AIM/Energy Snapshot Tool (ESS)

AIM Training Workshop Tsukuba, Japan Oct 27-31, 2008



Kazuya Fujiwara

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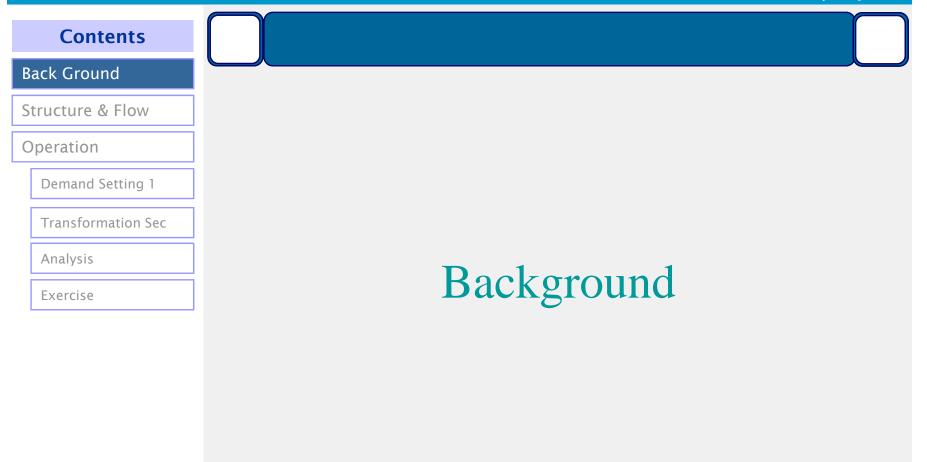
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- Background
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Steps of Japan 2050LCS study

- Energy Snap Shot tool (2 years ago)
 - Create narrative scenario (vision of 2050 LCS).
 - ESS shows us CO2 reduction quantitatively.
 - However, ESS doesn't provide us the concrete actions.
- Dozen of Actions (last year)
 - "Dozen of Actions" shows concrete policies / actions to realize LCS.
 - Various candidates of action are described.

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Steps of Japan 2050LCS study

- "Dozen of Actions" shows us what kind of actions are required to realize LCS, but we still don't obtain quantitative information (cost of actions / required term for implementing actions).
- Back Cast(ing) Model (this year)
 - BCM provide us following information quantitatively.
 - Which policies / actions will be introduced
 - When will those actions should be introduced
 - How mach will we have to pay for

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Steps of Japan 2050LCS study

• ESS

- Provide CO2 reduction amount (potential) in 2050.
- Dozen of Actions
 - Provide candidates of actions to realize LCS in 2050.
- BCM
 - Give quantitative bases to the actions.
 (implementing cost, timing of introduction, CO2 reduction amount, etc.)

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Background of development

- In LCS/SD visions developing processes, a tool with following feature would be useful
 - Clear assumptions & calculation processes
 - Easy interpretation of the results
 - Easy sensitivity analysis (assumptions can be changed manually)
 - Quick calculation
 - Overview of general energy flow (keep balance)



 Tools to describe future (ex. 2050) Energy Balance Table (EBT) in a spreadsheet: Energy Snapshot Tool (ESS)

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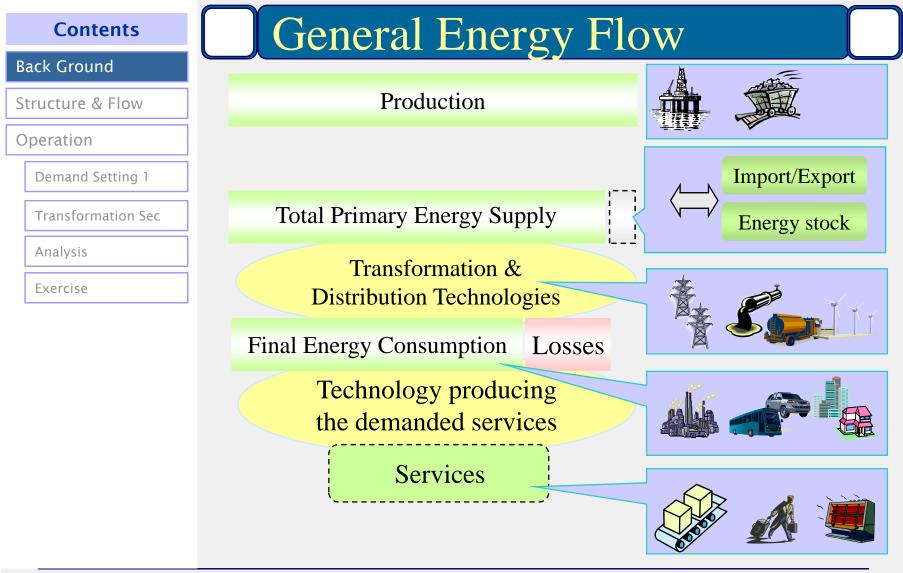
Analysis

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AIM/Energy snapshot tool

- Excel format
- Based on EBT
- Step by step approach
- The tool can be used for;
 - Developing and designing preliminary LCS/SD visions
 - "What if" analysis
 - Check the consistency among the sectors
 - Analyze the impacts of countermeasures package
 - Communication among stakeholders

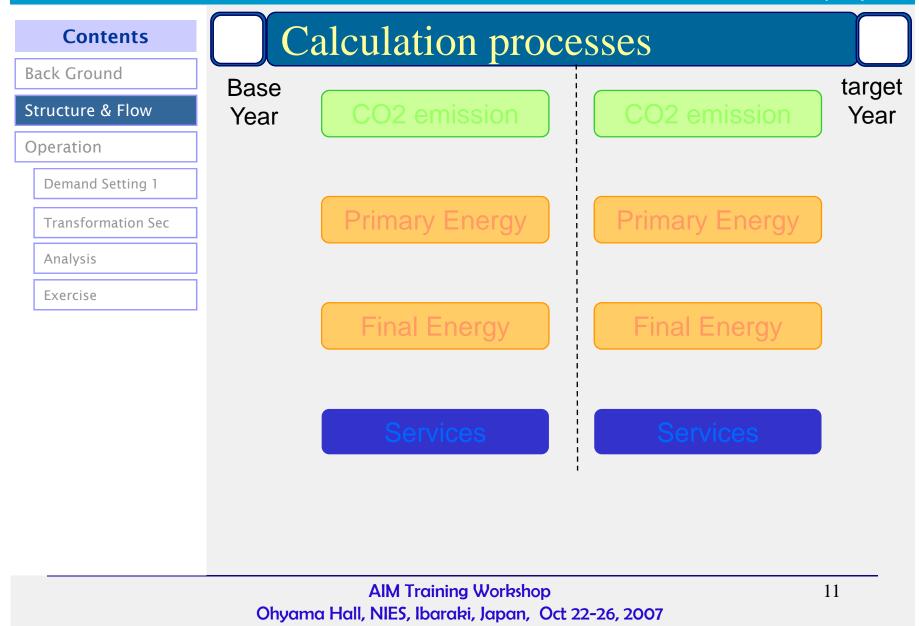
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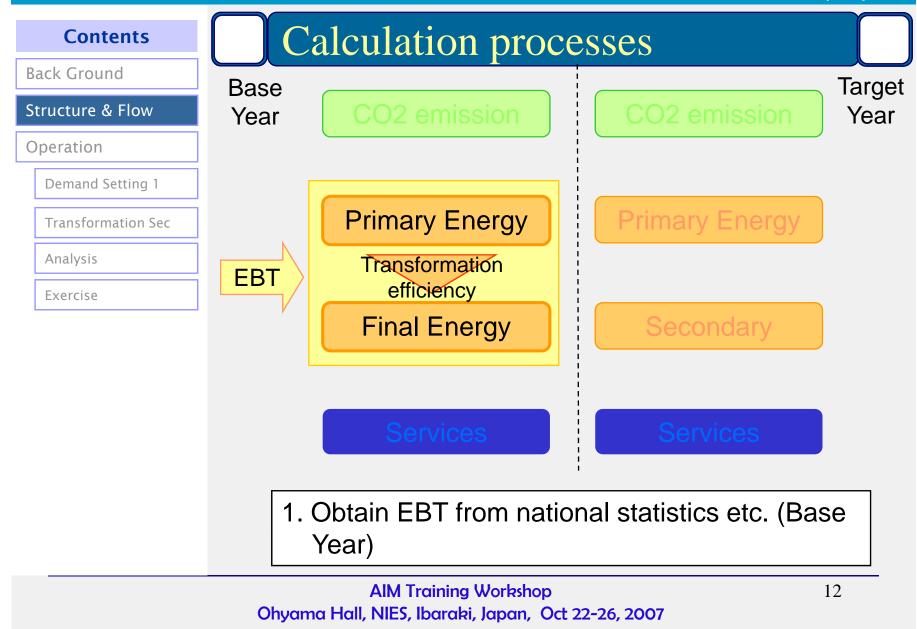


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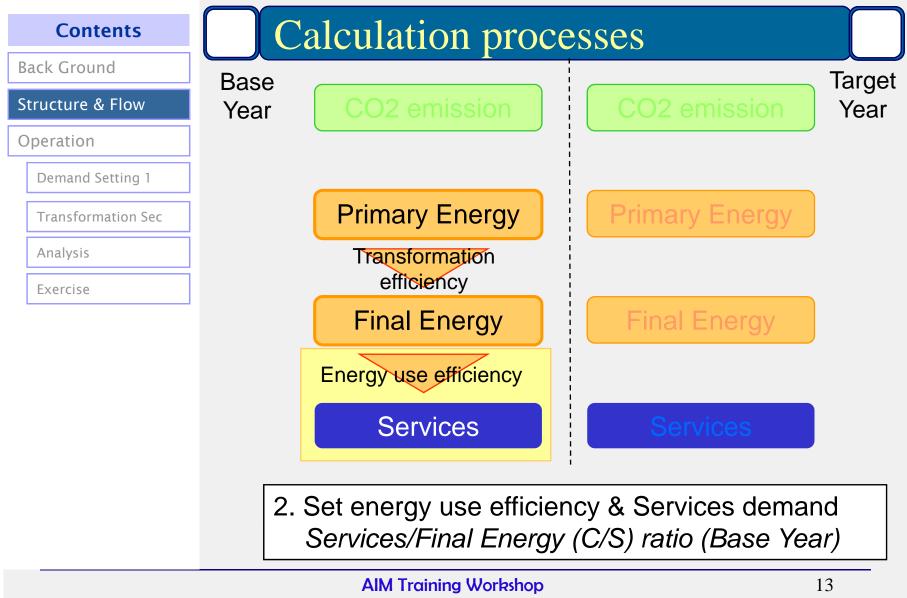




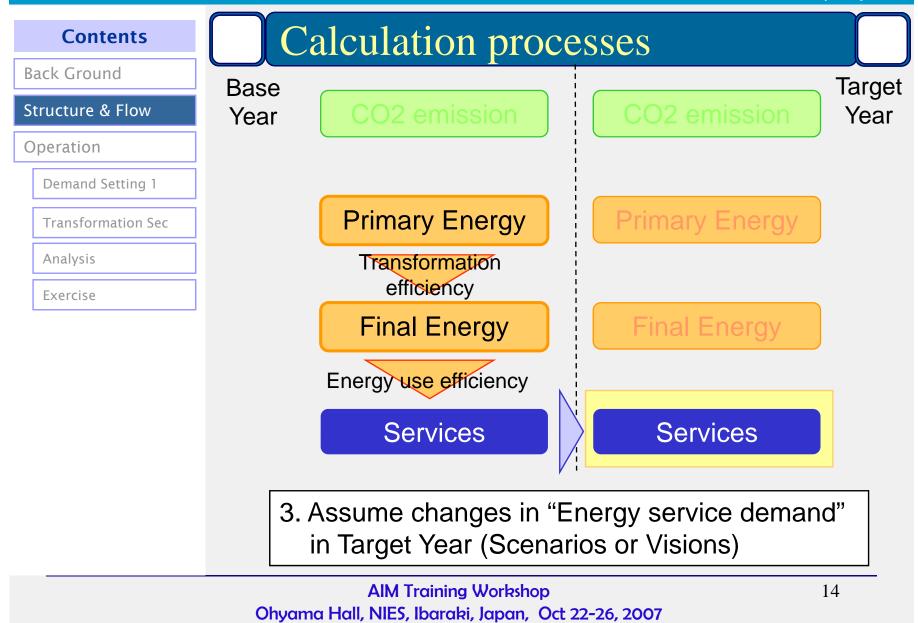


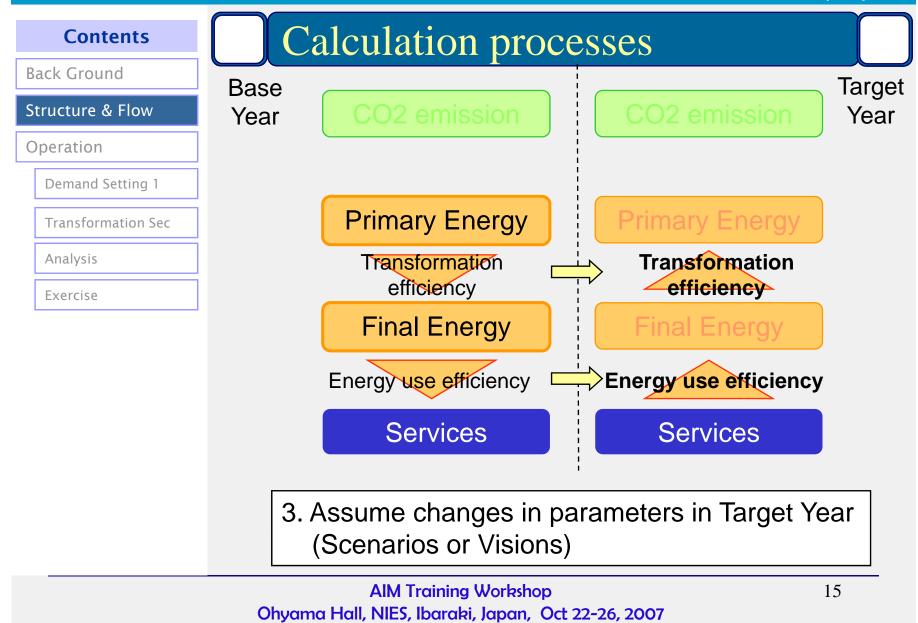


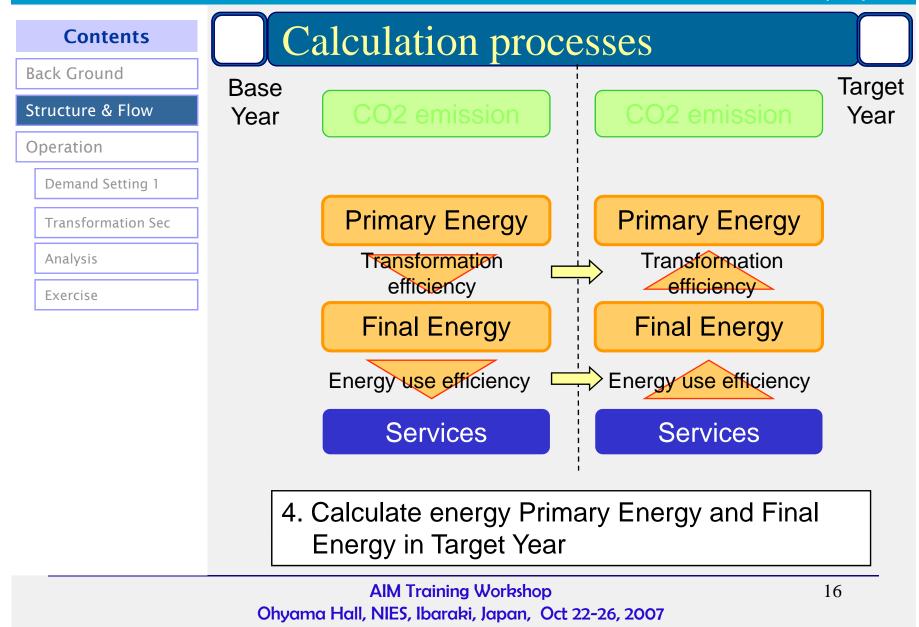
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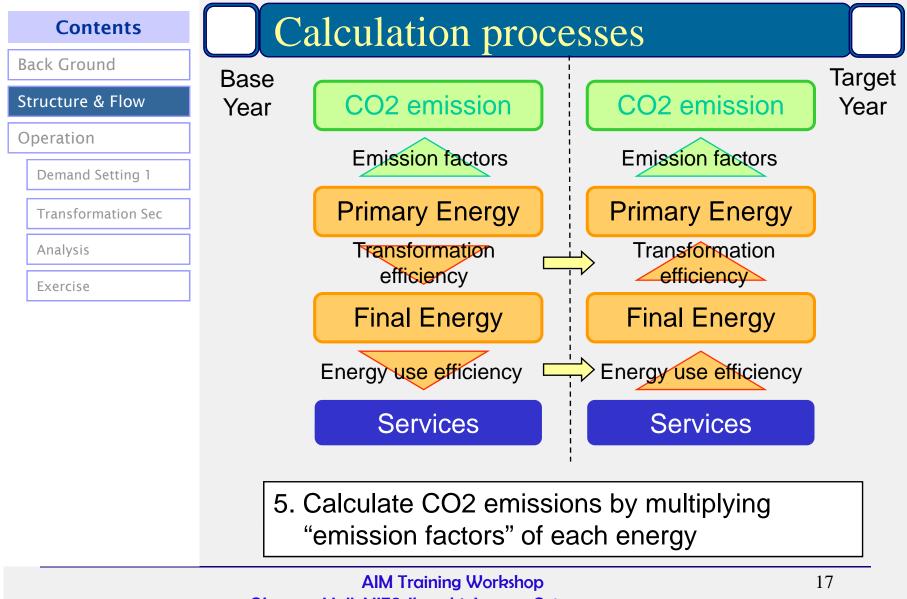
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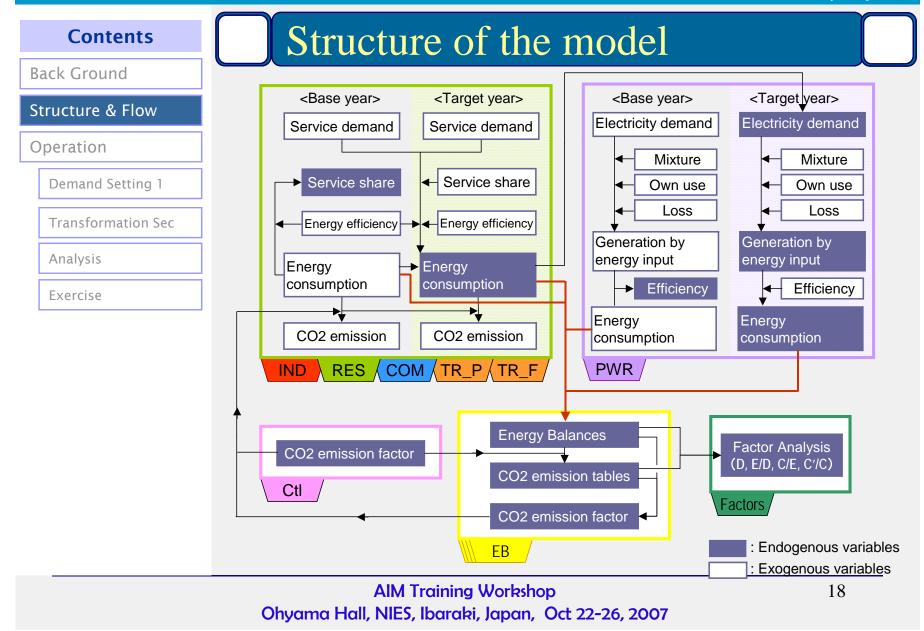




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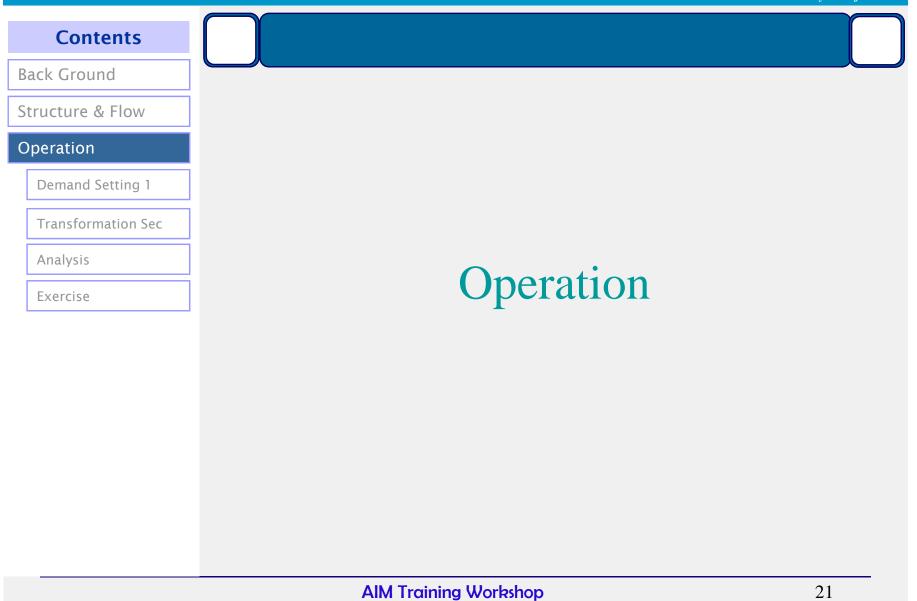
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Wo	orksheets
Name	Contents
Title	Cover of ESS
CTL	Unit, simulation year, visions name and CO2 emission factor
RES	Residential sector
IND	Industrial sector
COM	Commercial sector
TR_P	Passenger transportation sector
TR_F	Freight transportation sector
	Name Title CTL RES IND COM TR_P

Contents	W <u>o</u> 1	rksheets
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Structure & Flow	Name	Contents
Operation Demand Setting 1	EB_SD	Energy balance table (Service & Demand side countermeasures)
Transformation Sec Analysis	EB_S	Energy balance table (Service side countermeasures)
Exercise	EB_D	Energy balance table (Demand side countermeasures)
	EB_0	Energy balance table (No counter measures = Reference case)
	Factors	Factors analysis of CO ₂ reduction
	EneEms	Graphs of energy cons. and CO ₂ emissions

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Contents	Fundamental settings (CTL)
Back Ground	
Structure & Flow	Unit, Simulation Year, Scenario Name, Emission Factor
Operation Demand Settings	Unit Energy CO2 Mtoe MtC
Transformation Sec Analysis	Simulation YearBase YearTarget Year20002050
Exercise	Scenario NameScenario 1Scenario 2AB
	Emission FactorCOLOILGASBMSNUCHYDS/W1.050.80.550000Unit: MtC / Mtoe

General rules

- White cells: User input
- Colored cells: Automatically calculated values

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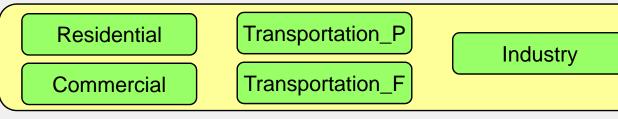
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Demand Settings



Residential sector

1 Energy service demand

					20	50			
	Unit	2000	RE	F	C	М	CM/	REF	4 Ene
			Α	В	Α	В	Α	В	Cons
Cool	Mtoe	4	4	4	4	4	90%	100%	
Warm	Mtoe	81	81	81	65	81	80%	100%	5 Emi
Hot Water	Mtoe	55	55	55	55	55	100%	100%	Fac
Cooking	Mtoe	60	60	60	30	60	50%	100%	
Others	Mtoe	5	5	5	5	5	100%	100%	6 CO2
	Mtoe				0	0			
	Mtoe				0	0			
	Mtoe				0	0			
	Mtoe				0	0			
					0	0			REF = Reference case
					0	0			CM = Countermeasure ca

4-6 Energy consumption / CO2 Emission

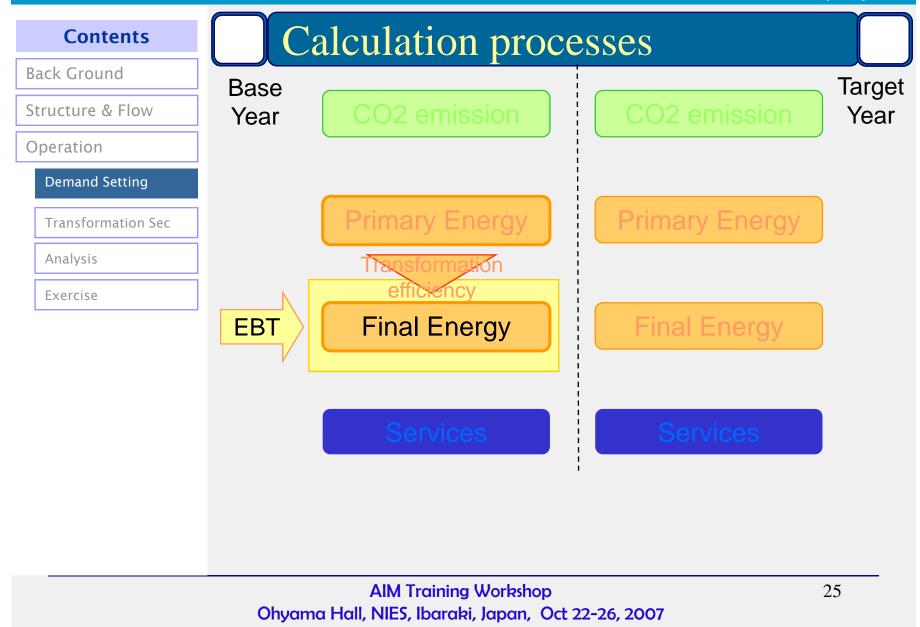
		Unit	COL	OIL	GAS	BMS	S/W
4 Energy	2000		45	13	5	213	0
Consumption	2050 A (CM)	Mtoe	53	12	38	86	0
	2050 B (CM)		45	13	5	214	0
5 Emission	2000		1.05	0.80	0.55	0.00	0.00
Factor	2050 A (CM)	MtC/Mtoe	1.05	0.80	0.55	0.00	0.00
	2050 B (CM)		1.05	0.80	0.55	0.00	0.00
6 CO2 Emission	2000		47	10	3	0	0
	2050 A (CM)	MtC	56	10	21	0	0
	2050 B (CM)		47	10	3	0	0

2 Service Share

	Unit					2000					2050 A (CM)									2050 B (0						
	UTIL	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W		
Cool	-	0%	0%	0%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	0%	0%	0%	100%	100%	0%	0	0	0%	0%		
Narm	-	23%	8%	2%	48%	0%	3%	0%	16%	100%	61%	8%	2%	10%	0%	3%	0%	16%	100%	23%	8%	2%	48%	0%		
lot Water	-	14%	4%	1%	71%	0%	5%	0%	4%	100%	0%	6%	50%	30%	0%	10%	0%	4%	100%	14%	4%	1%	71%	09		
Cooking	-	7%	0%	1%	92%	0%	0%	0%	0%	100%	7%	0%	1%	92%	0%	0%	0%	0%	100%	7%	0%	1%	92%	09		
Others	-	0%	0%	0%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	09		
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0	0	0%	09		
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0	0	0			
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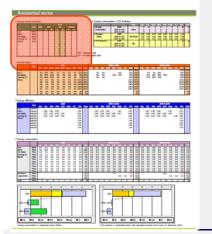
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0. Preparation

• Split or merge energy consumption from EBT and set the category

					20	50		
	Unit	2000	RI	EF	С	Μ	CM/	REF
			Α	В	А	В	А	В
Cool	Mtoe	4	4	4	4	4	90%	100%
Warm	Mtoe	81	81	81	65	81	80%	100%
Hot Water	Mtoe	55	55	55	55	55	100%	100%
Cooking	Mtoe	60	60	60	30	60	50%	100%
Others	Mtoe	5	5	5	5	5	100%	100%
	Mtoe				0	0		
	Mtoe				0	0		
	Mtoe				0	0		
	Mtoe				0	0		
					0	0		
					0	0		

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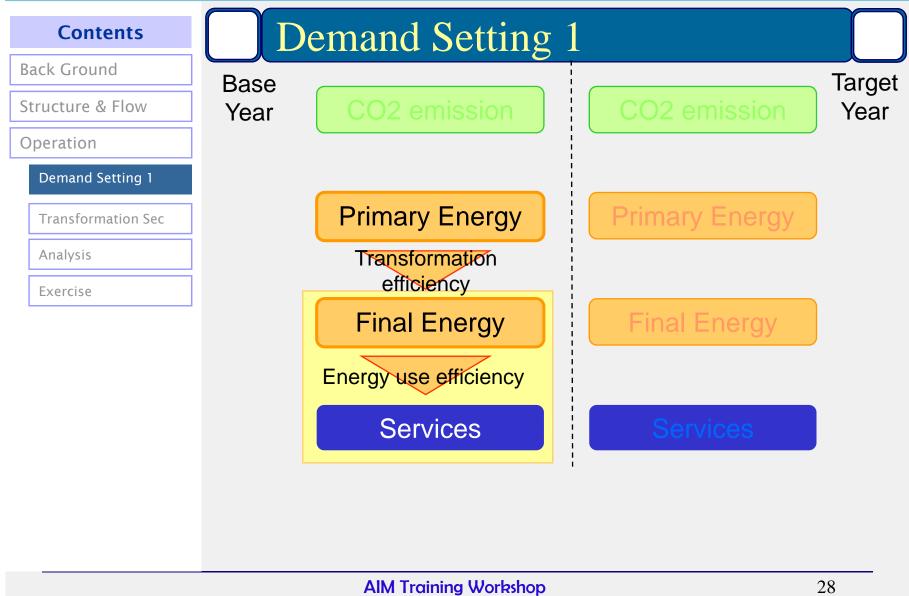
0. Energy Cons. in base year

- Past record of energy use in each sector
- Same structure as EBT
- Allocate energy consumption along with set categories

						2000				
		COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Cool	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0
Warm	Mtoe	30.0	10.0	3.0	50.0	0.0	3.0	0.0	5.0	101.0
Hot Water	Mtoe	10.0	3.0	1.0	50.0	0.0	3.0	0.0	2.0	69.0
Cooking	Mtoe	5.0	0.0	1.0	113.0	0.0	0.0	0.0	0.0	119.0
Others	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Generation	Mtoe									0.0
Cogeneration	Mtoe									0.0
	Mtoe									0.0
Total	Mtoe	45	13	5	213	0	6	0	14	296
	AIM	Trainir	ig wo	rkshor	<u> </u>					
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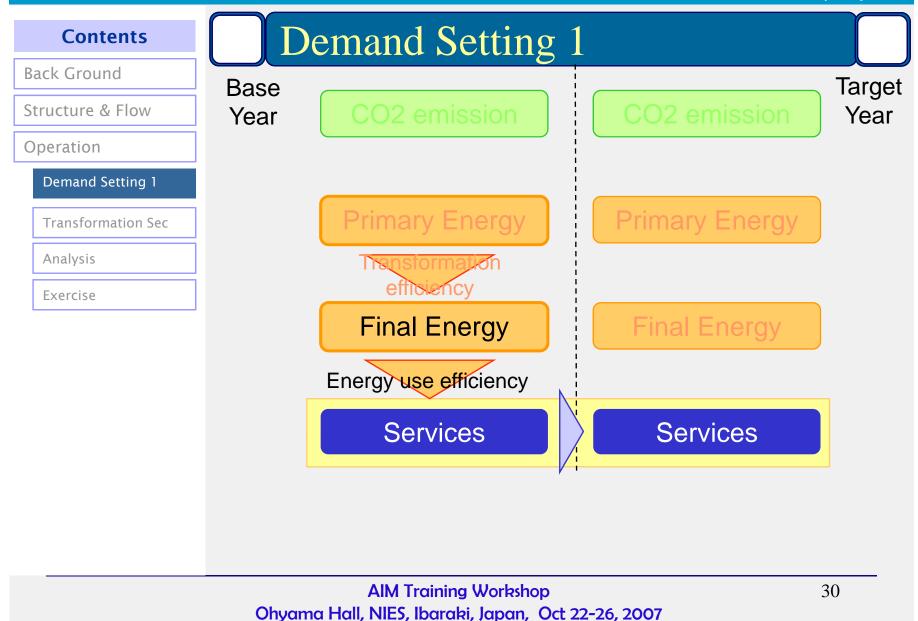
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2. Energy use eff. in base year

- Set energy efficiency of each energy use
 - Energy use efficiency: Ratio between the consumption of energy to service demand
 - Keep consistency
 - The value can be relative value (Base Year-1.00)

i.		Unit					2000				
		UTIIL	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
	Cool	toe/toe								2.00	-
- 1	Warm	toe/toe	0.70	0.70	0.70	0.90		1.00		3.00	-
F	Hot Water	toe/toe	0.80	0.80	0.80	0.80	1.00	1.00		1.00	-
	Cooking	toe/toe	0.80		0.50	0.45	0.45			0.70	-
	Others	toe/toe								1.00	-
		toe/toe									-
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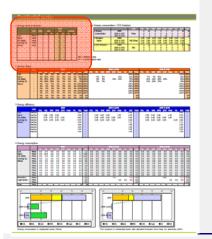
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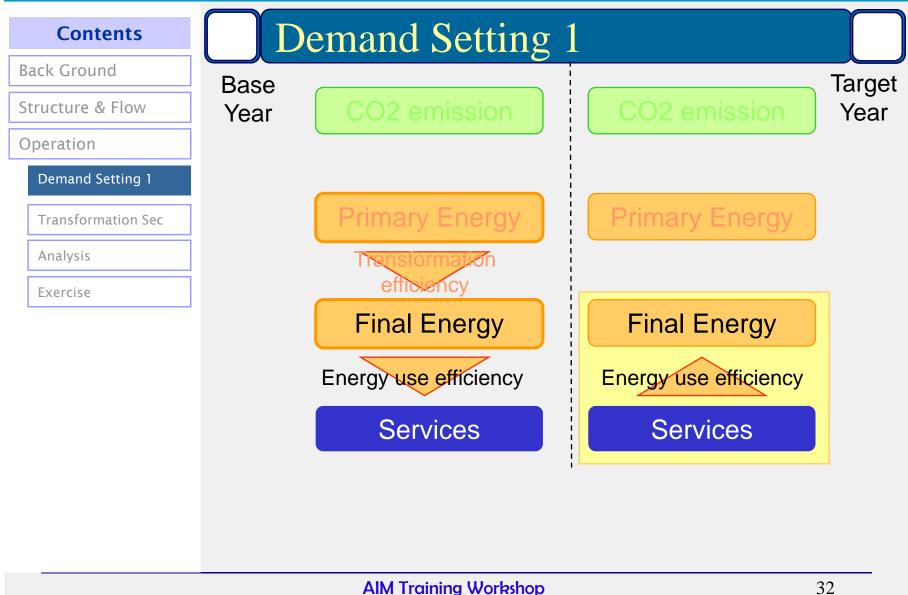
Exercise



3. Service Demand

- Service demand in base year
 - Service demand (Mtoe) = Energy consumption*EE
- Assume service demand in target year
- Reference case, Countermeasure case

					20	50		
	Unit	2000	RI	ĒF	С	М	CM/	REF
			Α	В	Α	В	А	В
Cool	Mtoe	4	4	4	4	4	90%	100%
Warm	Mtoe	81	81	81	65	81	80%	100%
Hot Water	Mtoe	55	55	55	55	55	100%	100%
Cooking	Mtoe	60	60	60	30	60	50%	100%
Others	Mtoe	5	5	5	5	5	100%	100%
	Mtoe				0	0		
	Mtoe				0	0		
	Mtoe				0	0		
	Mtoe				0	0		
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4. Service share in target year

- Set service share to fulfill the service demand
 - Assume the technology used
 - Check "total value" (=100%)

	Unit				205	50 A (C	CM)			
	UTIIL	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Cool	-	0%	0%	0%	0%	0%	0%	0%	100%	100%
Warm	-	61%	8%	2%	10%	0%	3%	0%	16%	100%
Hot Water	-	0%	6%	50%	30%	0%	10%	0%	4%	100%
Cooking	-	7%	0%	1%	92%	0%	0%	0%	0%	100%
Others	-	0%	0%	0%	0%	0%	0%	0%	100%	100%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
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5. Energy use eff. in target year

- Set energy efficiency of each energy use in Target Year
 - Keep consistency
 - The value can be relative value (Base Year=1.00)

	Unit	Unit 2050 A (CM)										
	Unit	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total		
Cool	toe/toe								2.00	-		
Warm	toe/toe	0.90	0.70	0.70	0.90		1.00		3.00	-		
Hot Water	toe/toe	0.80	0.80	0.80	0.80	1.00	1.00		1.00	-		
Cooking	toe/toe	0.80		0.50	0.45	0.45			0.70	-		
Others	toe/toe								1.00	-		
	toe/toe									-		
	toe/toe									-		
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6. Energy Cons. in Target year

- Calculated automatically
- Additional Input
 - Generation: PV etc.
 - CHP: Fuel cells, Gas engine etc.

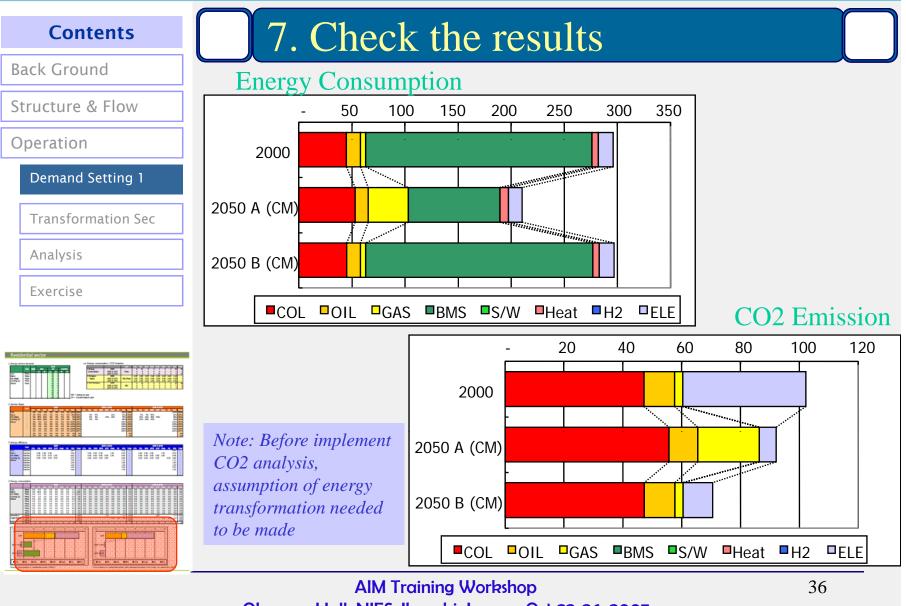
					205	50 A (C	CM)			
		COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Cool	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.8
Warm	Mtoe	50.6	8.0	2.4	8.3	0.0	2.4	0.0	4.0	75.7
Hot Water	Mtoe	0.0	4.2	35.0	21.0	0.0	5.6	0.0	2.0	67.8
Cooking	Mtoe	2.5	0.0	0.5	57.0	0.0	0.0	0.0	0.0	60.0
Others	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Generation	Mtoe									0.0
Cogeneration	Mtoe									0.0
	Mtoe									0.0
Total	Mtoe	53	12	38	86	0	8	0	13	210

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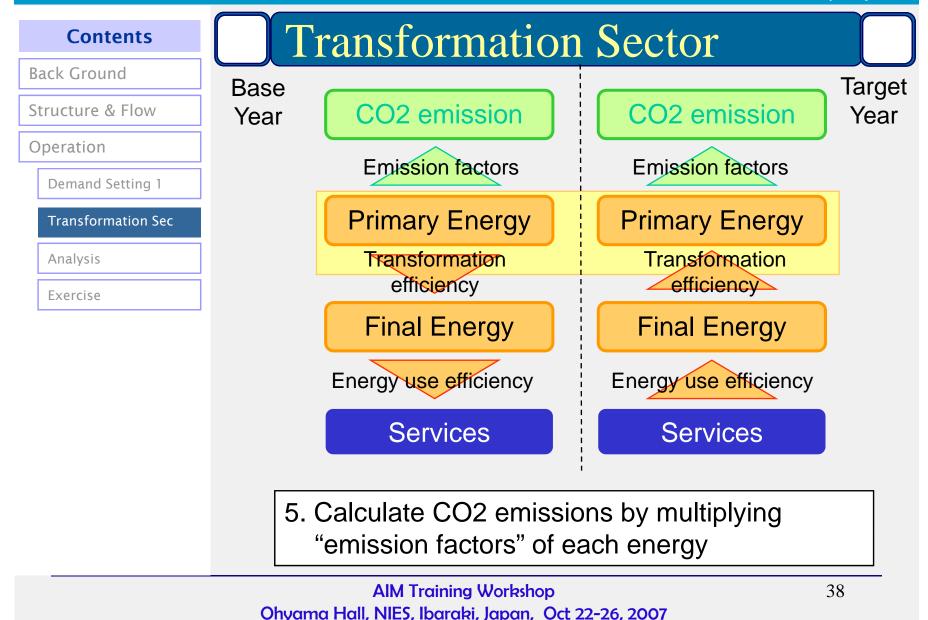
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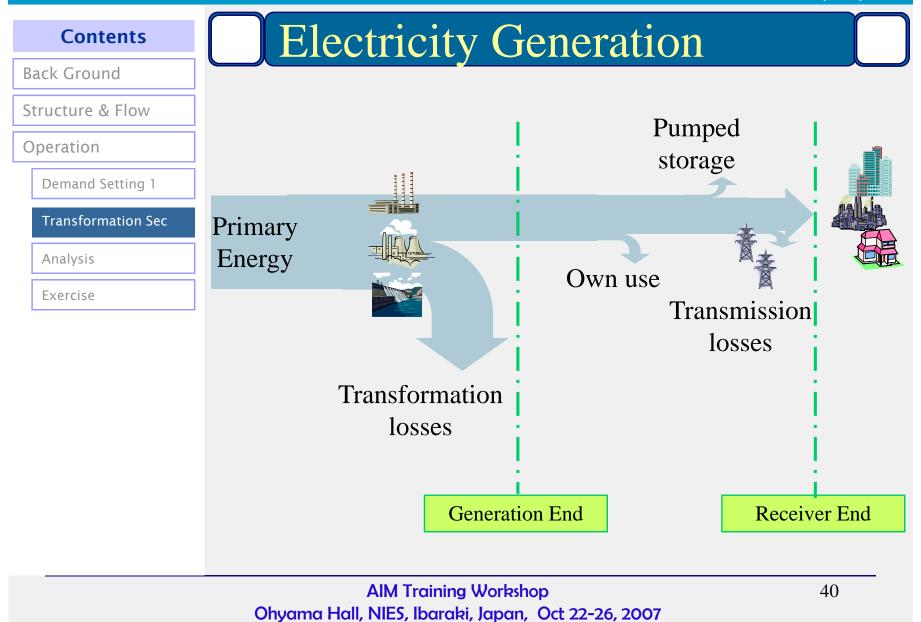
• Goal: Primary energy consumed for electricity generation in target year.

Power generation sector

					20	50				
Solver	2000	Supply & Demand		Only Demand		Only S	Only Supply		No	
		А	В	А	В	А	В	А	В	
1. Electricity demand at receiver	end									
Mtoe	98	88	86	88	86	98	98	98	98	
2. Difference between demand a	ind supply									
Mtoe	12.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3. Electricity supply at receiver en	nd									
Electricity supply Mtoe	103	88	86	88	86	98	98	98	98	
Transmission Loss	6.84%	5.31%	5.31%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	
4. Electricity supply before tranm	ission									
Electricity supply Mtoe	111	93	91	93	91	104	104	104	104	
Pumped storage (PS)										
Ele. demand of PS Mtoe	0	1	1	0	0	1	1	0	0	
Efficiency	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
Generation of PS Mtoe	0	1	1	0	0	1	1	0	0	
Own use Own use in plant Mtoe	6	4	4	5	5	5	4	6		
Own use rate	0	4	4	5	5	5	4	0	0	
COL	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	
GAS	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	
OIL	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	
NUC	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	
HYD	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
HYD(P)	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
GEO	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	

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-------------	------------

	ower dene	ratio	n sector	~							
							200	-0			
			2000	Supply &	Domond	2050 Only Demand Or			y Supply No		
- 1	Solver		2000	Supply α Α	B	A	B	A Only 3	В	A	В
		_		~	U	~	5	~	0	~	5
. Ele	ectricity demand a	TT.									
		He	ere!	88	86	88	86	98	98	98	98
D	ifference between										
	Incremee between	N41	10.1/	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Mtoe	12.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
. Ek	ectricity supply at r	eceiver e	nd								
Ele	ectricity supply	Mtoe	103	88	86	88	86	98	98	98	98
	ansmission Loss		6.84%	5.31%	5.31%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%
Ele	ectricity supply befo	ore tranm	nission								
	ectricity supply before	ore tranm Mtoe	nission 111	93	91	93	91	104	104	104	104
Ele Pui	ectricity supply mped storage (PS)	Mtoe		93	91	93	91	104	104	104	104
Ele Pui	ectricity supply mped storage (PS) Ele. demand of PS		0	1	1	0	0	1	1	0	0
<u>Ele</u> Pui	ectricity supply mped storage (PS) Ele. demand of PS Efficiency	Mtoe Mtoe	111 0 100.0%	93 1 100.0%	91 1 100.0%	0 100.0%	0 100.0%	104 1 100.0%	104 1 100.0%	0 100.0%	104 0 100.0%
Ele Pur	ectricity supply mped storage (PS) Ele. demand of PS Efficiency Generation of PS	Mtoe	0	1	1	0	0	1	1	0	0
Ele Pur Ow	ectricity supply mped storage (PS) Ele. demand of PS Efficiency Generation of PS vn use	Mtoe Mtoe Mtoe	111 0 100.0% 0	1 100.0% 1	1	0 100.0% 0	0 100.0% 0	1 100.0% 1	1 100.0% 1	0 100.0% 0	0
Ele Pur Ow	ectricity supply mped storage (PS) Ele. demand of PS Efficiency Generation of PS vn use Own use in plant	Mtoe Mtoe	111 0 100.0%	1	1	0 100.0%	0 100.0%	1	1	0 100.0%	0
Ele Pur Ow	ectricity supply mped storage (PS) Ele. demand of PS Efficiency Generation of PS vn use Own use in plant Own use rate	Mtoe Mtoe Mtoe	111 0 100.0% 0 6	1 100.0% 1 4	1 100.0% 1 4	0 100.0% 0 5	0 100.0% 0 5	1 100.0% 1 5	1 100.0% 1 4	0 100.0% 0 6	0 100.0% 0
Ele Pur Ow	ectricity supply mped storage (PS) Ele. demand of PS Efficiency Generation of PS vn use Own use in plant Own use rate COL	Mtoe Mtoe Mtoe	111 0 100.0% 0 6 6.0%	1 100.0% 1 4 6.0%	1 100.0% 1 4 6.0%	0 100.0% 0 5 6.0%	0 100.0% 0 5 6.0%	1 100.0% 1 5 6.0%	1 100.0% 1 4 6.0%	0 100.0% 0 6 6.0%	0 100.0% 0 6 6.0%
Ele Pur Ow	ectricity supply mped storage (PS) Ele. demand of PS Efficiency Generation of PS vn use Own use in plant Own use rate COL GAS	Mtoe Mtoe Mtoe	111 0 100.0% 0 6 6.0% 4.0%	1 100.0% 1 4 6.0% 4.0%	1 100.0% 1 4 6.0% 4.0%	0 100.0% 0 5 6.0% 4.0%	0 100.0% 0 5 6.0% 4.0%	1 100.0% 1 5 6.0% 4.0%	1 100.0% 1 4 6.0% 4.0%	0 100.0% 0 6 6.0% 4.0%	0 100.0% 0 6 6.0% 4.0%
Ele Pur Ow	ectricity supply mped storage (PS) Efficiency Generation of PS vn use Own use in plant Own use rate COL GAS OIL	Mtoe Mtoe Mtoe	111 0 100.0% 0 6 6.0% 4.0% 5.0%	1 100.0% 1 4 6.0% 4.0% 5.0%	1 100.0% 1 4 6.0% 4.0% 5.0%	0 100.0% 0 5 6.0% 4.0% 5.0%	0 100.0% 0 5 6.0% 4.0% 5.0%	1 100.0% 1 5 6.0% 4.0% 5.0%	1 100.0% 1 4 6.0% 4.0% 5.0%	0 100.0% 0 6 6.0% 4.0% 5.0%	0 100.0% 0 6 6.0% 4.0% 5.0%
Ele Pur Ow	ectricity supply mped storage (PS) Ele. demand of PS Efficiency Generation of PS vn use Own use in plant Own use rate COL GAS OIL NUC	Mtoe Mtoe Mtoe	111 0 100.0% 0 6 6.0% 4.0% 5.0% 4.4%	1 100.0% 1 4 6.0% 4.0% 5.0% 4.4%	1 100.0% 1 4 6.0% 4.0% 5.0% 4.4%	0 100.0% 0 5 6.0% 4.0% 5.0% 4.4%	0 100.0% 0 5 6.0% 4.0% 5.0% 4.4%	1 100.0% 1 5 6.0% 4.0% 5.0% 4.4%	1 100.0% 1 4 6.0% 4.0% 5.0% 4.4%	0 100.0% 0 6 6.0% 4.0% 5.0% 4.4%	0 100.0% 0 6 6.0% 4.0% 5.0% 4.4%
Ele Pur Ow	ectricity supply mped storage (PS) Ele. demand of PS Efficiency Generation of PS vn use Own use in plant Own use rate COL GAS OIL NUC HYD	Mtoe Mtoe Mtoe	111 0 100.0% 0 6.0% 4.0% 5.0% 4.4% 0.5%	1 100.0% 1 4 6.0% 4.0% 5.0% 4.4% 0.5%	1 100.0% 1 4 6.0% 4.0% 5.0% 4.4% 0.5%	0 100.0% 0 5 6.0% 4.0% 5.0% 4.4% 0.5%	0 100.0% 0 5 6.0% 4.0% 5.0% 4.4% 0.5%	1 100.0% 1 5 6.0% 4.0% 5.0% 4.4% 0.5%	1 100.0% 1 4 6.0% 4.0% 5.0% 4.4% 0.5%	0 100.0% 0 6 6.0% 4.0% 5.0% 4.4% 0.5%	0 100.0% 0 6 6.0% 4.0% 5.0% 4.4% 0.5%
Ele Pur Ow	ectricity supply mped storage (PS) Ele. demand of PS Efficiency Generation of PS vn use Own use in plant Own use rate COL GAS OIL NUC	Mtoe Mtoe Mtoe	111 0 100.0% 0 6 6.0% 4.0% 5.0% 4.4%	1 100.0% 1 4 6.0% 4.0% 5.0% 4.4%	1 100.0% 1 4 6.0% 4.0% 5.0% 4.4%	0 100.0% 0 5 6.0% 4.0% 5.0% 4.4%	0 100.0% 0 5 6.0% 4.0% 5.0% 4.4%	1 100.0% 1 5 6.0% 4.0% 5.0% 4.4%	1 100.0% 1 4 6.0% 4.0% 5.0% 4.4%	0 100.0% 0 6 6.0% 4.0% 5.0% 4.4%	0 100.0% 0 6 6.0% 4.0% 5.0% 4.4%

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Note: Solver

The Solver Add-in is an Excel add-in (add-in: A supplemental program that adds custom commands or custom features to Microsoft Office.) program that is available when you install Microsoft Office or Excel. To use it in Excel, however, you need to load it first.

1.On the **Tools** menu, click **Add-Ins**.

- 2.In the Add-Ins available box, select the check box next to Solver Add-in, and then click OK. Tip If Solver Add-in is not listed, click Browse to locate it.
- 3.If you see a message that tells you the Solver Add-in is not currently installed on your computer, click **Yes** to install it.
- 4.Click **Tools** on the menu bar. When you load the Solver Add-in, the **Solver** command is added to the **Tools** menu



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• Extended Kaya Identity



 $C = D \times \frac{E}{D} \times \frac{C'}{E} \times \frac{C}{C'}$ $\frac{\Delta C}{C} = \frac{\Delta D}{D} + \frac{\Delta(E/D)}{(E/D)} + \frac{\Delta(C'/E)}{(C'/E)} + \frac{\Delta(C/C')}{(C/C')} + \text{Cross term}$

- D: Driving forces (service demand)
- E: Energy Consumption
- C': CO₂ emission without measures in transformation sector
- C: CO₂ emission with measures in transformation sector
- E/D: Energy Intensity
- C'/E: CO₂ intensity in end-use sector (without measures in transformation sector)
- C/C': Change of CO_2 intensity by measures in transformation sector

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+ Cross term



Factor analysis

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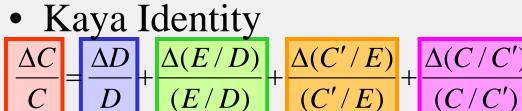
Demand Setting 1

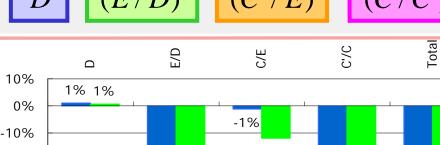
Transformation Sec



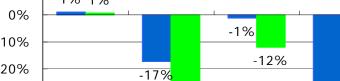
Exercise

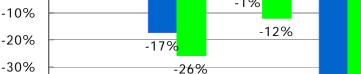


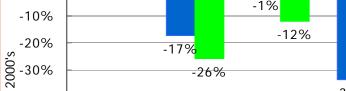












S -40%

-50%

-60%

-70%

-80%

Factors

0



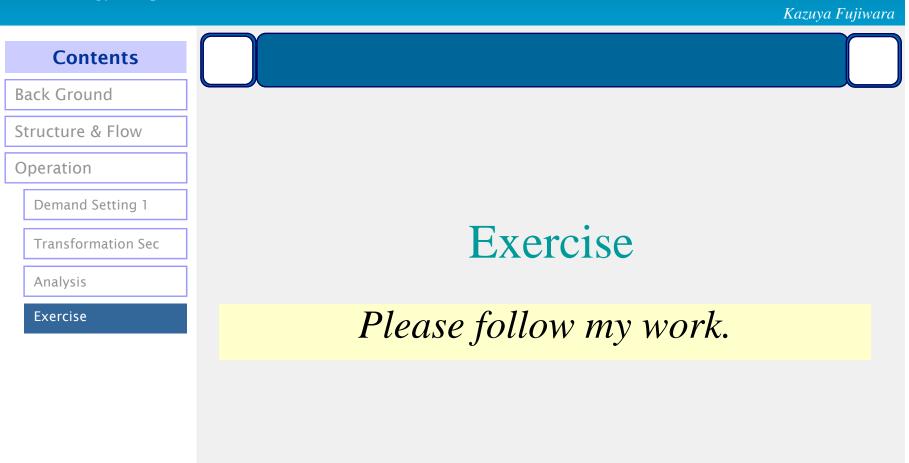
= 2050 A **=** 2050 B

-34%-36%

-51%

-73%





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Create some scenarios and express them by using ESS.

Ex1: Create renewables-dependent society.(→ increase share of renewable energy and check the result.)

Ex2: Create electricity-dependent society.(→ increase share of electricity use and check the result.)

Ex3: Society sustained by high technology.
(→ set very high energy efficiency in 2050.)
Ex4: Society with low carbon power plants.
(→ change thermal efficiency / fuel mix in power sector drastically)