Status and problems of wood-biomass utilization in Japan

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1. Introduction

(1) Current status of wood-biomass plant

Status of wood-biomass plants

Method	Type	Technolgy	Energy efficiency	Scale	Increase of fuel consumption	Future
Combustion	Fuel wood stove	developed	M to H	10kW	-	○
	Pellet boiler	developed	H	20kw ～1MW	+	△
	Wood residue boiler (fixed bed)	developed	H	1.5 ～10MW	+	△
	Chip boiler	developed	H	20kw ～10MW	+	◎
	Power plant with condensing turbine	developed	L to M	5 ～500MW	++	△
	Cogeneration power plant	developed	H	60 ～500MW	++	○
Gasification	Cogeneration power plant	almost developed	M to H	50kw ～30MW	several demonstrations	○
	Methanol (DME) plant	under developing	L to M	1000t/day	One demonstrations	△
Hydrolysis +Fermentation	Ethanol plant	under developing	L to M	1000t/day	N.A.	△

◎ Renewable energy plants, Pulp or board mills.

(2) Background of the expansion of biomass energy - Electric power production

- Policy support
  - 2000 The Anti Dioxins Law
  - 2001 Amendment of The Waste Management Law
  - 2002 The Construction Material Recycling Law

  → To make supply of waste apparent and secure
  - 2002 The Biomass Nippon Strategy
  - 2003 Renewable Portfolio Standard Law

  → To expand demand for renewable energy
- Large increases in crude oil price and coal price

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◆ Expansion of biomass power production
- Garbage, RPF, Construction-derived wood residues (CWR)
- Little forest biomass

Expanding demand for fuel chip

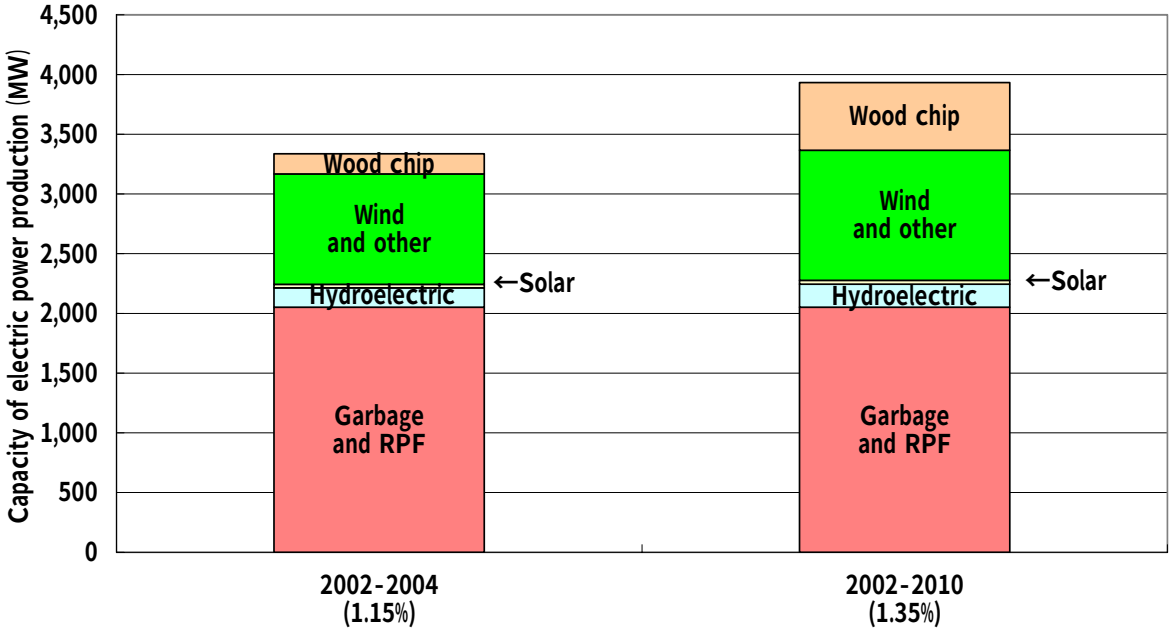

Fig 1. Increase in Renewable Electric Power under RPS Law

Source: Resources and energy agency (2005) List of certified facilities, http://www.rps.go.jp/RPS/new-contents/top/toplink-5.html
Assumptions: Wind and solar power and hydro power will increase with the obligation of renewable power purchasing, however, garbage and RPF will be stable.

- Consumption increases more than 1 million ton in power plants.

  = Mostly comes from CWR: from Illegal dumping to fuel supply
- Expansion of thermal recycle → Demand will be tripled by 2010.

Further increase of wood chip consumption

☆ Fuel chip consumption of large dealers in present = 1 million ton

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☆New demand in the planning = 2 million tons (Thermal) >= Remainder of CWR = 5 - recycled 3 million ton

Table 1. Planned large plants which consume construction-derived wood

Plant type	Material	Thermal
RPS1		90000
RPS2		100000
RPS3		100000
RPS4		200000
RPS5		200000
Pulp mill 1		410000
Chip factory		70000
Plywood		60000
Pulp mill 2		72000
N.A.		176000
N.A.		180000
N.A.		170000
N.A.		96000
Particle board	24000	
Total	24000	1924000

Source: Nikkei Ecology (2005) True power of biomass energy, E-contecture (2005) November special number featuring articles on wood

Possibility to disturb material recycle

- Higher level of oil and coal price
- Support for renewable energy

→ To Expand demand for fuel chip continuously

- Mixture of wood and other material by housing demolition contractors

→ Decrease of higher quality chip for material use

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☆ Fuel chip price will increase !

☆ Competition between material and thermal will occur.

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Forest biomass supply will be required.

2. Potential of forest biomass
(1)Why is it unutilized ?

- CWR
  - 3000 yen/t-10%　1600 yen/t-50% --- cheap !

    → Expanding
- Forest biomass
  - High cost because of the lack of supply system

    → Not utilized
- Mill residues
  - Mostly used as material: sawdust, slab

    → Some part used as fuel: Strip, Bark

(2) Profitable fuel chip price on the demand side

- Feasibility study on smaller scale energy plants
  - Chip boiler
  - Small gasification cogeneration system
  - Medium gasification cogeneration system
- Large scale power plant with condensing turbine
  - Thermal efficiency is 40**%** at best.
  - Fuel consumption exceeds 50 thousand ton-50**%**.

＝Not appropriate for mountainous region

Assumptions 1

- Subsidy for construction: 70%
- Labor cost: 4 million yen/person
- Maintenance: Construction cost×2%
- Depreciation: Construction cost×0.9/15years
- Steam price: 3,297 yen/t @heavy oil 40yen/l
- Hot water price: 3 yen/kWh
- Electricity price: 15 yen/kWh

Assumption 2

- All day operation through 300 days
- Construction cost: 1 million yen/kW

Table. Assumptions of energy plants for feasibility study

	Number of operator	Net power output (kW)	Output of Steam or Hot water (kW)	Construction site
Chip boiler	0		0.2～1t/h	Hotel, Hospital, Condominium
Small scale gasifying cogeneration	0	20～180	20～220	Hotel, Hospital, Condominium
Medium scale gasifying cogeneration-A	4	600～2200	250～730	District heat & power supply, Larger scale factory

Result-1: 5500 yen / t-50%

Chip boiler (all day operation)

Net output t/h	0.2	0.4	0.6	0.8	1.0
Plant cost	958	1,520	1,992	2,413	2,800
Maintenance	19	30	40	56	56
Depreciation cost	57	91	120	145	168
Fuel cost	362	725	1,087	1,450	1,812
Revenues form heat and power	459	925	1,392	1,859	2,328
Annual profit	20	78	145	209	292
Recovery period =Investment/profit	14	6	4	3	3

Small scale gasifying cogeneration (all day operation)

Net output t/h	20	60	100	140	180
Plant cost	3,420	7,114	10,000	12,515	14,797
Maintenance	68	142	200	250	296
Depreciation cost	205	427	600	751	888
Fuel cost	219	656	1,094	1,531	1,969
Revenues form heat and power	259	778	1,296	1,814	2,333
Annual profit	-233	-448	-598	-718	-819
Recovery period =Investment/profit	-4	-5	-5	-5	-5

Medium scale gasifying cogeneration (all day operation)

Net output t/h	600	1,000	1,400	1,800	2,200
Plant cost	60,000	84,343	105,553	124,805	142,670
Maintenance	1,200	1,687	2,111	2,496	2,853
Depreciation cost	3,600	5,061	6,333	7,488	8,560
Labor cost	1,600	1,600	1,600	1,600	1,600
Fuel cost	6,562	10,936	15,311	19,685	24,060
Revenues form heat and power	7,776	12,960	18,144	23,328	28,512
Annual profit	-5,186	-6,324	-7,211	-7,942	-8,561
Recovery period =Investment/profit	-3	-4	-4	-5	-5

○Chip boiler is only feasible.

Result-2: 4000 yen/t-50% & 0.5 million yen/kW

Chip boiler (all day operation)

Net output t/h	0.2	0.4	0.6	0.8	1.0
Plant cost	958	1,520	1,992	2,413	2,800
Maintenance	19	30	40	56	56
Depreciation cost	57	91	120	145	168
Fuel cost	264	527	791	1,054	1,318
Revenues form heat and power	459	925	1,392	1,859	2,328
Annual profit	119	276	441	604	786
Recovery period =Investment/profit	2	2	1	1	1

Small scale gasifying cogeneration (all day operation)

Net output t/h	20	60	100	140	180
Plant cost	1,710	3,557	5,000	6,257	7,399
Maintenance	34	71	100	125	148
Depreciation cost	103	213	300	375	444
Fuel cost	159	477	795	1,114	1,432
Revenues form heat and power	259	778	1,296	1,814	2,333
Annual profit	-37	16	101	200	309
Recovery period =Investment/profit	-14	67	15	9	7

Medium scale gasifying cogeneration (all day operation)

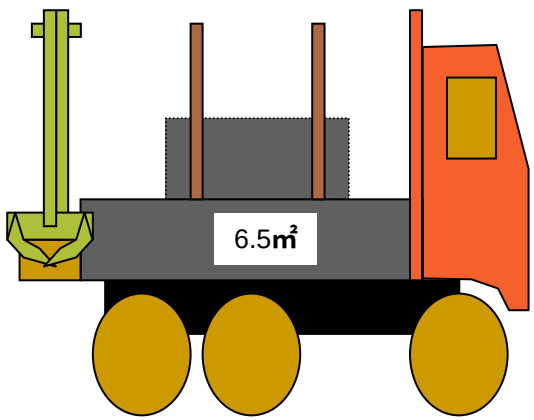
Net output t/h	600	1,000	1,400	1,800	2,200
Plant cost	30,000	42,172	52,776	62,403	71,335
Maintenance	600	843	1,056	1,248	1,427
Depreciation cost	1,800	2,530	3,167	3,744	4,280
Labor cost	1,600	1,600	1,600	1,600	1,600
Fuel cost	4,772	7,954	11,135	14,316	17,498
Revenues form heat and power	7,776	12,960	18,144	23,328	28,512
Annual profit	-996	33	1,187	2,419	3,707
Recovery period =Investment/profit	-9	387	13	8	6

○ All type will become feasible.

(3) Can we supply low cost forest biomass ?

- Field tests in Tohno city, Iwate prefecture
  - One loading for 3 harvesting sites
- To collect logging residues at the forest roadside
  - Almost priceless
  - Handy short logs
- Using log carrying truck with grapple
  - Loading limit: 9.3t
  - Using iron board to prevent log falling

Residual short logs



Log carrying truck with iron boards

Preview of the field test

Result

- Collecting amount

  ✶Average loading weight: 6.8t-50%/site

  ✶Loading time: 1.5〜3hours → 2 times per day

  ∴ 6.8 t✕2 times✕270 days = <u>3,672t-50% /year</u>

- Costs

  ✶Truck maintenance etc. ＋ Labor

  = 7 million yen ＋ 5 million yen = 12 million yen/year

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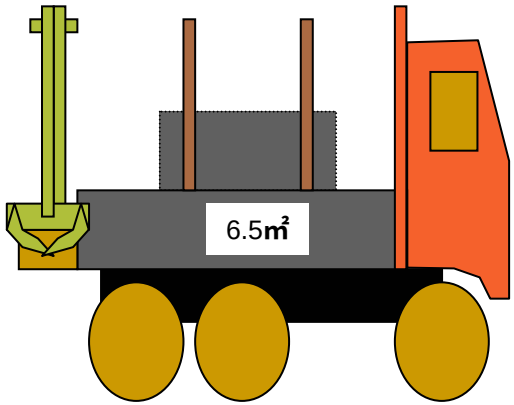
  Supply cost = 12 million yen / 3,672 t

  = 3,268 yen/t-50%@solid

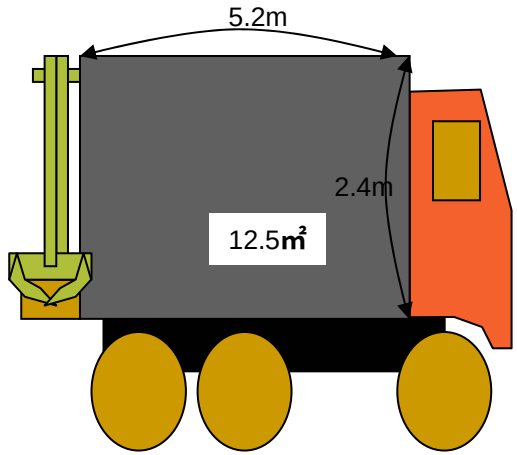
  < 5,500 yen/t-50%@chip

Further possibility to reduce cost



Truck used in the test

→Doubling
loading weight
loading speed



Modified truck

- Loading weight: 6.8 t →9.3 t
- number of transportation times: 2 → 3 times/day

Supply cost = 14 million yen / (9.3✕3✕270 3,672) t

= 14 million yen / 7,533 t = 1,858 yen/t-50%

< 4,000 yen/t-50%@chip

(4) How much forest biomass can we collect ?

- Energy logging is not feasible in Japan.
- To collect logging residues accompanied with timber harvest.

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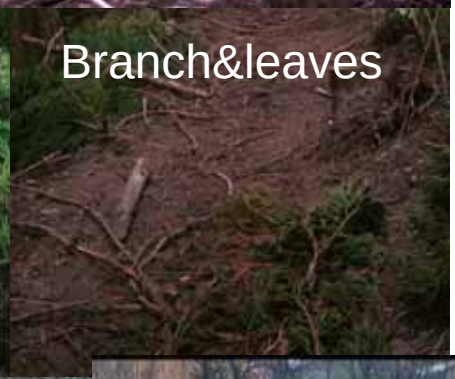
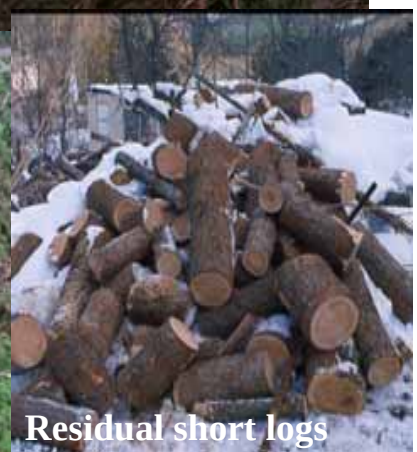
- Total amount of logging residues in Japan is 6.4 million t-50%.
- Unevenly distributed





Result from case study in Tohno city

Table1. Estimated amount of forest biomass and mil residues in Tohno region (2

	Biomass type	5 manicipals including Tohno city	Tohno city
Forest biomass	Residual short logs	21,149	8,309
	Top & branch from conifer trees	27,807	10,253
	Top & branch from hardwood	26,734	15,103
	Sub total	75,690	33,665
Mill residues	Bark from conifer trees	3,854	1,343
	Bark from hardwood	2,444	485
	Sawdust & strips from conifer trees	10,349	4,671
	Conifer chip for pulp	19,965	7,022
	Sub total	36,612	13,521
	Total	112,302	47,186

- More than 40 thousand of wood biomass will be available.
- Forest biomass is 2 to 3 times larger than mill residues.
- Forest biomass supply increases with timber production.

3. Conclusion

- Expanding demand for fuel chip
  - Most parts comes form CWR.
  - Possibility to disturb material recycle

→ To establish supply system for forest biomass

- Condition for expanding forest biomass energy
  - Maximum fuel chip price is around 5000 yen/t-50%
  - Construction cost must be below 0.5 million yen/kW

Conclusion 2

- Possibility of low cost forest biomass supply
  - 4000 – 5500 yen/t-50%
  - More than 40 thousand t-50**%**
- Material use is very important !
  - To make supply cost of forest biomass cheap
  - To expand supply amount of forest biomass

Thank you for
your attention !