http://www-iam.nies.go.jp/aim/

http://www.lowcarbon-asia.jp/

http://2050.nies.go.jp/LCS/

BACKCASTING MODEL: CURRENT STATUS AND FUTURE ACTIITIES

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What is Backcasting Model (BCM)? - Similar, but Different Model of Enduse Model

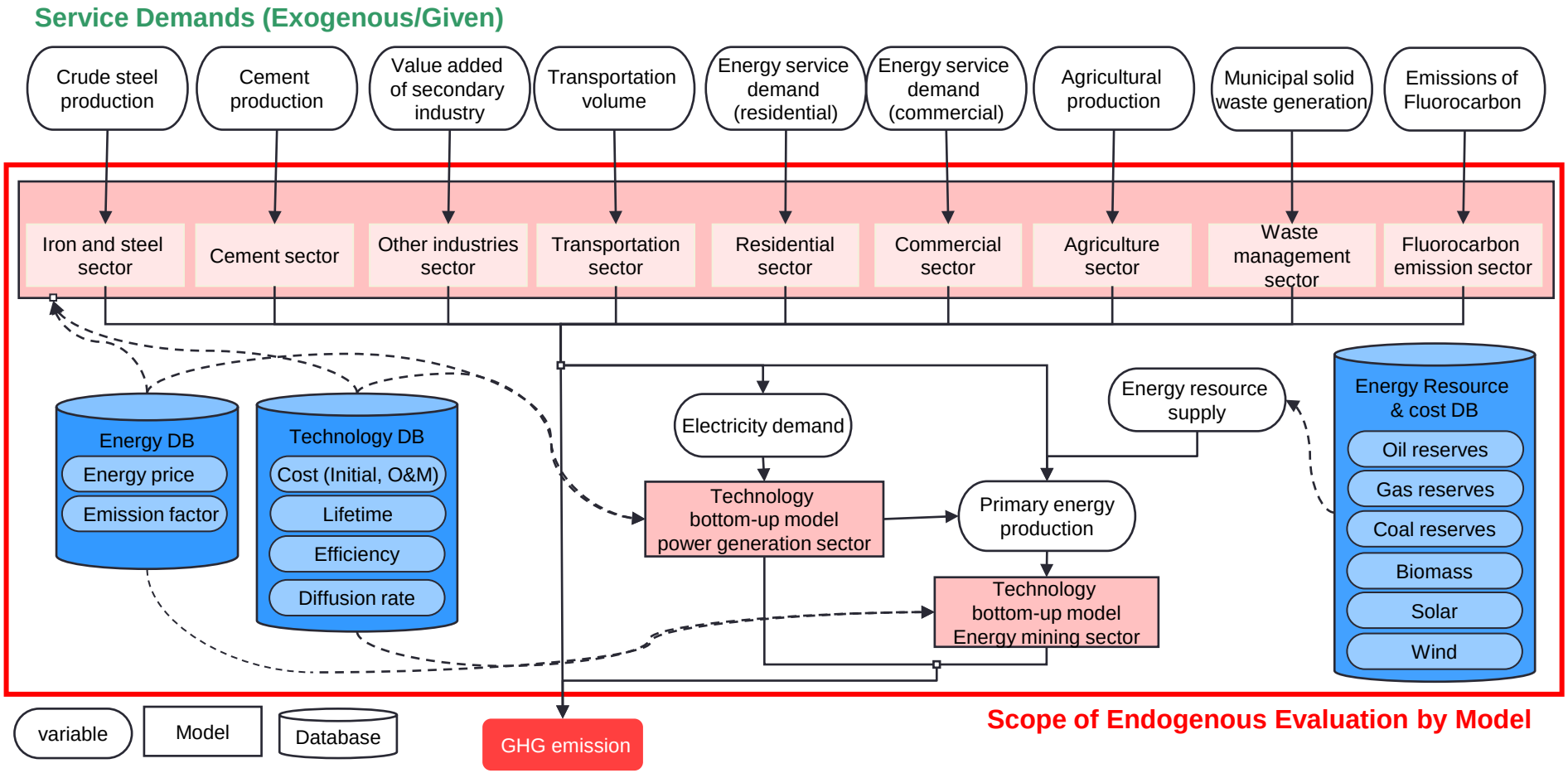
- Common Features among Enduse and BCM
  - Technology-rich description of energy system, options and costs.
  - Feature sectoral and technological details.
  - Service demands are given.
  - Multiscale models: Sub-national, National and Global

- Differences among models: Optimization Technique and Time Interval
  - Enduse Model: Recursive Dynamic Optimization, 1 year-interval
  - Backcasting Model: Inter-temporal Optimization, 5 year-interval

- Features in BCM (Currently available only for national model)
  1. Linearlized Learning Curve
  2. Autonomous Market Penetration of Technologies
  3. Policy/Technology Implementation Analysis with Ordering

Model Structure of BCM – Almost same as Enduse model

- Service demands are given as exogenous parameters.
- Most of data (technology, service demand, cost, price, emission factor etc) are loaded from Enduse database.
  - Basic BCM could run by simply importing data set file for Enduse (XXX.set, XXX_1.gms, XXX_2.gms)
- Period interval of BCM is 5 years but Enduse is usually 1 year.
  - This is due to the size of model – small model might run with 1 year interval.



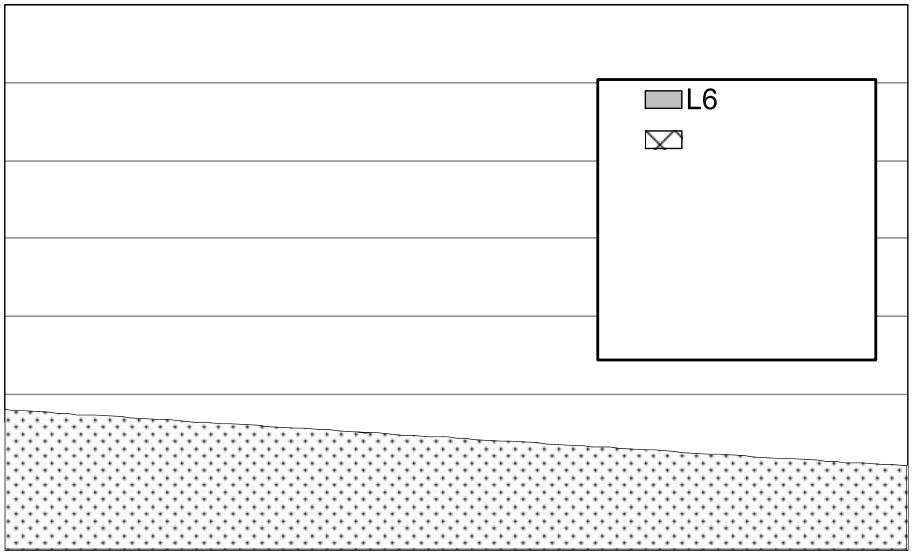
Features in BCM (1)
Linearized Learning Curve

- Because the BCM is under the Mixed Integer Programming framework, learning curve should be incorporated as linear functions.
- A learning curve is divided into two or more segments - the sum of the segments expresses the original learning curve.

Typical form for Learning Curve:

$$Y = aX^{\frac{\log b}{\log 2}}$$

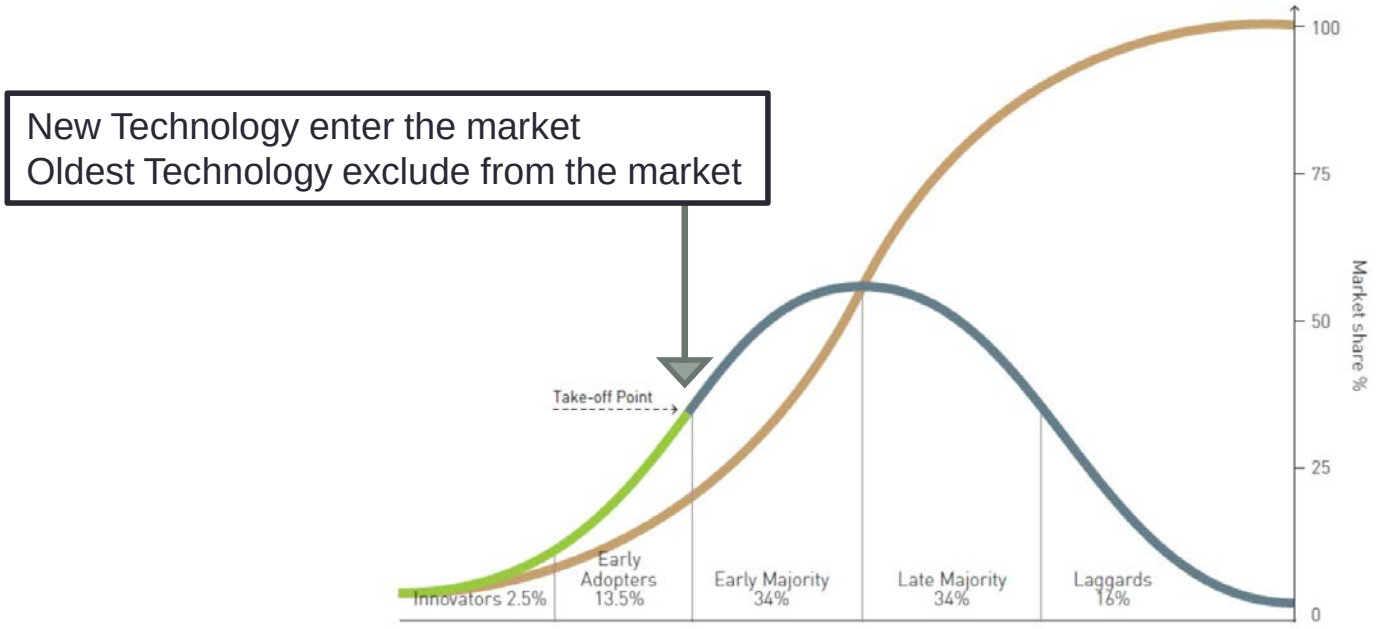
Linearized under the MIP framework



mulative production [unit]

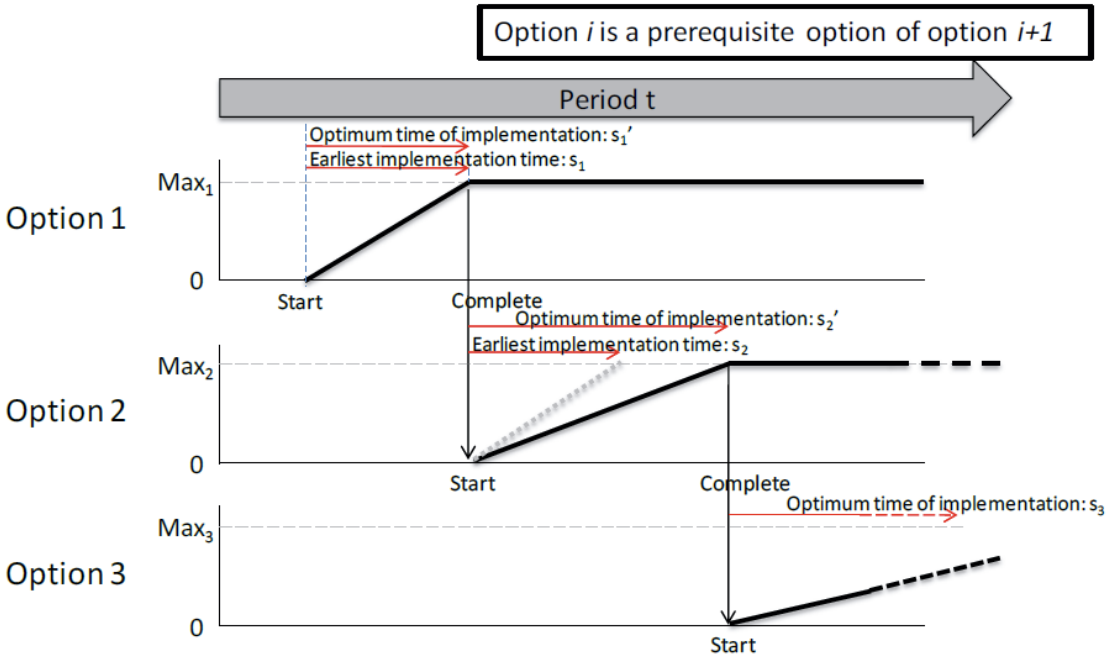
Features in BCM (2): Autonomous Market Penetration of Technologies

- The BCM includes the module of technology diffusion processes in the market based on consumer's preferences as autonomous market penetration of technology
- Basic concept of technology diffusion is followed by the S-curve by Rogers
  - *Assumption*: When the market share of a certain technology exceed a threshold (passing take-off point), the next technology (more efficient technology) is introduced to the market, and simultaneously the oldest technology is eliminated.



Features in BCM (3): Policy/Technology Implementation Analysis with Ordering

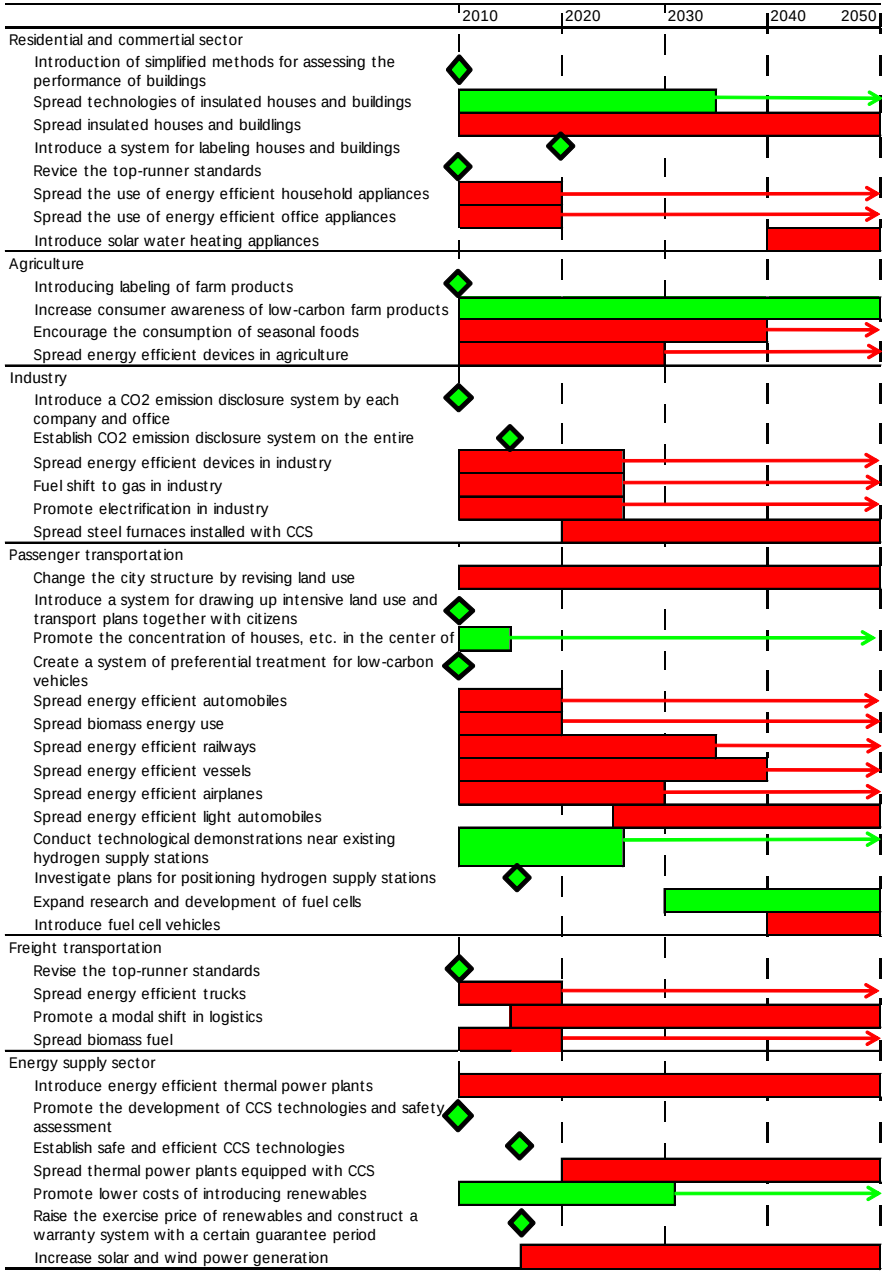
- Some technologies and/or policies could be deployed immediately.
  - Fuel shift to imported biofuels and levying carbon tax *could* start within a year.
- However, in most cases, introduction of technologies and/or policies requires pre-deployment of other technologies, policies and/or infrastructures.
  - Wide-spreading of hydrogen vehicle should be following installation of hydrogen stations.
- The BCM refers a relationship in which a certain option cannot be started without the full introduction of its prerequisite option, and formulate roadmaps and Gantt Chart for achieving future target.



Examples of Unique Output from BCM (1): Policy and Technology Gantt Chart

- The scheduling for the introduction of the assumed options can be organized in form of a Gantt chart.
- Each implementation timing defined based on relationship information among options.

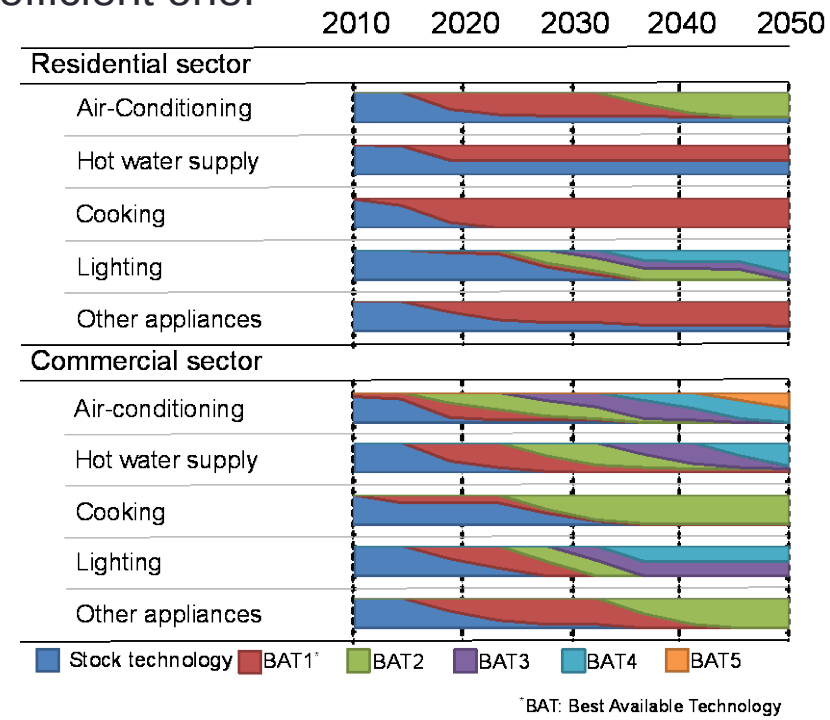
- Right figure is example for 70% reduction scenarios by 2050 in Japan
  - The energy-efficient household appliances in the figure are analyzed by preparing data for specific technologies separately, such as air conditioners and kerosene heaters.
  - The figure summarizes them together, however, as the analysis results for the technologies are similar.



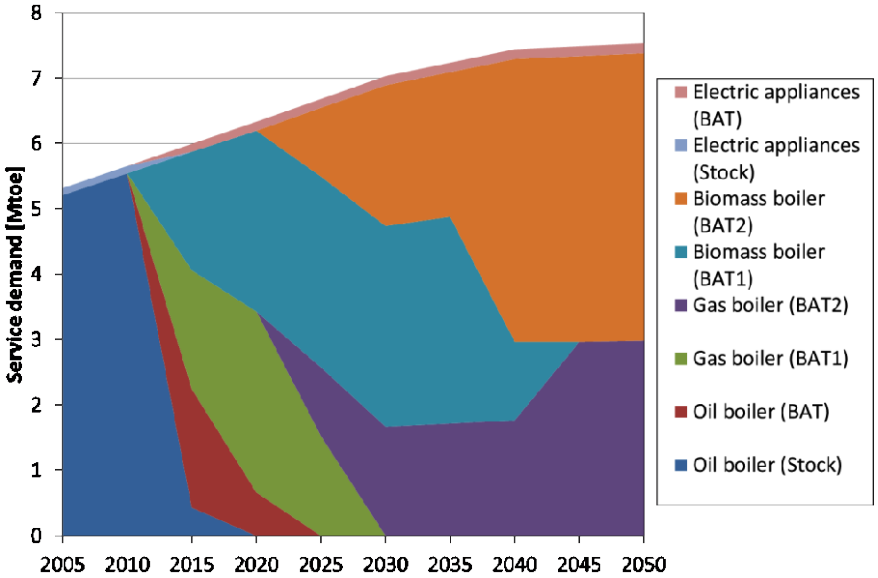
Colors in the figure: red: measure, green: policy
Width of the lines: Bars denote periods for actively spreading the measure or for spreading the policy nationwide. Arrows denote periods for maintaining the ratio of spread of the measure or the period for continuing the policy. Diamonds are the timing for drawing up and enforcing the policy.

Examples of Unique Output from BCM (2): Technology Diffusion Pattern and Roadmap

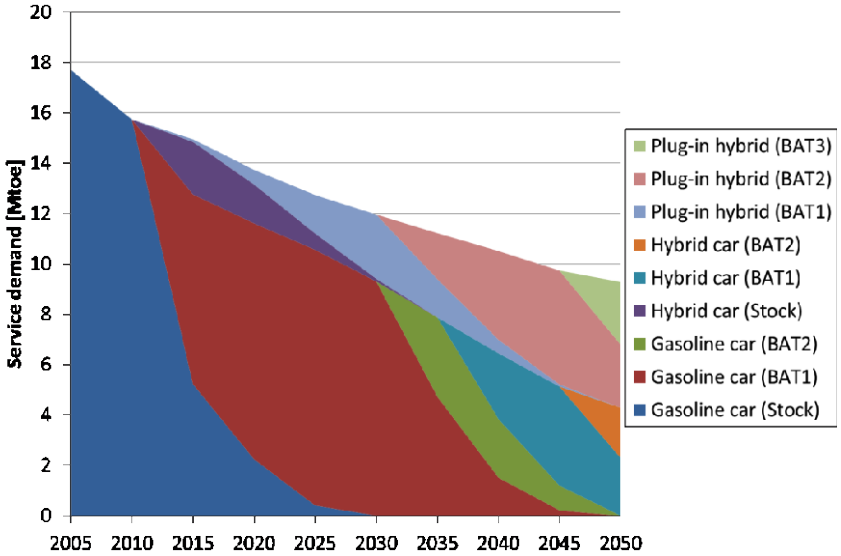
- Total service demand is assumed to be an externally given condition that does not change whether or not CO_2 emissions targets are imposed.
  - Without CO2 emission target, Only stock technology is selected by consumers.
- By imposing CO_2 reduction target in 2050, technologies gradually shift to energy efficient one.



*BAT: Best Available Technology



Dissemination of Technology in Agriculture Industry in Japan with CO2 reduction target in 2050



Dissemination of Technologies in Passenger Car in Japan with CO2 reduction target in 2050

Note: No Technology Share Constraint has been Imposed.

Recent Activities and Future Plan

- Progress of development of the BCM
  1. Commonalization of data with Enduse Model
  2. Development of the global BCM based on the AIM/Enduse [Global]
  3. Analysis of national LCS roadmap in Asia (yet finished)
  4. Development of subnational scale model (planning stage, full-scale development will start from next FY under the Fukushima study)

- Research Plan in FY2013 and FY2014: Application to Asia LCS
  - Since national LCS scenarios has been established in several Asian countries, for example, Thailand, India, Indonesia and Malaysia, and some countries started analysis of Enduse model such as Prof. Bundit team.
  - In this year and coming years, the BCM-related research work will focus on national LCS roadmap analysis in Asian countries.