansion plan on displacement of freight haulage from road to rail and the impact that this may have on projected demand.

ERC would like to add its voice to this suggestion without which the model will not be complete. Stakeholder engagement in the Carbon Calculator project made some initial estimates of practical limits on road to rail switch which could be useful as a basis for future IEP work.

3.2.6.3 Passenger car transitions

One of the most difficult aspects to deal with in a transport sector energy model is that of technology transition, particularly in the passenger car space where most of the large manufacturers now offer models using alternative fuels and technologies. Even hydrogen fuel cells vehicles are available on a lease basis in selected US markets. In an optimisation model like that used for the IEP, the relative capital costs of these technologies and their efficiencies will determine the outcome if unconstrained. The high efficiency of battery electric vehicles therefore means that if capital costs approach that of conventional technology they quickly dominate in the model. This does not of course reflect that consumer decisions will reflect that current low range and relatively long recharging times of these vehicles. Assuming both these issues will be mitigated in time, another question arises as to whether a gradual transition will feature widespread use of other electromobility technologies like hybrids and plug-in hybrids or natural gas internal combustion engines. inIt appears as if a quite rigorous exercise was undertaken to determine price premiums of technologies relative to conventional petrol technology. As regards hybrid cars the following was found:

> An average percentage price premium of 18% was determined between hybrid and conventional petrol cars. This was used to find an average capital cost premium of hybrid vehicles over the average cost of new conventional vehicles. (Annexure B)

This agrees well with the table below comparing models offered across the range of technologies for one manufacturer.

Table 1: Passenger car costs and efficiencies for the Honda range

Model	*Technology*	*Fuel*	*Range*	*Price*	*Fuel Consumption*
			(km)	*(US$)*	*litres/100km - diesel eq.*
Honda Civic	ICE	Gasoline	612	19905	6.7
Honda Civic Natural Gas	ICE	Natural Gas	354	26905	6.9
Honda FCX Clarity	FCV	Hydrogen	386	leased	3.4
Honda Civic Hybrid	HEV	Gasoline	841	24050	4.8
Honda Fit EV	BEV	Electricity	132	36625	1.8

The outcome of the assumed premium was described as follows:

> Most new vehicles in the vehicle fleet up to about 2040 are fuelled by petrol. Hybrid and diesel vehicles are not selected as their price premiums are not justified by their fuel savings based on the assumed average annual vehicle kilometres travelled by cars. (Annexure A)

Cost premiums for models available in South Africa can be considerably higher, in excess of 90%. The implication of the 21% cost premium for hybrids in the Honda range is that it would take about 10 years to recover the premium in avoided fuel costs which is around the average technical life of the car and thus this technology is unlikely to dominate in a cost optimisation model. What stands out for hybrids however is that their range can exceed that for conventional technology by over 35% while that of battery electric vehicles, the latest Tesla sedan excluded, can be over 75% less. It seems likely therefore that hybrids could come to dominate the less price sensitive upper price range market and if price premiums narrow due to economies of scale or increased CO2 taxes along with increased gasoline prices, even the mid and lower range.

Hybrid technology is also diversifying along a continuum of electromobility technologies from combustion engine dominated models that don't need charging through various types of plug-in hybrids, some of which that do not involve the combustion engine as direct drive, to full battery electric drive. Conceptually therefore is may be better to think of electromobility technologies as a technology family that offer various solutions to transport requirements depending on the nature of those requirements or demands for vehicle range and charging time. Change of vehicle ownership arrangements to include leasing for specific purposes such as intra or inter city trips may not be appropriate for the base case but are probably worthy components of scenario runs.

3.2.6.4 Alternative technologies in public transport

The passenger transport base case included 60% private passenger battery electric vehicles by 2050 but this was not evident in the public transport analysis which becomes diesel bus dominated. One would, however, expect alternative, more efficient technologies to premier in public transport applications before private for the following reasons:

- Public transport vehicles have longer life so there is more time to offset a price premium with savings in operating cost.
- Public transport vehicles run on captive routes and are generally centrally refuelled so they are not subject to the high costs of installing geographically dispersed fuel transmission and distribution infrastructure. The roll out of alternative technologies is therefore also considerably easier and quicker.
- Alternative technology buses are in service all over the world including gas, biodiesel and ethanol buses as well as hybrid and fuel cell buses and so the technology is readily available and operational paradigms are readily accessible.

3.2.6.5 Energy Demand from SUVs

SUVs account for a large share of passenger transport demand, accounting for 110 billion passenger.km by 2050 compared to 300 billion passenger km for passenger cars. This is assumed to be all petrol fuelled technology by 2050 based on the following definition: "smaller delivery type vehicles which are dual purpose and are predominantly fuelled by petrol."

These are, in other words, what are locally referred to as 'bakkies' and in the US as 'pick-ups' but are used for passenger transport not commercial activity. There are however undoubtedly a portion of this market in South Africa that are purpose built, usually luxury, Sport Utility Vehicles, for example the BMW X5 and derivatives. European legislation, with US legislation catching up, is placing SUVs as a product under enormous pressure. Current legislation[1] adopted in 2009 stipulates a fleet average of 130 g/km by 2015 phased in from 2012 and 95 g/km by 2020. In 2011 the EU adopted similar legislation for vans stipulating a fleet average of 175 g/km by 2017 and 147 g/km by 2010.

Its very likely that compliance will require smaller lighter cars and hybrids with SUVs classed as cars. Large passenger vehicles may remain as part of OEM offerings if priced such that their sales don't affect fleet averages but this then raises the question as to why these wouldn't be hybrids, given that the SUV market is essentially a luxury and upper range car market and can be assumed to not be highly sensitive to the premium. There are already hybrid, fuel cell and even battery electric SUVs on offer and it could be argued that OEMs will go in this direction to take pressure off their fleet average. The sustained large share of non-hybrid petrol SUV passenger km till 2050 therefore seems improbable.

This has however been recognised by the IEP modellers that "Other technologies should be considered for SUV and freight vehicles in future modelling" and therefore our comments are intended only to contribute to these considerations.

3.2.6.6 Biofuels, natural gas and hydrogen

Three alternative fuels were not evident in the IEP transport sector model: natural gas, biofuels whether alcohols, biogas or biodiesel and hydrogen. The significant penetration of these fuels and their associated technologies are of course contingent on a great many infrastructural, policy and cost evolution factors. As such it may well be argued that they would not form part of the base case but be examined in scenarios and 'test cases' (IEP term for policy driven scenarios). Aside from their importance as alternatives, until they are in the model, questions will continue to be raised by their respective interest groups.

The draft of the recent Mitigation Potential Study has indicated that there may be considerable scope for CO_2 mitigation, of similar order to that estimated for technology efficiency improvements, by developing a 2nd generation biofuels industry based on Agriculture, Forestry and Paper industry residues. This study also suggested that costs may also drop considerably before 2050. Sources for this work included a multi-country biofuel potential study by the IEA which indicated total potential of residues of over 550 PJ, similar to current total transport energy demand. This study makes clear however the caveat that much of these residues currently find other uses such as animal feed, manure and feedstock for heat and power. The sources are also dispersed and its not clear how this affects the claimed low 'wells to tank' CO_2 emissions relative to 1st generation biofuels by the Mitigation Potential Study. Given the potential and growing interest in 2nd generation biofuels, these considerations will need to find a home in future IEP, South Africa's limited arable land notwithstanding.

Natural gas uptake in any sector will be dependent firstly on the availability of the resource which may come from a number of sources including LNG, pipelines and shale. This is an issue for the supply side of the model but assuming natural gas as a commodity is available in the model its selection as an alternative will depend firstly on the policy driven cost of natural gas as there is no significant efficiency gain for natural gas vehicles to offset the price premium and secondly on the cost of distribution. Availability seems to have been the major barrier to uptake of natural gas vehicles in the US and distribution infrastructure costs and lead times are deciding

[1] see http://ec.europa.eu/clima/policies/transport/vehicles/cars/index_en.htm

factors in the outcome of this technology in an optimisation model. This requires the costing of capital replacement and maintenance of distribution infrastructure for petrol and diesel for comparison purposes which given the current lack of data outside the oil industry will in itself be a useful exercise.

Modelling hydrogen as a transport fuel raises similar issues, although offset farther into the future given that prototype fuel cell vehicles are only now approaching market readiness but at very high cost, such that only a few are leased for demonstration purposes. The properties of hydrogen also present challenges right through the production, transmission and distribution chain adding cost and losses at every step with current technology. The attraction of a hydrogen economy remains that it could potentially be produced by water electrolysis powered by renewable electricity; a zero-emission pathway theoretically without resource limits. Current costs of implementing such a vision appear prohibitive and the advantages over battery storage (the hydrogen would essentially be a storage medium) remain unclear, such that this would be an avenue for scenario modelling rather than the construction of a base case. Again, a more complete representation of transport fuel transmission and distribution infrastructure within the model would be required for an effective analysis.

3.2.7 Agriculture

Did energy demand calculation consider the different end uses shown in Figure 5-2 on page 95? It is not clear which end use will contribute to the massive increase in diesel. There seems to be three sub-sectors that are considered in the agriculture: “The agricultural sector includes animal husbandry, crop farming, forestry and fishing.” But it is not clear how the end uses in Figure 5-2 are split between these three sectors. If these sub-sectors are included, was the same value add used to drive energy demand in this sector or was the a particular one for each of the sub-sectors.

4. Carbon Tax

- We applaud the inclusion of the carbon tax in the IEP modelling, and also the inclusion of Section 6.2.1, which outlines the policy issue “Climate Change and Emissions Reductions”. In particular, the inclusion of Fig 6-1 with a ‘peak, plateau and decline’ trajectory of GHG emissions, disaggregated by categories of energy supply, energy end-use and non-energy end-use.
- However, the IEP assumes that the upper bound of the PPD trajectory, as per the National Climate Change Response White Paper (NCCRWP, 2011: 27)), is the PPD trajectory for the country. The IEP should rather use the mid range of the PPD, since the Benchmark trajectory was included in the White Paper as a broad range of values to account for uncertainty in the LTMS modelling.
- The emissions constraint should be updated to reflect the carbon budgets of different sectors once these have been decided on by the DEA run processes.
- The IEP acknowledges the need to align the IEP with the Carbon Tax policy to be implemented by the government in the coming years. Once promulgated, the IEP should adjust to reflect the final value/ton of the carbon tax policy.
- While the value/ton is discussed in the document and it is mentioned that two cases were run (one at R48/t to account for the 60% exemption), the model output of the carbon tax test case has not been included in the document. This makes it impossible to comment on the technological, financial in mitigation implications of the carbon tax test case.
- Since the carbon tax policy is designed to affect the relative prices of fossil fuels against other fuels in the economy, and thus demand for fossil fuels, the price impacts of the carbon tax should, in the long-term, be incorporated into the demand modelling. The

complexities of doing so are discussed in the demand modelling report, and the utility of a carbon tax case is understood, but once promulgated the carbon tax impacts on demand should be included across all test cases.

- Section 7.4 does not seem to report the costs for other cases (carbon tax, gas; oil prices)
- Figures 7-1 to 7-5 need to be included in the next IEP such that the graphs can be read properly

5. Comments on reporting

As this is a very crucial document, it would be useful to have supporting tables as the area charts that are provided are difficult to read. To illustrate the importance of graphs, we will refer to a figure in the report, the key graphs showing power plants (Fig 7-1 to 7-5) have the legend cut off, so that it is impossible to see the build plans (p. 135-7).

6. For future iterations of the IEP, the following points are crucial:

1. The Energy Balance

a) Getting the basics right – a cohenerent picture of energy supply and demand in the base year comes from an energy balance, therefore effort must be made to make sure that the Energy Balance is coherent and a true reflection of activities within the country.

b) The EB is more than just data it is an abstraction of the energy economy according to certain rules and is therefore essentially a model.

c) The energy balance is the master model that informs many other models, not just IEP but IRP, toxic emission and GHG inventory models

2. Future energy demand

a) Exogenous demand for draft IEP 2012 is only in terms of energy service (useful energy – e.g. Lumens of lighting rather than kWh of energy for lighting) for the transport sector and even here there are limited representation of technologies.

b) This limits the ability of the model to explore fuel switching in response to price and more efficient technologies.

c) This makes the model vulnerable to overstating demand for final energy.

3. Consideration of water resources in energy planning

Given the water scarcity and vulnerability that South Africa faces, it is crucial to integrate energy planning processes with water resource modelling. This will allow the true cost of water, which might increase water scarcity increases and will allow the dismantling of water costs from the power stations operating costs.

4. Socio-economic impacts

There should be an attempt to quantify them and carry any feedback back to (e.g. demand, power plant construction/operation costs due to changes in labour costs or exchange rates). This is not trivial but would be good to be aiming to have these interactions incorporated in future analysis.

References

IAEA, 2008. Integrated Energy Planning for Sustainable Development, s.l.: International Atomic Energy Agency (IAEA).

Sarah Ward, 2008. From City of Cape Town. Presentation on IEP on 24- 25 October 2013