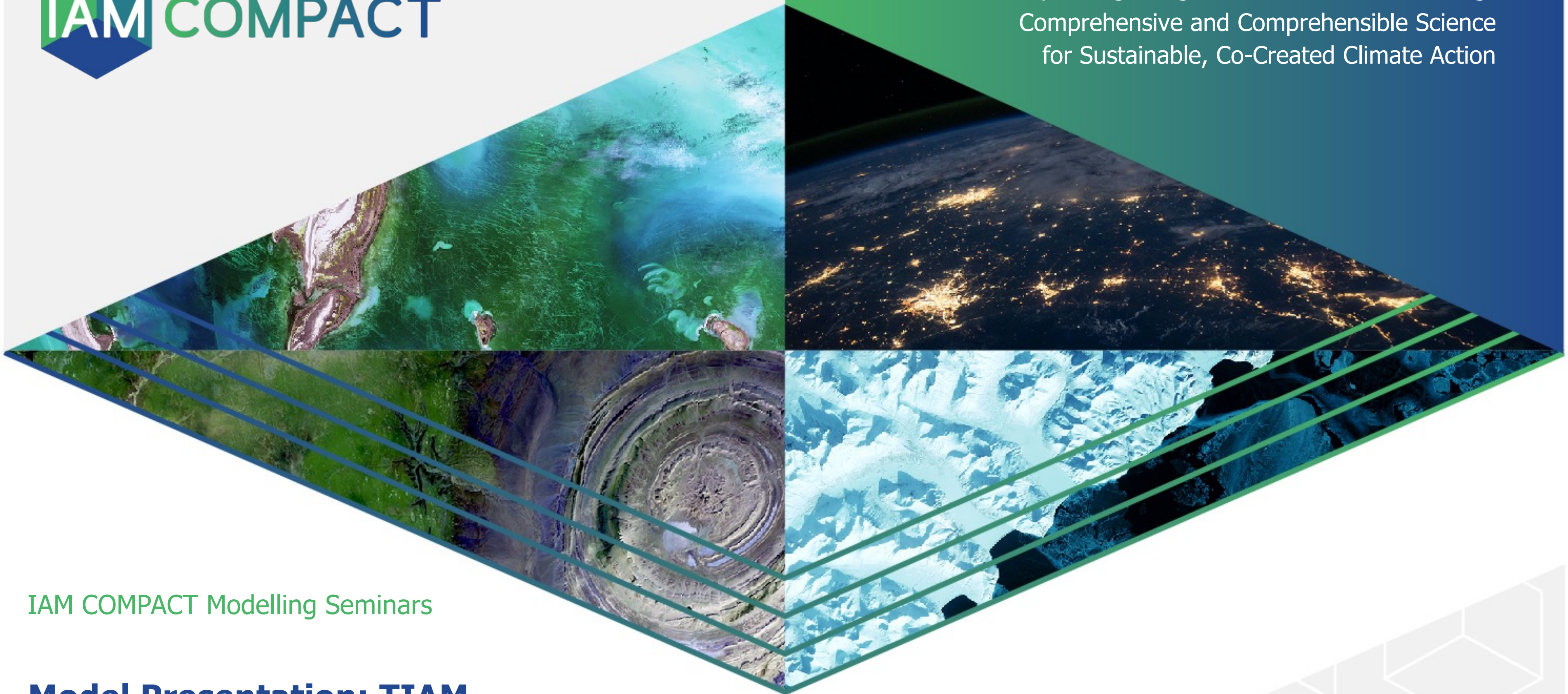
IAM COMPACT

Expanding Integrated Assessment Modelling:
Comprehensive and Comprehensible Science
for Sustainable, Co-Created Climate Action



IAM COMPACT Modelling Seminars

Model Presentation: TIAM-Grantham Model

Grantham Institute, Imperial College London

The IAM COMPACT project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement No 101056306.

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- Developed under the IEA Energy Technology Systems Analysis Programme (ETSAP)
- The seed / origins of TIAM are from global models used by IEA (ETP) and US-EIA
- TIAM stands for TIMES Integrated Assessment Model
- TIMES stands for The Integrated MARKAL-EFOM System
- MARKAL stands for MARKet ALlocation
- EFOM stands for Energy Flow Optimisation Model
- Many versions of TIAM (TIAM-UCL, TIAM-WORLD, TIAM-Grantham, TIAM-ECN, etc)

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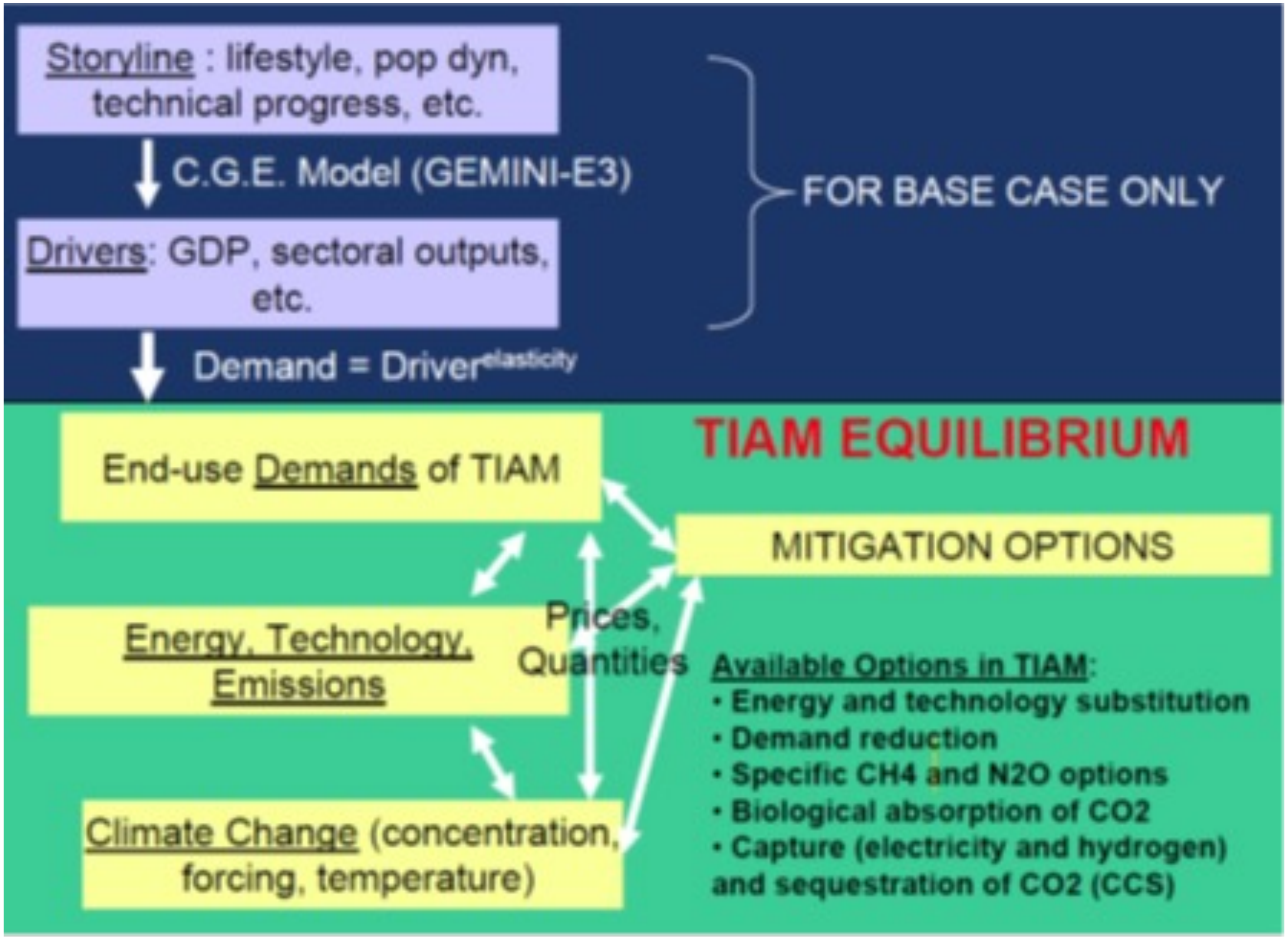

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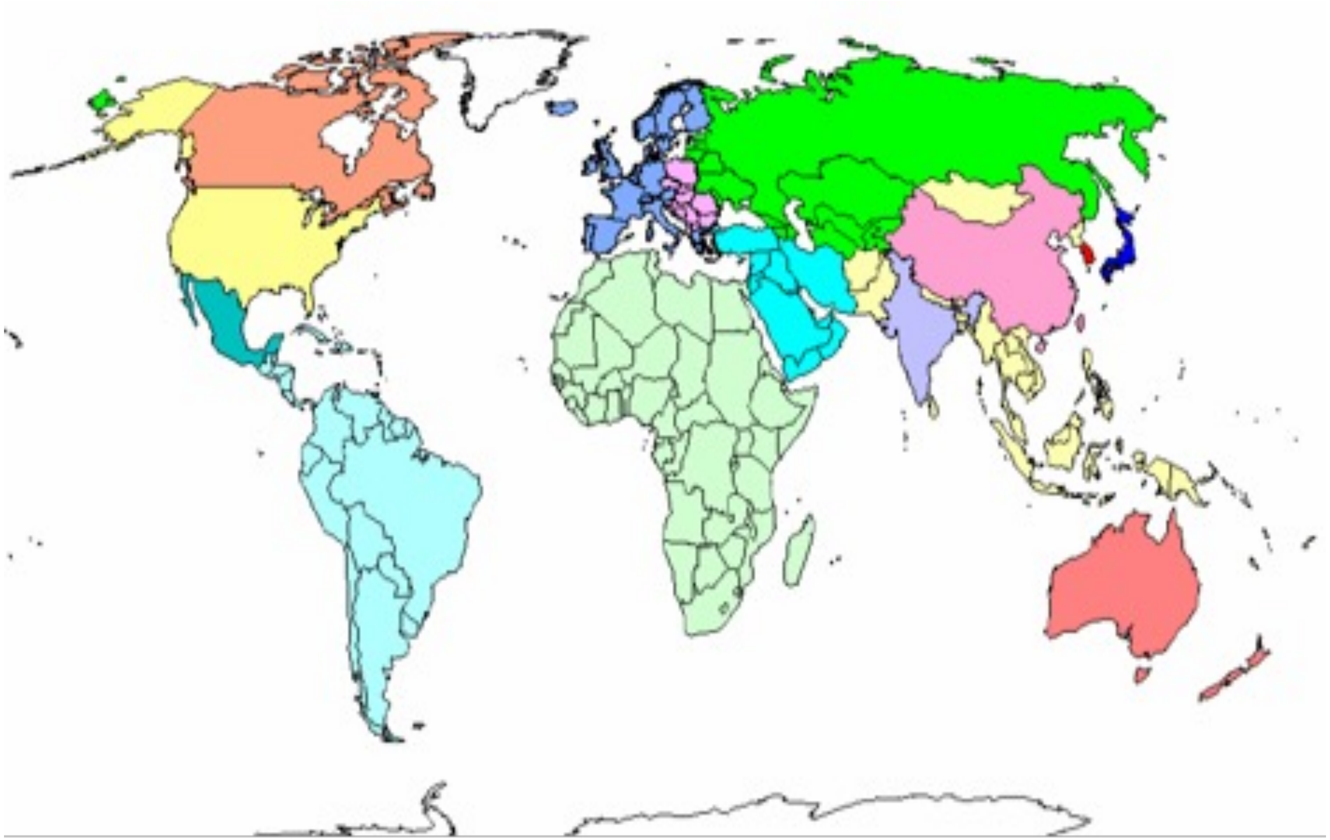
- 15 regions
- OPEC/non-OPEC oil production and pricing
- 5 end-use sectors
    - Agriculture
    - Industry
    - Commercial
    - Residential
    - Transport
- Energy supply sectors:
    - Fossil fuel extraction
    - Fuel transformation
    - Electricity
    - Hydrogen production
    - Heat, co-generation
- Inter-regional trade in:
    - Fuels
    - Carbon permits



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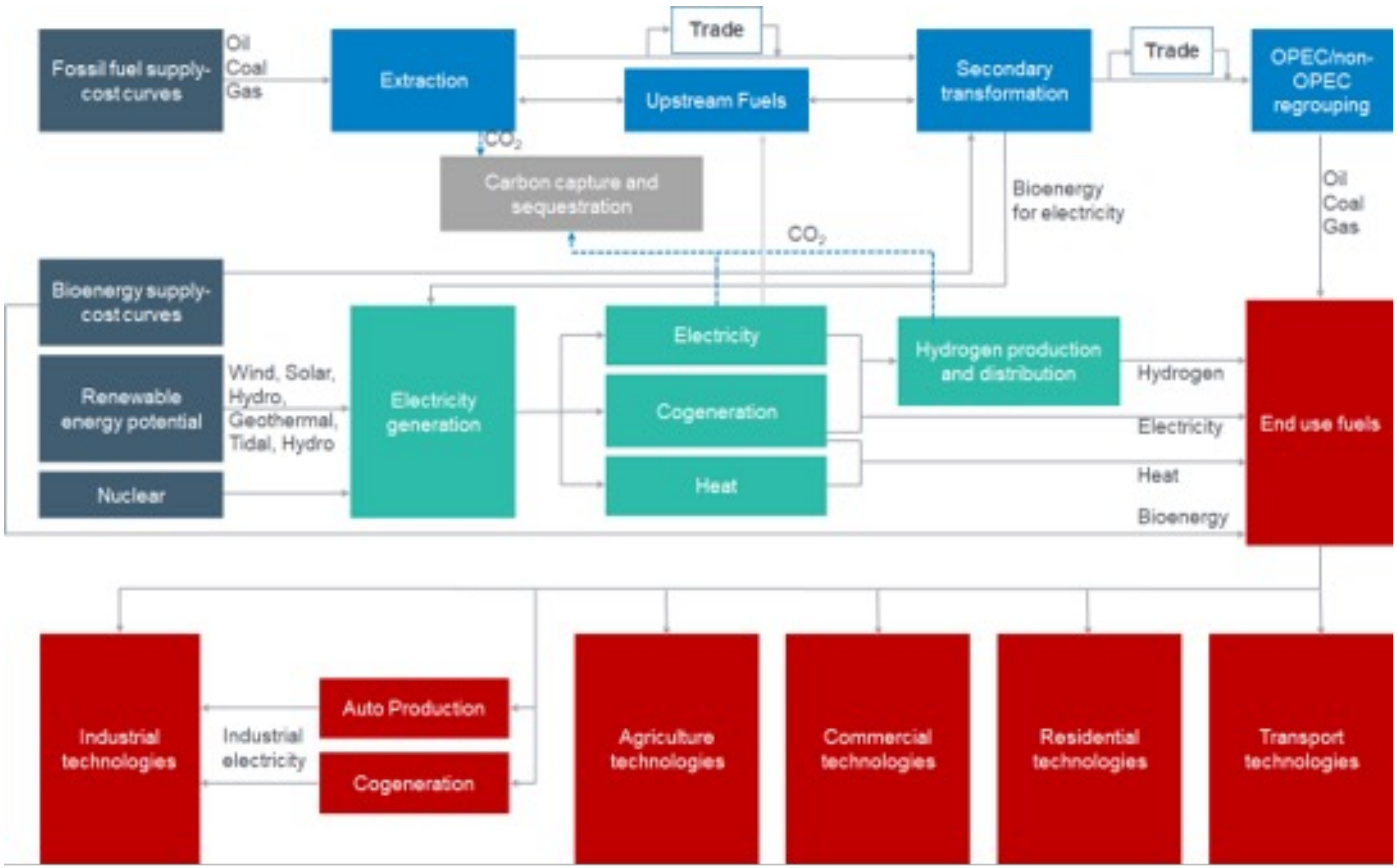

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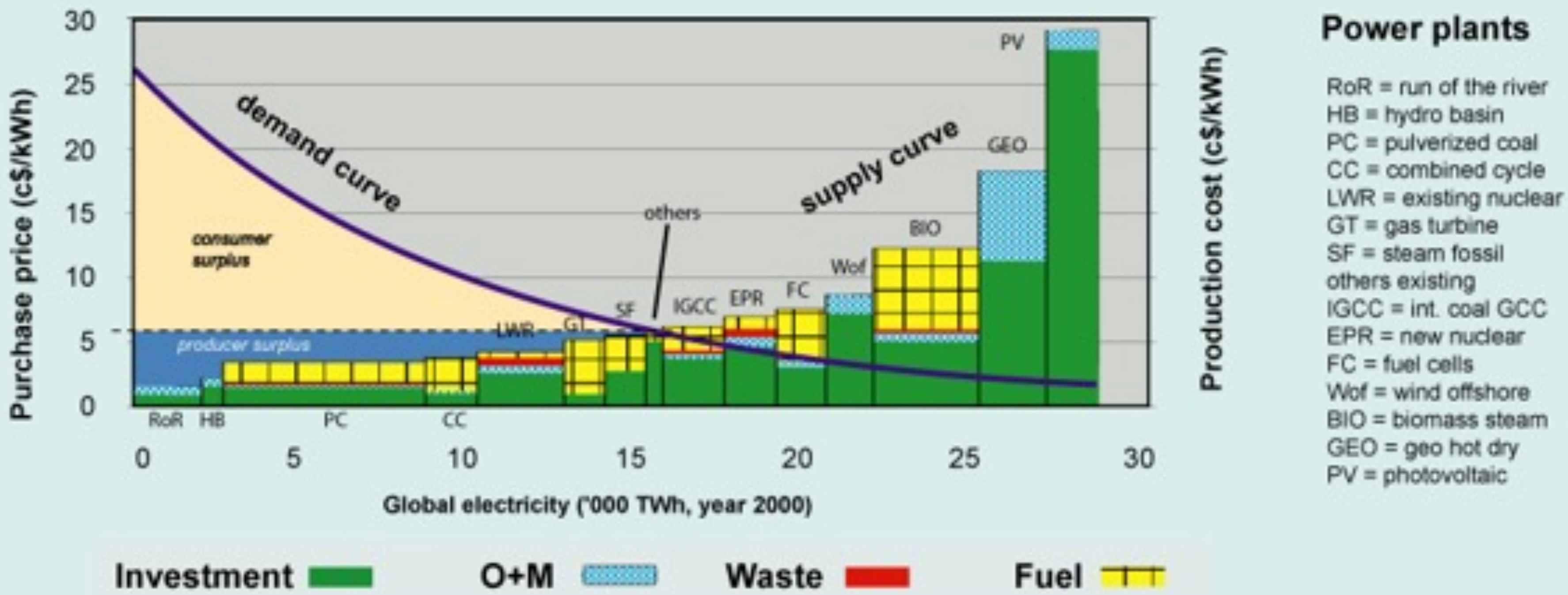

Typical representation of an energy commodity in MARKAL - TIMES.
The algorithm maximises the global surplus over thousands such markets.

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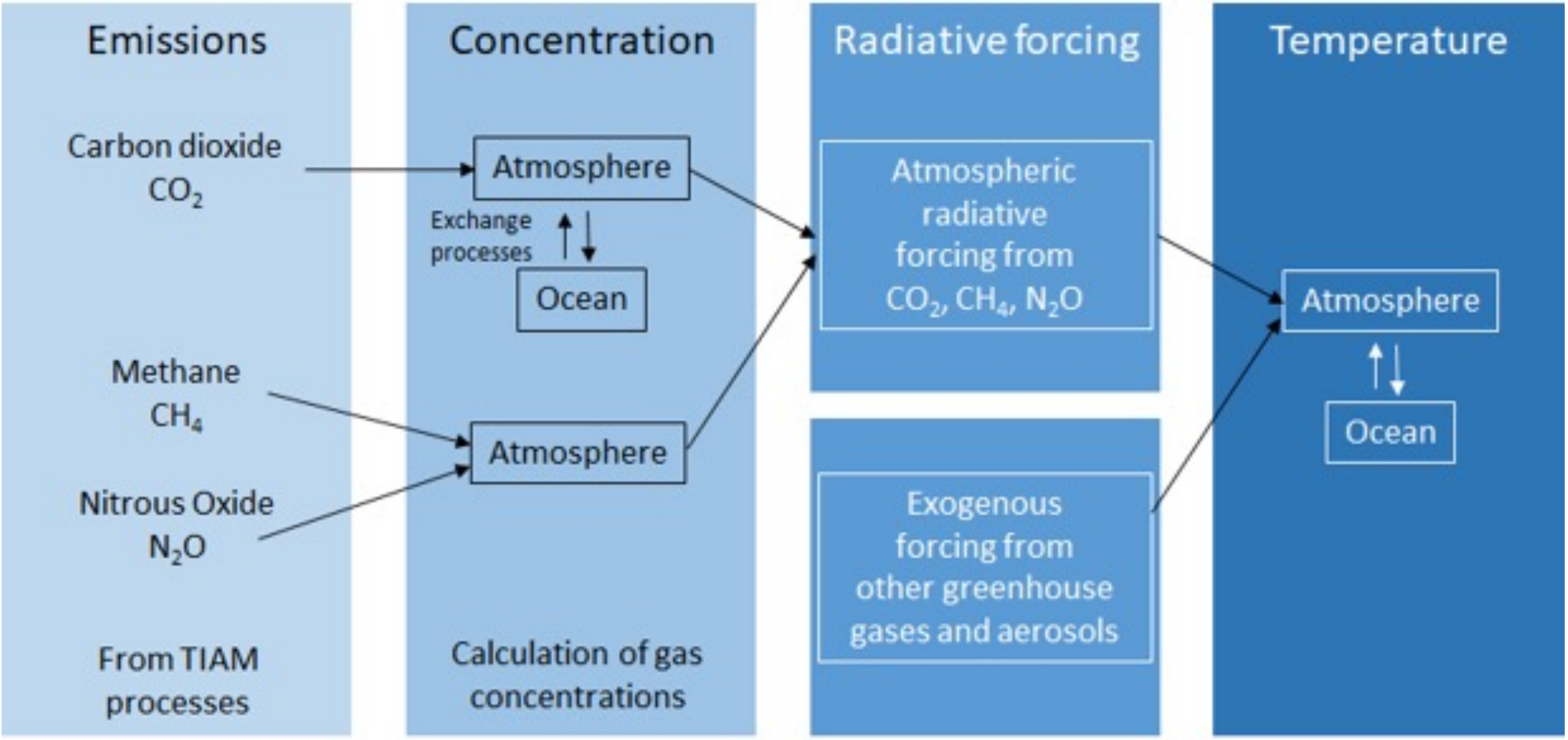

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TIAM predominantly works by specifying either a **carbon price** (imposed as a tax) or a **carbon emissions constraint** in each region that it represents, or alternatively all regions simultaneously.

The following further policies can be implemented:

- Minimum / maximum capacity factors on fossil fuel power generation plants (e.g. to simulate minimum or maximum desired levels of operation);
- Subsidies on particular technologies (through adjusting their costs);
- Constraints on the availability of particular technologies (e.g. "no nuclear", variable renewables accounting for no more than 50% of electricity generation);
- Constraints on the growth rates of particular technologies (e.g. carbon capture and storage power generation capacity cannot grow at more than 20% per year)
- Inter-regional emissions trading (or no trading);

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- Macroeconomic cost implications of delay in mitigation (Gambhir et al., 2017)
- Feasibility of global / regional mitigation (Gambhir et al., 2017)
- Macroeconomic cost implications of mitigation with / without carbon trading (Gambhir et al., 2014)
- Macroeconomic cost / feasibility / carbon price implications of exploiting shale gas (Few et al., 2017)
- Implications of delayed / unavailable technologies e.g. CCS (Gambhir et al., 2017)
- As above, but with stochastic / probabilistic availability of CDR (Grant et al., 2021a)
- Implications of Direct Air Capture on mitigation pathways (Realmonte et al., 2019)
- Implications of aligning future technology growth rates / transitions with history (Napp et al, 2017)
- Implications of advanced demand side technologies and low energy demand (Napp et al., 2019)
- How cost reductions in renewables impact value of CCS in mitigation scenarios (Grant et al., 2021b)

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SDG	Details
§3. Health (e.g., air-pollution related mortality)	The use of solid fuels in buildings can form the basis of local air pollution calculations.
§7. Affordable and clean energy	Cost-effectiveness and availability of low-carbon energy is a central set of TIAM outputs.
§8. Decent work & economic growth	TIAM reports energy system costs under different scenarios, often expressed as a share of GDP, giving a measure of economic losses due to mitigation. Note, this does not account for economic gains due to mitigation that result from lower temperature changes.
§15: Life on land	Afforestation measures can be taken into account; RES potential/exploitation and investment decisions (e.g. energy infrastructures) can be subject to land-specific constraints (natural and regulatory).

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Few, S., Gambhir, A., Napp, T., Hawkes, A., Mangeon, S., Bernie, D., & Lowe, J. (2017). The impact of shale gas on the cost and feasibility of meeting climate targets—a global energy system model analysis and an exploration of uncertainties. Energies, 10(2), 158.

Gambhir, A., Drouet, L., McCollum, D., Napp, T., Bernie, D., Hawkes, A., ... & Lowe, J. (2017). Assessing the feasibility of global long-term mitigation scenarios. Energies, 10(1), 89.

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Grant, N., Hawkes, A., Mittal, S., Gambhir, A. (2021a). The policy implications of an uncertain carbon dioxide removal potential. Joule, 5(10), 2593-2605

Grant, N., Hawkes, A., Napp, T.., Gambhir, A. (2021b). Cost reductions in renewables can substantially erode the value of carbon capture and storage in mitigation pathways. One Earth, 4(11), 1588-1601

Napp, T. A., Few, S., Sood, A., Bernie, D., Hawkes, A., & Gambhir, A. (2019). The role of advanced demand-sector technologies and energy demand reduction in achieving ambitious carbon budgets. Applied energy, 238, 351-367.

Napp, T., Bernie, D., Thomas, R., Lowe, J., Hawkes, A., & Gambhir, A. (2017). Exploring the feasibility of low-carbon scenarios using historical energy transitions analysis. Energies, 10(1), 116.

Realmonte, G., Drouet, L., Gambhir, A., Glynn, J., Hawkes, A., Köberle, A. C., & Tavoni, M. (2019). An inter-model assessment of the role of direct air capture in deep mitigation pathways. Nature communications, 10(1), 3277.

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Thank you!

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