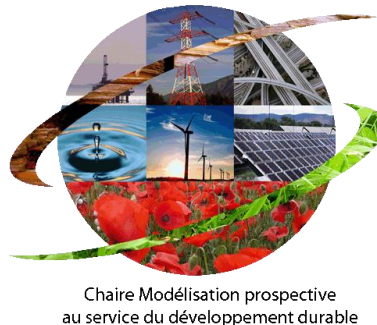
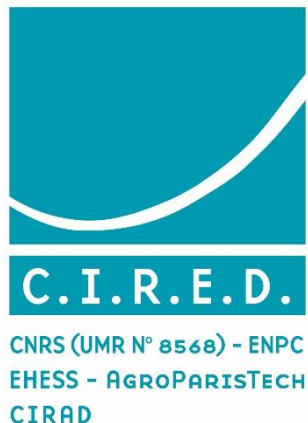


# How choosing a Carbon Tax revenue recycling scheme can & cannot contribute to decarbonizing an economy

## An analysis with IMACLIM South Africa

Jules Schers (CIRED , UCT/Expertise France)  
Co-authors: Frédéric Gherzi, Franck Lecocq (CIRED)

*Funding or support:*



# IMACLIM « hybrid » CGE modelling network & model coupling developments

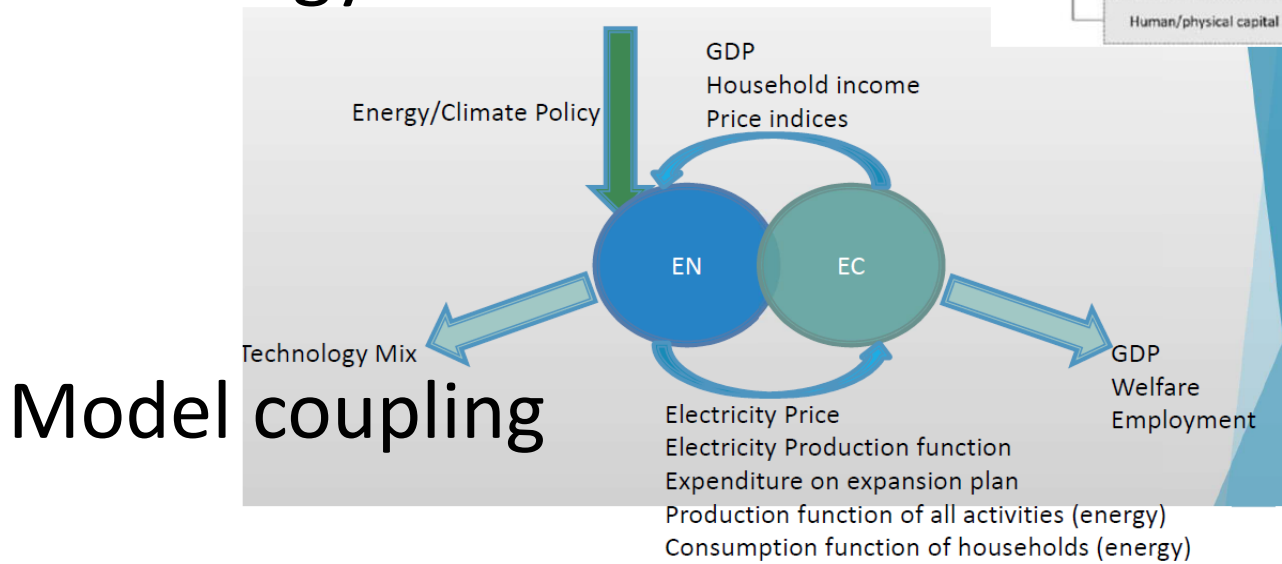
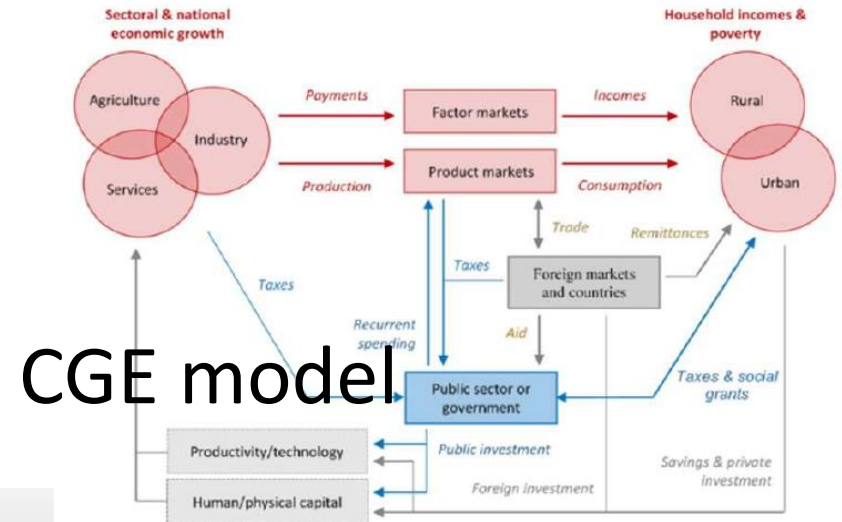
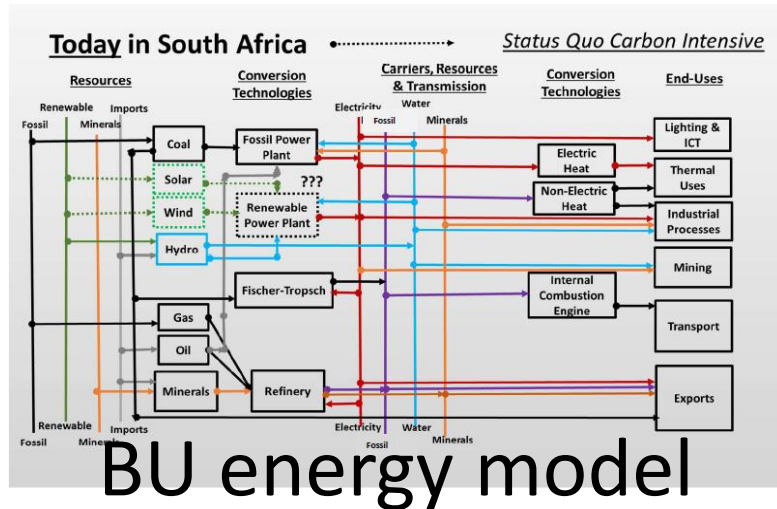
- From integrated BU energy tech-rich *Recursive*, to KLEM, and detailed socio-economic rich models:
  - **Global** (IAM), IMACLIM-R monde, CIREN
  - **France** (2 versions), CIREN, *Recursive* and using reduced forms of BU models
  - **Brazil**, COPPE/UFRJ, soft-coupling to MESSAGE and LEAP & land use models
  - **South Africa**, CIREN with UCT, exogenous tech coefficient from SA TIMES
  - **India**, IIMA, with AIM/end use model
  - **China**, Tsinghua University, KLEM - TIMES coupling
  - **Saudi Arabia**, CIREN & EDF with KAPSARC, with KEM bottom-up model
- Under development:
  - **Argentina**, Fondation Bariloche, coupling with LEAP model
  - **Russia**, HSE Moscow
  - **Viet Nam**, USTH, Ha Noi
  - **Senegal**, ENDA, coupling with LEAP model
  - **Ireland**, CIREN with UCC, coupling in TIAM-KLEM model
- Next week, 27-29 Nov : 5<sup>th</sup> international IMACLIM workshop in Cape Town

# Content overview

1. Introduction : Problem definition
2. Methodology : IMACLIM South Africa
3. Scenarios & results
4. Analysis : Why choice of revenue recycling scheme matters or not for decarbonizing the economy
5. Recommendations

# The other model of UCT: SATIM-GE: coupled, optimisation models for South Africa

Model comparison improves model quality and insights



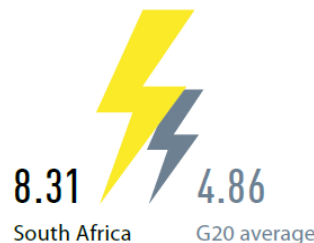
Source: Merven et al, UCT/SATIED, (2019)

# 1. Introduction / Problem definition

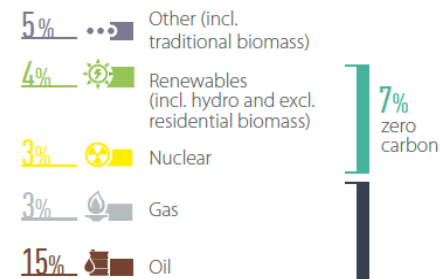
# Overview of SA's GHG emissions & climate policy

- Very high energy and CO<sub>2</sub> intensity of the economy;
- Big minerals sector, Power is 90% from coal, and Coal-to-Liquids used for fuels;
- SA's NDC: peak-plateau-decline is outdated by recent trends, but insufficient for 1.5°C
- SA's Carbon Tax, since June 2019 : 120 ZAR/tCO<sub>2</sub> (~\$6), but 60-95% industry exemptions

## Energy intensity of the economy (TJ/PPP US\$2015 million)

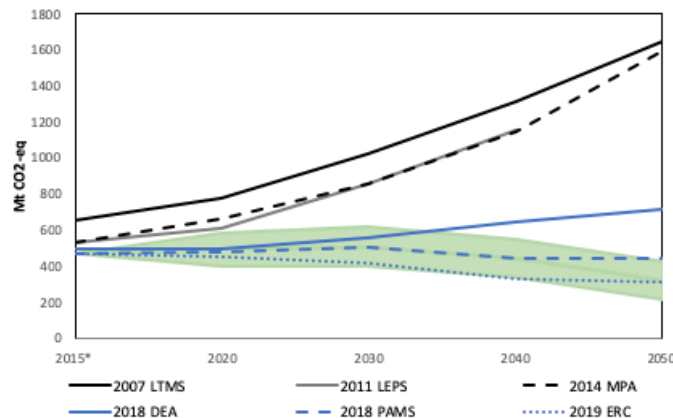


## Share in 2018



Source: Climate Transparency (2019)

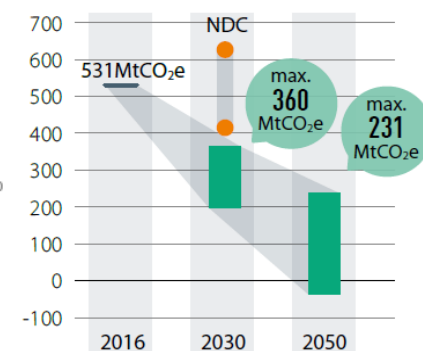
Data for 2018 | Source: Enerdata 2019; World Bank 2019



Source: Marquard, SATIED (2019)

70% Coal

## 1.5°C compatible pathway<sup>2</sup> (MtCO<sub>2</sub>e/year)



Source: CAT 2019

# South Africa's economic problems (despite progress since 1994 / end of Apartheid)

- Low growth, High income inequality, and High unemployment for low & medium skilled labour:
  - Spatial segregation remaining from Apartheid era : accompanied by high transport costs and crime rates;
  - Problems with educational quality (Spaull, 2013): Segmented labour market
  - High-skill labour shortage.
- Guivarch et al. (2010): labour costs important for estimating both costs and benefits of transition to a low carbon economy : Rigidities must be accounted for.
- Could carbon tax revenue be used to lift economic constraints?
  - First exercise: Analyse growth, and Ctax for tax reform or transfers.

## **2. Methodology : IMACLIM South Africa**

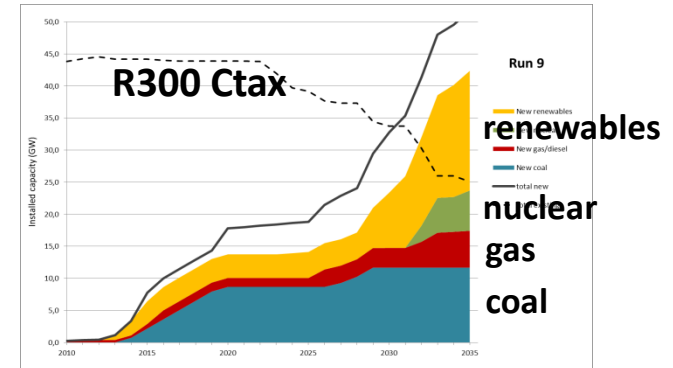
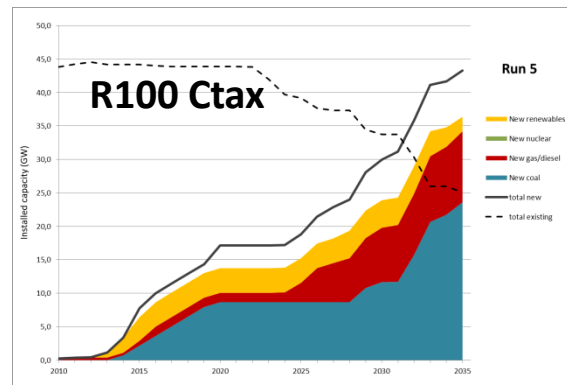
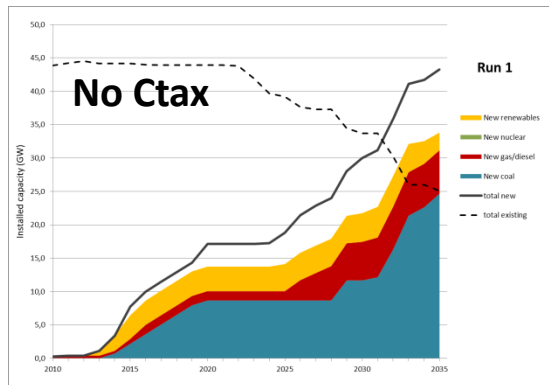


# Main characteristics of IMACLIM-ZA

- *CGE, because 99% of jobs in non-energy sectors: macro-economic feedbacks thus very important!*
- IMACLIM “hybrid”, open economy CGE, with dual accounting of values & quantities of energy flows;
- Myopic simulation in a one-step projection from 2005 to 2035;
- 3 Labour markets segmented by skill (Low, Medium, High) with for each a wage-curve (Blanchflower & Oswald)
- 5 « income-skill » household classes;
- Secondary income distribution: direct taxes, social security & transfers, for Firms, Government, the 5 Hhs, Rest of the World;
- Capital market: Amortisation of physical capital separated from Net Operating Surplus; NOS modelled as a fixed mark-up; modelling net saving/borrowing; debt accumulation; endogenous rate of interests & dividends.

# Technology in electricity sector by Leontief coefficients per scenario

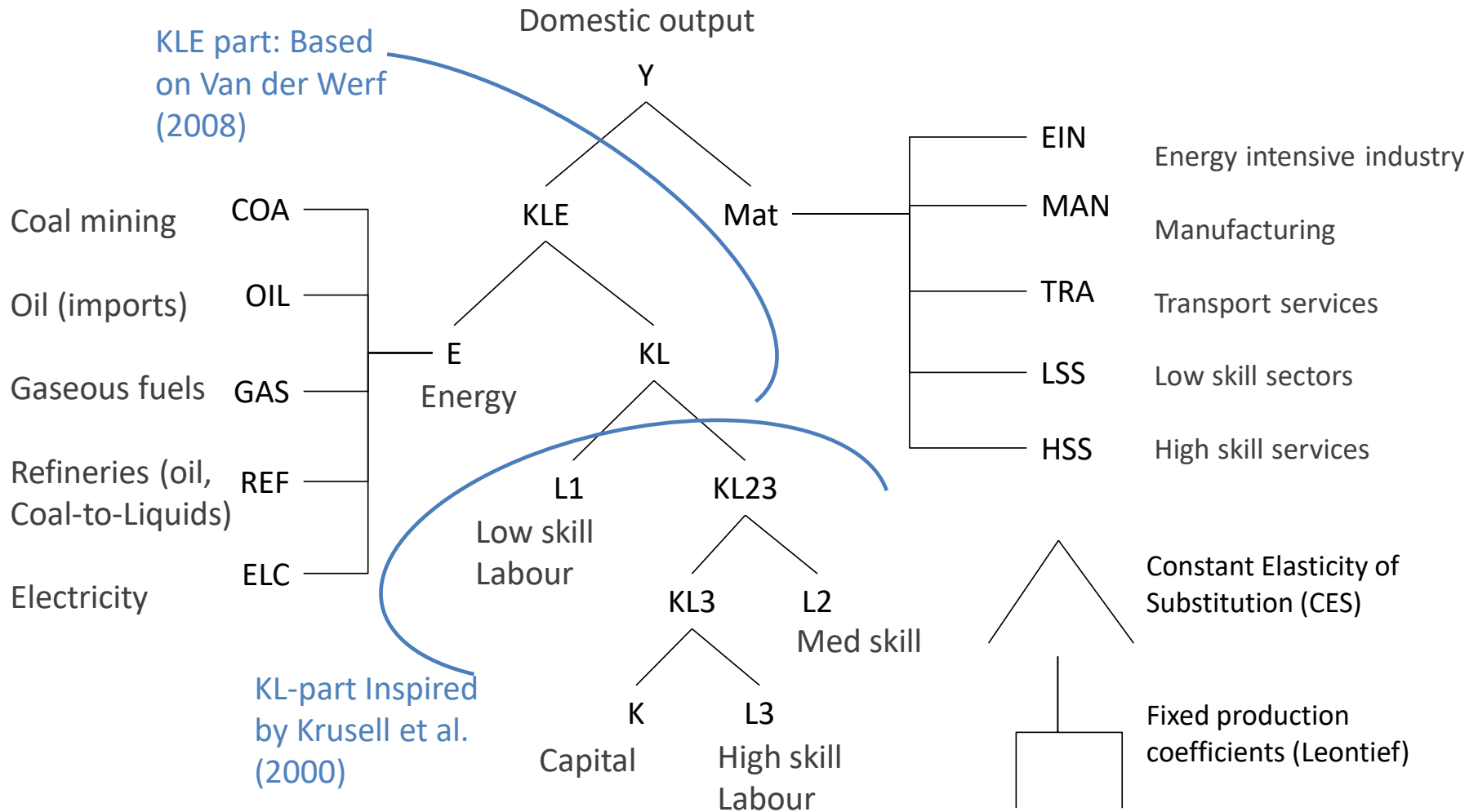
- Hybridisation of I-O table with energy balance & price data:
  - Allows better accounting of energy in economy
  - To fit I-O to Bottom-Up energy modelling insights and e.g. integrate rigidities in energy supply and demand
- Leontief coefficients for ELC per Ctax scenario from SA TIMES\*:



- Future plans: estimate reduced forms of SATIM and expand.

# Nested CES KLEM production function for other sectors

KLE part: Based on Van der Werf (2008)



KL-part Inspired by Krusell et al. (2000)

## 3. Scenarios & results

# Carbon tax revenue recycling scenarios

- Revenue Recycling scenarios for 2 carbon tax rates:
  1. Per capita Lump Sum for all households
  2. Reduction of profit taxes, with:
    - *Case 1: No-change* in profit mark-up rates (*fixed*)
    - *Case 2: Reduction of profit mark-up rates*
  3. Reduction of a Sales tax on final consumption
  4. Subsidies to labour
- Economic impacts *small* for  $C_{tax} 100 \text{ ZAR}_{2005}/\text{tCO}_2$  ( $20 \text{ \$}_{2017}/\text{tCO}_2$ )
- Next: Results for  $C_{tax} 300 \text{ ZAR}_{05}/\text{tCO}_2$  ( $60 \text{ \$}_{2017}/\text{tCO}_2$ )

# Choice of revenue recycling matters for GDP, jobs, and inequality, but not much for CO<sub>2</sub>-intensity

	GDP growth 2005 to 2035	Broad unemploy- ment rate	Energy CO <sub>2</sub> emiss. (Mt)	CO <sub>2</sub> intensity GDP (kg CO <sub>2</sub> /\$ <sub>'13</sub> GDP)	Ratio of class 5 over 1 income
Base Year (2005)	-	39%	443	1.54	42
Reference (2035, No Ctax )	<b>+141%</b>	<b>24%</b>	<b>728</b>	<b>1.05</b>	<b>45</b>

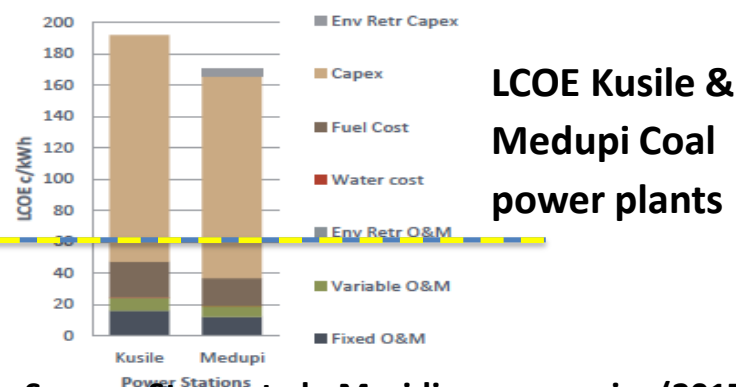
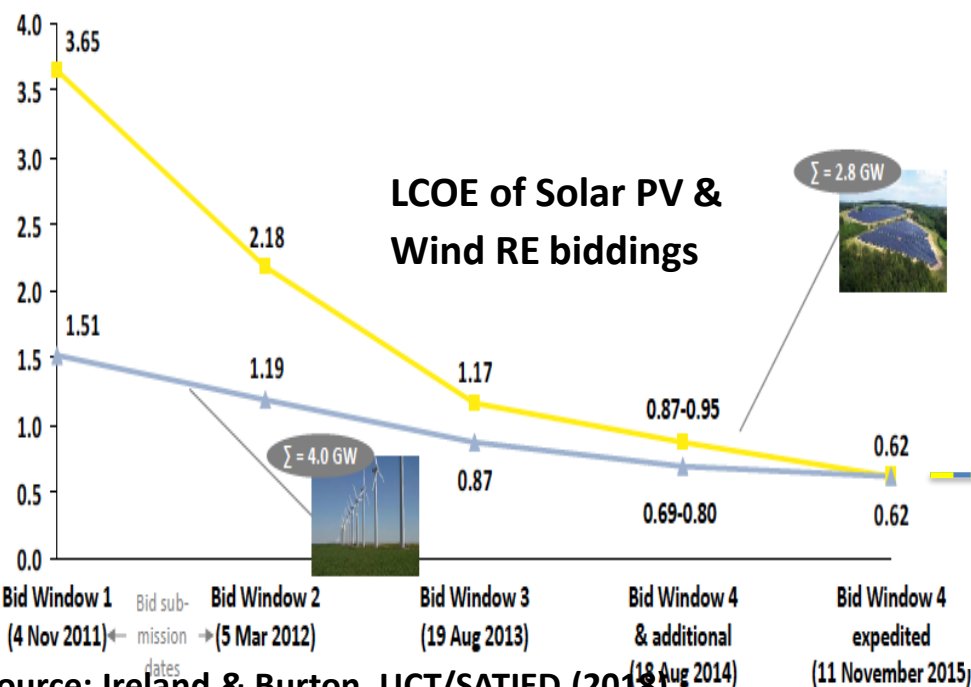
## Results of revenue recycling of Ctax 300 ZAR<sub>2005</sub>/tCO<sub>2</sub> (60 \$<sub>2017</sub>), vs Reference:

	GDP	Nr of jobs	CO <sub>2</sub> emissions	CO <sub>2</sub> intensity of GDP	Class 5 over 1 income ratio
Lump Sum transfer	-20%	-19%	<b>-49%</b>	-36%	<b>-49%</b>
Profit tax cut & Constant margins	-20%	-20%	<b>-49%</b>	-36%	-4%
Profit tax cut & Lower margins	-12%	-11%	-44%	-36%	-2%
Sales tax reduction	-11%	-11%	-44%	-37%	-2%
Labour subsidies	<b>-8%</b>	<b>-6%</b>	-43%	<b>-38%</b>	-4%

# Absolute results likely too pessimistic, but comparison of schemes holds

- No border tax adjustments, no foreign Ctax;
- Labour market maybe too rigid;
- No fuel switching in refineries and transport;
- Model not up-to-date for RE now 2 to 3 times cheaper than newest coal in SA :

Average tariff in R/kWh (Apr-2016-R)



Source: Steyn et al., Meridian economics (2017)

## **4. Analysis : Why choice of revenue recycling scheme matters or not for decarbonisation**



# Economic equilibrium requires that an increase of revenue at one place (CO<sub>2</sub> tax) is compensated at another place

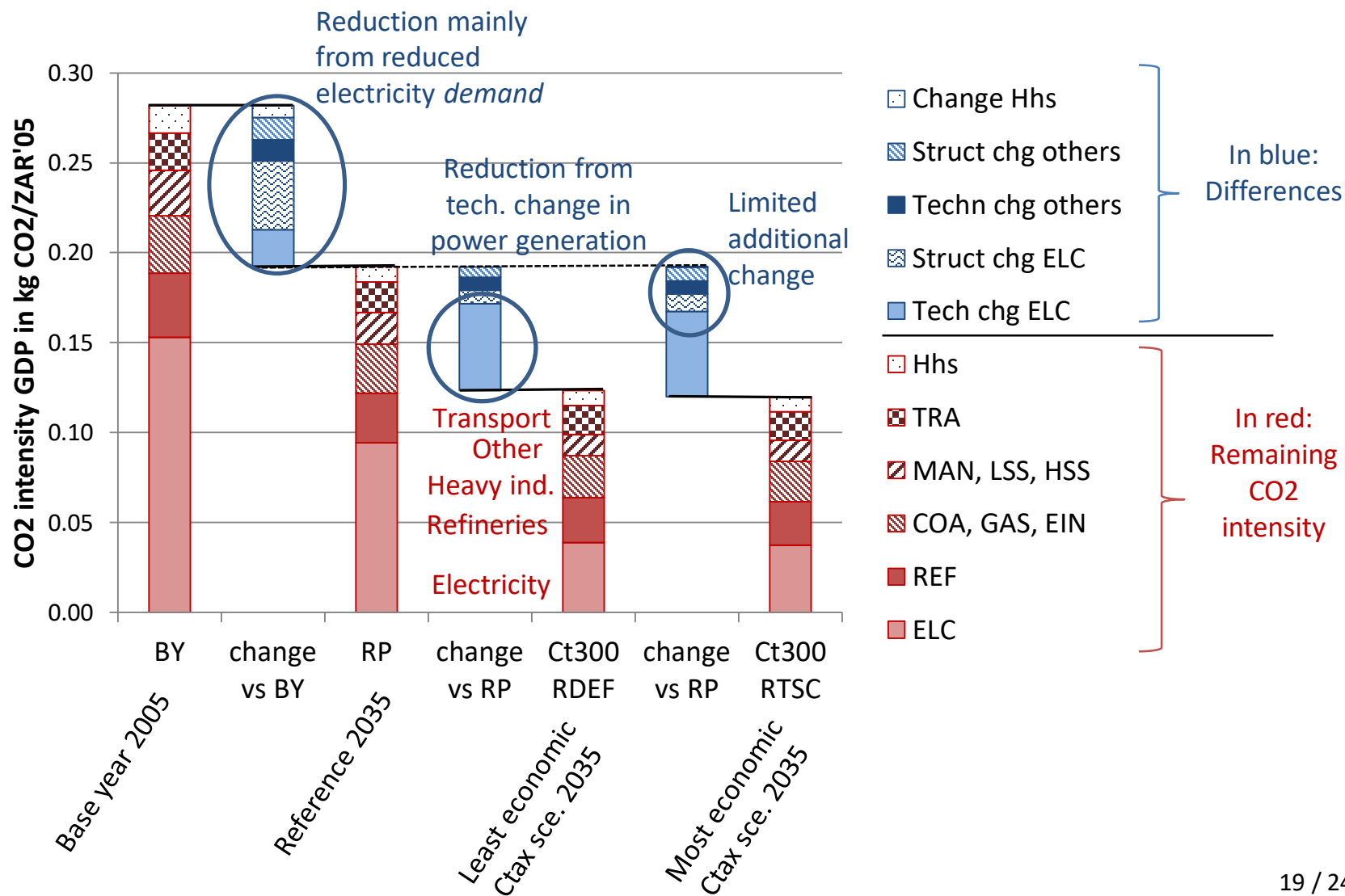
*... all other things (e.g. productivity, trade) almost equal*

Comparison with RP for R300 Ctax & Recycling via:	Lump sum	Corporate profit tax cut		Sales tax cut	Labour subsidies
		+ Fixed margins	+ Lower margins		
<b>Indirect taxes</b> → Ctax effect, unless recycling	<b>+1.5%</b>	<b>+1.5%</b>	<b>+1.5%</b>	<b>+0.1%</b>	<b>+1.5%</b>
<b>Labour costs</b> → wage elasticity or recycling effect	<b>-1.6%</b>	<b>-1.6%</b>	-0.7%	-0.7%	<b>-1.6%</b>
<b>Consumption of fixed capital</b> → K intensity ELC and substitution effects	+0.3%	+0.3%	+0.3%	+0.3%	+0.3%
<b>Net Operating Surplus</b> → mixed effects	-0.2%	-0.2%	<b>-1.1%</b>	+0.3%	-0.1%
<b>Sum of primary income components (by definition 0)</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>
<b>Energy intermediates costs</b> → indirect Ctax effect	<b>+1.0%</b>	<b>+1.1%</b>	<b>+1.2%</b>	<b>+1.3%</b>	<b>+1.1%</b>
<b>Materials and services intermediates costs</b> → substitution effect	-1.2%	-1.1%	-0.6%	+0.8%	-0.6%
<b>Import costs</b> → substitution effect	<b>+1.0%</b>	<b>+0.8%</b>	+0.4%	<b>+0.9%</b>	+0.3%
<b>Sum of non-income components</b>	<b>+0.8%</b>	<b>+0.7%</b>	<b>+1.0%</b>	<b>+2.9%</b>	<b>+0.8%</b>
<b>Total change in aggregate costs of supply over GDP</b>	<b>+0.8%</b>	<b>+0.7%</b>	<b>+1.0%</b>	<b>+2.9%</b>	<b>+0.8%</b>

# Choice of revenue recycling matters for decarbonisation, because ...

- Economically successful revenue recycling schemes (Labour subsidies, and Profit tax reduction *with* reduced margins) can reduce negative economic consequences of carbon taxation and thus increase public support,
- ... while such recycling of revenue into a reduction of costs of labour or production costs of energy-extensive sectors promotes labour (substituting energy) as a factor to production as well as consumption of energy-extensive products in intermediate or final consumption (vs energy-intensive).

# However... only up to a certain limit: little decarbonisation beyond Reference outside ELC



# Energy costs have to rise due to limited efficiency gains (beyond Reference)

- Energy efficiency gains already high in Reference Projection:
- Price-elasticity of energy use is low in energy-intensive sectors;

	COA	GAS	REF	EIN	MAN	LSS	HSS	TRA
Reference	-15.5%	-1%	-3%	-11%	-30%	-22%	-37%	-4%
R100 Ctax avg	-19%	-2%	-3%	-14.5%	-41%	-28%	-48.5%	-5%
R300 Ctax avg	-21%	-3%	-3.5%	-18%	-51.5%	-34%	-58%	-6.5%

- Allwood et al (2011): efficiency potentials in steel, cement, plastics, aluminium, and paper range from 23 to 40% - but what is their cost?

## 5. Recommendations

# Recommendations

## *Policy:*

- Even with expensive RE + rigid labour market SA can achieve its NDC while achieving significant economic growth at rates above current Carbon tax law;
- Recycling of Ctax revenue should reduce production costs, especially for use of labour or energy-intensive sectors, here: Labour subsidies;

## *Knowledge gaps:*

- For higher decarbonisation with continued GDP growth, energy & material efficiency are very important, but little literature discusses the costs, e.g. capital and labour intensity of efficient technologies or efficiency measures;
- Also, it is unclear whether K-L and E-L price elasticities for CES production functions sufficiently capture labour-intensity (and productivity) of future low carbon technologies;
- *Scenario not discussed: Explore investing Ctax revenue in education & training.*

# Thank you for your attention!

Jules Schers  
schers / at / centre-cired.fr

- PhD thesis: Jules Schers. Economic growth, unemployment and skills in South Africa: An Analysis of different recycling schemes of carbon tax revenue. Economics and Finance. Université Paris-Saclay, 2018. English. NNT: 2018SACLA039. tel-02293182
  - <https://tel.archives-ouvertes.fr/tel-02293182/document>
- *Other publication for this study:* EAERE 2019 conference paper: “The impact of carbon tax revenue recycling on GDP and employment in South Africa”
  - <http://www.fleximeets.com/eaere2019/getpaper.php?fid=1301>