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The JRC-EU-TIMES modelling platform

Inputs to prioritisation for energy research and innovation

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Serving society
Stimulating innovation
Supporting legislation

Joint Research Centre

Outline

Setting the scene

- Inputs to prioritisation for energy research and innovation with the JRC-EU-TIMES model
  - The JRC-EU-TIMES model
  - Technology learning based on experts judgment
  - Stochastic technology learning
  - Endogenous technology learning

Research and innovation for a low-carbon Europe

- Strategic Energy Technology Plan (SET Plan) – the EU's Energy Research & Innovation Strategy – delivering the energy and climate policy objectives
  - R&D investment increased from 3.2 to 5.4bn euro/year in EU
- The Energy Technologies and Innovation Communication [COM(2013/253] calls for an Integrated Roadmap and an Action Plan for Implementation to:
  - Prioritise the development of innovative solutions
  - Put forward key research and innovation actions to be undertaken
- This calls for prioritising research and innovation to inform the allocation of funds and maximise impact of support measures

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EU 2030 Climate and Energy Framework…

2020

20% GHG

20% RES

20% EE

2030

40% GHG

≥27% RES

≥45% RES-e

2014

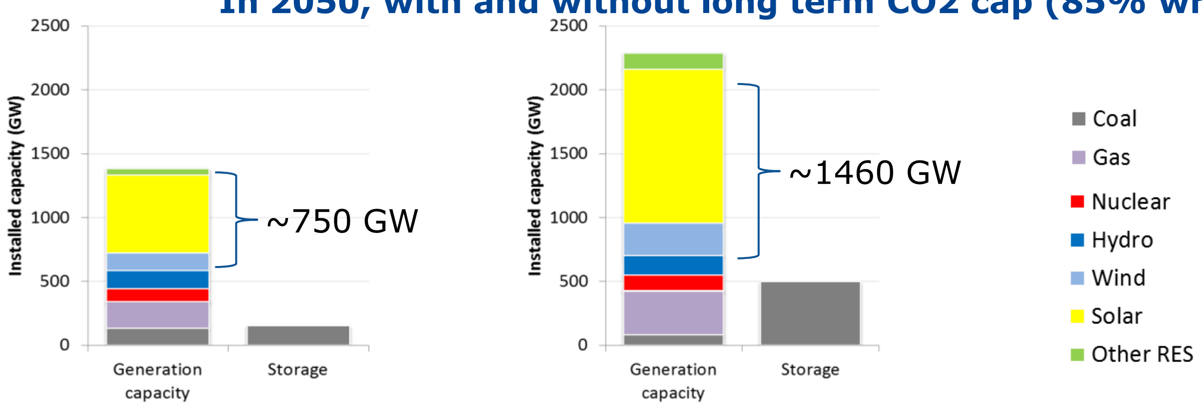
Key indicators

Technological Innovation

Source: COM(2014)15

In 2050, with and without long term CO2 cap (85% wrt 1990)

Installed electricity generation capacity



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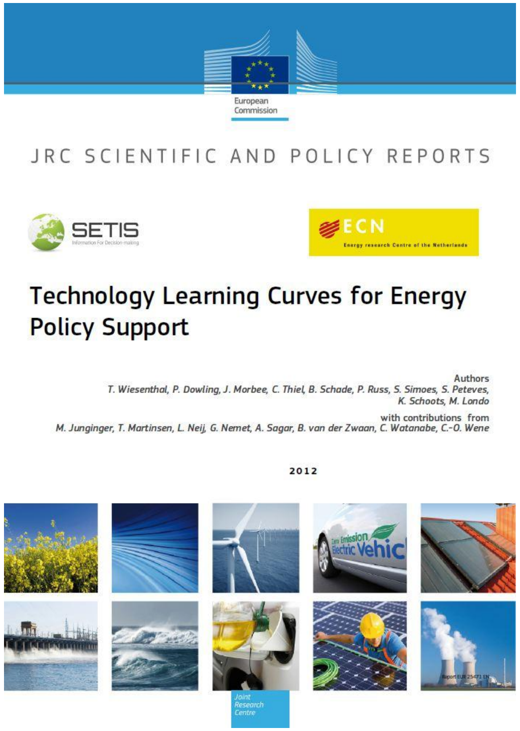
JRC Scientific and Policy Reports: The JRC-EU-TIMES model. Assessing the long-term role of the SET Plan Energy technologies, 2013

Technology learning does exist and has a significant impact, but there is not one single way to extrapolate it or model it

Continued need for assessing impact of research and innovation policies on energy systems beyond cost

- Need to explore differentiated impacts of research and innovation beyond technology costs
- Policies for research and innovation and support to deployment are complementary
- Uncertainty → sensitivity analysis around learning factors is needed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JRC SCIENTIFIC AND POLICY REPORTS

SETIS

ECN

Technology Learning Curves for Energy Policy Support

Authors
T. Wiesenthal, P. Dowling, J. Morbee, C. Thiel, B. Schade, P. Russ, S. Simoes, S. Peteves, K. Schoots, M. Londo

with contributions from
M. Junginger, T. Martinsen, L. Neij, G. Nemet, A. Sagar, B. van der Zwaan, C. Watanabe, C.-O. Wene

2012

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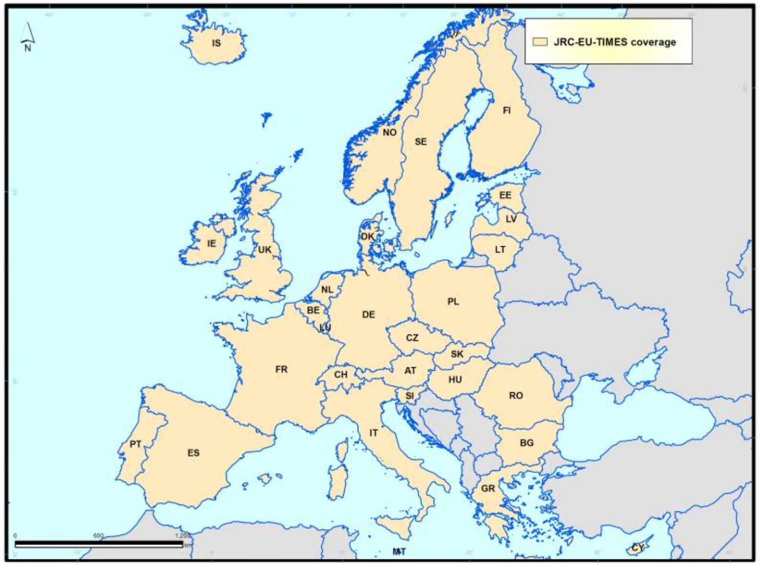
JRC-EU-TIMES key characteristics

- Maximisation of welfare - economic equilibrium for energy markets (supply and end use)
- Model horizon is 2005-2050 (2075)
- 70 exogenous demands for energy services across 5 demand sectors (agriculture, residential, commercial, industry, and transport)
- Economic drivers from general equilibrium model GEM-E3 – with demand elasticities used for different drivers
- Supply sector description (fuel mining, primary and secondary production, import and export)
- Explicit representation of country-to-country energy flows, incl. endogenous electricity and gas trade, an import / exports with non-European regions
- Electricity multi-grid model (high, medium and low voltage grid), tracking demand-supply via 12 time slices (4 seasons, 3 diurnal periods), and gas across seasons
- Country specific differences for characterisation of th conversion and end-use technologies



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Model techno-economic inputs influenced by R&D and innovation

Technical parameters	Economic parameters	Environment	Energy Service demand
Existing stock/Capacity	Discount rate	**Emission coefficient**	Reference year value
Commodity input(s)/output(s)	Technology-specific discount rate	Environmental targets	Projection over the time horizon
Efficiency or Consumption	**Investment costs**		
Fuel share for multi-fuel technologies	**Fixed and Variable O&M costs**		
Technical life or retirement profile	Import/Export commodity price		
Maximum availability	**Economical life**		
Starting year for new technologies			
Construction time			

R&D and innovation measures lead to changes in technological deployment and affect learning, which is a critical assumption in energy system models used for policy and priority setting

- In the JRC-EU-TIMES model, we assess the benefits of research and innovation measures through:
  - Expert based judgment
  - Stochastic processes
  - Endogenous technology learning
- Assessing the role of cost and efficiency in influencing the competitiveness and the large scale deployment of key technologies in an energy system perspective

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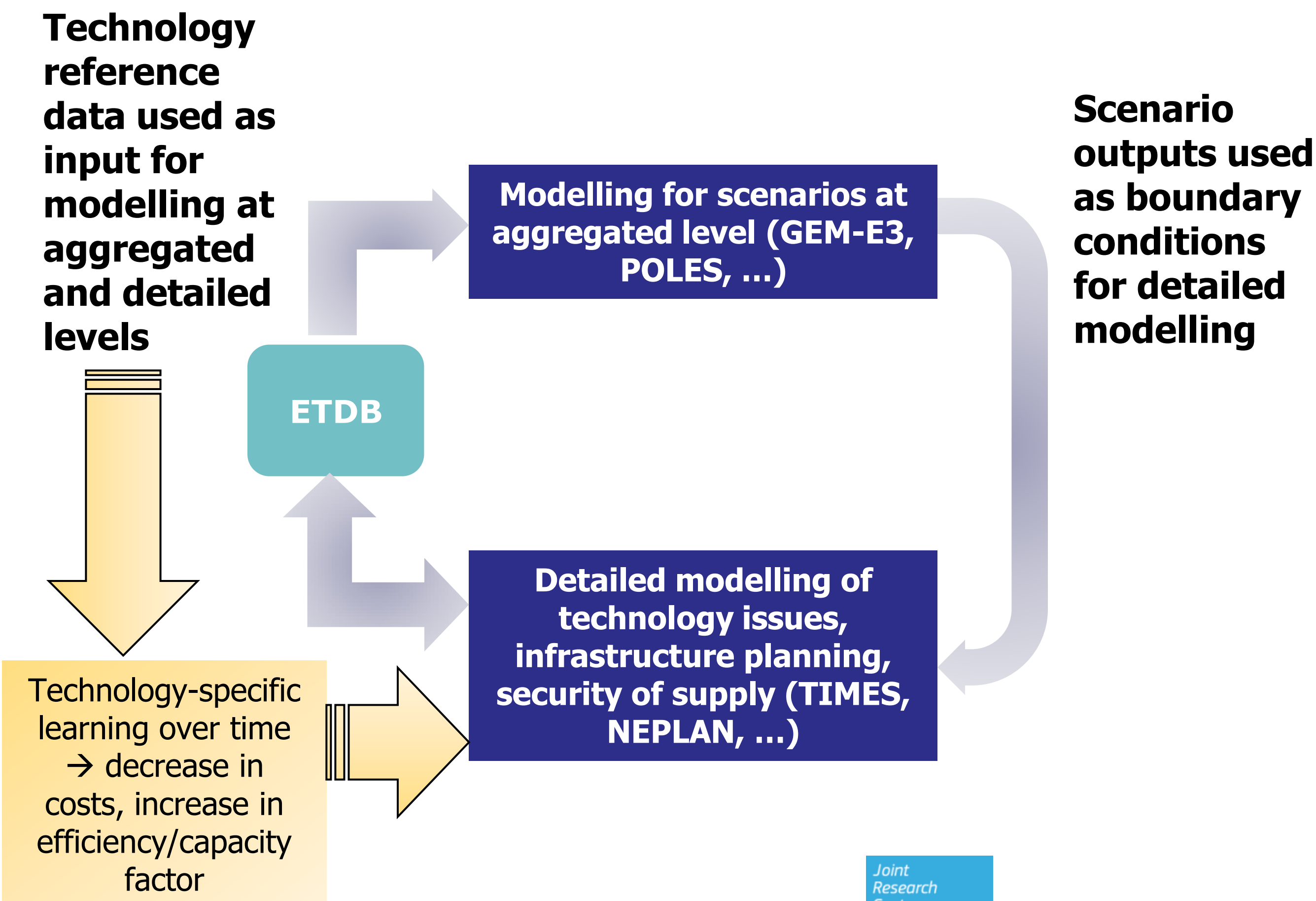
ETDB: Energy Technology DataBase

Data input and validation

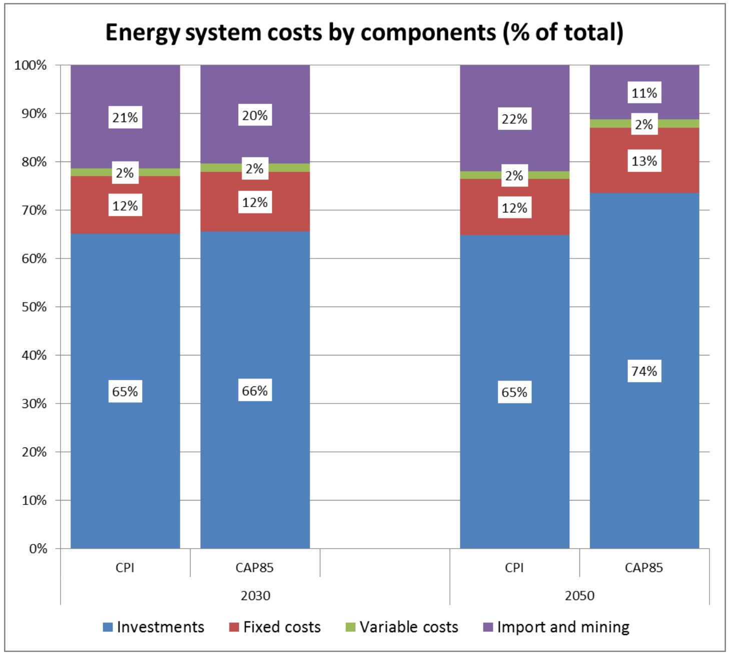


ETDB: online central database for sharing technical and economic characteristics of energy technologies between JRC technology experts and JRC modellers

Need to reflect on R&D and innovation priorities *in an energy system perspective* while ensuring the least cost path to decarbonisation

The costs to a low carbon transition do not differ substantially from the business as usual (0.15%/1.65% of GDP in 2030/ 2050 – COM(2014)15). It is the *composition* of the costs that changes substantially

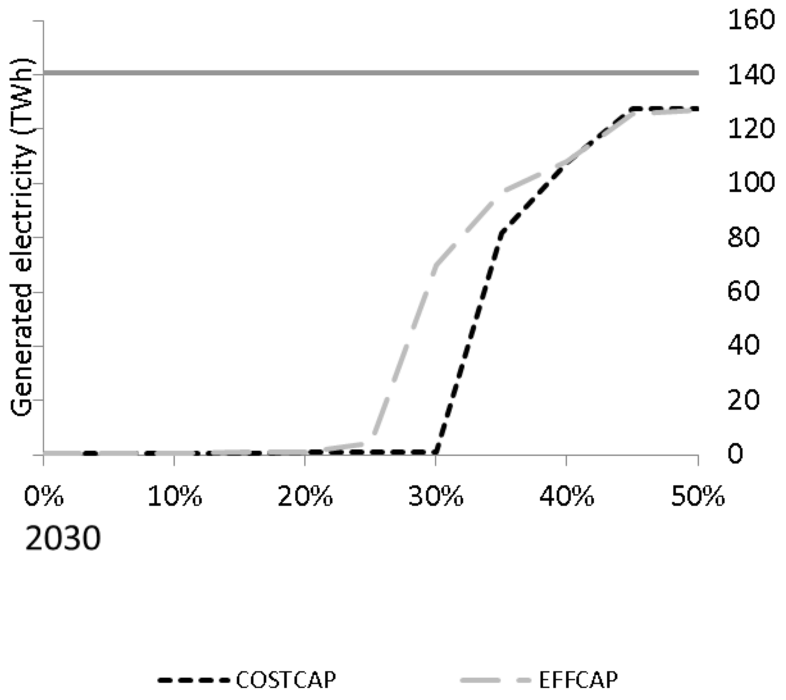
- Higher investment in innovative equipment…
- …lower fuel expenditure
- Lowering the cost of meeting GHG reduction targets requires research and innovation to focus on decreasing investment cost of low-carbon technologies



JRC Scientific and Policy Reports:
The JRC-EU-TIMES model. Assessing the long-term role of the SET Plan Energy technologies, 2013

Uncertainty on the effects of R&D and innovation calls for simultaneous efforts on reducing costs and improving technological efficiencies

- Marine energy would not become competitive in the short term without a cap
- Costs are an important barrier, but efficiency improvements have earlier and stronger impact on deployment and market penetration
- Results give indication of tipping point, i.e. target reduction/improvement in cost/efficiency to change merit order (25% for efficiency, 35% for cost reduction)



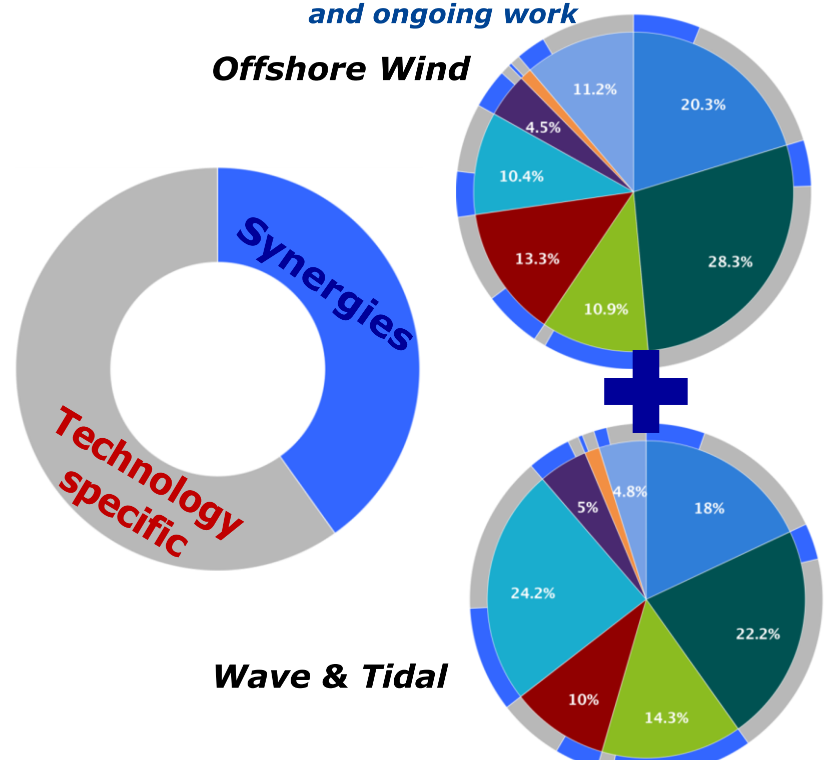
Source: JRC-EU-TIMES model, ongoing work

Emissions reduction of the magnitude required involves the simultaneous deployment of several low carbon technologies

Improving the effectiveness of R&D and innovation calls for common actions targeting more technologies to exploit synergies

- More than 40% of their costs can be reduced by common research and innovation actions
  - Similar equipment, infrastructure, operating and maintenance practices
  - Shared project development and permitting
  - Common offshore grid infrastructure and land connectors

Source: JRC Report (2012). ISBN 978-92-79-27956-0 and ongoing work



O&M ■ Power Take Off ■ Electrical Infrastructure ■ Support Structure ■ Logistic & Installation ■ Project Development Permit ■ Other CAPEX ■ Other VAR

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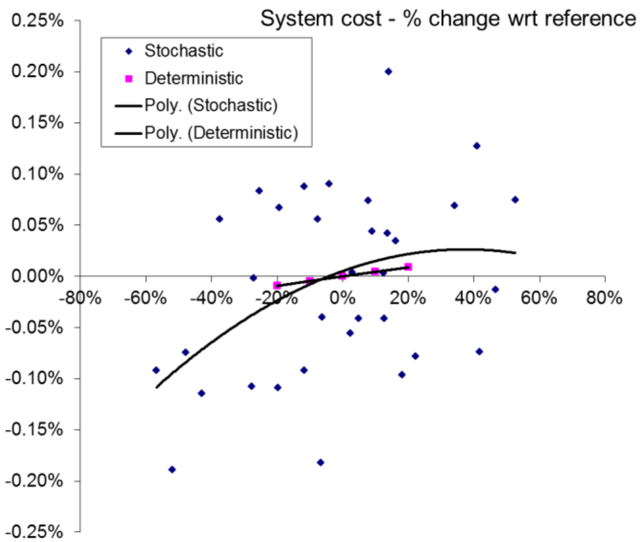
Innovation is inherently uncertain, and not treating it as such may lead to underestimation of benefits and thus sub-optimal research and innovation efforts

Because of breakthrough, the impact of research and innovation on energy system cost is non-linear

- Without the stochastic approach the value of innovation would be understated by up to a factor 3
- Stochastic modelling can capture non-linear benefits of energy technology breakthroughs, which are ignored in deterministic simulations that consider only an average technology



Increase/decrease in specific investment cost of solar in 2020*

A stock price model for technology learning in energy systems modelling, Dr. J. Morbee/JRC, presented at IEW 2013

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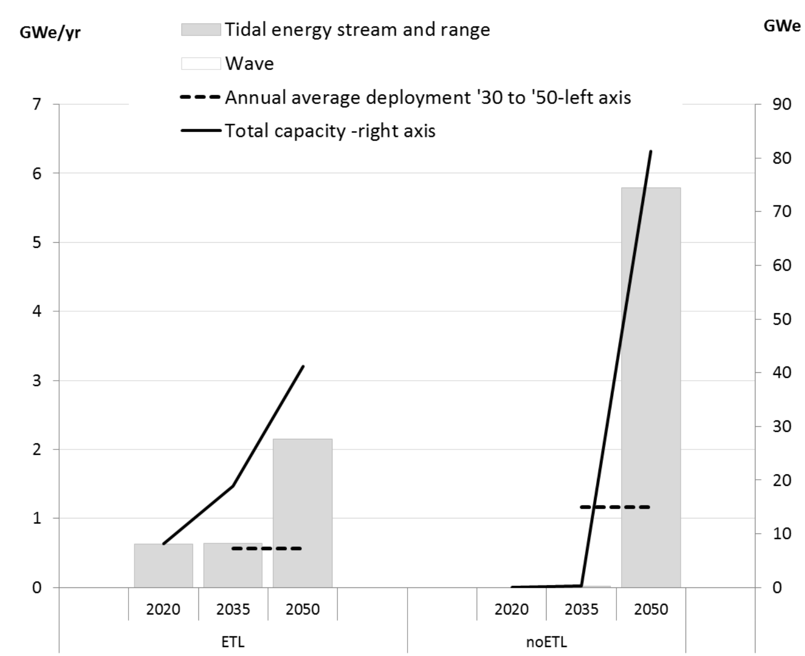
Modelling with endogenous technology learning can be instrumental in setting research and innovation priorities and their timing

- In the short term (2020-2035), endogenous learning (EL) in electricity generated from marine energy (tidal and wave) leads to earlier deployment – from 2020 and differences across countries
- Result dependent on learning rate assumed → need for sensitivity analysis and empirical research to support modelling work
- Country differences need to be considered in priority setting for research and innovation



Source: JRC-EU-TIMES model, ongoing work

CONCLUSIONS

- **Energy system modelling work can support research and innovation prioritisation and the identification of crucial technologies. Some general conclusions can be drawn:**

  - It is important to consider the effects of targeted research and innovation efforts in an energy system perspective – synergies and competition
  - While technological cost is an important barrier to deployment, research and innovation should also address technological efficiencies, which is critical in determining earlier deployment and market penetration of fringe low-carbon technologies
  - Uncertainty around the impact of research and innovation highlights the importance of sensitivity analysis to derive robust results through modelling
  - The robustness of identifying priorities and effectiveness of research and innovation in an energy system model can be further enhanced by modelling with endogenous technical learning or stochastic processes

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Thank you!

The Commission's Strategic Energy Technologies Information System

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Information For Decision-making

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http://setis.ec.europa.eu