

PAUL SCHERRER INSTITUT



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# Integrating ecoinvent into an energy systems model

LCA DF 64, 30 March 2017, ETH Zurich, Switzerland



# Outline

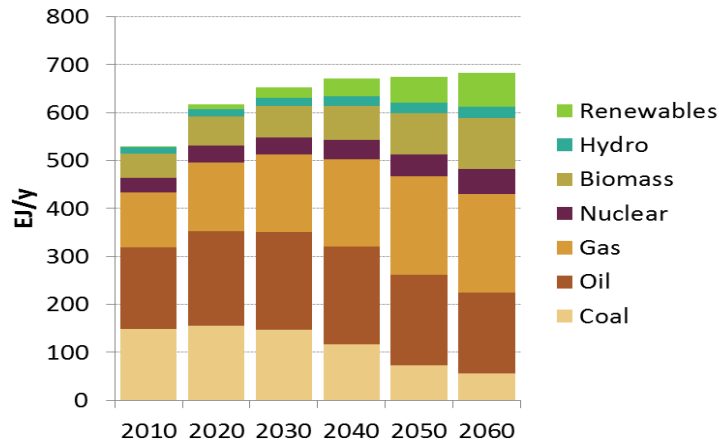
- Motivation
- Approach
- Uncertainties and limitations

# Motivation

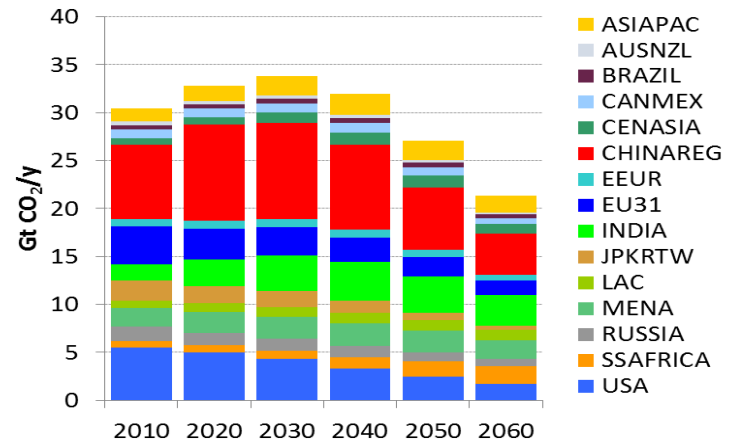
- Energy system modelling
- 3 World Energy Scenarios
- 15 world regions
- 2010-60



Total Primary Energy Supply



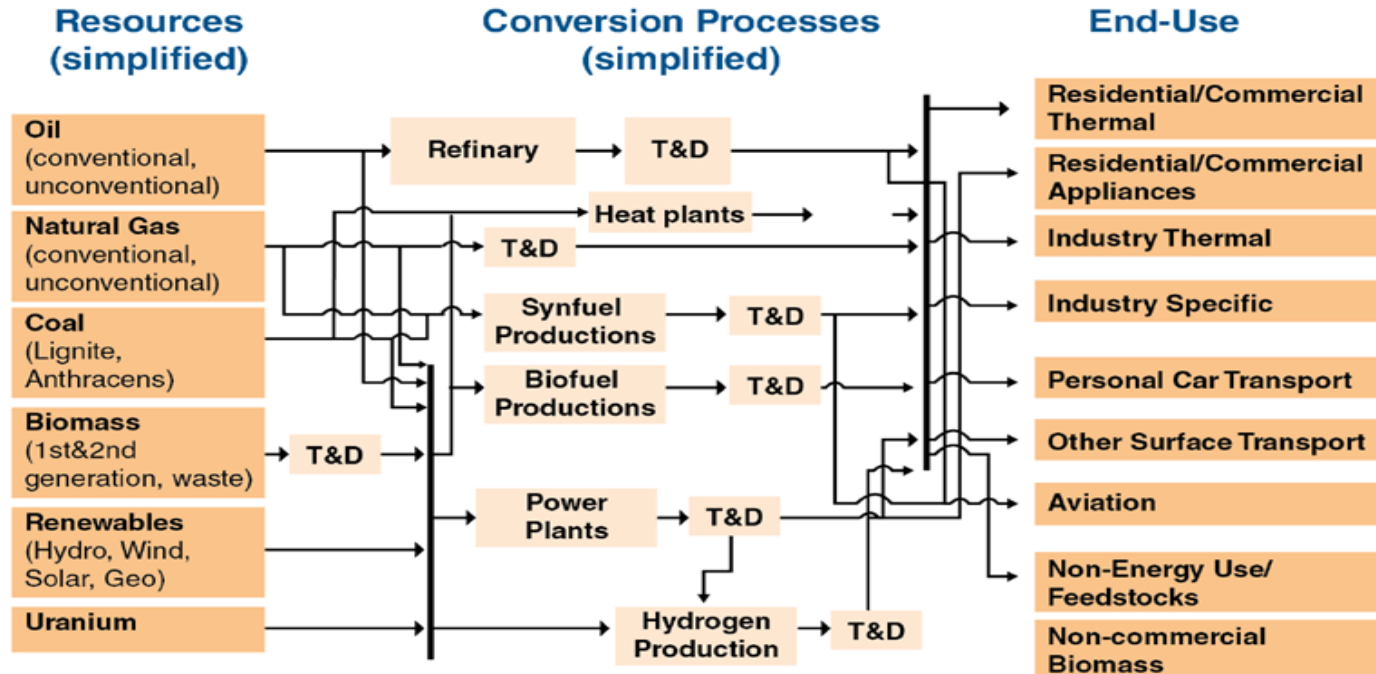
CO<sub>2</sub>-Emission



- Impacts on human health and ecosystems?

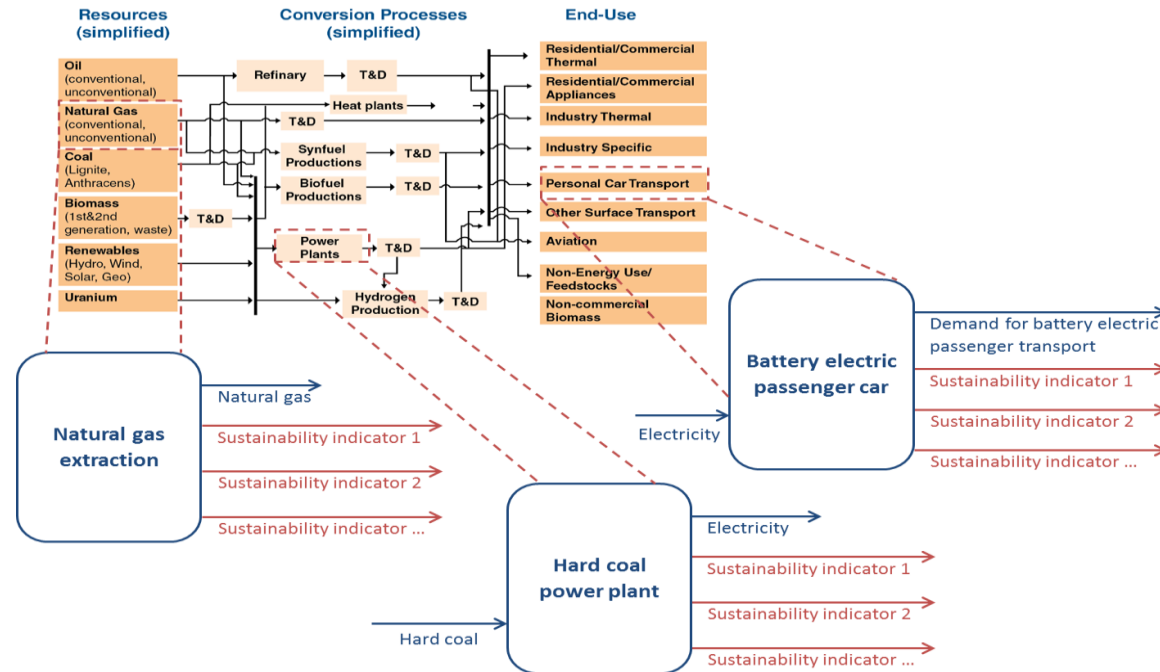
# Modelling of the energy system

- Technology-based partial equilibrium energy system model
- Reference Energy System: Resources – Conversion – End-use
- Techno-economic characteristics



# Approach

- 1) Matching of LCI data and energy system model processes
- 2) Subdivision of the LCI data
- 3) Preparation of the background database
- 4) Calculation of the life-cycle impacts and implementation in the energy system model



# Step 1: Matching

- Technological
  - CHP, energy own use, ...
  - dummies, sectors, ecoinvent version, ...
- Regional
- Temporal

E61	Onshore Wind turbine	Electricity, high voltage {xxx}  electricity production, wind, >3MW turbine, onshore	[75]
E62	Offshore Wind Park	Electricity, high voltage {xxx}  electricity production, wind, 1-3MW turbine, offshore	[75]
E6A	Cogeneration Gas Turbine	Heat, central or small-scale, natural gas {xxx}  natural gas, burned in micro gas turbine, 100kWe	[75]
E6C	Cogeneration Coal	Heat, district or industrial, other than natural gas {xxx}  heat production, at hard coal industrial furnace 1-10MW	[75]
E70	Oil electric	Electricity, high voltage {xxx}  electricity production, oil	[75]
E71	Hard Coal Heating Plant	Heat, district or industrial, other than natural gas {xxx}  heat production, at hard coal industrial furnace 1-10MW	[75]
E72	Fuel Oil Heating Plant	Heat, district or industrial, other than natural gas oil, at industrial furnace 1MW	
E73	Gas Heating Plant	Heat, district or industrial, natural gas {xxx}  heat condensing modulating >100kW	
E74	Biomass Heating Plant	Heat, district or industrial, other than natural gas chips from forest, at furnace 1000kW	
E75	Geothermal Heating Plant	18_electricity, at geothermal power plant, Basel.	
E80	Biomass power plant	Electricity, at wood burning power plant 20 MW,	
E81	Geothermal electric	18_electricity, at geothermal power plant, Basel.	
E82	Biomass IGCC Power Plant	Electricity, at BIGCC power plant 450MW, no CCS	
E83	Biomass IGCC Power Plant w/ CO2 scrubber	Electricity, at BIGCC power plant 450MW, pre, pi 1000m/2025/xxx U	
EC2	Coal Advanced Electric with CO2 scrubber	Electricity, at power plant/hard coal, post, pipeli 1000m/2025/RER U	
EH2	Hydrogen Fuel Cell CoGen IND	PEM fuel cell system, with disposal, 2012	
EH3	Hydrogen Fuel Cell CoGen R&C	PEM fuel cell system, with disposal, 2012	
		<b>GMM region</b>	<b>ecoinvent region</b>
		ASIAPAC	TH   ID   MY
		AUSNZL	AU
		BRAZIL	BR   RLA
		CANMEX	CA-AB   CA-BC   CA-MB   CA-NB   CA-NF   CA-NS   CA-NT   CA-NU   CA-ON   CA-PE   CA-QC   CA-SK   CA-YK   MX   RNA
		CENASIA	-
		CHINAREG	CN
		EEUR	BA   MK   RS   TR   UA   Europe without Switzerland   RER   RER w/o DE+NL+NO
		EU31	WEU   Europe without Switzerland   RER   RER w/o DE+NL+NO   AT   BE   BG   CH   CZ   DE   DK   ES   FI   FR   GB   GR   HR   HU   IE   IT   LU   NL   NO   PL   PT   RO   SE   SI   SK
		INDIA	IN
		JPKRTW	JP   KR   TW
		LAC	RLA   PE   CL
		MENA	IR   SA   DZ
		RUSSIA	RU
		SSAFRICA	ZA   TZ
		USA	HICC   ASCC   WECC, US only   MRO, US only   NPCC, US only   RFC   SERC   SPP   TRE   US   FRCC   RNA

# Step 2: Subdivision

## Life-cycle inventory electricity generation from hard coal

### Outputs to technosphere

Electricity  
Hard coal ash  
...

### Inputs from technosphere

Hard coal  
Power plant  
...

### Inputs from biosphere

Cooling water

### Outputs to biosphere

CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>  
...





# Step 4: Calculation & Implementation

- Calculation of the cumulative results for each process and region
  - per operation (direct)
  - per operation (indirect)
  - per infrastructure



GMM		ecoinvent v3 equivalents	available v3 regions	upstream ("cut-off")	available v3 regions	infrastructure ("cut-off")	available v3 regions
Technology	Name	Dataset		Dataset		Dataset	
MINBST1	Stover	Sweet sorghum stem {xxx}  sweet sorghum production   Alloc Rec, U	CN, RoW	-	-		
STTD	Stover T&D	Sweet sorghum stem {xxx}  market for   Alloc Rec, U	GLO	Sweet sorghum stem {xxx}  sweet sorghum production   Alloc Rec, U	CN, RoW		
BB1	Ethanol From Cellulosic Biomass / Stover	Ethanol, without water, in 95% solution state, from fermentation {xxx}	CN, RoW	Sweet sorghum stem {xxx}  market for   Alloc Rec, U	GLO	Ethanol fermentation plant {xxx}  market for   Alloc Rec, U	GLO
						Heat and power co- generation unit, 6400kW thermal, common	GLO
						Heat and power co- generation unit, 6400kW thermal, building {xxx}	GLO
						Heat and power co- generation unit, 6400kW thermal, components for	GLO

- Post-processing (unit, energy content, efficiency)
- Implementation in the energy system model

# Uncertainties and Limitations

- Inconsistency in the LCI data (different data sources due to missing technologies)
- Missing regions
- Constant background
- Differentiation direct vs. indirect

## Economy-wide analysis

- Education
- IT & Communication
- Entertainment
- Services
- Retail trade
- Real estate activities
- Accommodation
- ...

## Life-cycle assessment

- Construction
- Plastics
- Metals
- Waste treatment
- ...

## Energy systems analysis

- Energy crops
- Fuel mining
- Fuel production
- Electricity
- Transport
- ...

**Thank you for the  
attention!**





# Title



Text



# Title

- Text

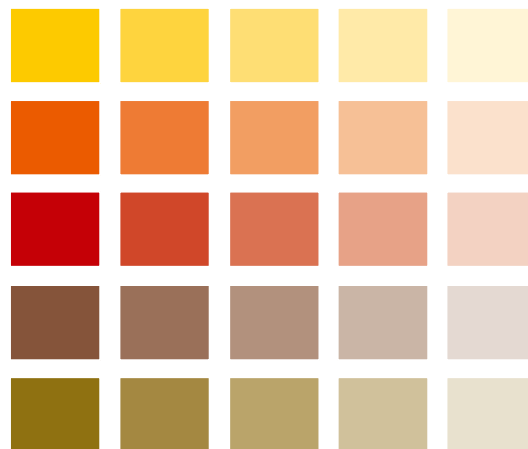
- Text

# PSI Colour Scheme

PSI's basic colours



Colour options for  
graphs:  
1<sup>st</sup> choice



Colour options for  
graphs:  
2<sup>nd</sup> choice

