

Development of Low Carbon Scenarios for Asia Regions



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

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

BACKCASTING MODEL: CURRENT STATUS AND FUTURE ACTIITIES

Shuichi Ashina (芦名 秀一)

National Institute for Environmental Studies (国立環境研究所)

The 19th AIM International Workshop, December 14, 2013. At Ohyama Memorial Hall of National Institute for Environmental Studies

The model has been developed with support of the Environment Research and Technology Development Fund (S-6 and 2A-1103) of the Ministry of the Environment, Japan.

What is Backcasting Model (BCM)?

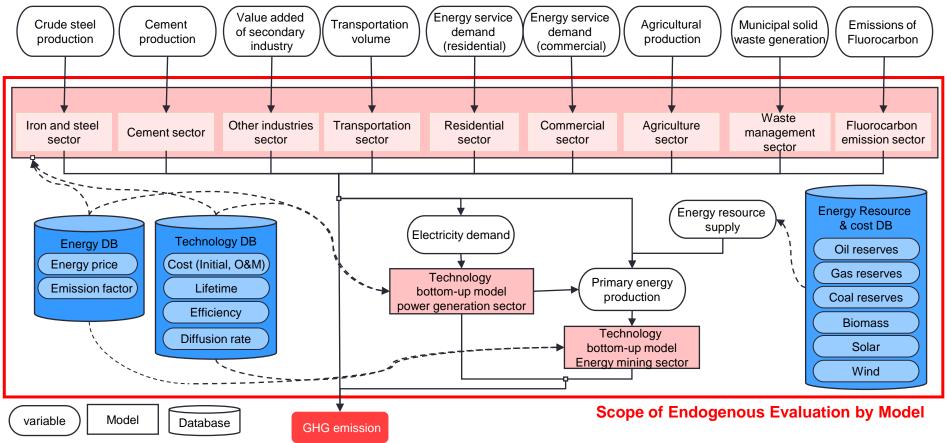
- Similar, but Different Model of Enduse Model

- 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.

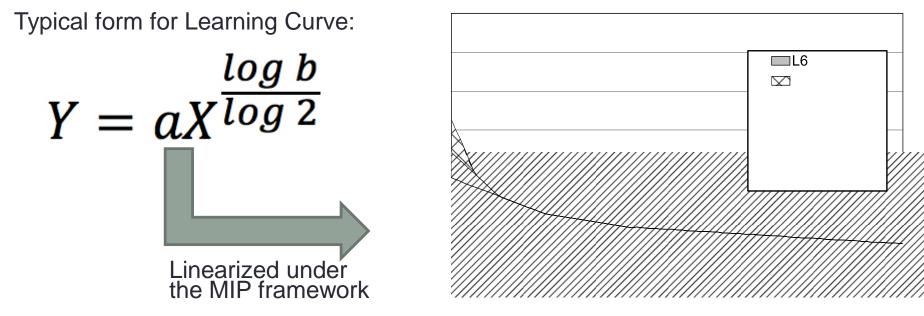
Service Demands (Exogenous/Given)



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.

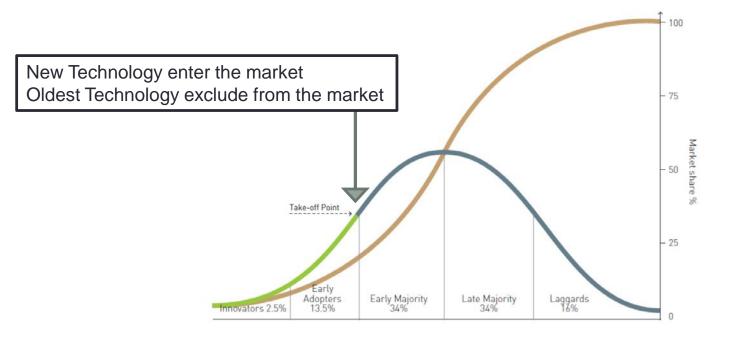


mulative production [unit]

Features in BCM (2):

Autonomous Market Penetration of Technologies

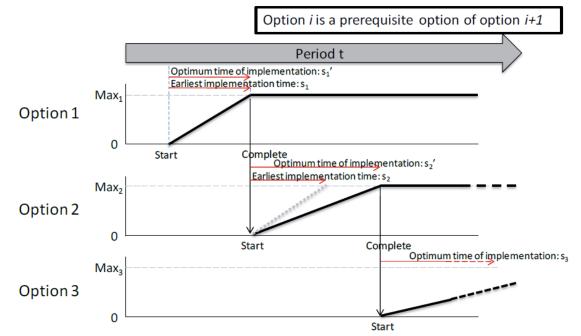
- The BCM includes the module of technology diffusion processes in the market based on consumer's preferences as autonomous market penetration of technology
- Basic concept of technology diffusion is followed by the S-curve by Rogers
 - Assumption: When the market share of a certain technology exceed 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.

	2010	2020	2030	2040	2050
Residential and commertial sector		ł		-	i
Introduction of simplified methods for assessing the performance of buildings	\diamond	I	1	I	I
Spread technologies of insulated houses and buildings					
Spread insulated houses and buildings					
Introduce a system for labeling houses and buildings		\diamond			
Revice the top-runner standards	\diamond	×		•	I
Spread the use of energy efficient household appliances			•		\rightarrow
Spread the use of energy efficient office appliances				-	—́→
Introduce solar water heating appliances					
Agriculture			-		
Introducing labeling of farm products	\diamond	I	1	I	I
Increase consumer awareness of low-carbon farm produc	ts				
Encourage the consumption of seasonal foods					→
Spread energy efficient devices in agriculture					\rightarrow
Industry					
Introduce a CO2 emission disclosure system by each	\diamond		1	I	
company and office Establish CO2 emission disclosure system on the entire					I
Spread energy efficient devices in industry					→ .
Fuel shift to gas in industry					\rightarrow
Promote electrification in industry					→
Spread steel furnaces installed with CCS					
Passenger transportation				1	
Change the city structure by revising land use					
Introduce a system for drawing up intensive land use and transport plans together with citizens Promote the concentration of houses, etc. in the center	~		I	-	
Create a system of preferential treatment for low-carbon vehicles		I	I	1	- 1
Spread energy efficient automobiles			_	-	<u>→</u>
Spread biomass energy use					\rightarrow
Spread energy efficient railways					\rightarrow
Spread energy efficient vessels					\rightarrow
Spread energy efficient airplanes			_		\rightarrow
Spread energy efficient light automobiles		1			
Conduct technological demonstrations near existing hydrogen supply stations Investigate plans for positioning hydrogen supply stations			I	1	~
Expand research and development of fuel cells	\checkmark				
Introduce fuel cell vehicles		1			
Freight transportation					
Revise the top-runner standards	\diamond		I	1	1
Spread energy efficient trucks					→
Promote a modal shift in logistics					
Spread biomass fuel					—
Energy supply sector			1		-
Introduce energy efficient thermal power plants					
Promote the development of CCS technologies and safet assessment	×		I		
Establish safe and efficient CCS technologies	\diamond				
Spread thermal power plants equipped with CCS					
Promote lower costs of introducing renewables					\rightarrow
Raise the exercise price of renewables and construct a warranty system with a certain guarantee period				1	
Increase solar and wind power generation Colors in the figure: red: measure, green: policy					

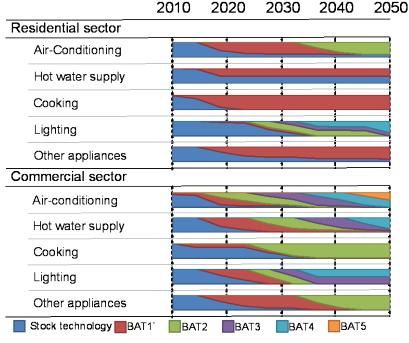
7

Colors in the figure: red: measure, green: policy

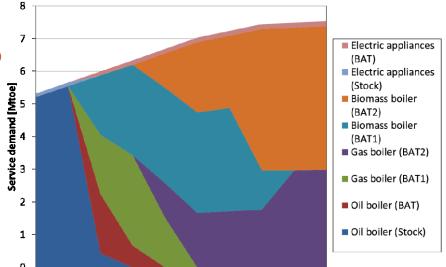
Width of the lines: Bars denote periods for actively spreading the measure or for spreading the policy nationwide. Arrows denote periods for maintaining the ratio of spread of the measure or the period for continuing the policy. Diamonds are the timing for drawing up and enforcing the policy.

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

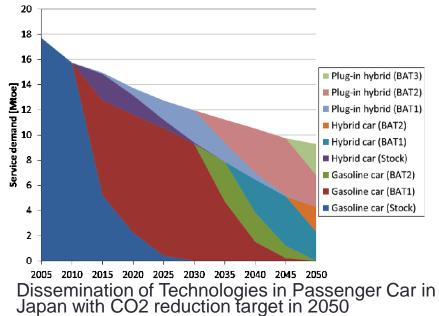
- Total service demand is assumed to be an externally given condition that does not change whether or not CO₂ emissions targets are imposed.
 - Without CO2 emission target, Only stock technology is selected by consumers.
- By imposing CO₂ reduction target in 2050, technologies gradually shift to energy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



^{*}BAT: Best Available Technology



2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 Dissemination of Technology in Agriculture Industry in Japan with CO2 reduction target in 2050



Note: No Technology Share Constraint has been Imposed.

8

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.