
Appendix A Specific input parameters for representative vehicles

TabelA1 Specific Input Parameters(CV)

Shape	Representative Vehicle	Wheelbase (mm)	Curb Weight (kg)
CV-S	Wuling Hongguang S	2720	1299
CV-M	Haval H6	2738	1590
CV-L	Camry	2825	1610

TabelA2 Specific Input Parameters(BEV)

Shape	Representative Vehicle	Wheelbase(mm)	Curb Weight(kg)	Driving Range(km)	Battery Capacity(kWh)	Weight of Battery(kg)
BEV-S	MINI EV	1940	750	200	17	147
BEV-M	Chery EQ1	2150	1015	301	35	246
BEV-L	AION S	2750	1685	410	58.68	402

TabelA3 Specific Input Parameters(PHEV)

Shape	Representative Vehicle	Wheelbase (mm)	Curb Weight(kg)	Driving Range(km)	Battery Capacity(kWh)	Weight of Battery(kg)
PHEV-M	BYD Qin PLUS	2718	1500	55	8.32	97
PHEV-L	BYD Song PLUS	2765	1790	110	18.3	122

Appendix B Specific input parameters for electricity acquisition paths

TableB1 Energy Consumption of Coal Mining and Washing Process in China

Energy Sources	Coal	Electricity	Diesel	Gasoline	Natural Gas
Energy Consumption(10^4 tce)	2064.4	1041.02	222.86	13.07	112.95
Proportion(%)	59.8	30.1	6.5	0.4	3.3

TabelB2 China's Coal Transportation Mode and Share

Mode of Shipment	Railway	Water way	Highway
Proportion(%)	70.6	19.1	10.3
Distance(km)	640	1255	179

Appendix C Specific input parameters for fuel acquisition paths

TabelC1 Energy consumption of crude oil extraction process in China

Energy Sources	Crude Oil	Electricity	Diesel	Coal	Fuel Oil	Gasoline	Natural Gas
Energy Consumption(10^4 tce)	457.32	569.25	71.87	97.55	47.85	14.59	1480.1
Proportion(%)	16.7	20.8	2.6	3.6	1.7	0.5	54

TabelC2 Crude oil transportation mode and share in China

Mode of Shipment	Ocean-going Tanker	Railway	Pipeline	Water way
Proportion(%)	50	45	80	10
Distance(km)	11000	950	500	250

TabelC3 Proportion of energy consumption in China's crude oil refining process

Energy Sources	Crude Oil	Coal	Electricity	Refinery Dry Gas	Fuel Oil	Natural Gas	Diesel	Gasoline
Proportion(%)	50	20	12	10	4	2	1	1

TabelC4 Transportation of refined oil products in China

Mode of Shipment	Highway	Railway	Ocean-going Tanker	Water Way
Proportion(%)	10	50	25	15
Distance(km)	50	900	7000	1200

Appendix D Parts mass mapping of representative vehicles (kg)

Parts \ Shape		CV-S	CV-M	CV-L	BEV-S	BEV-M	BEV-L	PHEV-M	PHEV-L
Liquid	Lubricant	9.8	12.0	12.2	1.6	2.1	3.5	10.6	12.6
Mass	Brake Agent	2.7	3.3	3.3	0.8	1.0	1.7	2.9	3.4
	Power Fluid	0.98	1.2	1.21	1.0	1.3	2.1	1.1	1.3
	Coolant	13.8	16.9	17.1	11.0	14.0	23.3	14.9	17.7
	Detergent	6.5	7.9	8.0	1.3	1.7	2.8	7.0	8.3
Parts	Chassis	223.9	274.1	277.6	127.4	162.5	271.2	225.5	268.1
Mass	Body	694.6	850.2	860.9	376.5	480.1	801.0	699.7	831.8
	Accumulator	34.2	41.8	42.3	-	-	-	34.2	40.6
	Electromotor	8.9	10.8	11.0	39.4	50.2	83.7	99.8	118.6
	Engine	140.4	171.9	174.1	-	-	-	140.8	167.3
	Engine	70.9	86.7	87.8	-	-	-	71.1	84.5
	Accessory								
	Transmission	29.1	35.6	36.1	18.8	24.0	40.0	30.1	35.7
	Tire	63.3	77.4	78.4	25.3	32.2	53.7	62.9	74.7

Appendix E Input parameters for system dynamics model

TabelE1 Initial input data for whole life cost

Type	Attribute	Unit	Shape		
			S ^a	M ^a	L ^a
CV	Initial fuel consumption	L/100 km	6	8	10
	Initial production capacity	vehicle/year x10 ⁴	500	1500	500
	Unit capacity investment cost	CNY/vehicle x10 ⁴	1	1.2	1.5
	Base fixed cost	CNY/vehicle x10 ⁴	1	1.2	1.5
	Glider cost	CNY/vehicle x10 ⁴	3	6	9
	Initial cost of Internal combustion engine (CV)	CNY/vehicle x10 ⁴	2	3	4
	Fractional reduction of Internal combustion engine (CV)	—	0.01	0.01	0.01
	Initial Maturity of Internal combustion engine (CV)	—	0.70	0.70	0.70
	Maintenance cost	CNY/year	1500	3000	4500
	Insurance premium	CNY/year	3000	5000	6000
BEV	Initial electricity consumption	kWh/100 km	15	18	21
	Initial production capacity	vehicle/year x10 ⁴	0	0	0
	Unit capacity investment cost	CNY/vehicle x10 ⁴	1.2	1.5	1.8
	Base fixed cost	CNY/vehicle x10 ⁴	1.2	1.5	1.8
	Glider cost	CNY/vehicle x10 ⁴	3	6	9
	Initial cost of BEV battery	CNY/vehicle x10 ⁴	10	20	30
	Fractional reduction of BEV battery	—	0.1	0.1	0.1
	Initial Maturity of BEV battery	—	0.30	0.30	0.30
	Maintenance cost	—	0.30	0.30	0.30
	Insurance premium	CNY/year	450	900	1350
PHEV	Initial electricity consumption	kWh/100 km	—	18	21
	Initial fuel consumption	vehicle/year x10 ⁴	—	2	4
	Initial production capacity	vehicle/year x10 ⁴	—	0	0
	Unit capacity investment cost	CNY/vehicle x10 ⁴	—	1.8	2
	Base fixed cost	CNY/vehicle x10 ⁴	—	2	2
	Glider cost	CNY/vehicle x10 ⁴	—	6	9
	Initial cost of Internal combustion engine (PHEV)	CNY/vehicle x10 ⁴	—	2	3
	Initial cost of PHEV battery	CNY/vehicle x10 ⁴	—	12	18

	Initial Maturity of PHEV battery	—	—	0.3	0.3
	Maintenance cost	CNY/year	—	2000	3000
	Insurance premium	CNY/year	—	5500	7500
CV/ BEV/ PHEV	Cost of Vehicle license plate	CNY	70000 (megapolis) or 0 (other cities and rural areas)		
	Annual travel distance	km/year	15000		
	Purchase tax	—	10%		
	Average years kept	Year	15		
	Oil price	CNY/L	6.5		
	Electricity	CNY/kWh	0.6 (day) or 0.3 (night) 1400		
	Road tolls	CNY/year	950		
	V&V tax	CNY/year	1000 (megapolis) or 0		
	Cost of Driving restriction	CNY/year	(other cities and rural areas) 4800 (megapolis) or		
	Park charges	CNY/year	2400 (other cities) or 0 (rural area) 1500 (megapolis) or		
	Cost of congestion	CNY/year	750 (other cities) or 0 (rural area)		

TabelE2 Initial input data for vehicle attributes

Attribute	Consumer sensitivity to attributes	Initial Value		
		CV	BEV	PHEV
Environmental Friendliness	0.67	0.73	0.96	0.7
Power	0.94	0.85	0.72	0.77
Reliability	0.94	0.95	0.83	0.80
Safety	0.91	0.95	0.60	0.85
Convenience	0.80	1	0.05	0.60
Popularity	0.70	—	—	—
Choice Space	0.68	—	—	—

TabelE3 Calibration parameters of the model

Parameter	Value
Sensitivity of convenience to effective infrastructure	1.2
Base prevalence for popularity	0.5
Sensitivity of popularity to prevalence	1
Market share for base choice availability	0.1
Sensitivity of availability to sales	0.6
Base utilization	0.7
Reference utilization discrepancy	0.1
Sensitivity of adjustment to utilization	0.5
Sensitivity of capacity adjustment to policy penalty	1.5
Sensitivity of price adjustment to utilization	0.8
Sensitivity of price adjustment to penalty	0.7
Sensitivity of R&D adjustment to penalty	1.5

Appendix F Multi-objective equation reference data for the initial game of government enterprises

Enterprise	Expected Sales(10k)	Carbon Emission per Vehicle(t)	Revenue (100M Yuan)	Quota Expected by Enterprises(10kt)	Government's Ideal Allocation Scheme (10kt)
SAIC	300.0016	35.4108	6229.258	10623.3	7282.365
GAC	168.9063	34.85151	595.3159	5886.64	4803.941
BAIC	1.245209	22.86026	151.1865	28.4658	1608.079
DFMC	230.1208	35.4224	119.213	8151.393	4489.704
Chang'an	104.6072	35.48362	733.26	3711.841	2378.891
GWM	80.31315	34.9509	902.0822	2807.017	2138.176
JMCG	3.942234	35.41916	258.9395	139.6306	1541.86
JAC	10.62058	28.28332	446.3472	300.3853	1576.142
Haima	1.486101	24.92731	38.64016	37.0445	1541.861
BYD	42.10222	25.62309	1382.98	1078.789	5403.485

Appendix G The reported quotas of enterprises(RQOE) and the ideal allocation scheme of the government(IASOG) for each round

Unit:10kt														第 6 轮		第
Enterprise	Before the game		Round 1		Round 2		Round 3		Round 4		Round 5		企业上 报预期	政府理 想分配	企业上 报预期	
	RQOE	IASOG	RQOE	IASOG	RQOE	IASOG	RQOE	IASOG	RQOE	IASOG	RQOE	IASOG				
GWM	2807.02	2138.18	2807.02	2743.67	—	—	—	—	—	—	—	—	—	—	—	
GAC	5886.64	4803.94	5886.64	5055.25	5592.31	5338.23	5312.69	5358.34	—	—	—	—	—	—	—	
Chang'an	3711.84	2378.89	3711.84	2990.29	3526.25	3293.51	3349.94	3344.14	—	—	—	—	—	—	—	
DFMC	8151.39	4489.70	8151.39	5678.41	7743.82	7096.39	7356.63	6712.92	6988.80	6954.45	—	—	—	—	—	
JMCG	139.63	1541.86	139.63	361.25	167.56	296.22	201.07	303.18	241.28	298.26	—	—	—	—	—	
JAC	300.39	1576.14	300.39	781.35	360.46	501.33	432.55	689.52	519.07	670.87	622.88	633.27	—	—	—	
BAIC	28.47	1608.08	28.47	1200.73	34.16	1051.96	40.99	791.36	49.19	781.76	59.03	764.01	70.83	719.40	85.00	
BYD	1078.79	5403.49	1078.79	4960.44	1294.55	3720.03	1553.46	3933.41	1864.15	3493.13	2236.98	3152.53	2684.37	3087.96	3221.25	
Haima	37.04	1541.86	37.04	1467.93	44.45	923.54	53.34	1161.32	64.01	1129.42	76.82	970.93	92.18	956.02	110.61	
SAIC	10623.30	7282.37	10623.30	7525.19	10092.13	7799.63	9587.53	7726.63	9108.15	7990.45	8652.74	8544.90	8220.11	8668.99	9864.13	
TAIC	32764.50	32764.50	32764.50	32764.50	28855.69	30020.83	27888.20	30020.83	18834.65	21318.35	11648.44	14065.63	11067.49	13432.37	13280.99	

Unit:10kt

Enterprise	Round 6		Round 7		Round 8		Round 9		Round 10		End
	RQOE	IASOG	RQOE	IASOG	RQOE	IASOG	RQOE	IASOG	RQOE	IASOG	
											The Final Allocation Results
GWM	—	—	—	—	—	—	—	—	—	—	2743.67
GAC	—	—	—	—	—	—	—	—	—	—	5358.34
Chang'an	—	—	—	—	—	—	—	—	—	—	3344.14
DFMC	—	—	—	—	—	—	—	—	—	—	6954.45
JMCG	—	—	—	—	—	—	—	—	—	—	298.26
JAC	—	—	—	—	—	—	—	—	—	—	633.27
BAIC	70.83	719.40	85.00	142.82							142.82
BYD	2684.37	3087.96	3221.25	3184.61							3184.61
Haima	92.18	956.02	110.61	583.09	132.74	581.98	159.28	459.80	191.14	252.78	252.78
SAIC	8220.11	8668.99	9864.13	9521.85	9370.92	9522.95	11245.10	9645.14	10682.85	9852.15	9852.15
Total	11067.49	13432.37	13280.99	13432.37	9503.66	10104.93	11404.39	10104.93	10873.99	10104.93	32764.50