



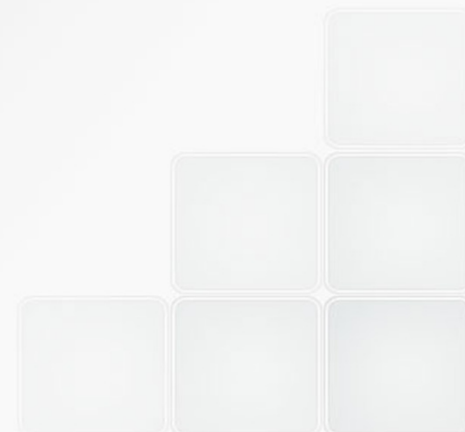
Work Package 2

Identification, Characterization and Assessment of existing tools

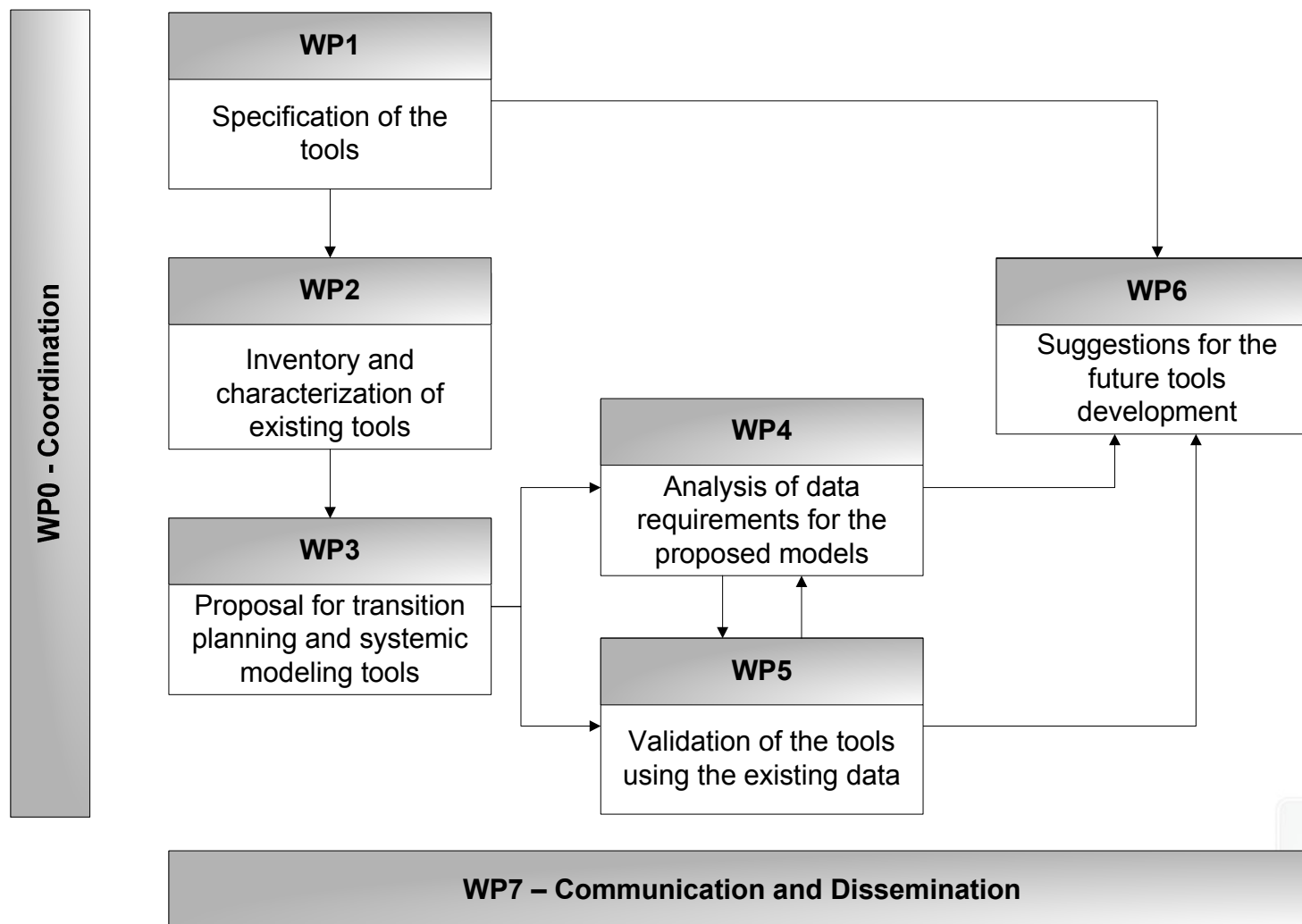
ATEsT Models Characterization Report

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ATEsT Final Workshop
Brussels, March 26th, 2012



Work Plan

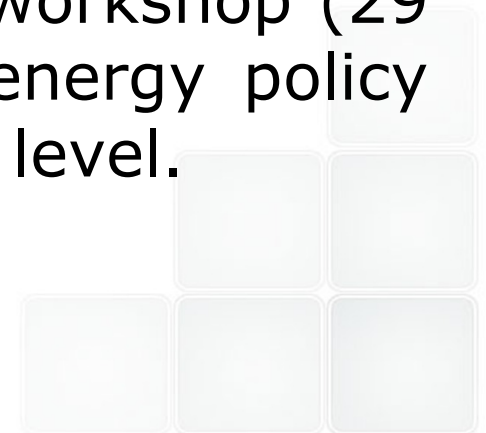


Models Characterization Report



The **Models Characterization Report** builds an Inventory and Characterization of the existing Models that can cover transition planning to a low carbon energy system and the specifications about SET-Plan needs as defined in the *Specification Report* (WP1, Schoots and Bunzeck, 2010).

List of Specifications: specific requirements from SET-Plan stakeholders as emerged from the workshop (29 Jan 10) with stakeholders involved in energy policy making and modeling at national and EU level.



Models Characterization Report



Model: used to identify different types of tools, methodologies and procedures for the analysis of the energy system.

- **Methodology/procedure:** refers to a sequence of codified and systemic steps (shared by the scientific community) in investigating a given topic (e.g. SocioTechnical Scenario, Horizon Scanning).
- **Model:** applies to quantitative mathematically-based (e.g., system optimisation, market simulation, mathematical programming) methodologies (e.g., TIMES, POLES, GEMINI-E3) .
- **Tool:** denotes applications of methodologies intended to perform semi-quantitative (combining data and qualitative information) and/or qualitative assessments (e.g., ESTEEM, LEAP, GRAPE).

Model Characterization Report



STRUCTURE

▪ **Methodology**

▪ **Preliminary Results**

Ideal model matrix toolbox

Coupling Issues

Overview and first characterization of the models

▪ **Primary focus assessment**

Strategic Planning

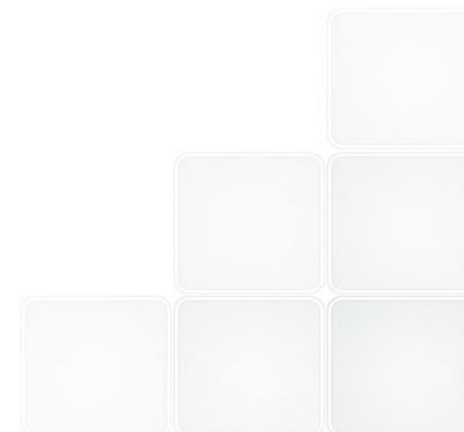
Technology Deployment and Transition planning

Innovation and R&D

International Cooperation

▪ **Feature analysis**

▪ **Conclusions**



Methodology



A list of EU and non-EU modeling teams was compiled based on literature review, expert suggestions and web search - **85 models** identified.

Open Call Consultation – JRC:

Questionnaires and corresponding **Guidelines** were submitted to EU and non EU modeling teams through the project website: www.atest-project.eu.

Literature review for the missing models (45%) has been conducted by WP2 and ATEsT project partners.

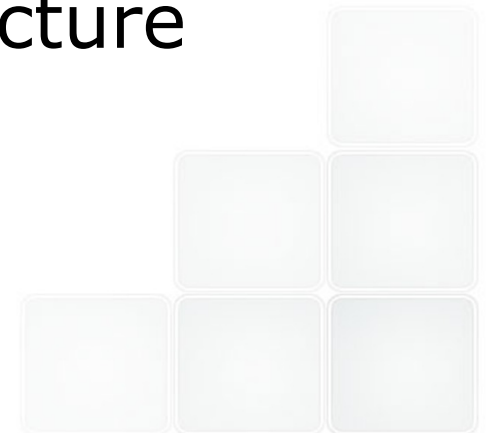


Methodology



Questionnaire: 40 questions - 7 sections:

- A. Identification
- B. Evaluation capabilities and main application
- C. Specific capability to model and evaluate SET-Plan needs and priorities
- D. Model scope
- E. Theoretical background and structure
- F. Access
- G. Additional notes and comments

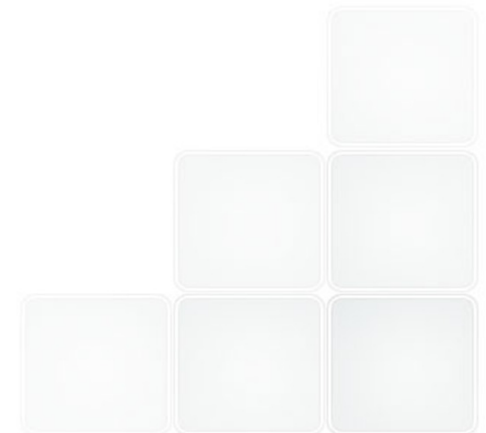


Methodology



The “**List of Specifications**” from the Specification Report WP1 has been used to construct a framework for the characterization of the identified models.

This framework consists of **two sets of matrices** relating the list of specifications both to the primary focus of the model and to the model main features.



Methodology



List of Specifications:

Strategic Planning: relates to technology performance, interdependencies between energy technologies at various level in the supply chain, growth path of new technologies, effects of various policy instruments on technology introduction.

Technology Deployment and Transition Planning: Spatial planning; deployment pathways based on demonstration projects; barriers and time delays on implementation of technology; public perception and social acceptance of technologies.

Innovation and R&D: calls for targets and monitoring of R&D progress in specific technologies as well as for identification of EU strengths and weaknesses in energy technologies compared to the rest of the World.

Reinforcing International Cooperation: on energy technology R&D and deployment, in an attempt to share costs and benefits among different countries.

Methodology

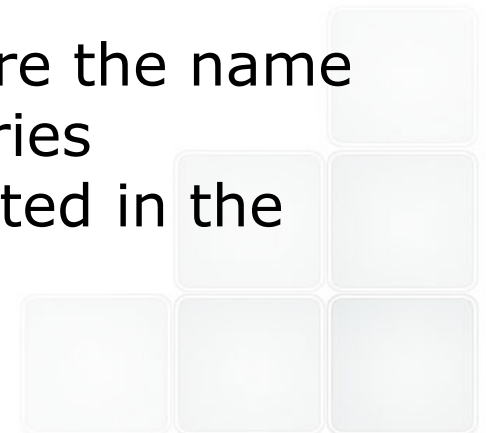


Matrices for Primary Focus Assessment

Four matrices for primary focus assessment relate identified models to the list of specifications.

Matrix cells are filled by assessing whether the model under consideration can provide an answer to a given specification, specifically whether this is its (or one of its) primary focus of analysis.

In each of the four matrices, the *row* entries are the name of the models identified and the *column* entries correspond to the list of specifications collected in the Specification Report.



Matrices for Primary Focus Assessment



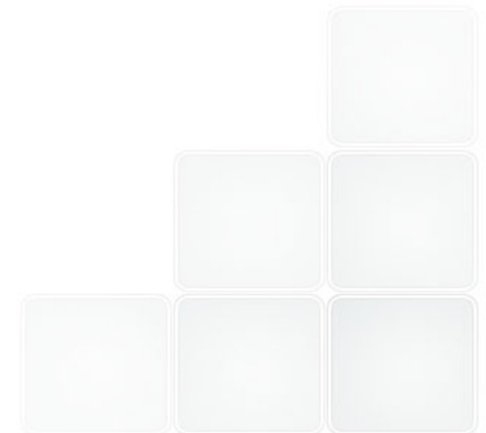
Strategic Planning		Specifications					
		GENERAL SPECIFICATIONS		TECHNOLOGY PERFORMANCE AND DEVELOPMENT POTENTIAL			
Models (number and name)		Resilience of the energy system against shocks of energy prices and supply of primary energy sources	Resilience of the energy system against shocks of power system failures and extreme weather events	SET-Plan Key Performance Indicators	Investment, O&M costs, technical and environmental performance	Potential for cost reduction as a function of time/technical improvements through RD&D/deployment/learning effects	Overall efficiency gain and efficiency gain per tech/per kWh
1	BALMOREL			PF	PF	PF	PF
2	BEST						PF
3	COALMOD (COALMOD-World)						
4	COMPETES						
5	E2M2s				PF		PF
6	E3ME						
7	E3MG						
8	EMELIE				PF	PF	PF
9	EMM	PF	PF		PF	PF	PF
10	ESTEEM						
11	GASMOD						
12	GEM-E3						
13	GEMED						
14	GEMINI-E3						
15	GET				PF	PF	PF
16	GRAPE						
17	Model for Power Plant and Transmission Expansion	PF	PF	PF	PF	PF	
18	IMACLIM						
19	IMAGE-TIMER						
20	Wilmar Planning Tool (mainly consisting of Joint Market Model (JMM) and Scenario Tree Tool)	PF	PF		PF		PF
21	LEAP	PF	PF	PF	PF	PF	PF
22	MDM-E3						
23	"Long-term energy demand model" consisting in three sub models: MURE-Residential, ISIndustry, TEP-Tertiary.	PF	PF	PF	PF	PF	PF
24	NEWAGE						
25	OILMOD						
26	POLES	PF		PF	PF	PF	PF
27	POWERS						
28	PRIMES	PF		PF	PF	PF	PF
29	RESolve-E (formerly known as ADMIRE-REBUS)				PF	PF	PF
30	RESolve-T			PF	PF	PF	
31	ROM		PF				

Methodology



Matrices for feature analysis

In each of the four matrices, the *column* entries correspond to the list of specifications collected in the Specification Report, whereas the *row* entries represent the model features, i.e. dimensions that characterize the model approach, structure, scope and assessment capability.



Matrices for feature analysis

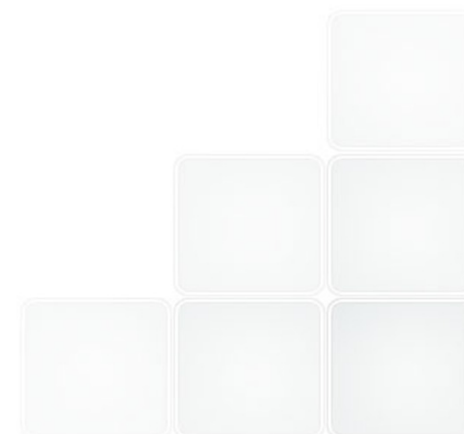


Strategic Planning		Specifications					
		GENERAL SPECIFICATIONS TECHNOLOGY PERFORMANCE AND DEVELOPMENT POTENTIAL					
Models (number and name)		Resilience of the energy system against shocks of energy prices and supply of primary energy sources	Resilience of the energy system against shocks of power system failures and extreme weather events	SET-Plan Key Performance Indicators	Investment, O&M costs, technical and environmental performance	Potential for cost reduction as a function of time/technical improvements through RD&D/deployment/learning effects	Overall efficiency and efficiency gain per kWh
Model primary focus							
Technology detail	End Use techs						
	Supply side techs						
	Resources						
	Infrastructure						
Spatial dimension	Micro level						
	Region						
	Country						
	Multi-country						
	Global						
Time frame	Intra-day to year						
	Year to multiple-year periods						
System boundaries	Sector level						
	Energy system						
	Entire economy						
Innovation and R&D effects	Technology learning						
	Performance/Cost/Uncertainty						
Economic system detail	Sectors detail						
	Branches detail						
Behavioral aspects	Social acceptance						
	Other behavioral aspects						
Environmental aspects	Emissions						
	Land use						
Type of operation	Market simulation						
	System optimisation						
	Qualitative assessment						

Matrices for feature analysis

Strategic Planning		GENERAL SPECIFICATIONS						TECHNOLOGY PERFORMANCE AND DEVELOPMENT POTENTIAL					
		Resilience of the energy system against shocks of energy prices and supply of primary energy sources		Resilience of the energy system against shocks of power system failures and extreme weather events		SET-Plan Key Performance Indicators		Investment, O&M costs, technical and environmental performance		Potential for cost reduction as a function of time/technical improvements through R&D/deployment/learning effects		Overall efficiency gain and efficiency gain per tech/kWh	
Model features													
Model primary focus		9,17,20,21,23,26,28,33,34,35,44,47,50,57,58,60,62,65,73,75,77,79,80,81,82,83,84,85,		9,17,20,21,23,31,33,34,35,44,47,50,57,60,62,65,73,75,77,79,80,81,82,83,84,85		1,17,21,23,26,28,30,32,33,34,44,50,58,60,62,65,69,77,		1,5,8,9,15,17,20,21,23,26,28,29,30,32,33,34,35,44,45,46,47,50,53,60,65,68,69,70,73,77,		1,8,9,15,17,21,23,26,28,29,30,32,33,34,44,50,58,60,65,69,70,73,77,		1,2,5,8,9,15,20,26,27,28,29,32,35,44,45,46,47,55,60,61,65,68,73,74,77	
Technology detail	End Use techs	23,33,44,50,60,65,34,21,28,47,77,73,58,62		33,44,50,60,65,34,21,31,47,77,73,69,23,62		1,33,44,50,60,65,34,21,23,28,77,69,58,32,62		1,33,44,50,60,65,34,21,23,32,28,47,77,73,7,0,69,15,53,68,9		1,33,44,50,60,65,34,21,28,77,73,70,69,15,5,8,23		1,32,33,44,50,4,21,23,28,47,0,69,15,55,68,	
	Supply side techs	9,33,44,50,60,65,34,21,35,20,26,28,17,47,77,73,58,80,81,82,83,84,85,62		9,33,44,50,60,65,34,21,35,20,31,17,47,77,73,69,80,81,82,83,84,85,62		1,33,44,50,60,65,34,21,30,26,28,17,77,69,58,62		1,5,8,33,44,50,60,65,34,21,35,20,29,30,26,2,46,17,47,77,73,7,0,69,15,53,68,		1,33,44,50,60,65,34,21,29,30,26,28,45,17,7,73,70,69,15,58,9,8		1,33,44,50,60,1,35,20,29,26,5,46,47,77,74,9,15,55,68,61,	
	Resources	33,44,50,60,65,34,21,35,20,26,28,17,47,77,73,7,5,57,58,		33,44,50,60,65,34,21,35,20,31,17,47,77,73,69,75,57,		1,33,44,50,60,65,34,21,26,28,17,77,69,58,		1,8,33,44,50,60,65,34,21,35,20,26,28,17,47,77,73,70,69,15,53,68,		33,44,50,60,65,34,21,26,28,17,77,73,70,69,15,58,8,		1,33,44,50,60,1,35,20,26,28,3,70,69,15,68,	
	Infrastructure	9,33,44,50,60,65,34,21,35,20,17,77,73,79,80,81,82,83,84,85,		9,33,44,50,60,65,34,21,35,20,31,17,77,73,69,79,80,81,82,83,84,85,		1,33,44,50,60,65,34,21,28,17,77,69,		1,5,8,33,44,50,60,65,34,21,35,20,28,17,77,7,3,70,69,15,53,68,9		33,44,50,60,65,34,21,28,17,77,73,70,69,15,9,8		1,33,44,50,60,1,35,20,28,77,9,15,68,5,2,8	
Spatial dimension	Micro level	35,20,17,79,80,81,82,83,84,85,		35,20,17,79,80,81,82,83,84,85,		17,		1,35,20,17,53,68,		17,			
	Region	35,20,17,79,80,81,82,83,84,85,		35,20,17,69,79,80,81,82,83,84,85,		17,69,		1,5,35,20,46,17,69,53,68,		17,69,		46,69,	
	Country	9,35,20,17,47,73,75,58,79,80,81,82,83,84,85,62		9,35,20,31,17,47,73,69,75,79,80,81,82,83,84,85,62		29,30,17,69,58,32,62		1,5,6,7,8,35,20,29,30,32,46,17,47,73,69,53,68,9		1,29,30,17,73,69,58,9,8,		1,32,35,20,29,7,73,69,52,55,2,8	
	Multi-country	9,34,21,35,20,28,47,77,75,58,79,80,81,82,84,85,62		9,34,21,35,20,47,77,75,79,80,81,82,84,85,62		1,34,21,29,30,23,28,77,58,62		1,8,34,21,35,20,29,30,23,28,46,47,77,70,9		1,34,21,29,30,28,77,70,58,9,8		1,34,21,35,20,6,47,77,74,70,	
	Global	33,44,50,60,65,26,47,77,75,57,58,		33,47,77,75,57,		33,44,50,60,65,26,77,58,		33,44,50,60,65,26,45,46,47,77,70,15,		33,44,50,60,65,26,45,77,70,15,58,		33,44,50,60,65,46,47,77,74,70,	

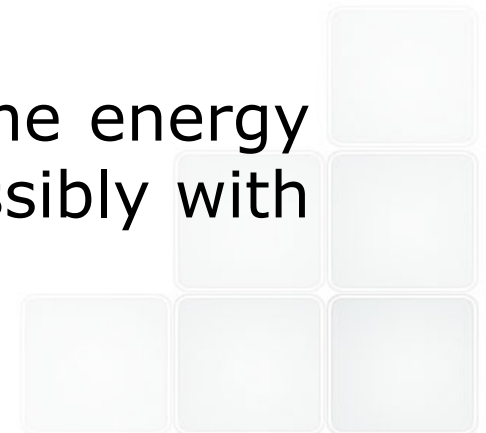
Preliminary results



Types of models and tools



- *Disaggregated* models: very detailed models that address specific issues such as plant design, resource potential assessment, infrastructure expansion or reinforcement, etc.
- *Sector level* models: models for *single* markets (coal, gas, oil, etc.) or for single sectors (electricity, transport, residential, etc.).
- *Energy system* models: focus on competition and complementarities between energy technologies (multiple sectors and fuels).
- *Macro-economic* models: include both the energy system and the rest of the economy possibly with feedback effects between them.



Types of models and tools

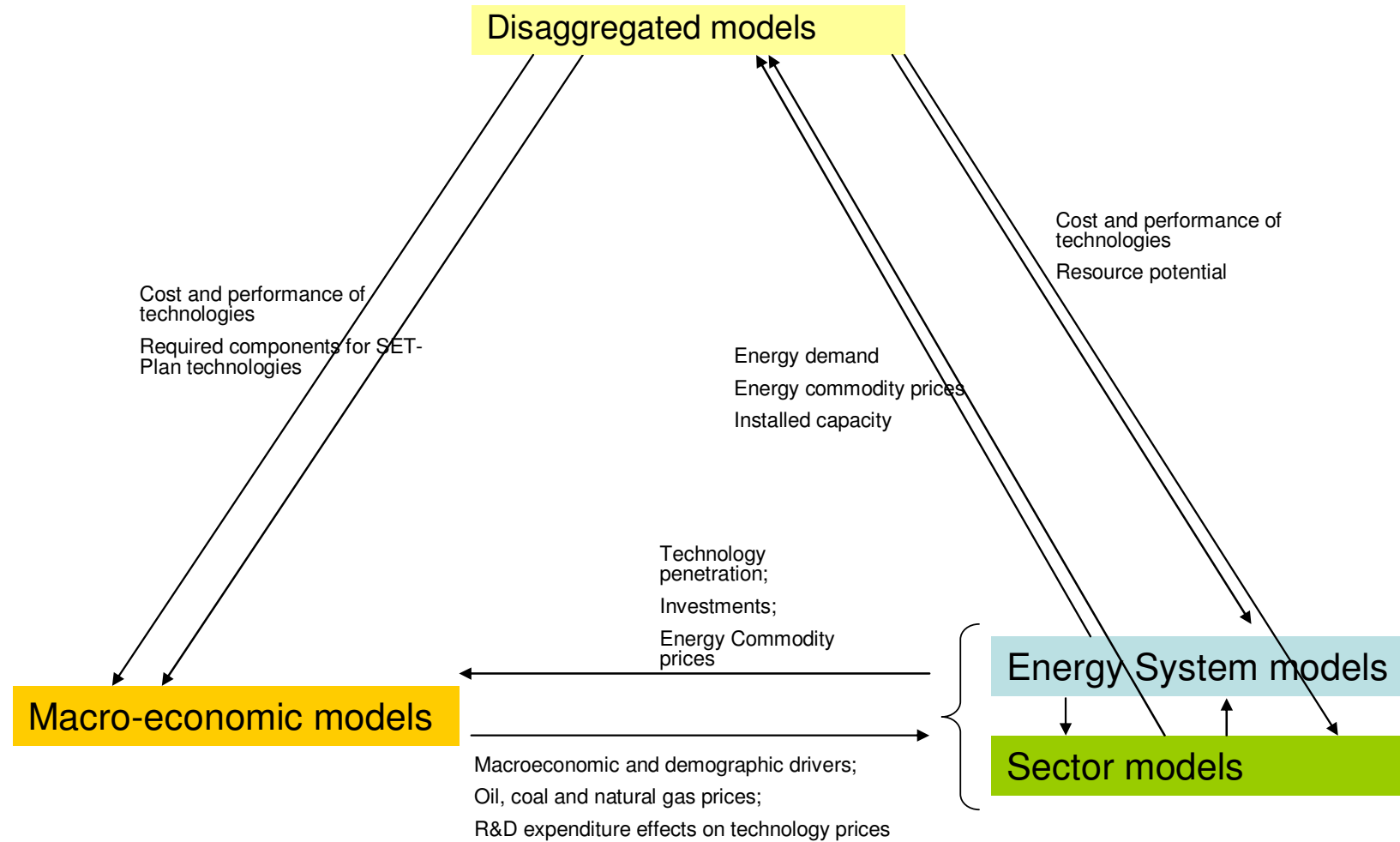


- *Energy behaviour* tools: focus on the demand side of the economy; designed mainly to make people aware of their energy consumption decisions and to deal with social acceptance issues.
- *Socio-technical scenarios*: address the way transition paths may unfold in a process of interaction between a range of actors and the rules they act upon (technical, regulatory, forms of provision, infrastructure requirements, etc.).
- *Horizon Scanning methodologies*: systematic examination of potential threats, opportunities and likely future developments, including those at the margin of current thinking and planning.

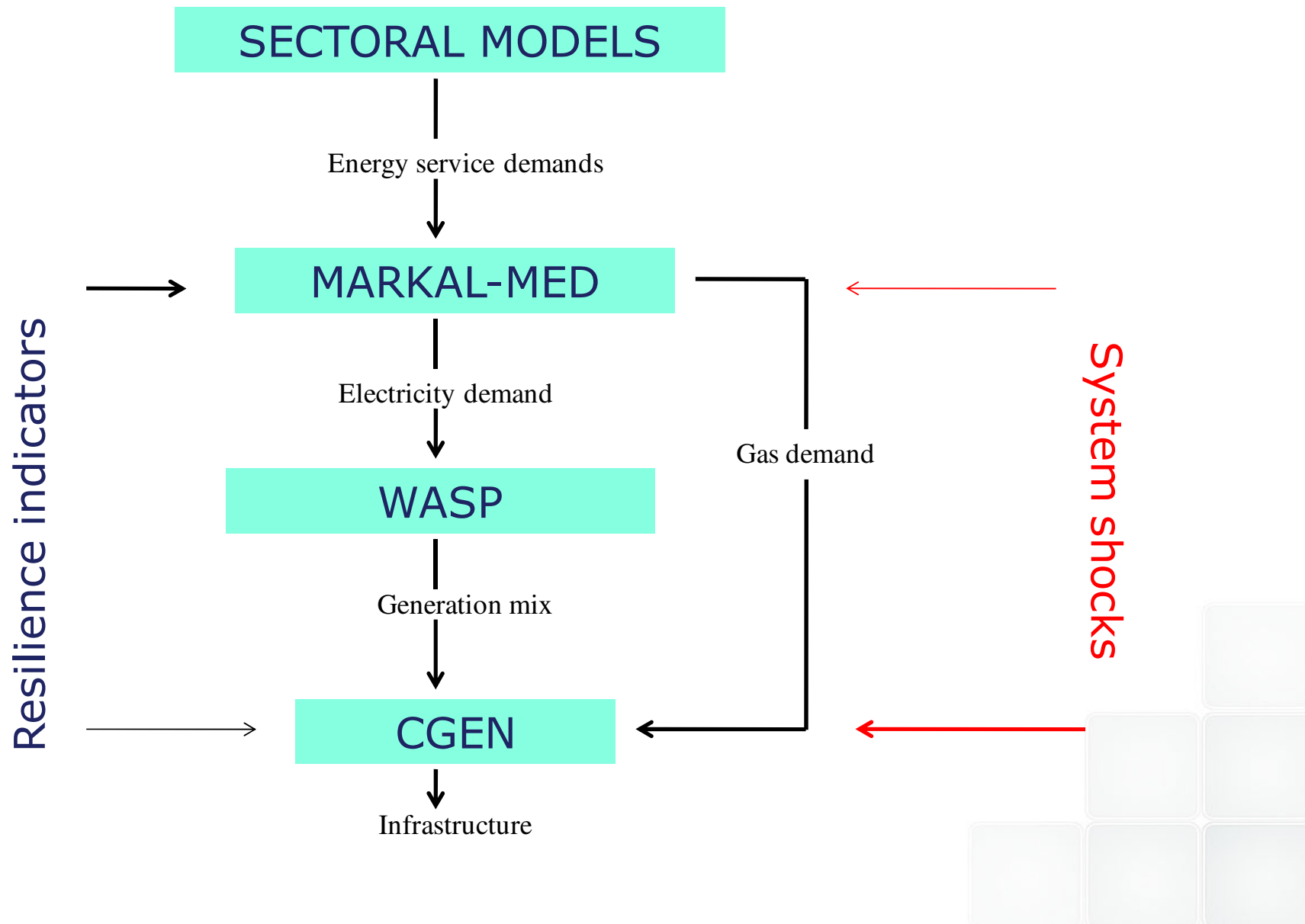
Ideal model matrix toolbox

	Issues	Required outputs	Type of Model/Tool	Modelling focus integration: Stand-alone (S), Possibly Combined (PC)
Strategic Planning	Technology performance and development potential	Performance/economic data on technologies	Disaggregated models	(S)
	Technology deployment	Technical/physical/economic evaluation of resources; technology short- and long-term potential	Disaggregated models, Sociotechnical scenarios	(S) or (PC)
	Policy Indicators	Comprehensive analysis of the energy system; technology mix	Sector, Energy system, Macro-economic models, Sociotechnical scenarios	(S) or (PC)
Technology Deployment and Transition Planning	Spatial planning	Trans-national electricity interconnections, infrastructure requirements; territorial integration and land use	Disaggregated, Sector models	(S) or (PC)
	Deployment pathways	Capacity and infrastructure expansion, effects on migration and labor demand	Disaggregated, Sector, Macro-economic models	(S) or (PC)
	Timing	Effects of regulatory and administrative barriers on lags between investment decisions and energy production	Disaggregated, Sector, Sociotechnical scenarios	(S) or (PC)
	Market designs and organisational changes	Required changes to overcome market and organisational barriers	Sector, Macro-economic models, Sociotechnical scenarios, Energy behavior tools	(S) or (PC)
	Acceptance/perception of a technology	Behavioral responses and social acceptance and perception of technologies related to risk, employment and safety issues	Sociotechnical scenarios, Energy behavior tools	(S) or (PC)
Innovation and R&D	R&D	R&D investments effectiveness, risks, targets, public vs private role	Sector, Energy system, Macro-economic models, Horizon scanning methodologies	(S) or (PC)
	Innovation	EU strengths and weaknesses, industrial perspectives, competitiveness, sectoral and regional trade	Sector, Macro-economic models	(S) or (PC)
International Cooperation	International cooperation on R&D	Strategic approach (collaboration vs free riding in knowledge creation and diffusion), identification of centres of excellence	Energy system, Macro-economic models, Horizon scanning methodologies	(S) or (PC)
	International cooperation on technology deployment	Spillover effects and potential for flexible mechanisms	Energy system, Macro-economic models, Sociotechnical scenarios	(S) or (PC)

Coupling issues



UKERC “Energy 2050” project

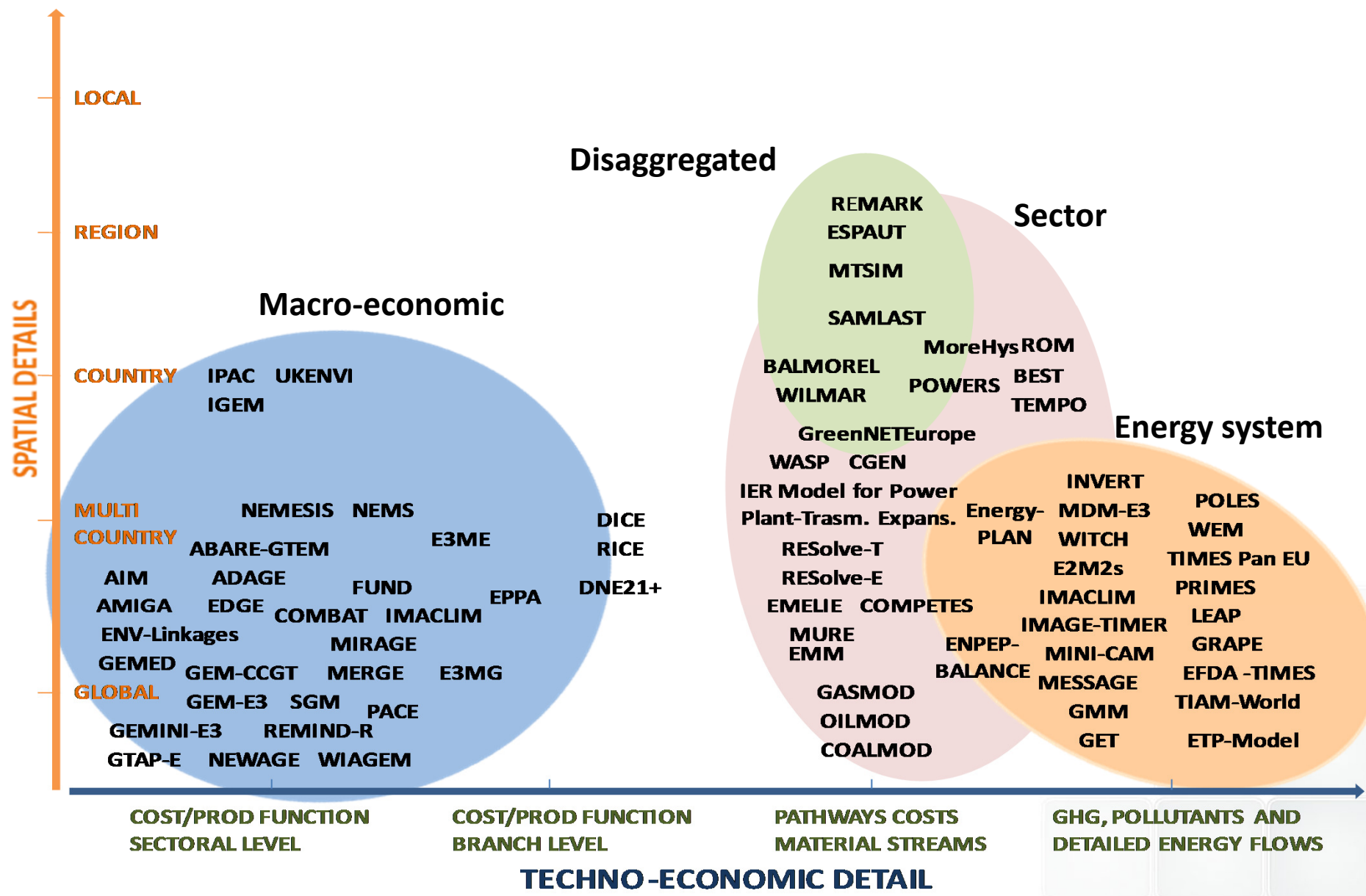


Overview and first characterization

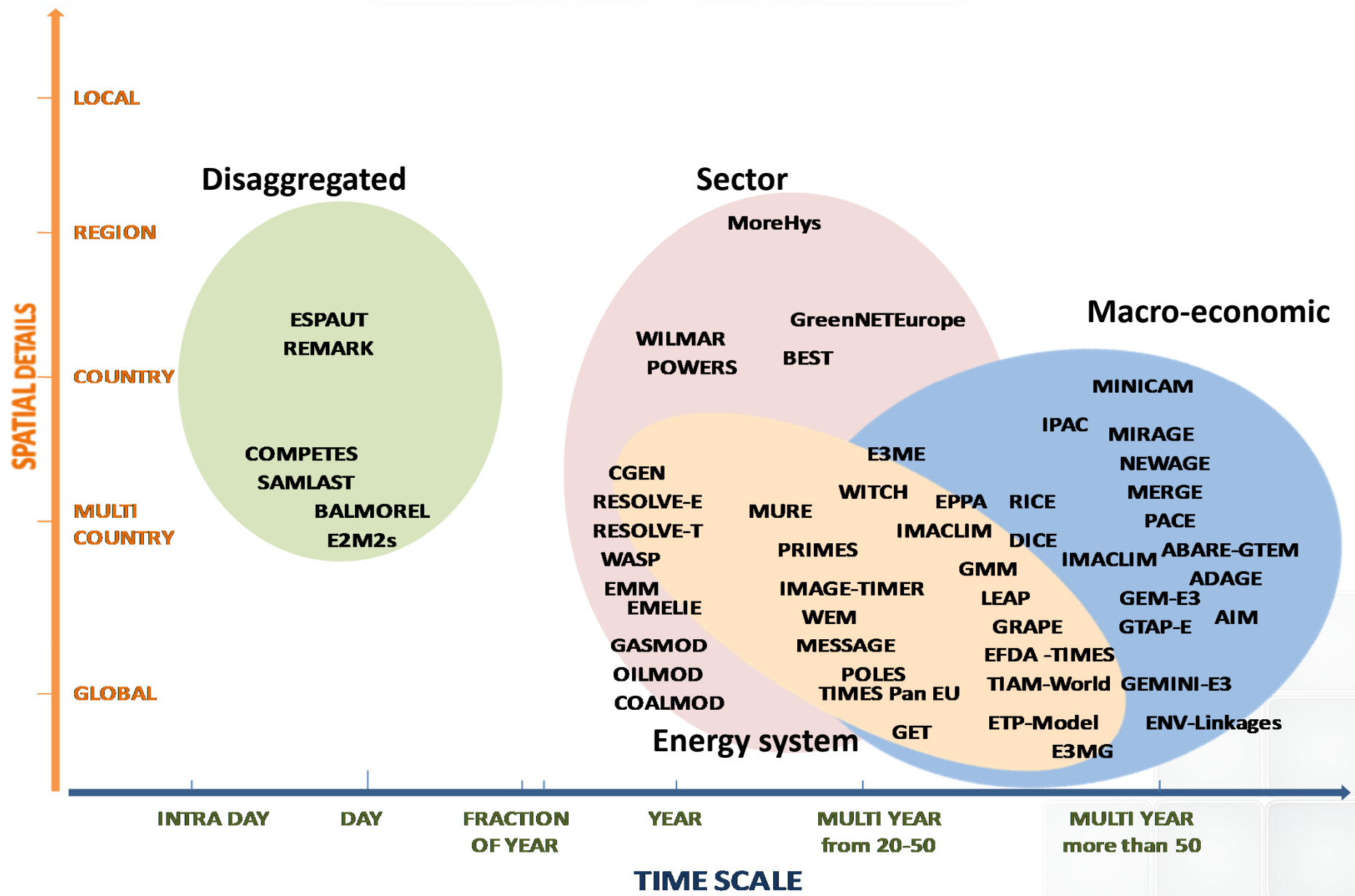


Type of model	Models	Approach
Disaggregated models	BALMOREL, CGEN, ESPAUT, GreenNET-Europe model, MTSIM, REMARK, SAMLAST, WASP, WILMAR, Wilmar Planning Tool (JMM, STT).	Bottom-up
Sector level	BEST, COALMOD, COMPETES, EMELIE, EMM, GASMODO, Long term energy demand model (MURE, ISI, TEP), Model for Power Plant and Transm. Expansion, MoreHys, OILMOD, POWERS, RESolve-E, RESolve-T, ROM, TEMPO.	Bottom-up
Energy system	E2M2s, EFDA-TIMES, EnergyPLAN, ENPEP-BALANCE, ETP model, GET, GMM, GRAPE, IMAGE-TIMER, INVERT, LEAP, MDM-E3, MESSAGE, MINI-CAM, POLES, PRIMES, TIAM-World, TIMES PanEU, WEM,	Hybrid-IA, Bottom-up
Macroeconomic	ABARE-GTEM, ADAGE, AIM, AMIGA, COMBAT, DICE, DNE21+, E3ME, E3MG, EDGE, ENV-Linkages, EPPA, FUND, GEM-CCGT, GEM-E3, GEMED, GEMINI-E3, GTAP-E, IGEM, IMACLIM, IPAC, MERGE, MIRAGE, NEMESIS, NEMS, NEWAGE, PACE, REMIND-R, RICE, SGM, UKENVI, WIAGEM.	Top-down, Hybrid, Hybrid-IA
Energy behavior	ESTEEM, Changing Behavior, IEE - Behave/PRECEDE-PROCEED Planning Model, Climate Bonus/Carbon footprinting, monitoring, feedback & rewards.	Semi-Quantitative
STSc	STSc SocioTechnical Scenario, GoReNEST framework.	Qualitative
Horizon scanning	Horizon Scan, iKnow.	Qualitative

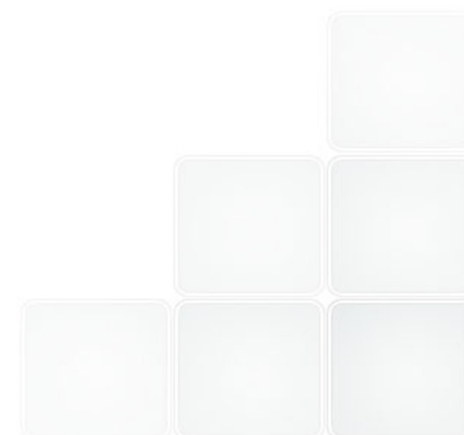
Spatial and techno-economic detail



Geographical and time coverage



Primary focus assessment

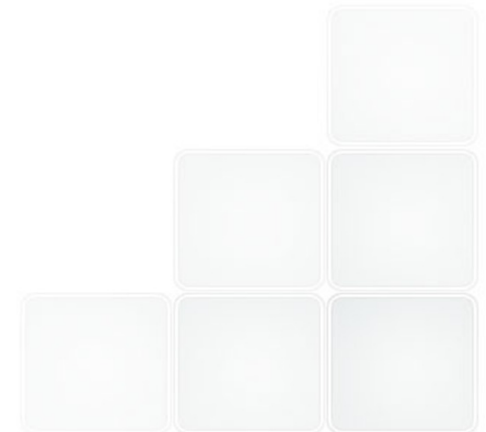


Strategic Planning



Main gaps

- *Bottlenecks to technology deployment (industry not ready to follow the demand):* require an in-depth analysis of the production chain for a given technology!
- *LCA analyses*



Technology Deployment and Transition Planning



Main gaps (related to high level of spatial detail required, multi-dimensional nature of the issues, poor interrelation between technical and behavioral issues)

- Territorial integration and migration flows
 - Supply chain logistics
 - Synergies between technology, industry, social and policy changes
 - Public-private agent behaviors and partnerships
 - Effects of 1st demonstration projects in Europe
 - Issues related to “Timing” and “Acceptance/perception of a technology”
- Dedicated sub-modules!

Innovation and R&D



Main gaps

- Risks involved in research activities (long-term perspective)
- Technology specific R&D interim and final targets
- Decision parameters to modify the ambition level of targets and the time paths
- Assessment and monitoring of R&D funding mechanisms
- Quantify necessary R&D spending on specific technologies in order to cover the gap between EU and the rest of the world
- R&D intrinsically uncertain activity (difficult to provide forecasts for specific technology needs)

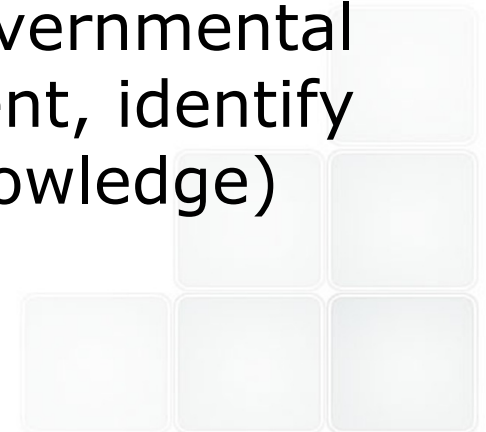
International Cooperation



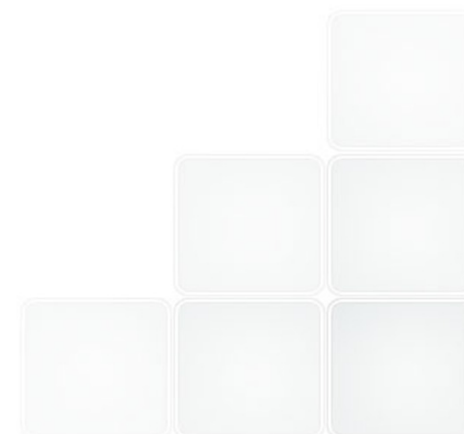
Main gaps

International cooperation on R&D

- Identify win-win situations
- Monitor benefits of international cooperation
- Effectiveness of past international cooperation initiatives
- Need for global centres of excellence
- Main research interests in and outside EU (mapping technology, international governmental investments in programs for deployment, identify and avoid unidirectional transfer of knowledge)



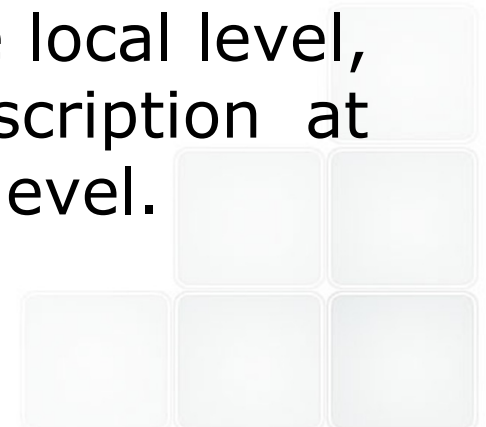
Feature analysis



Strategic Planning



- “Technology rich” bottom-up or hybrid models that cover the entire energy system. In general, trade-off between spatial detail (very poor) and technology detail (very rich).
- “Technology rich” bottom-up models for specific sectors of the energy system.
- Top-down models with sub-modules containing a description of the most relevant technologies can be used as a second best option.
- Major deficiencies: spatial detail at the local level, behavioral aspects and economy description at branch (or even more disaggregated) level.



Technology Deployment and Transition Planning

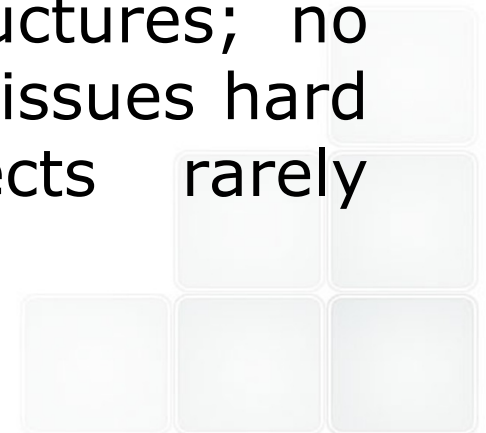


- A few sector models with high geographical detail at the local level provide information on technology and infrastructure development.
- Qualitative or semi-quantitative tools may be useful in analyzing synergies between technology, industry, social and policy changes as well as acceptance issues.
- Major deficiencies: systemic approach that analyses competition between different energy carriers and new infrastructures location and development; some SET-Plan technologies are not satisfactorily covered; quantitative analysis of acceptance issues is missing.

Innovation and R&D



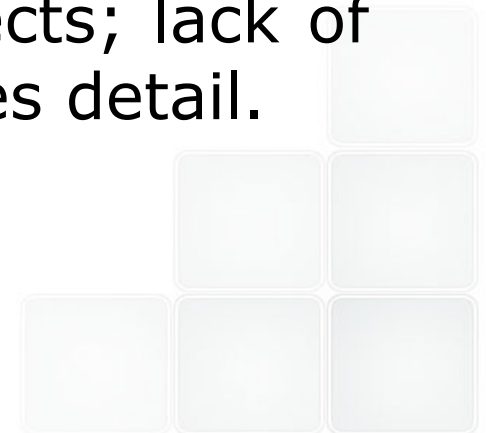
- Horizon scanning methodologies relevant to identify the risks involved in research activities, but only partially the risk of a technology breaking through.
- A very limited number of hybrid Integrated Assessment or econometric models are able to account for the effects of R&D spending in achieving EU policy goals.
- Major deficiencies: limited coverage of end-use technologies, resources and infrastructures; no branch detail level; social acceptance issues hard to analyze and behavioral aspects rarely modeled.



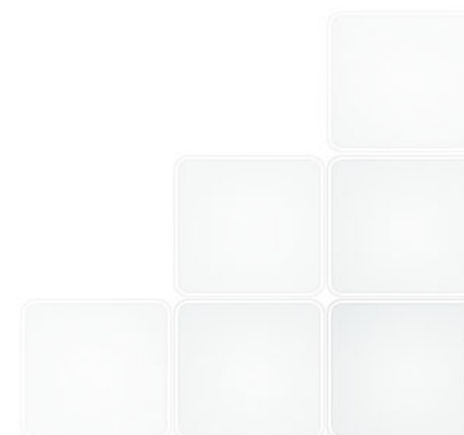
International Cooperation



- Horizon scanning methodologies and a few Integrated Assessment econometric models useful to deal with R&D-related issues.
- Multi-country and global models with different analytical approaches cover the potentials of JI and CDM and technology market developments at the world level. Socio-technical scenarios can be used as a complementary tool.
- Major deficiencies: lack of project and regional dimensions as well as behavioral aspects; lack of macroeconomic models with a branches detail.



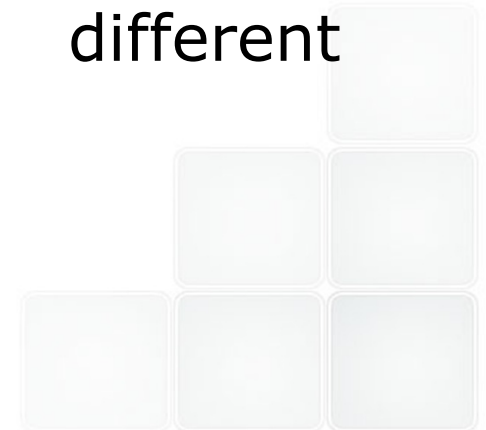
Conclusions



To sum up



- This report contributes to the identification and characterization of models and tools that can cover the specifications set out by ATesT WP1.
- List of models and tools identified based on experts' suggestions and literature review.
- Open call (questionnaire and guidelines), literature references and web search.
- Matrices for model evaluation (primary focus assessment and feature analysis) show the degree of coverage for the different specifications.



Key findings



- Strategic planning: further modeling efforts needed to investigate the possible “Bottlenecks to technology deployment”
- Transition planning: poor interrelation between technical and behavioral issues (need for multi-dimensional analysis); specificity of some issues would need dedicated sub-modules to be addressed properly.
- Innovation and R&D: R&D issues represent one of the most challenging tasks for modelers (data availability; methodology; feedback loops and spillovers)
- International cooperation: R&D issues more problematic than technology deployment!