



International Energy Agency

Implementing Agreement for a Programme of  
Energy Technology Systems Analysis (ETSAP IA)

***Strategic Plan***

***(2015-2020)***

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## 1. INTRODUCTION

The first oil crisis more than forty years ago made policy makers and the public at large suddenly aware of the need to find alternatives to oil. Since then, concerns regarding economic sustainability, climate change, energy security, environment protection and social safety have called for an energy revolution with increasing urgency. Decision makers need robust policy analyses that encompass the relevant global, regional national and local factors with increasing detail. Policy-makers are looking at the critical role of technological options with new interest and hope. The current urgent need is to identify i) the key technologies to achieve the energy revolution and ii) the appropriate programs and policies that will bring them to the market. Robust evidence from analytical tools is needed to inform these policies and strategies.

The Energy Technology Systems Analysis Programme, ETSAP, is a Multilateral Technology Initiative (formerly called Implementing Agreement) that was initiated in 1976, under the aegis of the International Energy Agency (IEA). The aim of ETSAP is to carry out a joint program of energy technology systems analysis. In the first year of its operation, ETSAP focussed on the analysis of existing tools for evaluating R&D strategies. Then, for the period 1978-1980 the MARKAL model generator development was its only activity. In 1981 the first Annex of the Implementing Agreement was initiated, with a duration of three years and this was the first time that the Energy Technology Systems Analysis Project was used as a title. After this the ETSAP community continued to coordinate for common projects and tools improvement. Environmental issues were always taken into consideration. During the 1980's it was SO<sub>2</sub> and NO<sub>x</sub> emissions that were the main concern and the focus changed towards greenhouse gases from about 1990. The tools development moved towards the combination of the energy flow optimisation approach with macroeconomic top-down modelling, technology learning, and stochastic modelling.

Today ETSAP is a unique network of energy modelling teams from approximately seventy countries over the world. The contracting parties of ETSAP are the governments of eighteen countries and the European Commission. The key focus of ETSAP was (and still is) to cooperate to establish, maintain and expand a consistent multi-country energy/economy/environment/ engineering analytical capability mainly based on the MARKAL/TIMES family of models. The objective is to build modelling capability in order to assist and support government officials and decision-makers in increasing the robustness of the evidence base underpinning energy and environmental policy issues by applying these tools for energy technology assessment and analysis. ETSAP developed, through co-operation, the MARKAL (MARKet ALlocation) and – subsequently – the TIMES (The Integrated Markal-Efom System) energy systems model generators, both based on a multi-regional, multi-period, bottom-up, linear programming, optimization paradigm. These bottom-up techno-economic models have been used to build long term energy scenarios and to provide in-depth national, multi-country, and global energy and environmental analyses. ETSAP's energy systems models have underpinned a significant body of research studies. This research and analysis contributes to building a rich knowledge base in energy systems, impacts of policy decisions, climate change mitigation and energy security.

The work done using the MARKAL/TIMES tools includes Global Models, including the IEA Energy Technology Perspective (ETP) model, the original TIMES Integrated Assessment Model (TIAM), several different derived TIAM models (developed by various modelling teams, the Global TIMES Model of the European Fusion Development Agreement (EFDA), the TIMES G5 model and the Global

Multi-regional MARKAL Model (GMM). Regional Models have also been developed, including the Pan-European TIMES model, as well as MARKAL-TIMES Models for Europe, Asia and North America. The Pan-European TIMES model was created as the outcome of a number of projects over the last years. It was used for the evaluation of the RES Directives implementation in EU27 for 2020, an analysis of the future European gas supply, an analysis of the interplay between the global goal of mitigating climate changes and the European goal of reducing dependence and vulnerability of the energy system, the transmission infrastructure development to support sustainable electricity supply, the effect of a White Certificate Trading Scheme in the EU-27 and the analysis of potentials and costs of CO<sub>2</sub> storage in the Utsira aquifer in the North Sea. The JRC-EU-TIMES model builds on the results of several EU funded research projects, and represents the energy system of the EU28 member States, Iceland, Norway and Switzerland. It is also set up to include Balkan countries. The model is designed for analysing the role of energy technologies and their innovation for meeting Europe's energy and climate change related policy objectives. It is used to assess the role of technologies in decarbonizing Europe's energy system, and to identify key parameters that can influence the early competitiveness and the large scale deployment of key low-carbon technologies.

A large number of applications are based on National Models, which cover many individual countries in all continents. Sub-National Models have also been developed, for example the models for Western China, Reunion Island (France), Lombardy (Italy), Pavia (Italy), Southwest region (Sweden) and Kathmandu Valley (Nepal). Finally, local models for rural areas and cities have been developed in Austria and Germany, as well as other local studies in rural areas such as Val d'Agri in Italy, other bigger cities such as Madrid (Spain), Beijing, Guangdong and Shanghai (China) and New York City (United States).

The main distinguishing feature of the ETSAP modeling frameworks is that they combine a detailed technology rich database with an economically optimizing solver, providing useful guidance into how to achieve policy decisions (e.g., emissions targets) using a least-cost approach. The collaborative nature of the activity in conjunction with the large user group, also ensures that new requirements are regularly identified and continual improvements made.

A joint international programme of energy systems analysis seems now even more necessary than forty years ago, since the interactions between energy, environment and economy became more complex as a result of environmental policies, energy security issues and the current economic environment. ETSAP is well equipped to provide experts and tools for these analyses.

## 2. STRATEGIC DIRECTION

The ETSAP Contracting Parties core aim is to carry out significantly advanced energy systems modelling through cooperative activities. The primary areas of focus are on i) improving ETSAP modelling tools in order to respond to the increased complexity and ambition in energy and climate policy, ii) growing the number of ETSAP tool users through training and capacity building in energy systems modelling iii) supporting the independent activities of Contracting Parties, iv) facilitating tool users to offer their capabilities independently to national and international organizations in building energy models, compiling scenarios and conducting analyses and v) collaborating with non-IEA member countries, building on recent positive engagements with China and Kazakhstan.

The requirement for a path towards a very different energy system is dictated by the needs for economic sustainability, for energy security, and for social safety together with the critical issues related to climate change and environmental protection. In this context, decision makers need robust policy analyses that encompass the relevant global, regional national and local factors with increasing detail. In order to assess the contribution of new technological options, the key technologies need to be identified and the policies that can bring them to the market should be defined. Therefore analytical tools that examine the integrated energy system operation, including environment and economics are essential in increasing the evidence base underpinning these policies.

The tools developed by ETSAP to date cover some of the most important issues needed in this analysis. They

- incorporate environmental impact issues through the accounting of pollutant emissions,
- incorporate climate change issues in the TIMES Integrated Assessment Model (TIAM) and
- link the energy systems analysis with macro-economic models (TIMES-MACRO, TIAM-MACRO).
- allow for analysis of uncertainties related to future energy sector developments.

However new questions and aspects of the future energy system require tools enhancement and further studies. These aspects include:

- The integration of variable renewables in the energy system poses new question related to the flexibility of the system operation which should be addressed by enhanced tools.
- The coupling of energy system tools and more detailed macro-economic models. This will give the possibility to take into account in the analysis the effects of the energy system on the other sectors of the economy and the feedback from the other sectors to the energy sector.
- The incorporation of behavioural analysis in the energy systems methodology.
- The extension of the analysis beyond energy and economics to include water, land and ultimately food.

These new aspects point strongly to the increased development of advanced ETSAP tools and of the common research projects performed by the contracting parties.

Extending the number of ETSAP tool users is one of the main strategic directions for ETSAP, in order to provide a consistent framework for energy policy analysis to more countries world wide.

### 3. SCOPE

In order to address the new challenges described above, the cooperative activities in the framework of ETSAP will include:

(a) Tools maintenance

Maintaining, updating and improving ETSAP Tools and methodologies is the minimum objective. This includes:

1. Maintenance of MARKAL model generator. Further development of MARKAL is not foreseen (because of the development of TIMES), but in order to ensure that the needs of current MARKAL users are covered, the tool will be maintained.
2. Maintenance, update and improvement of TIMES, with a special attention to improving the documentation. TIMES will be improved from the methodological point in order to include the specific aspects that are needed in the analysis of the future energy system (variability of renewables, behavioural analysis, etc). The documentation is important for new and existing users, so one of the main priorities will be the continuous update and enhancement of the existing material to include new features and to be more user friendly (especially for new users).
3. The continuous effort to improve and make the model “shells” (ANSWER and VEDA) more ‘user-friendly’ and well documented. The model “shells” are used for:
  - a. data input to the MARKAL/TIMES models,
  - b. analysis of the model results.

Therefore, they are extremely important in facilitating the work of energy modelers. The shells will be continuously enhanced to follow the updates of TIMES and the related documentation will be revisited frequently in order to assist new users to get acquainted with them.
4. Maintain and update the models provided via the ETSAP platform (ETSAP-TIAM). The ETSAP TIMES Integrated Assessment Model, incorporates a climate change module in a global energy systems analysis model and is updated and enhanced in the framework of common research project within the ETSAP community. The model is available to the contracting parties who use it for their research activities and contribute to its further development.
5. Maintain and update the Energy Technology Data Source (E-TechDS), with particular attention to the direct potential contribution to modellers and integration with the other tools. ETSAP initiated the “Energy Technology Data Sheets” ETechDS project in order to collect the detailed techno-economic data that are required in the modeling exercise. The project produced 68 technology briefs that are published on the ETSAP website, available to all interested parties. Some of these briefs related to renewable energy technologies have been developed in collaboration with IRENA and a number of Implementing Agreements have contributed to the development of other ETechDS. Future planned steps include:
  - a. the update of the existing technology briefs in order to include current trends and
  - b. the development of tools and approaches that will facilitate the direct use of the data in the briefs by modeling teams.

*(b) Capacity building*

This objective, aims to maintaining, extend and improve international and national capabilities, across developed and developing countries, for

- proper use of the ETSAP Tools (MARKAL/TIMES);
- enhanced capabilities for energy systems analysis incorporating technological and market issues by building consistent energy / engineering / economic / environment scenarios,
- modelling a range of possible long term development paths with ETSAP tools, and

- underpinning and evaluating energy related policies focusing on the future transition of the energy system.

More specifically this activity will include:

- Improvement of the users' guide and "getting started" manuals of the MARKAL and TIMES model generators and of the model "shells" (ANSWER and VEDA).
- Improvement and enhancement of the global ETSAP-TIAM integrated assessment model with respect to the representation of its region-specific particularities. As a global model, ETSAP-TIAM uses a limited number of geographical regions to model the global energy system. The details of the energy systems of these regions should be analyzed further, and perhaps the geographic granularity could be increased.
- Availability of online web support systems. Currently a number of short videos are available explaining certain features of ETSAP's tools. This will be expanded to include even more approaches to provide help to new and existing model users.
- Regular provision of training courses. Currently the TIMES training courses are offered at least twice per year (together with the ETSAP workshops). Extra training courses are also arranged and provided on request.
- The current approach of organizing two workshops per annum will continue. The workshops will be held in different locations, both in countries that participate in ETSAP and in countries that are interested in the tools or even users of the tools, but are not Contracting Parties.

(c) *Research and Development*

ETSAP will support research and development activities that continually advance the state-of-the-art of energy systems analyses and integrated energy / economic / environmental / engineering modelling, to the extent that available common funds allow.

More specifically the research activities will include:

- Improvement of the modelling of the interaction between the energy system and the economy. A current project looks into identifying existing best practices which will be used as the basis for the development of new approaches.
- Improved incorporation of behaviour into energy systems modelling, which might require updates in the model methodologies. A workshop will be organized in Spring 2015 in order to present and analyse existing methodologies.
- Improved modeling of variable renewables in the energy system, related to the flexibility of the system operation.
- Improved incorporation of technical and financial variability including contribution to job creation. The extension of the analysis beyond the energy system and into the impacts in the other sectors of the economy is the natural next step for ETSAP's analyses.
- Extending the use of the tools for performing analysis beyond energy and economics to include water, land and ultimately food.

The current Contracting Parties which are participants in ETSAP are the following:

<b>Country</b>	<b>IA Date of signature</b>	<b>Contracting Party</b>	<b>Participating till / from Annex:</b>
Belgium	08.09.81	The Government	Current
Canada	07.07.82	NRCan	Until Annex XII
Denmark	04.12.80	DEA	Current
European Commission	11.01.82	European Commission	Current
Finland	09.01.02	TEKES	Current
France	29.01.08	ADEME/EMPT	/XI Current
Germany	13.11.80	IER	Current
Greece	01.12.80	CRES	Current
Ireland	01.05.09	SEAI	/XI Current
Italy	13.11.80	IMAA/CNR-ENEA	Current
Japan	17.09.81		
Kazakhstan	2015	The Government	Current
Korea	15.05.96	KEMCO	Current
The Netherlands	02.04.82	ECN	Current
Norway	13.11.80	IFE	Current
Russian Federation	15.09.2010	ERIRAS	XI Current
Spain	01.07.2010	The Government	VIII/ /XI Current
Sweden	18.11.80	The Government	Current
Switzerland	01.04.81	PSI	Current
United Kingdom	09.06.81	The Government	Current
United States	13.11.80	DOE	Until Annex XII
Sponsors	2014	ENEL Foundation	Current

**The following countries were invited to join ETSAP in the Executive Committee meeting in Beijing on 3<sup>rd</sup> June 2014:** Turkey, China, India, Mexico, South Africa, Brazil, Australia, Austria, Indonesia, Portugal, Croatia, Ukraine, Czech Rep. and Singapore.

### 3. CONTRACTUAL AND MANAGEMENT REQUIREMENTS

The working structure and the organization of ETSAP will remain in accordance with the management requirements and the contractual obligations of the IEA. The IEA rules for the operation of the multilateral technology initiatives will be followed in all the aspects.

**The funding of all the activities in the framework of ETSAP will be through the following mechanisms:**

*(a) Common Financial Obligations*

The Common Program will be funded by contributions by the Participants (Contracting Parties and Sponsors) and managed by the Operating Agent. The actual costs of the Common Program of the IA will be divided among all Participants. If the number of Participants changes, the Executive Committee will decide whether or not to adjust the budget and the annual fees. New Participants will pay a full share of the costs beginning in the year in which they become Participants.

The annual fee for 2014 was €20,000 per participant, and the Executive Committee will decide on the future level of the contribution. The Executive Committee will also decide the annual



budget, taking into account the actual number of Participants and any agreed changes in the Common Program. Sponsors participating in ETSAP will contribute through an annual fee that will be decided by the Executive Committee.

*(b) Individual Financial Obligations*

In addition to the contributions set out in subparagraph (a) above, each Participant shall bear all costs associated with carrying out this program of work, including the costs of its national team to carry out the program and their participation in workshops and seminars.

*(c) Additional contribution*

Any fees collected from carrying out training programs will add to the ETSAP budget.

Voluntary contributions from participants and other possible sponsors, if any, are welcome and will be used to more actively pursue the objectives and goals for the program of work, as approved by the Executive Committee.

ETSAP may provide seed money for (large) capacity building and analysis projects, to be decided on a case-by-case by the Executive Committee. In addition the Operating Agent and the Contracting Parties are urged to seek funding sponsors ready to co-finance projects for training and analysis based on ETSAP tools, similarly to what presently happens with competing modelling tools.

With the approval annually of the Executive Committee, ETSAP will continue to be a sponsor of the International Energy Workshop (IEW), where ETSAP partners have continually been contributors and participants. The International Energy Workshop is one of the leading conferences for the international energy modeling research community and is the ideal conference for presenting energy modeling approaches including economic and environmental issues and ranging from bottom up detailed tools to top down approaches.

#### **4. CONTRIBUTION TO TECHNOLOGY EVOLUTION / PROGRESS**

ETSAP activities are not directly limited to individual technologies, therefore its specific contribution to technological evolution or technology deployment and market facilitation are difficult to quantify. ETSAP tools do however analyse the role of technologies and their possible development pathways in the energy system, thus supporting decision makers in defining policies or technology strategies. In order to achieve this the Participants in ETSAP will use the following approaches:

1. Collecting, analysing and disseminating information and consistent data related to energy systems, energy technologies, energy and environment models and scenarios;
2. Promotion of common research on energy systems analysis, integration of existing tools in the present methodology and development of new tools, together with other groups active in the field;
3. Enhancement of existing ETSAP Tools and implementation of new ones, by linking ETSAP's methodology to other approaches;

4. Organization of training courses to inform new experts or to widen the analytic capabilities of existing experts domestically, locally and in outreach activities, including “in-reach” capability building for participants in the use of the global models;

The following are expected as outputs of these activities:

1. Updated versions of the Energy Technology Data Sheets that will be available on the website.
2. Peered reviewed publications in journals and conference proceedings.
3. Updated common tools for energy systems analysis to include new methodological approaches that can provide answers to the new questions (integration of variable renewables, behavioural, economic modelling etc).

## 5. POLICY RELEVANCE

The work of ETSAP is directly linked with policy making. ETSAP tools are currently used by the EU Joint research Centre (JRC) to analyse future technology development, by the IEA in the ETP series and related energy technology roadmaps and by national governments formulating energy and environmental policies. MARKAL/TIMES is listed as one of the four selected modelling tools in the UNFCCC guide for preparing the national communications for non-Annex I parties. In order to continue the close relationship between the ETSAP outputs and policy making, the contracting parties will

- (a) Carry out common analyses on key aspects of present energy technology systems and their possible future developments;
- (b) Publish independent analyses and background material resulting from the studies carried out towards the achievement of the above objectives; this will materialise in common reports / books as well as contributions to journals and other reports;

## 6. CONTRIBUTION TO ENVIRONMENTAL PROTECTION

ETSAP tools are examining energy-environment-economy interactions in a medium to long term horizon using a least cost approach methodology, so by definition the issue of environmental protection is included in all the analysis performed. The results of ETSAP-TIAM studies are being included among the groups that assess climate mitigation policies through the Energy Modelling Forum (EMF) and IPCC. MARKAL/TIMES is listed as one of the four selected modelling tools in the UNFCCC guide for preparing the national communications for non-Annex I parties. The studies and tools of ETSAP will continue to include the environmental dimension of the future energy system, extending their scope to include water and land uses.

## 7. CONTRIBUTION TO INFORMATION DISSEMINATION

In order to enhance information dissemination ETSAP will:

1. Develop an improved website to better support the global community of ETSAP Tool users, including a password protected area with models and data accessible only to Contracting Parties and others approved by the OA/ExCo. The website will also include sections offering online help and information for new tool users and probably online training material as well.
2. Publish periodic reports on workshops or seminars, and on analytical studies undertaken in connection with the IA activities.
3. Hold a workshop every six month in order to present the work done by ETSAP members and connect it with modelling work in the countries that host the workshops.
4. Publish a final report on the activities carried out under each Annex.

## 8. OUTREACH TO IEA NON-MEMBER COUNTRIES

The Russian Federation and Kazakhstan are contracting parties of ETSAP and ETSAP tools are used in countries around the world including Brazil, China, India, Mexico, Pakistan, South Africa and Ukraine. ETSAP is continuously trying to expand the use of its tools in more countries through training sessions offered during the bi-annual workshops as well as targeted training sessions in specific countries which request for these. ETSAP hosted a recent Workshop in China (2014) and participated in an IEA MOST NEET Workshop on Integrate Approaches to Energy Technologies in China in 2012. ETSAP will continue the existing collaboration with non-member countries of the IEA through a twinning that will be established between ETSAP Contracting Parties and new countries. This twinning approach will provide materials to guide new and recent users of ETSAP methodologies, as part of “Outreach” initiatives of ETSAP.

## 9. ADDED VALUE

The added value of collaboration within ETSAP will be enhanced through the:

1. Organization of semi-annual meetings/workshops of experts, to exchange information and experience in the area of work covered by the Agreement. Furthermore, workshops with specific topics will also be organized in order to present state of the art research on the topics that are of interest to the ETSAP members.
2. Participation in joint meetings with related international projects, making a concerted effort to communicate with the wider professional community. Involving decision-makers in these meetings is important in order to communicate the policy relevance of energy system analysis approaches.
3. Promotion of, and participation to, common projects. Ideally these will be international funded research project.
4. Exchange of specialists, experts and students active in the sector among the members of ETSAP in order to gain from each other’s experience.
5. Using national and multi-national reference groups for the development and analysis of the models and linkage to users.

