

Modelling the global energy system feedback to welfare in developing energy secure climate policy scenarios

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UCC-ETSAP Workshop:

Methodologies linking energy systems models and economic models

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- Rationale
 - First steps in understanding energy system feedback methods
- Learning to use ETSAP-TIAM-MSA
- Input data
- Calibration
 - Data requirements
 - Default parameters
- Example results
- Learning outcomes thus far

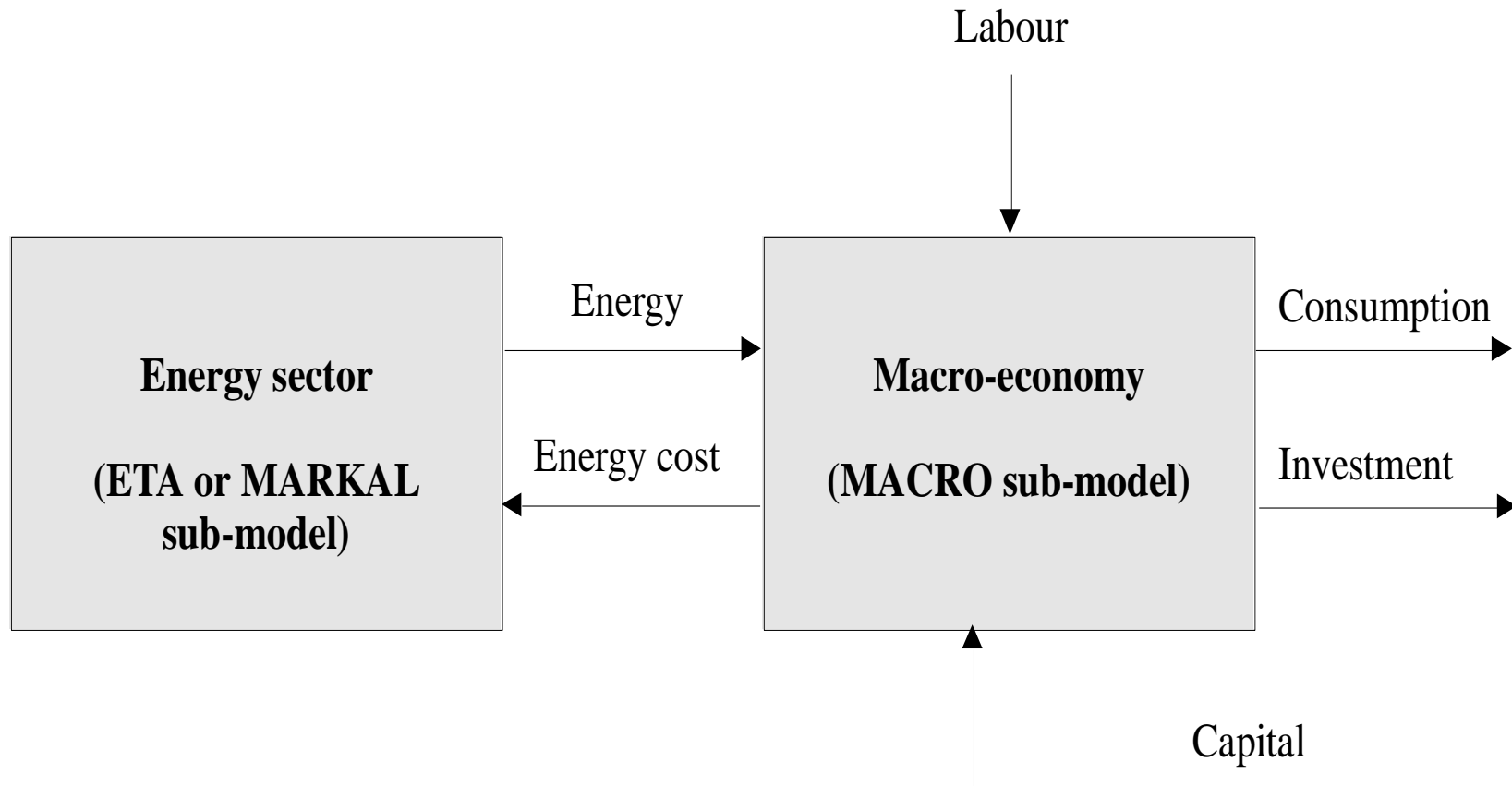
- Understanding of Energy System – Macro economy Feedback tools
- MACRO Stand Alone was tested with ETSAP-TIAM 2010
 - Safe place to start (“The TIAM Monster”)
 - Plug in an Play? (not so much)
- Plan: Learn by doing
 - Explore MSA parameter sensitivities
- Model Questions?
 - Cost/Value of a Climate mitigating energy system?
 - Macro-economy response to future scenario energy systems?
 - Energy service demands response to macro-economy adjustments?
- Implement lessons learned to provide some first steps in initial macro-feedback in Irish-TIMES

- TIMES Integrated Assessment Model
- Global 15 Region Energy Systems Model
 - Least cost optimisation
 - Energy Technology choice
 - Elastic Demands
 - Energy Commodity Trade
 - Climate Module
- Using ETSAP-TIAM 2010 “Common Version”
 - DISCLAIMER: Results are for illustration of MSA only
- ETSAP-TIAM working group project
 - Newer version, updated, improved & stable
 - Shale Resources, Iron & Steel, Gas Trade, China,...

Macro Stand Alone

- Implemented in VEDA_FE
- Cumulative Utility Maximisation
 - Energy Service Demand adjustment
 - Energy System Cost
- VAR_Macro result variables (VEDA_BE)
 - Production
 - Consumption
 - Investment
 - Energy System Cost
 - Reference GDP
 - Loss in GDP

TIAM - MACRO interaction schema



MSA Calibration (CSA)

- Critical Data requirements
 - Initial Regional GDP
 - Regional GDP growth rates for each period
 - Synchronous with TIAM/TIMES Demand Drivers
 - Calibration of default input parameters
- Calibration runs of reference case scenario
 - Create Demand Decoupling factors
 - For each Energy service demand, by region and time period

Input Parameters

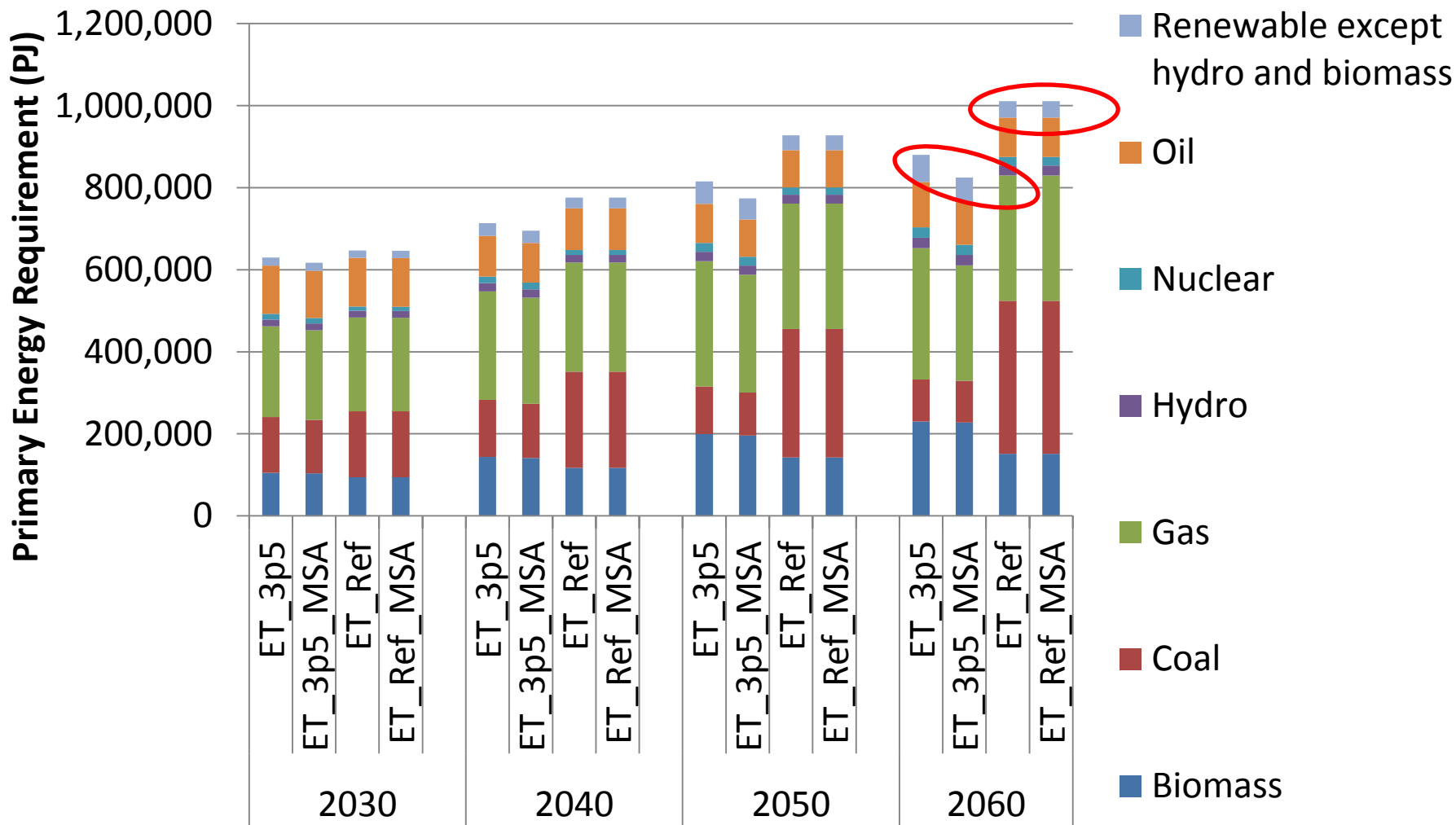
TIMES-MSA

| Parameter | Description | Default Value |
|-----------------|---|---------------|
| TM_ARBM | Arbitrary multiplier for the last period replication | 1.000 |
| TM_DEFVAL(item) | Default values for regional Macro constants | |
| TM_DEFVAL(ESC) | | 1.028 |
| TM_DEPR(r) | Depreciation rate (percentage) | 5.000 |
| TM_DMTOL(r) | Lower bound factor for the demand variables | 0.500 |
| TM_ESUB(r) | Elasticity of substitution | 0.250 |
| TM_GDP0(r) | GDP in the first period | |
| TM_GR(r,y) | Projected annual GDP growth in per cent | |
| TM_IVETOL(r) | Investment and energy cost upper bound tolerance | 0.500 |
| TM_KGDP(r) | Initial capital to GDP ratio | 2.500 |
| TM_KPVS(r) | Initial capital value share in all production factors | 0.250 |
| TM_SCALE_CST | Scaling factor for cost units | 0.001 |
| TM_SCALE_NRG | Scaling factor for the demand units | 1.000 |
| TM_SCALE_UTIL | Scaling factor for the utility function | 0.001 |
| TM_QFAC(r) | Switch for market penetration penalty function * | 0.000 |

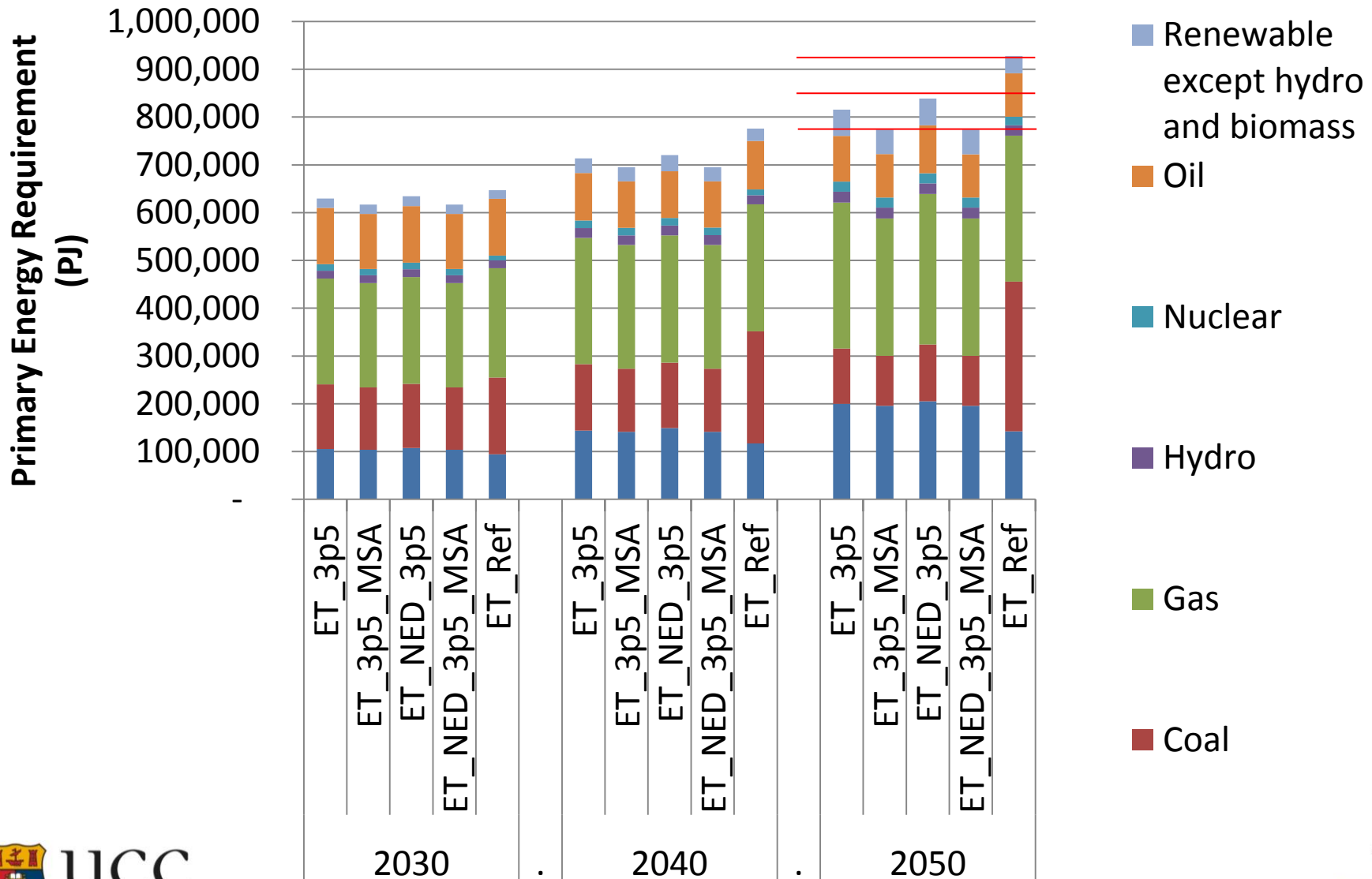
Initial GDP Values & Regional Rates

| TM_GDP0 | | TM_GR(REG, YEAR) | | | | | | | |
|---------|-------|------------------|------|------|------|------|------|------|-----|
| | | 2005 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | |
| AFR | 1230 | AFR | 5.1 | 4.3 | 3.4 | 3.3 | 3.3 | 2.5 | 2.2 |
| AUS | 610 | AUS | 2.9 | 2.3 | 1.6 | 1.1 | 1.1 | 1.0 | 1.0 |
| CAN | 900 | CAN | 2.9 | 2.2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| CHI | 4110 | CHI | 9.6 | 6.3 | 5.5 | 4.4 | 4.0 | 1.9 | 1.6 |
| CSA | 2270 | CSA | 4.2 | 3.7 | 3.0 | 2.9 | 3.2 | 2.4 | 2.0 |
| EEU | 830 | EEU | 3.2 | 2.2 | 2.0 | 1.4 | 1.3 | 1.0 | 1.0 |
| FSU | 1080 | FSU | 5.9 | 5.4 | 5.5 | 2.4 | 2.2 | 1.5 | 1.2 |
| IND | 1470 | IND | 8.6 | 8.1 | 6.9 | 5.0 | 3.9 | 1.9 | 1.6 |
| JPN | 4200 | JPN | 2.2 | 1.5 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| MEA | 1560 | MEA | 5.4 | 4.1 | 3.2 | 2.9 | 2.8 | 2.1 | 1.9 |
| MEX | 790 | MEX | 3.9 | 4.3 | 3.7 | 3.4 | 3.3 | 2.4 | 2.0 |
| ODA | 2220 | ODA | 4.7 | 4.0 | 3.0 | 2.6 | 2.5 | 1.8 | 1.6 |
| SKO | 780 | SKO | 3.2 | 2.4 | 1.4 | 1.3 | 1.4 | 1.0 | 1.0 |
| USA | 10150 | USA | 2.8 | 2.2 | 2.0 | 1.4 | 1.3 | 1.0 | 1.0 |
| WEU | 9940 | WEU | 2.8 | 2.2 | 2.0 | 1.4 | 1.3 | 1.0 | 1.0 |

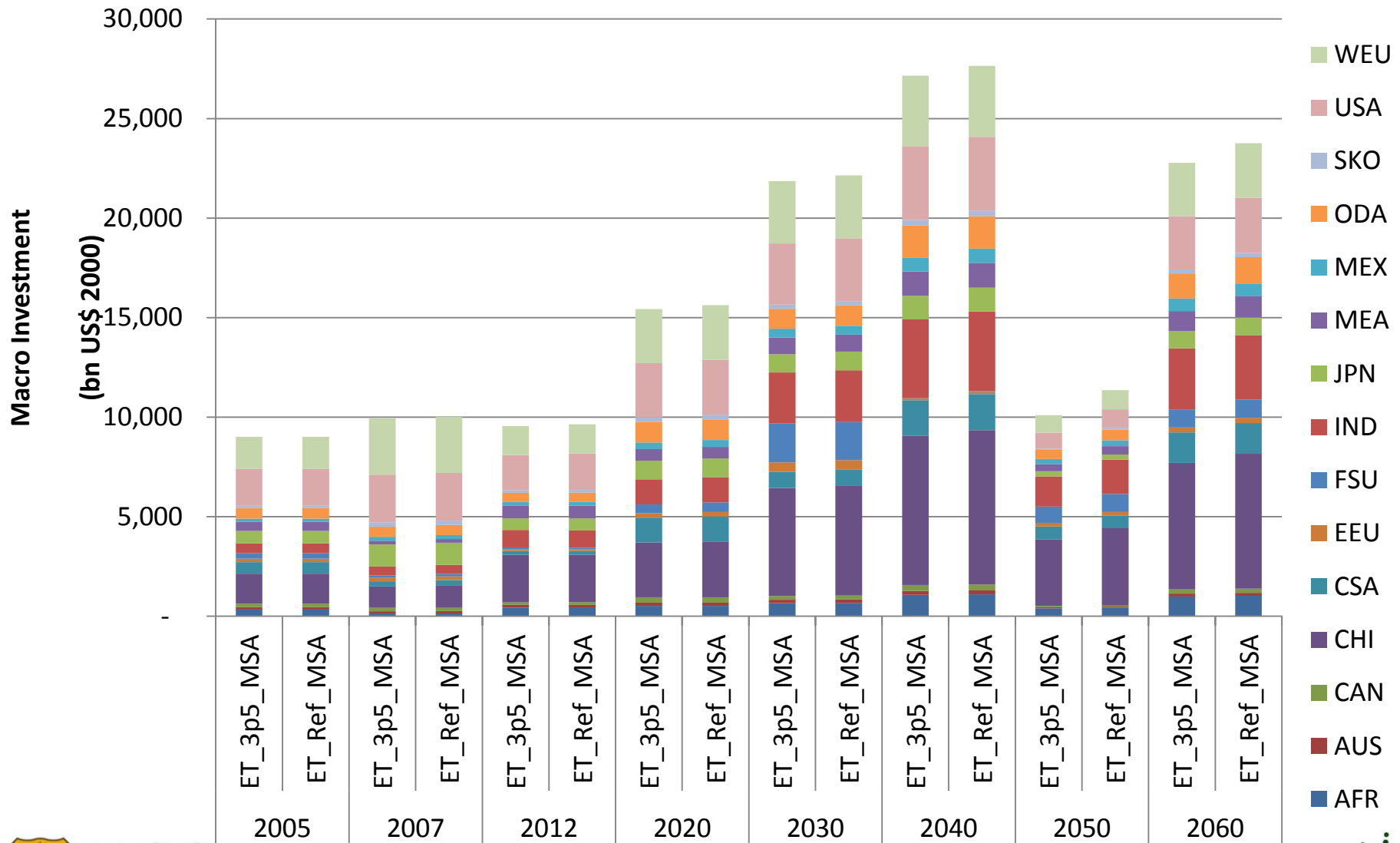
REF Case MSA Calibration + 3p5 Case



Demand Adjustment – Non ElasDem



Terminal Condition Effects on Macro Investment Period T-1



Learning Outcomes

- Initially VEDA_FE did not solve ETSAP-TIAM-MSA
 - Missing MACRO attributes
 - Some Data import bugs
 - Solved with recent updates
- Grappling with scale of TIAM
 - Some results seem questionable in 2010 version
 - Possible Interesting GDP benefits to carbon capture/ afforestation mitigation technologies? – AUS, CAN
- Initial MSA DDF calibration method working
- Next Steps with ETSAP-TIAM-MSA
 - Estimation of regional elasticity's of substitution
 - Adjust/calibrate default parameters
- Start Smaller with Irish-TIMES-MSA

Thank you for your attention