

Penetration of renewable energy in rural areas in Japan

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Cost and performance of generating technologies

Component	Life (year)	Specific capital cost (JPY/kW)	Fixed operating cost (JPY/kW/yr)	Variable operating cost (JPY/kWh)	Efficiency (%)	Reference
Woody biomass*						(A)
Direct fired	20	480,000	35,600	1.17	28	(B)
Gasification	20	700,000	18,200	1.18	36	(C)
Animal manure**						(A)
Anaerobic digestion	20	4,770,000	70,600	14.6	25	(D)
PV	20	870,000	2,300	0	-	(E)
Wind	20	240,000	6,200	0	-	(E)

* Density: 0.47 (t/m³), Heating value: 4.99 (kcal/t).

** Generated biogas: 456 (m³/cow-yr), Heating value: 6,000 (kcal/m³).

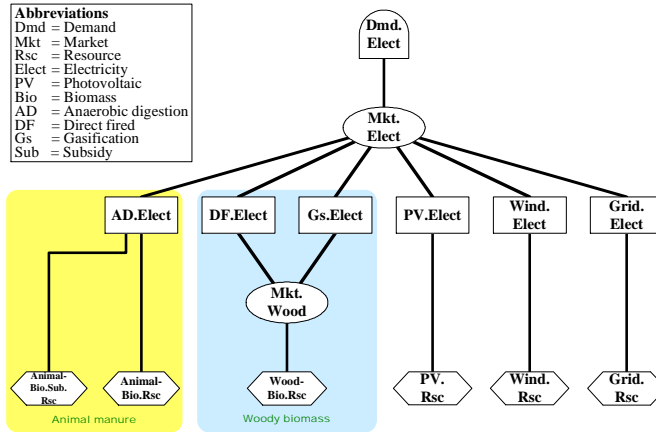
Resource price

Resource	Price (JPY/kWh)
Thinned wood (inside Kuzumaki)	2.93
Thinned wood (outside Kuzumaki)	4.31
Animal manure	0
Grid electricity	21.6

CO₂ emission factor

Resource	Emission factor
Grid electricity	1.16×10^{-1} TC/MWh
Woody biomass	2.16×10^{-3} TC/MWh _{fuel}

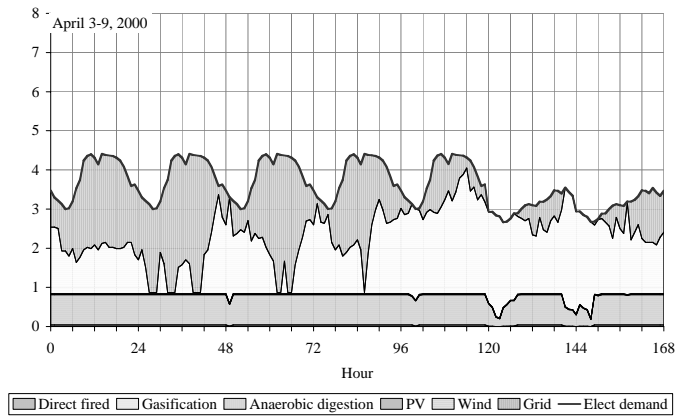
Network of renewable energy system



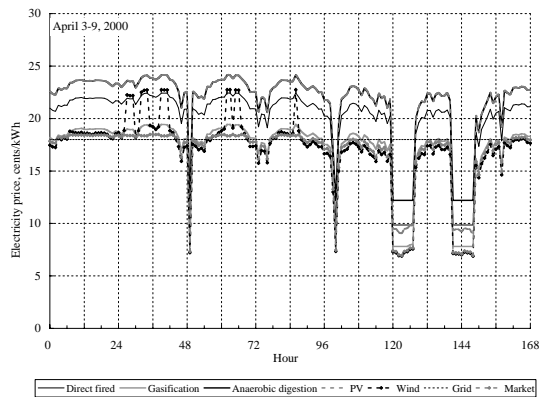
Systems capacity configuration and annual generation

	Capacity [MW]	Annual generation [MWh]
Woody biomass - Direct fired	0.045	337
Woody biomass - Gasification	0.762	6,231
Animal manure - Anaerobic digestion	0.011	77
PV	0.071	89
Wind	8.67	12,594
Grid	3.999 (Peak)	10,013

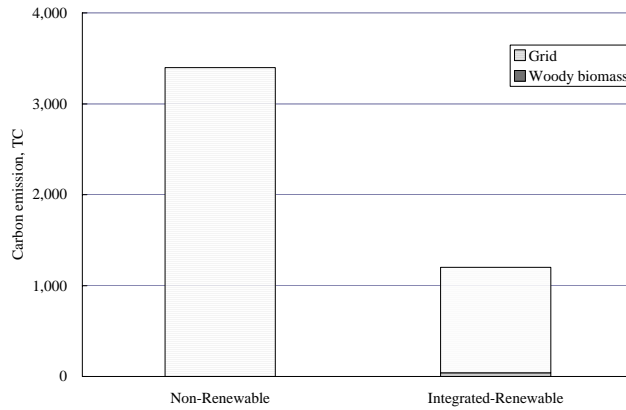
Electricity generation in early April



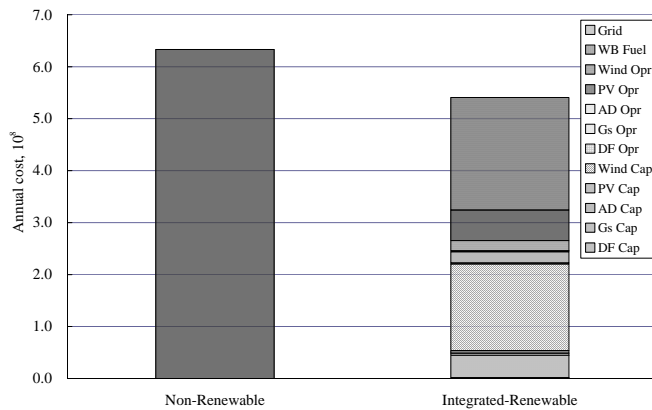
Electricity marginal cost in early April



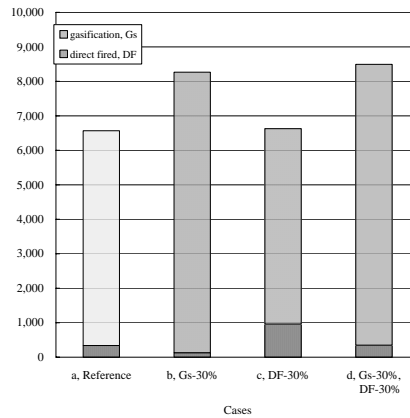
Annual CO₂ emissions for the non-renewable and renewable systems



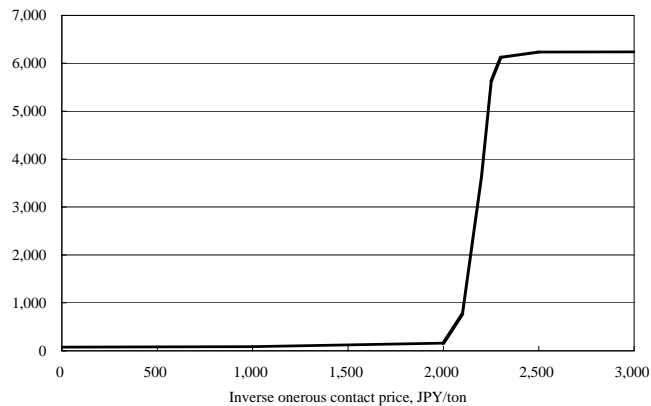
Comparison of annual system costs



Annual electric generation by woody gasification and direct fired combustion



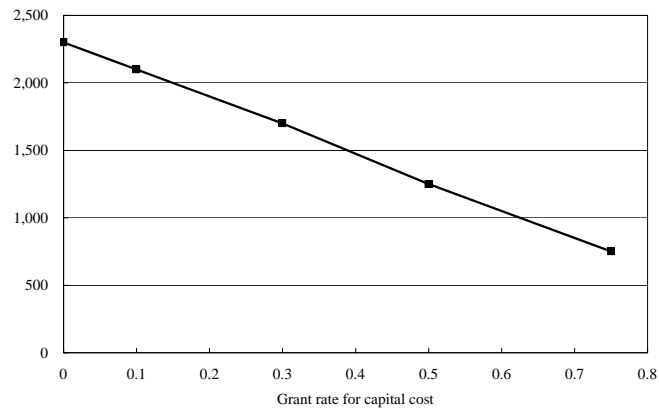
Anaerobic digestion generation as a function of inverse onerous contract price



Burden of waste disposal for dairy farmer

Charge for disposing livestock manures (A)	JPY 4.4×10^8
Income from dairy farming (B)	JPY 3.6×10^9
A / B	12%
Cost per dairy farm household	JPY 1.6×10^6

Inverse onerous contract price as a function of subsidy for capital cost



Subsidy for facilities and the cost reduction in farmer's payment

Grant rate	10%	30%	50%	75%
Subsidy (A) (10 ⁸ JPY)	3.3	10.0	16.7	25.1
Reduction in farmer's payment (B) (10 ⁸ JPY)	4.7	14.2	25.0	32.3
B / A (%)	142	142	150	129