Part 2: Calculation methods suggested

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- Electricity chains and vehicle running are considered in the calculation, that is, upstream and operation stages are both covered in life cycle consumption and emissions.
- Data for fossil fuel and non-fossil fuel to power:
 - ♦ Three kinds of fossil fuels including Coal, Oil and Natural gas are used as feedstock in power generation. Energy consumption and emissions include the upstream stages, such as feedstock exploration, transportation, fuel production, in addition to the energy consumption emissions occurring in the fuel utilization; but the facility construction and vehicle manufacturing stages are excluded for their little effect on the life cycle energy consumption and emission. Take coal power for example[©].
 - ✓ Life cycle analysis of GHG emissions situation of coal power (the share of different stages):
 - Coal mining and processing: 10.76%
 - Coal transportation:1.36%
 - Construction and decommissioning of the power plant:0.2%
 - Operation of the power plant:87.56%
 - Power transmission:0.3%

GHG emission the of the construction and decommissioning stage only accounts for 0.2%, so it has little effect on the life cycle emission and often be ignored.

- ♦ Non-fossil fuels includes Hydro, Nuclear, Solar, Wind and other types. The energy consumption and emission during facility manufacturing and factory construction stages are allocated to the total power supplying during the whole life time of those power stations for they account for a very large proportion. Life cycle analysis of GHG emissions situation of different power(the share of different stages)[®]:
 - ✓ Nuclear power (General situation):
 - Uranium mining and metallurgy: 20%
- Uranium conversion and enrichment: 10%
- Fuel element fabrication: 2%
- Facility construction and operation: 20%
- Transportation process: < 0.1%, always be negligible
- Backend of nuclear fuel cycle: 44%.
- Waste disposal: 4%

-

[®] Reference: China Academy of Engineering. 2015. Greenhouse gas emissions of different power energy in China [M]. Beijing: Atomic Energy Press.

[®] Reference: China Academy of Engineering. 2015. Greenhouse gas emissions of different power energy in China [M]. Beijing: Atomic Energy Press.

- Facility decommissioning: Rarely be conducted in China and always be estimated about 30%-50% of the construction stage
- ✓ Hydro power (Typical power plants in China):
- Material and facility production: 4.3%
- Material and facility transportation: 2.1%
- Civil engineering construction: 70.2%
- Power production plant: 23.4%
- ✓ Solar power(Polycrystalline silicon solar photovoltaic):
- Material and facility production: 84.14%
- Power production and operation: 0.08%
- Power transmission: 5.5%
- Decommissioning of the power plant: 10.28%
- ✓ Wind power(A typical power plant in China):
- Manufacturing stage: 71.42%
- Material transportation: 10.73%
- Power plant operation and maintenance: 10.71%
- Wind power plant decommissioning: 7.14%

4+ Ecnewncvkqp"hqt o wnc"

- Gpgti { "eqpuw o rvkqp"
- \Leftrightarrow Life cycle energy consumption for mixed electricity generation and supply $(E_{LC.Mixed}, MJ/MJ \text{ power supplying})$:

$$E_{LC,Mixed} = \left[\sum_{k=1}^{i} E_{LC,k} * SH_k\right] * \frac{1}{1 - \eta_{Loss}}$$

 \Leftrightarrow EV life-cycle energy consumption (EN_{FV} , MJ/ km):

$$EN_{EV} = \left[\sum_{k=1}^{i} E_{LC,k} * SH_{k}\right] * \frac{1}{1 - \eta_{Loss}} * \frac{E_{Ele,EV}}{\eta_{Charg.e}} * \frac{3.6}{100}$$

♦ Labelling of EV direct energy consumption:

$$\checkmark E_{E,EV} = E_{D,EV} *100/3.6$$
, (kWh/100km)

$$\checkmark$$
 $E_{V.EV} = E_{D.EV} *100 / Q_{Gasoline}$, (liter/ 100km)

 \Leftrightarrow PHEV life-cycle energy consumption (EN_{PHEV} , MJ/km):

$$EN_{PHEV} = \left[\sum_{k=1}^{i} E_{LC,k} * SH_{k}\right] * \frac{1}{1 - \eta_{Loss}} * \frac{E_{Ele,PHEV}}{\eta_{Charge}} * \frac{3.6}{100} * SH_{Ele} + (1 - SH_{Ele}) * E_{LC,Gasoline} * V_{Gasoline} * Q_{Gasoline} * \frac{1}{100} * SH_{Ele} + (1 - SH_{Ele}) * E_{LC,Gasoline} * V_{Gasoline} * Q_{Gasoline} * \frac{1}{100} * SH_{Ele} + (1 - SH_{Ele}) * E_{LC,Gasoline} * V_{Gasoline} * Q_{Gasoline} *$$

♦ Labelling of PHEV direct energy consumption :

$$\checkmark E_{E,PHEV} = E_{D,PHEV} *100/3.6$$
, (kWh/100km)

$$\checkmark$$
 $E_{V,PHFV} = E_{D,PHFV} *100 / Q_{Gasoline}$, (liter/ 100km)

 \diamond Gasoline ICEV life-cycle energy consumption (EN_{ICEV} , MJ/ km):

$$EN_{ICEV} = E_{LC,Gasoline} * V_{Gasoline} * Q_{Gasoline} * \frac{1}{100}$$

- I J I "g o kuukqpu"
- \Leftrightarrow Life cycle GHG emission for mixed electricity generation and supply ($EM_{LC,Mixed}$, g CO2,e /MJ power supplying):

$$EM_{LC,Mixed} = \left[\sum_{k=1}^{i} EM_{LC,k} * SH_k \right] * \frac{1}{1 - \eta_{Loss}}$$

 \Leftrightarrow EV life-cycle GHG emission (EM_{EV} ,g CO₂, e/km)

$$EM_{EV} = \left[\sum_{k=1}^{i} EM_{LC,k} * SH_{k}\right] * \frac{1}{1 - \eta_{Loss}} * \frac{E_{Ele,EV}}{\eta_{Charge}} * \frac{3.6}{100}$$

 \Leftrightarrow EV GHG emission in running stage ($EM_{D,EV}$, g CO₂, e/km):

$$EM_{DEV} = 0$$

 \Leftrightarrow EV GHG emission in upstream stage ($EM_{Ups,EV}$,g CO₂, e/km):

$$EM_{Ups,EV} = EM_{EV} - EM_{D,EV}$$

 \Rightarrow PHEV life-cycle GHG emission (EM_{PHEV} ,g CO₂, e/km):

$$EM_{PHEV} = \left[\frac{EM_{LC,Coal}}{\eta_{Coal-to-ele}} * SH_{Coal} + \frac{EM_{LC,NG}}{\eta_{NG-to-ele}} * SH_{NG} + \frac{EM_{LC,Oil}}{\eta_{Oil-to-ele}} * SH_{Oil} + \sum_{k=1}^{i} EM_{LC,k} * SH_{k}\right] * \frac{1}{1 - \eta_{Loss}} * \frac{E_{Ele,PHEV}}{\eta_{Charge}} * \frac{3.6}{100} * SH_{Ele} \\ + (1 - SH_{Ele}) * EM_{LC,Gasoline} * V_{Gasoline} * Q_{Gasoline} * \frac{1}{100}$$

 \Rightarrow PHEV GHG emission in running stage ($EM_{D,PHEV}$, g CO₂, e/km):

$$EM_{D,PHEV} = (1 - SH_{Ele}) * V_{Gasoline} * Q_{Gasoline} * EM_{Gasoline} * \frac{1}{100}$$

 \Rightarrow PHEV GHG emission in upstream stage ($EM_{Ups,PHEV}$,g CO₂, e/km):

$$EM_{U_{DS,PHEV}} = EM_{PHEV} - EM_{D,PHEV}$$

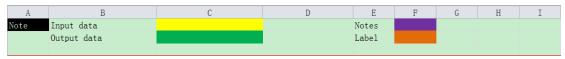
 \diamond Gasoline ICEV life-cycle GHG emission (EM_{ICEV} , g CO₂, e/km):

$$EM_{ICEV} = EM_{LC,Gasoline} * V_{Gasoline} * Q_{Gasoline} * \frac{1}{100}$$

	U{ odqn	Wpkv	Fguetkrvkqp
	<i>k</i> "	,	The type of power technologies from 1 to i mean : Coal, Oil, NG, Hydro, Nuclear, Solar, Wind ,Biomass, Geothermal, Others"
	$E_{LC,k}$ "	MJ/MJ^n	Life cycle energy consumption for electricity generation and supply of type k "
	$EM_{LC,k}$ "	g CO ₂ , e/MJ"	Life cycle GHG emission for electricity generation and supply of type k"
	SH_{k}	%"	The share of type k in the total electricity supplying
Kprwv Xctkcdngu: The input data based on annual statistical	$\eta_{\scriptscriptstyle Loss}$ "	%"	Electricity transmission loss rate"
data books or formal report vary from country to country	$E_{Ele,EV}$ "	kWh/100km"	Direct Energy consumption of EV in running stage"
in the calculation, and they can be collected from most	$\eta_{{\it Ch}{ m arg}e}$ "	%"	Charging efficiency"
countries.	$E_{{\scriptscriptstyle Ele,PHEV}}$ "	kWh/100km"	Energy consumption of PHEV driven by power in running stage"
	$SH_{\it Ele}$ "	%	The range share by electricity"
	$E_{LC,Gasoline}$ "	MJ/MJ	Life cycle energy consumption for gasoline production and utilization"
	$EM_{LC,Gasoline}$ "	g CO ₂ , e/MJ ⁿ	Life cycle GHG emission for gasoline production and utilization*
	$V_{\it Gasoline}$ "	Liter/100km"	Energy consumption of PHEV driven by gasoline in running stage"
Poto o gratu	$Q_{Gasoline}$ "	32 MJ/L ^{®n}	Calorific value of gasoline"
Rete o gygtu	EM _{Gasoline} "	67.91 g CO ₂ , e/MJ ^{©₁₁}	GHG emission intensity for gasoline"

Part 3: Operating manual

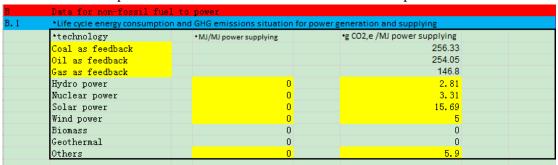
The methods are based on EXCEL tools to get life cycle analysis results. Based on the data of different regions and countries input in the Yellow Cell, the results will be showed in the output cell (the Green Cell) and the labelling is presented in the Orange Cell. The data is explained in the Purple Cell.



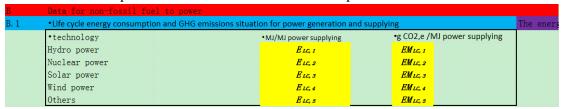
[®] Average value. $Q_{Gasoline} = \mathbf{Q}^* \mathbf{D}/1000$, \mathbf{Q} : gasoline calorific value, 43.07 MJ/kg (GB/T 2589-2008); \mathbf{D} : gasoline density, 720-775 kg/ \mathbf{m}^3 (GB 17930-2013).

[®] EM _{Gasoline} =44/12*FCO*CEF, FCO: fuel oxidation rate, 0.98; CEF: carbon emission factor, 18.9 g/MJ. (Reference: China Academy of Engineering. 2015. Greenhouse gas emissions of different power energy in China [M]. Beijing: Atomic Energy Press.)

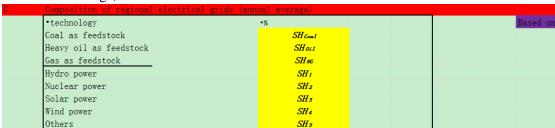
- Wruvtgc o "uvcig"
- In original model Table A presents the data for different fossil fuel to power, while in the new model Table A is deleted, and it's packaged into Part B.1
 - ♦ Table **D** presents the data for fossil and non-fossil fuel to power.



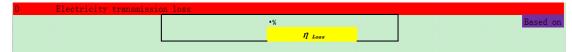
→ Table D presents the data for non-fossil fuel to power.



→ Table E presents the data for composition of regional electrical grids (annual average).



→ Table F presents the data on electricity transmission loss.



• Twppkpi"uvcig"

Table G presents the data on EV and HPEV charging and running. G
 G presents the charging efficiency; G
 presents the energy consumption for EV running; G
 presents the energy consumption for PHEV running, two different running modes are presented in the modulates, including driven independently by power consumption (kWh /100 km) and gasoline consumption (liter/100 km).

E	Data on EV charging and	d running				
E. 1	Charging efficiency					Based on
			•%			
			η Charge			
E. 2	Energy consumption for	EV running				
			•kWh /100 km			Based on
			E E1e, EV			
E. 3	Energy consumption for	PHEV running				Based on
			•kWh /100 km	•liter /100 km	•Range s	hare by el
			E e1€, PHEV	V Gasoline	SHE1e	

→ Table H presents the data on vehicle fuel life-cycle energy consumption and GHG emissions situation for gasoline production and utilization.

		_	_				
F	Data on vehicle fuel li	fe-cycle energy consum	ption and GHG emiss:	ion			
F. 1	•Life cycle energy consumption	on and GHG emissions situati	ion for gasoline productio	on and utiliza	ation		
			•MJ/MJ fuel obtained and u	used	•g CO2,e /MJ fu	el obtained an use	j
	Gasoline		ELC, Gasoline		EMLC, Gasoline		Based on

lacktriangledown Table I . presents the ecnewncvgf"tguwnvu0

G	Life cycle analysis resu	lts	
G. 1	*Life cycle energy consumption	and GHG emissions situation for mixed electricity generation and supplying	
		•MJ/MJ fuel obtained and used •g CO2,e /MJ fuel o •g CO2,e /kWh fuel obtained an use	d
	Mixed electricity	ENILC. Mixed ENILC. Mixed #VALUE!	
G. 2	Energy consumption for p	ure Battery EV	
		•MJ/ km driven	
		ENEV	
G. 3	GHG emissions for pure B	attery EV	
		•g CO2,e / km driven	calculted
		EM EV	carcurted
G. 4	Energy consumption for P	HEV	
		•MJ/ km driven	
		ENPHEV	
G. 5	GHG emissions for PHEV		
		•g CO2,e / km driven	
		EM PHEV	
G. 5	Energy consumption for g	asoline ICEV	
		-MJ/ km driven	
		EN ICEV	
G. 5	GHG emissions for for ga	soline ICEV	
		•g CO2,e / km driven	
		EM ICEV	

• Table **J** presents the ncdgnnkpi.



Part 4: Data to collect

The following data are encouraged to submit for the calculation mentioned above:

1) Data on electricity chains

- Electricity generation efficiency of fossil fuel (by type, %)
- Life cycle energy consumption and GHG emissions situation for fossil and non-fossil fuel power generation and supplying (Coal, Oil, Gas, Hydro, Nuclear, Solar, Wind, Biomass, Geothermal and others)
 - ♦ MJ/MJ power supplying
 - ♦ g CO2,e /MJ power supplying
- Composition of regional electrical grids (Coal, Oil, Gas, Hydro, Nuclear, Solar, Wind, Biomass, Geothermal and others, %)
- Electricity transmission loss (%)
- Composition of regional electrical grids (Coal, Oil, Gas, Hydro, Nuclear, Solar, Wind, Biomass, Geothermal and others, %)
- Electricity transmission loss (%)
- 2) Data on EV and PHEV charging and running
 - Charging efficiency (%)
 - Energy consumption for EV running (kWh /100 km)
 - Energy consumption for PHEV running driven by electricity (kWh /100 km)
 - Energy consumption for PHEV running driven by gasoline (Liter /100 km)
 - The range share by electricity for PHEV (%)

Part 5: Stating Methods suggested

About the stating methods, some rules are suggested.

- 1) Labelling together
 - ** kWh /100 km
 - ** Liter (gasoline equivalent)/ 100 km
- 2) Comparing energy consumption by primary energy
- 3) Comparing GHG emissions to conventional gasoline vehicle
 - Total
 - By stages

Part 6: Supports are welcomed from contracting parties

- 1) The data listed in Part 4 should be collected with clear sources such as statistical book or formal report. The data format please see Appendix I;
- Modifications suggestion for our suggested methods, with the presentation about the
 experiences of current calculation and labelling methods in EU, US and other specific
 regions.

Appendix I: Data Collection Table

1) Data for fuel to power

Butte for fuel to poss				
	Life cycle energy consumption and GHG emissions situation for			
T 1 1	power generation and supplying*			
Technology	Energy Consumption	GHG Emissions		
	(MJ/MJ power supplying)	(g CO2,e /MJ power supplying)		
Coal as feedstock				
Oil as feedstock				
Gas as feedstock				
Hydro Power				
Nuclear Power				
Solar Power				
Wind Power				
Biomass				
Geothermal				
Others(please add)				

^{*} For the fossil fuel(Coal, Oil, NG), data include: Energy consumption and emissions occurring in upstream stages, such as feedstock exploration, transportation, fuel production, and transportation, in addition to the energy consumption emissions occurring in the fuel utilization; the facility construction and vehicle manufacturing stages are excluded. For the non-fossil fuel, the energy consumption and emission during facility manufacturing and factory construction stages are allocated to the total power supplying during the whole life time of those power stations.

2) Composition of regional electrical grids (annual average)

Fuel Type /	Develope (0/)
Technology	Percentage (%)
Coal as feedstock	
Heavy oil as feedstock	
Gas as feedstock	
Wind Power	
Hydro Power	
Nuclear Power	
Solar Power	
Wind Power	

Biomass	
Geothermal	
Others(please add)	

3) Electricity transmission loss

Electricity	
transmission loss (%)	

4) Life cycle energy consumption and GHG emissions situation for gasoline production and utilization

	Energy Consumption	GHG Emission
	(MJ/MJ fuel obtained and used)	(g CO2,e /MJ fuel obtained an used)
Gasoline		

5) EV and PHEV Charging efficiency

Charging efficiency (%)	
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