

Two recent applications of TIAM: Future role of renewables (RETD) and World climate strategies (SynsCOP15)

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TIMES Integrated Assessment Model

- **Multi-region technology rich partial equilibrium model** representing the entire energy systems of the World
- Based on **maximization of the total surplus** with own price elastic service demands
- **Driven by demands** for energy services. eg. tons aluminum, km travelled by car, etc.
- **16 regions** (+ Opec and Non-Opec) linked by **trade** of 9 energy commodities + emission permits
- **CO2 and other GHGs**, from energy and non-energy activities, either explicitly modeled (CO2, CH4, N2O) or indirectly represented by their exogenous radiative forcing
- **Reference year 2005** – IEA Energy Statistics
- **Time horizon** 2005-2100

Websites: www.etsap.org/documentation
www.kanors.com/DCM/TIAM



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Application 1 - RETD

Renewable Energy Deployment Technology



Joint RETD-ETSAP study (2009) to evaluate the future potential share of renewable energy considering:

1. Concentration of LLGHG limited to around **400 ppm CO2 eq.**
2. Insecure world and desire for **energy independence**, especially (but not only) from Middle East
3. Deployment of **smart grids**

Scenarios (more than 100 runs in total)

- **Reference (with mild carbon tax)** *Reference*
- Reference + Smart grids
- Climate only
- Climate + Smart grids
- **Climate + Smart grids + Energy security** *RETD scenario*

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Application 1 - RETD

Some of the main changes (data, scenarios)

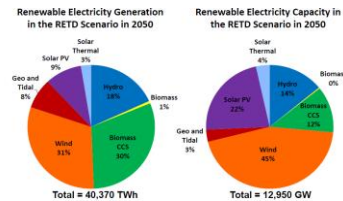
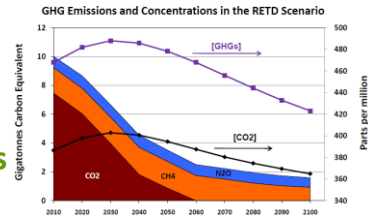
Requested and provided, as far as possible, by the “client”:

- Technology **data adjustment**, addition of technologies: renewable power plants, biorefineries (CCS), electric vehicles (EV, PHEV, HEV)
- Update of the **installed capacity** for solar PV, solar thermal, wind, bioethanol and biodiesel plants + on-going projects
- Adjustment of the **non-energy emissions**, and their mitigation potentials, especially agriculture (quite optimistic)
- **Avoided grid costs** for distributed electricity
- Future **nuclear** capacity
- **CSP** potentials and import from Africa and Middle East

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Application 1 - RETD Examples of results

- Reaching the 400 ppm target is **difficult but feasible**, GHG concentration peaks around 2030.
- Important role of **non-energy emissions**
- The system becomes **CO2-free by 2060** (crucial role of negative emissions by **biomass-based plants with CCS**)
- Electrification of the energy system + decarbonized electricity by 2030 + RE supplies about **70% of electricity generation** by 2050 + all RE important
- RETD scenario is achieved at an **incremental cost of less than 1%** of cumulative global GDP through 2050 (NPV)



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Application 1 - RETD Examples of results

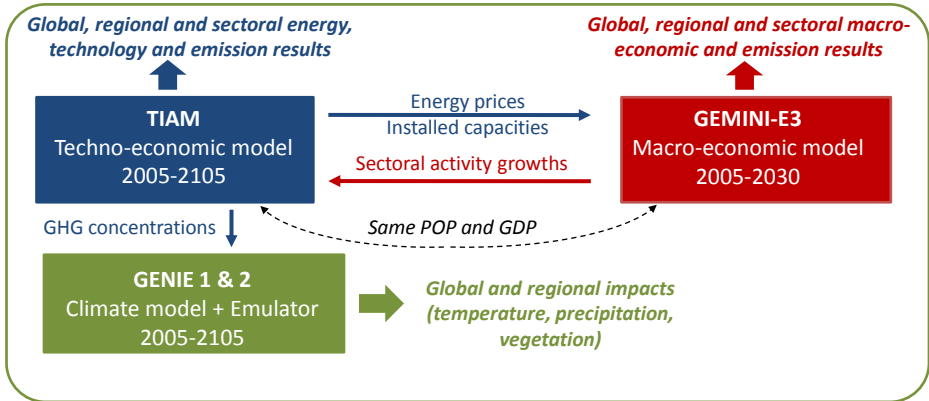
- **Smart grids** help increasing the share of renewable energy in the Reference case, and reducing carbon price and total cost in the scenarios with climate constraint
- In Climate scenarios, **Trade restrictions** affect mainly coal and oil trades: higher consumption of coal produced locally (used for electricity generation with CCS and generation of synthetic fuels). They also result in an advanced penetration of RE
- The **climate target is dominant**
- The RETD Scenario achieves **more rapid energy-sector decarbonization** than the WEO 2009 and the ETP 2008

Presentations at COP15:

http://regserver.unfccc.int/seors/reports/events_list.html?session_id=COP15

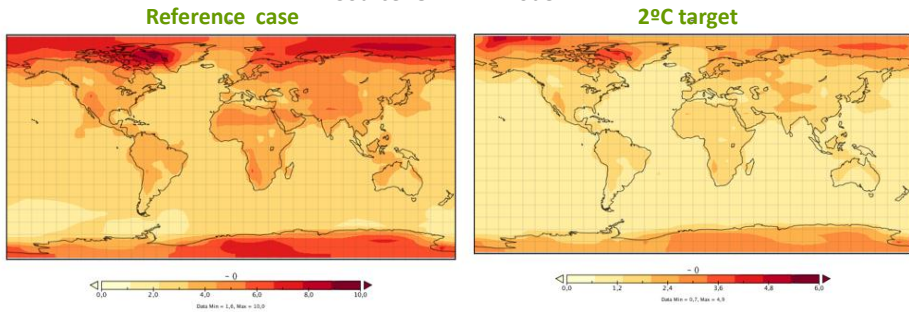
Application 2 – SynsCOP15 World climate negotiations

To establish an integrated system of monitoring and assessment of the climate negotiations based on the harmonized use of:



Application 2 – SynsCOP15 Examples of results

Surface air temperature warming average in 2105 relative to 2005.
Source: GENIE-2 model

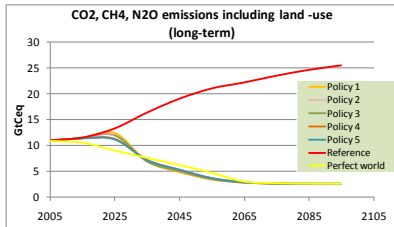


Average temperature increase of **4.17°C in 2105** compared to pre-industrial period (higher in Northern Hemisphere Eurasia/Africa, and in North America)

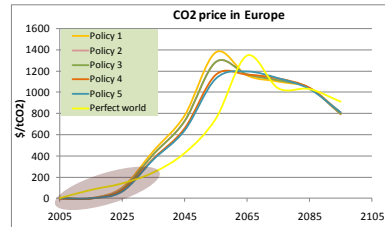
Application 2 – SynscOP15

Examples of results

GHG emissions (2°C target). Source: TIAM



CO₂ price (2°C target). Source: TIAM



- **Reference + 5 policy scenarios**, from complete failure in negotiations, to an agreement within G20, to a full international agreement.
- The 2°C target is difficult to reach, but **remains feasible** whatever the short term climate agreement is.
- Differences in the **transitional** period: faster changes (2040-2060) needed to compensate for lower mitigation the first part of the horizon
- The energy-system must be **CO₂-free almost 10 years earlier** than in the international agreement scenario

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Application 2 – SynscOP15

More scenarios to come

- Refine the **policy scenarios** (national targets proposed by countries at the end of January by countries, CDM bounds)
- Explore other **climate targets** (1.5 and 2.5°C), maybe with stochastic analysis
- Evaluate the **other impacts** (precipitations, vegetation)
- Other **nuclear** assumptions

More information on the project and first results:

<http://synscop15.ordecys.com/>

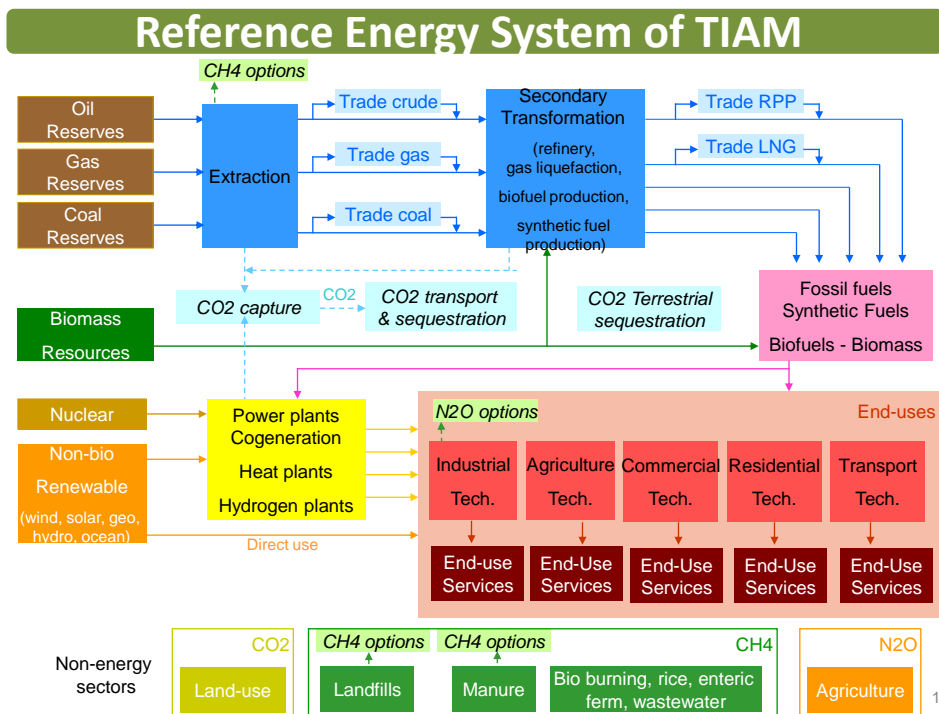
Detailed first results (VBE format) and short descriptive note on

results: <http://www.kanors.com/DCM/GICC>

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Appendix

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Application 2 – SynsCOP15 Commitments and scenarios

National commitments

	Base year	2020	2050
EU	1990	-20% à -30%	-75%
USA	2005	-17%	-80%
Australia	2000	-5 à -25%	-60%
Japan	2005	-15%	
Canada	2006	-20%	-65%
Russia	1990	-20%	-50%
China		No commitment	
India		No commitment	
Brasil		No commitment	

Reference case	No climate target is implemented. Only EU meets its commitments of -20% in 2020. However, in 2020, proven global warming revives the negotiations. The USA, Japan, Canada and Australia decide to reach -20% in 2030 (relative to 2005) . The rest of the World does not commit.
Policy 1: Failure of Negotiations	
Policy 2: Minimum agreement in OECD	Industrialized countries (except Russia) will fulfill their commitments in 2020 and set up, gradually from 2021, an international market for emission permits . Russia and other countries are doing nothing.
Policy 3: Agreement in OECD+Russia	Same as in Policy 2 except for the accession of Russia from 2020 .
Policy 4: Agreement within G20	Industrialized countries + China + India + Brazil set up an international market for emission permits from 2020. From 2020, China and India are allocated quotas as 150% of their 2005 emissions, and Brazil 120% . For industrialized countries, 2030 quotas are equal to objectives consistent with their goals for 2050, the European Union deciding to -30% in 2020 given the participation of China, India and Brazil to the agreement.
Policy 5: International Agreement (World)	Same as Policy 4 but with all countries. From 2020, the Rest of the World obtains a quota equal to 120% of their 2005 emissions.
Perfect World	Represents the social optimum : all countries cooperate from 2010 to reach the climate target. A global market for CO ₂ is implemented from 2010.