

# Modelling macro-economic impacts of carbon constrained scenarios with Irish-TIMES MSA

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# Overview

- Introduction
- TIMES-MACRO vs TIMES-MSA
- How MSA works in VEDA-FE
- Case Study: preliminary results for Irish-TIMES-MSA
- Next steps

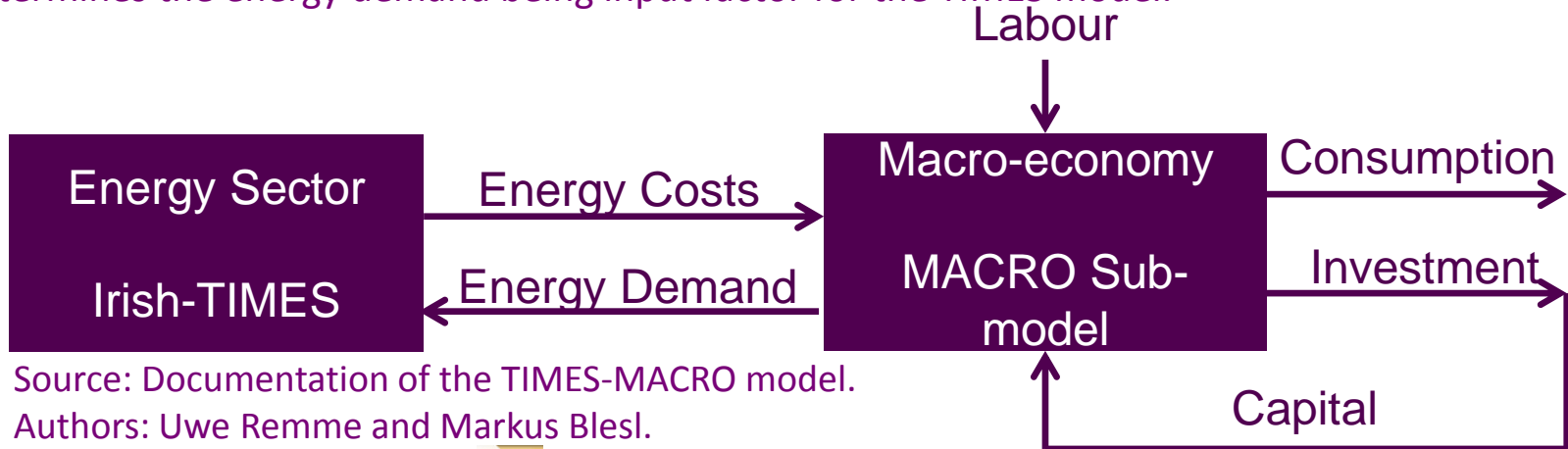
# Introduction

- Assess and develop possible linkages between energy and economy.
  1. Irish-TIMES Elastic demand.
  2. Irish-TIMES-MSA.
    - a. First time the MSA is used for a National TIMES model.
    - b. Calibration and test of the Irish-TIMES-MSA version.
    - c. Sensitivity analysis with different elasticities of substitution.
  3. Irish TIMES-HERMES (macroeconomic model of the Irish economy) to allow feedback between the Irish TIMES and HERMES models to allow better insight on the interaction of the energy system and the economy.

# TIMES MACRO vs TIMES MSA (1/3)

## TIMES-MACRO

- Very similar to the MARKAL-MACRO model. The MACRO model is a single-sector, optimal growth dynamic inter-temporal general equilibrium model which maximises the national (regional) utility.
- The utility is a logarithmic function of the consumption of a single generic consumer.
- Inputs for the production are labour, capital and energy.
- The energy demand is covered by the energy sector, which is represented by the TIMES model.
- Part of the annual production is used to cover the costs for energy demand. The other part can be used for investments in the capital stock or for consumption by the households.
- TIMES provides the costs of the energy demand to the MACRO model, while the MACRO model determines the energy demand being input factor for the TIMES model.



# TIMES MACRO vs TIMES MSA (2/3)

## TIMES-MSA (decomposed Macro Stand-Alone implementation)

- Based on decomposition approach (Kypreos 2006). This implementation makes it possible to use the Macro facility for large multi-regional energy system models.
- The new Macro stand-alone formulation support multiple regions. In the multi-regional case the model is solved by maximizing the Negishi-weighted sum of regional utilities, iterating between the standalone TIMES-Macro model (TMSA) and the standard TIMES LP model.
- Only few small changes in the TIMES code compared to the standard MACRO formulation (e.g period-wise multipliers in the objective function, representing period-length-dependent weights in the utility function).
- Simplified calibration routine to calculate the demand decoupling factors (DDF) needed from the model.

# TIMES MACRO vs TIMES MSA (3/3)

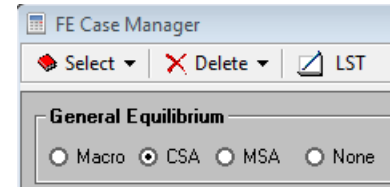
## Calibration

- TIMES-MACRO and TIMES-MSA requires that demand decoupling factors (DDF) and labour growth rates have first been calibrated with the Baseline scenario and corresponding GDP growth projections.
- The calibration produces a file containing the calibrated parameters, which must then be included in the subsequent policy scenarios to be evaluated.
- The Baseline calibration can be carried out in two ways.
  1. Using the original calibration procedure based on the standard TIMES-Macro formulation (for more details see the original MACRO documentation, Remme & Blesl 2006);
  2. Using the new calibration procedure developed for the MSA and based on the decomposed formulation (for more details see the MSA documentation Kypreos&Lehtila).

# How MSA works in VEDA-FE (1/2)

## Calibration in VEDA-FE

- The new calibration procedure based on the decomposed formulation can be activated by using the following switch in VEDA-FE.
  - Case Manager → Control Panel → General Equilibrium → CSA  
This activate MSA in calibration mode.
- The only required Macro input parameters (specified in a scenario file in VEDA-FE are:
  - TM\_GDP0(r) : GDP in base year (currency units).
  - TM\_GR(r,y) : GDP growth projection (per cent / a).
- All the other Macro input parameters have pre-defined default values (see documentation). The default values are overridden by any user-specified values.

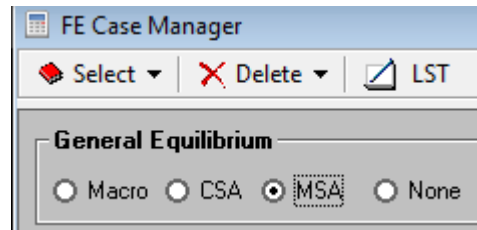


~TFM_INS		
Attribute	Year	IE
TM_GDP0		157
TM_GR	2005	5.70
TM_GR	2006	5.40
TM_GR	2010	-1.00
TM_GR	2015	3.07
TM_GR	2020	2.62
TM_GR	2025	1.46
TM_GR	2030	1.34
TM_GR	2035	0.96
TM_GR	2040	0.96
TM_GR	2050	0.96
TM_GR	2060	0.96

# How MSA works in VEDA-FE (2/2)

## TIMES-MACRO and TIMES-MSA policy run

- The CSA calibration procedure produces a file MSADDF.DD, which contains the calibrated parameters.
- This file is automatically included in subsequent TIMES-MACRO or TIMES-MSA policy runs by using the following switch in VEDA-FE.
  - Case Manager → Control Panel → General Equilibrium → Macro or MSA
  - Macro means activate standard TIMES-MACRO mode
  - MSA means activate decomposed TIMES-MSA mode



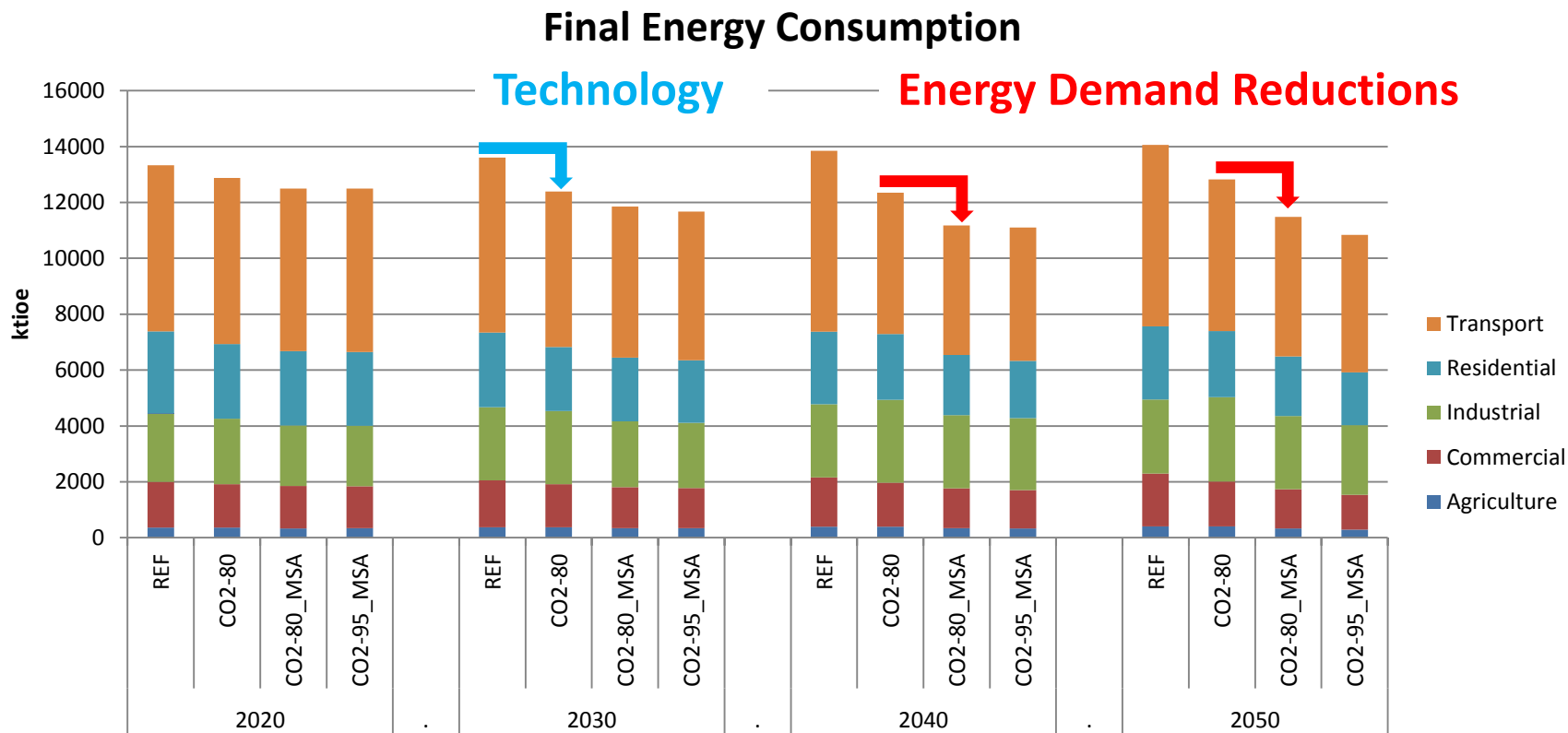


# Case study: preliminary results for the Irish-TIMES

To calibrate and run the Irish-TIMES-MSA, the evolution of the shadow prices of the demands over time has been reviewed to be as smooth as possible.

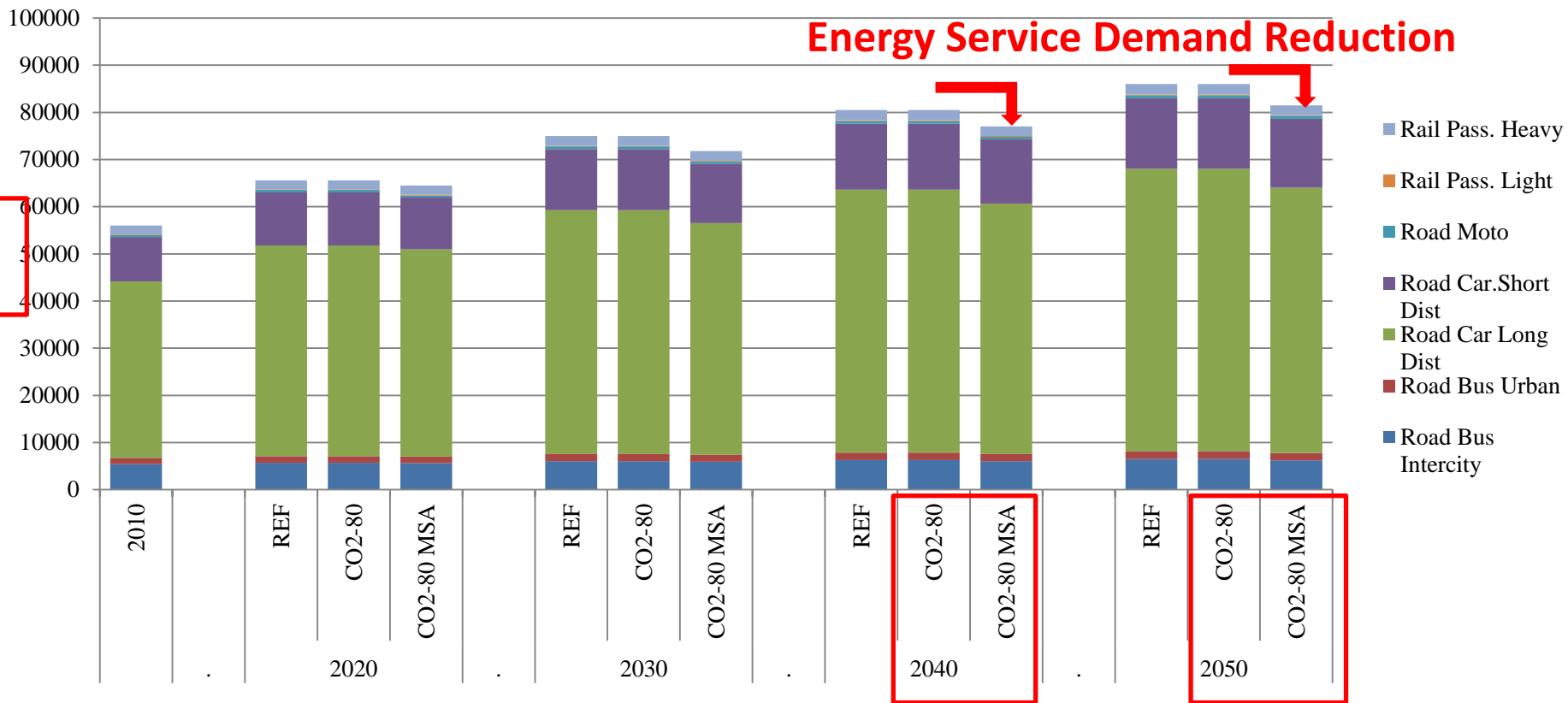
- The refinery cost production was causing price volatility in marginal prices of oil products → cost production updated to get costs close to the import price.
- Sharp spikes or drops of the shadow prices have been removed.
- Zero shadow price of one of the commodities should be avoided (commodity over production).

# Case study: preliminary results for the Irish-TIMES



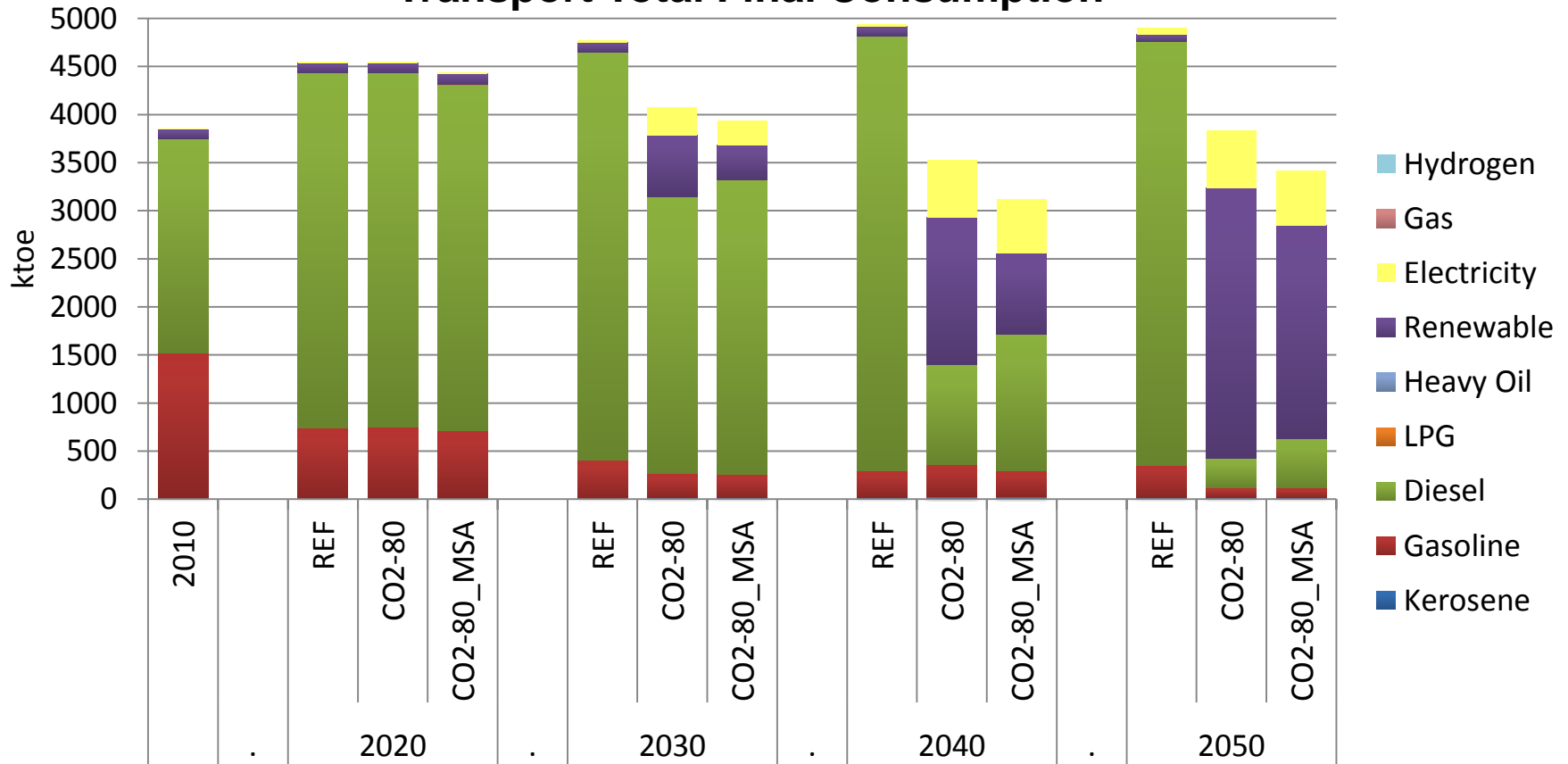
# Case study: preliminary results for the Irish-TIMES

## Transport Energy Service Demands



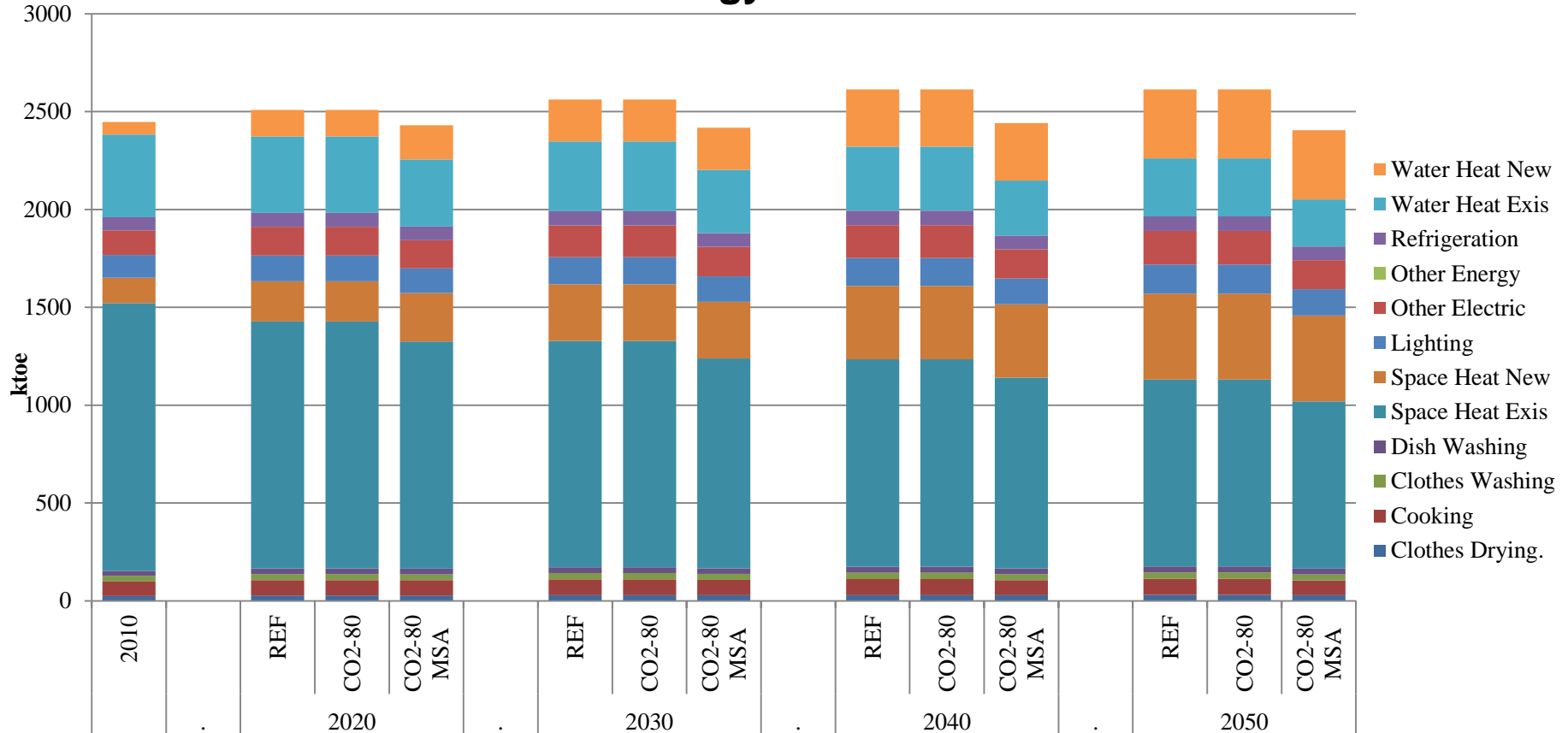
# Case study: preliminary results for the Irish-TIMES

## Transport Total Final Consumption



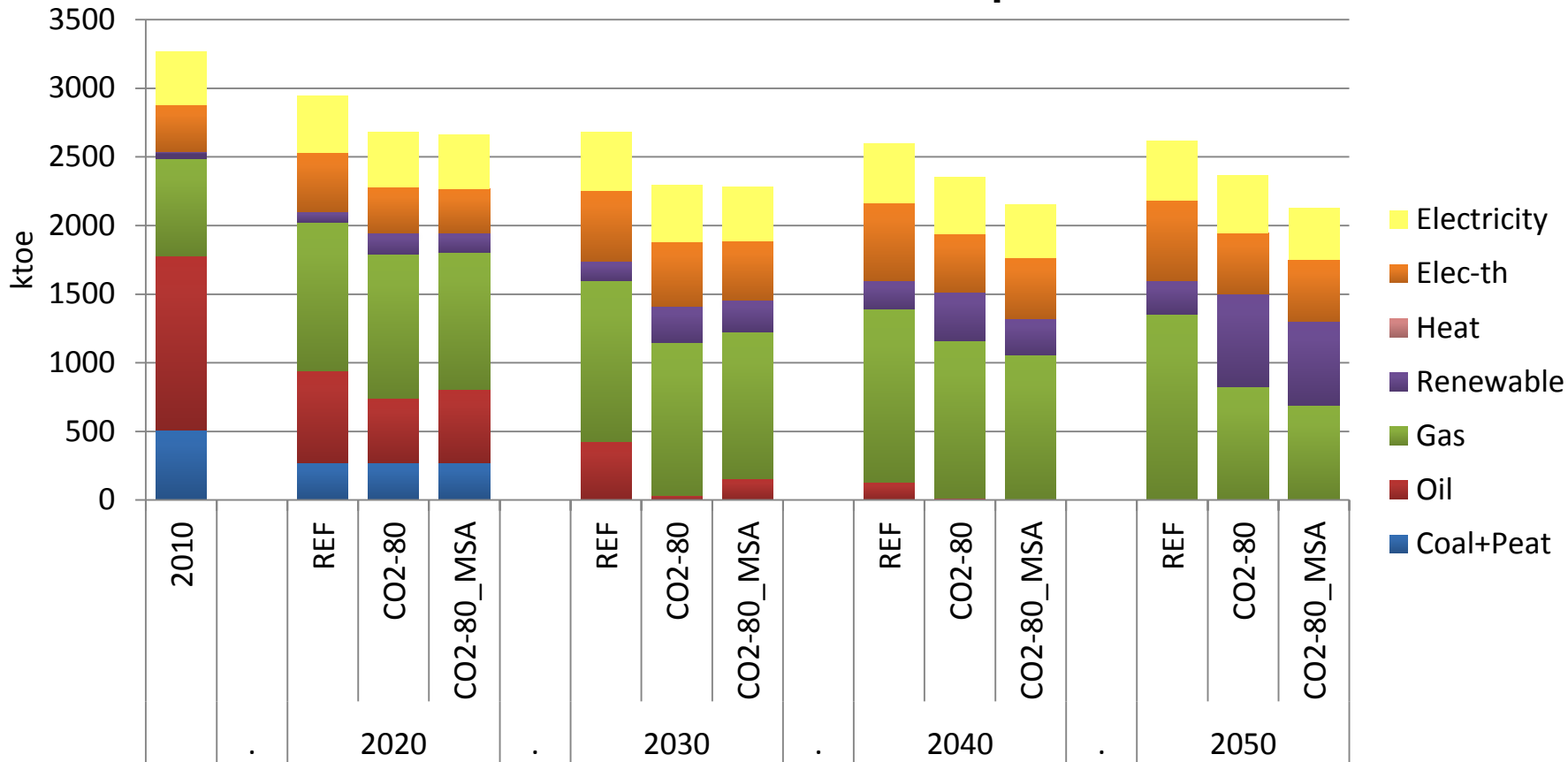
# Case study: preliminary results for the Irish-TIMES

## Residential Energy Service Demands



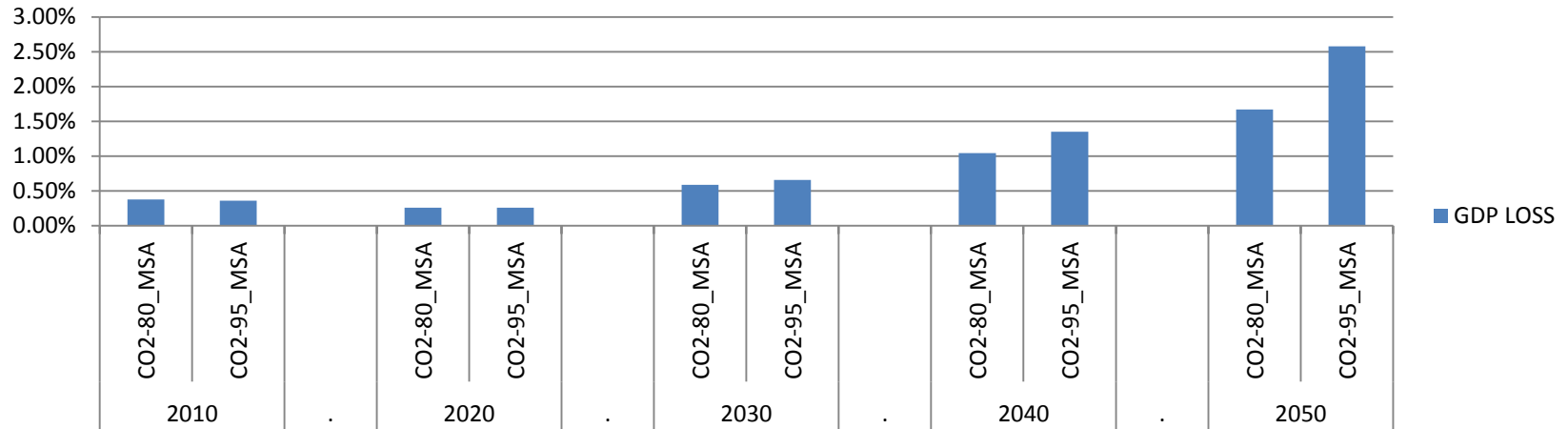
# Case study: preliminary results for the Irish-TIMES

## Residential Total Final Consumption



# Case study: preliminary results for the Irish-TIMES

## GDP LOSS in Comparison to REF scenario



- Estimates potential reduction in macro consumption
- Energy Service Demand reductions drive additional TFC reductions
- Scenario-relative reductions in emissions and emission costs
- More calibration & testing required of input parameters

# Next Steps

## Next Steps for Irish-TIMES-MSA

1. Test different elasticities of substitution.
2. Comparing results with Irish-TIMES-HERMES.

## Open issues

1. Can we improve the MSA including sectoral elasticity of substitution?
2. Can we move to CGE?
3. Other ideas?