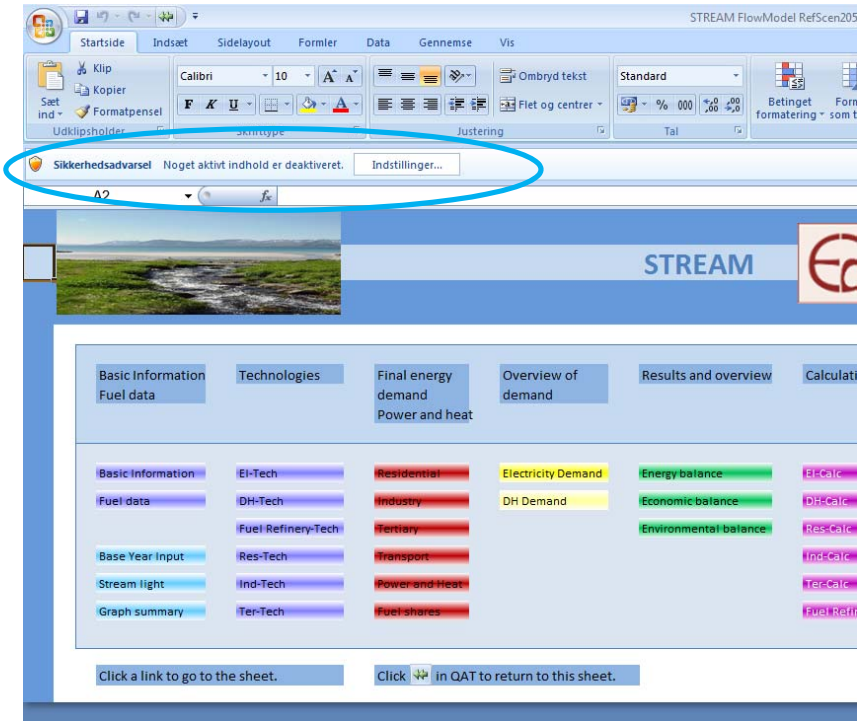
STREAM Light

Before you start with the exercise you must activate the content from the safety warning.



STREAM Light Exercise 1

The STREAM Light sheet in the Flow Model gives you a quick overview of the combined energy system. The tasks below will take you through the basics of the sheet.

For each task below start with an original file and **save with a different name**.

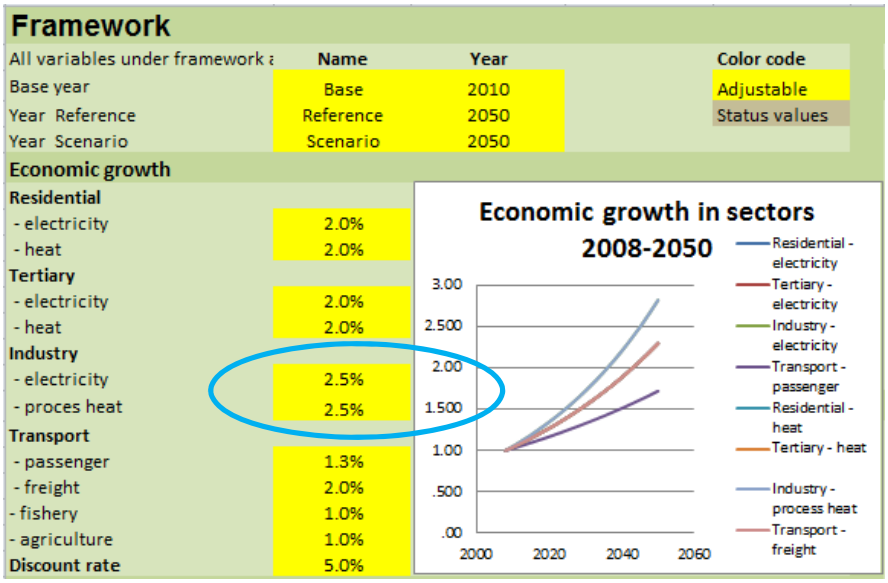
In the "2050 Scenario" check the effect on changes within:

- Fuel consumption vs. potentials
- CO_2 emissions
- Costs

1. **Increase economic growth in the industrial sector to 2.5%. What are the effects?**

Change of economic growth:

Remember to update the model values by pressing *'Put STREAM Light data into the model'*, **press more than once**.

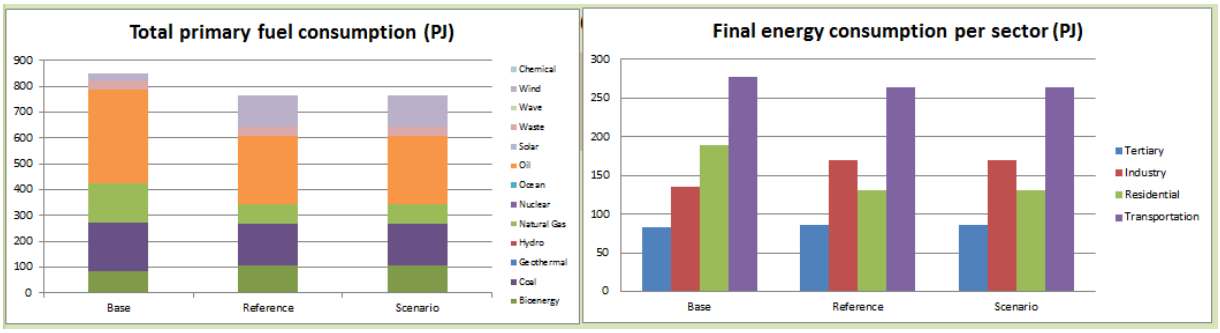


Annual economic growth is defined in STREAM as constant – from the base year to the year of the modelled scenarios. In other words, it is an average growth between base year and scenario years divided equally for every year between them. So the Reference and the Scenario will assume by definition the same economic growth for every sector.

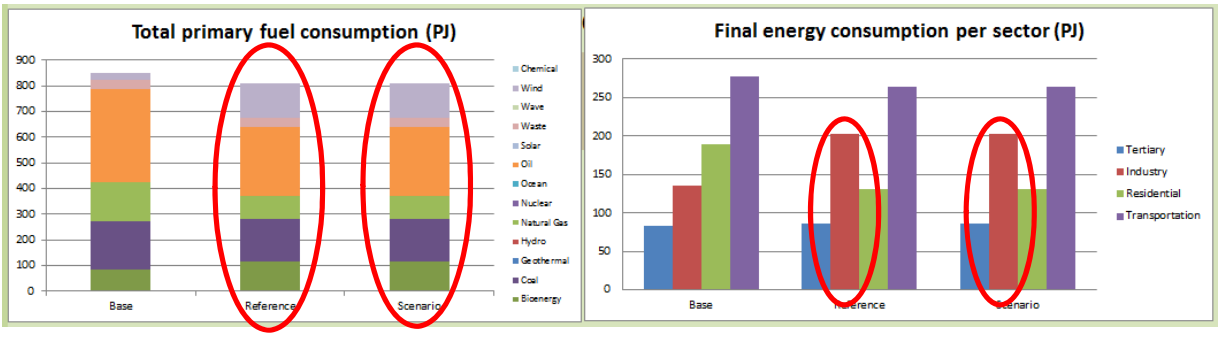
Fuel consumption:

A higher annual economic growth of the industry sector will cause a higher final energy consumption per sector which in turn, will cause a higher primary fuel consumption.

Before:

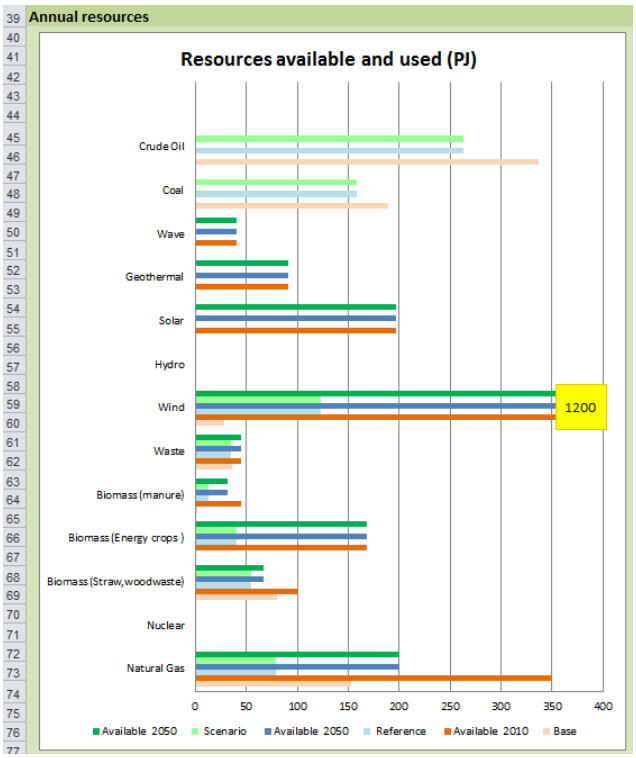


After:



Resource Potential:

Before:



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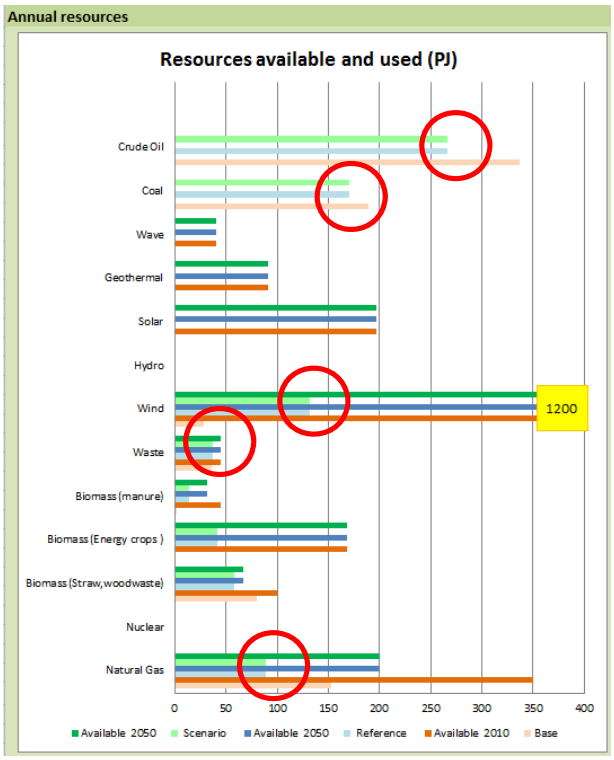
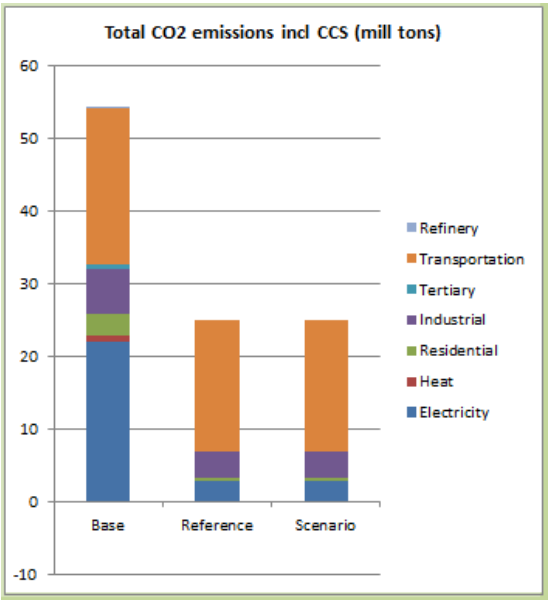
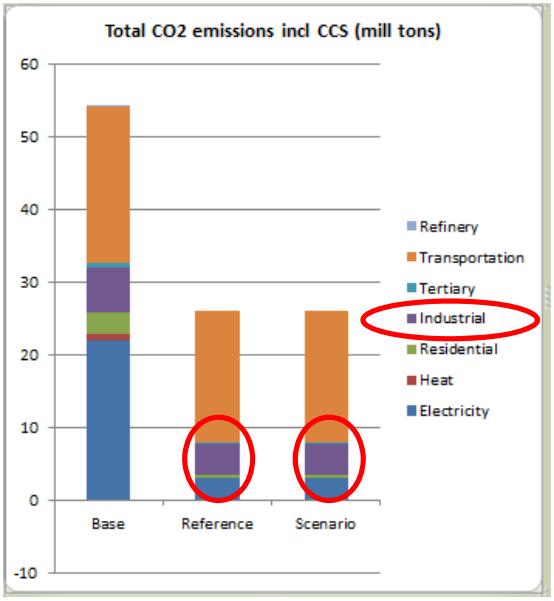


CO2 emissions:

Before:

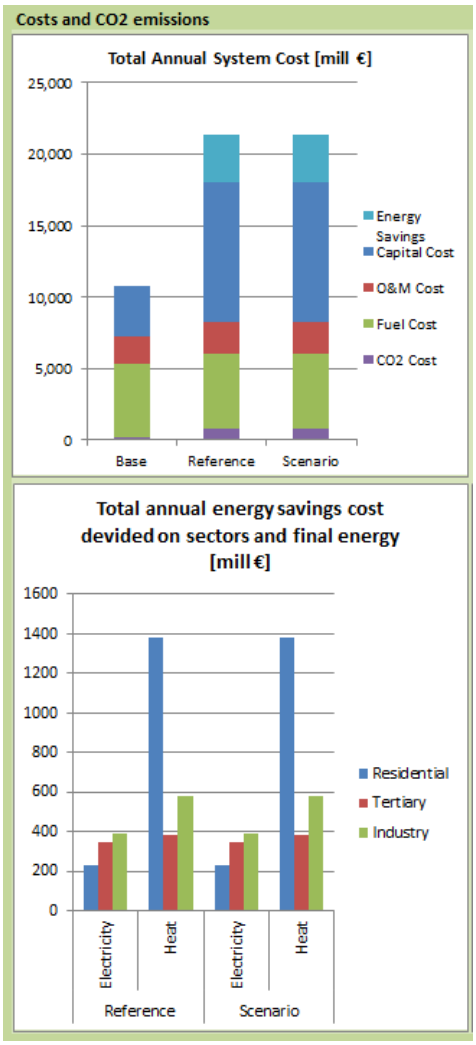


After:

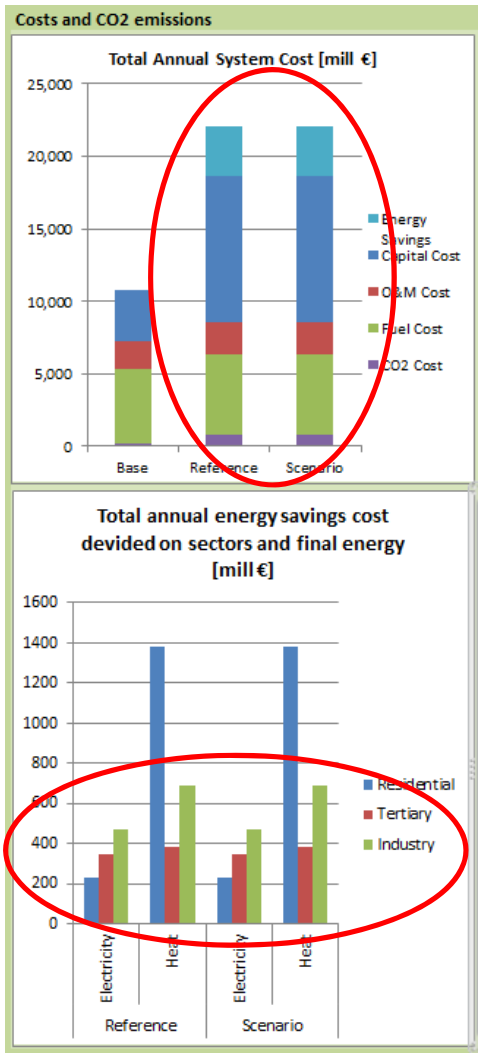


Costs:

Before:



After:



2. Increase the price on coal to 7 €/GJ in the 2050 Scenario. What are the effects?

Coal price change:
(Remember to change the economic growth back to the original value)

Change only the price for the ***Scenario***, in that way it becomes easier to compare the effect of the input change.

Prices				
Fuel prices	**Base**	**Reference**	**Scenario**	
Natural Gas	5.01	8.59	8.59	€/GJ
Nuclear - Uranium	4.00	4.00	4.00	€/GJ
Biomass (Straw,woodwaste)	5.00	5.15	5.15	€/GJ
Biomass (Energy crops)	7.00	7.00	7.00	€/GJ
Biomass (manure)	8.00	8.00	8.00	€/GJ
Imported electricity	11.00	21.00	21.00	€/GJ
Coal	2.97	3.27	7.00	€/GJ
Imported heat	9.00	11.00	11.00	€/GJ
Oil	10.07	15.24	15.24	€/GJ
		Reference	**Scenario**	
CO2-price	5.00	35.00	35.00	€/t CO2

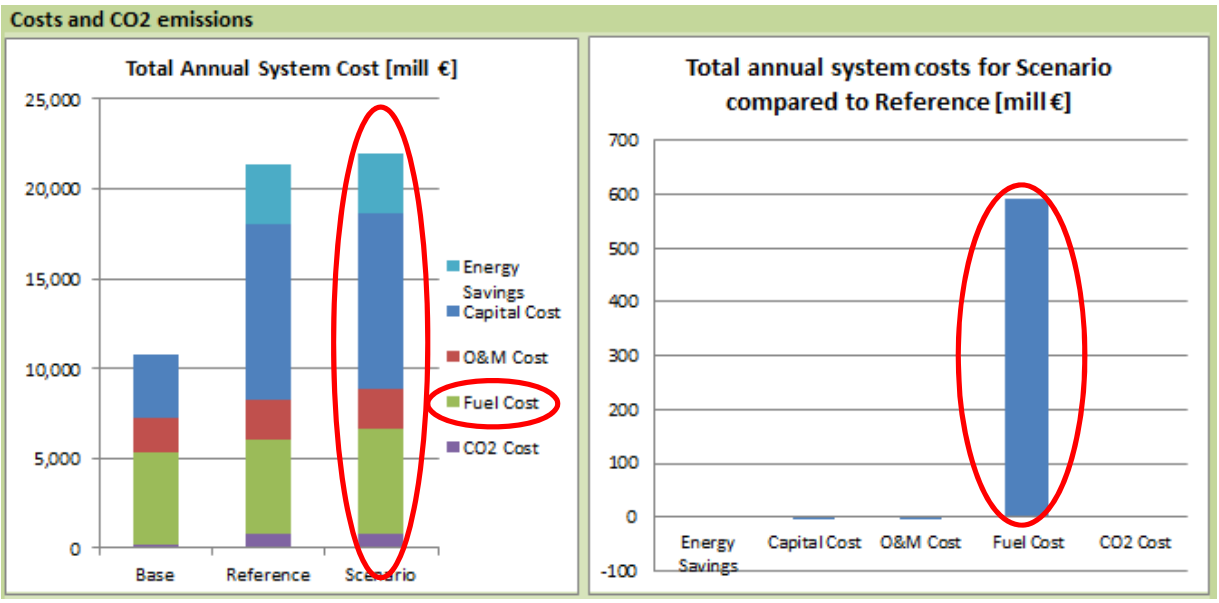
Fuel consumption:

There is no change in fuel consumption (STREAM is not an optimization tool).

CO_2 emission:

There is no change in CO_2 emissions.

Costs:



3. **Implement yearly savings of 2% in the residential sector in the 2050 Scenario. What are the effects?**

Change of yearly savings:

Change the input values in the blue circle and see the result in the red

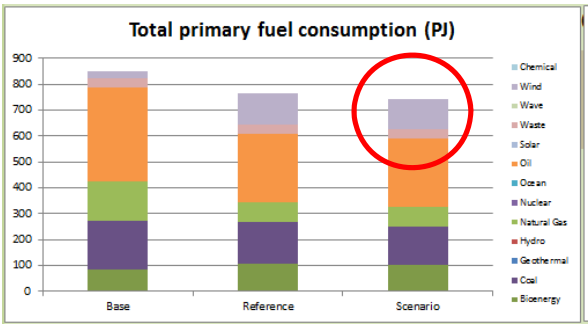
Final energy consumption

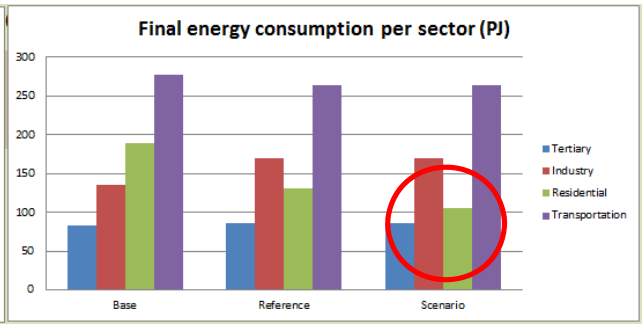
Put Stream Light data into the model

Final energy savings compared to frozen efficiency

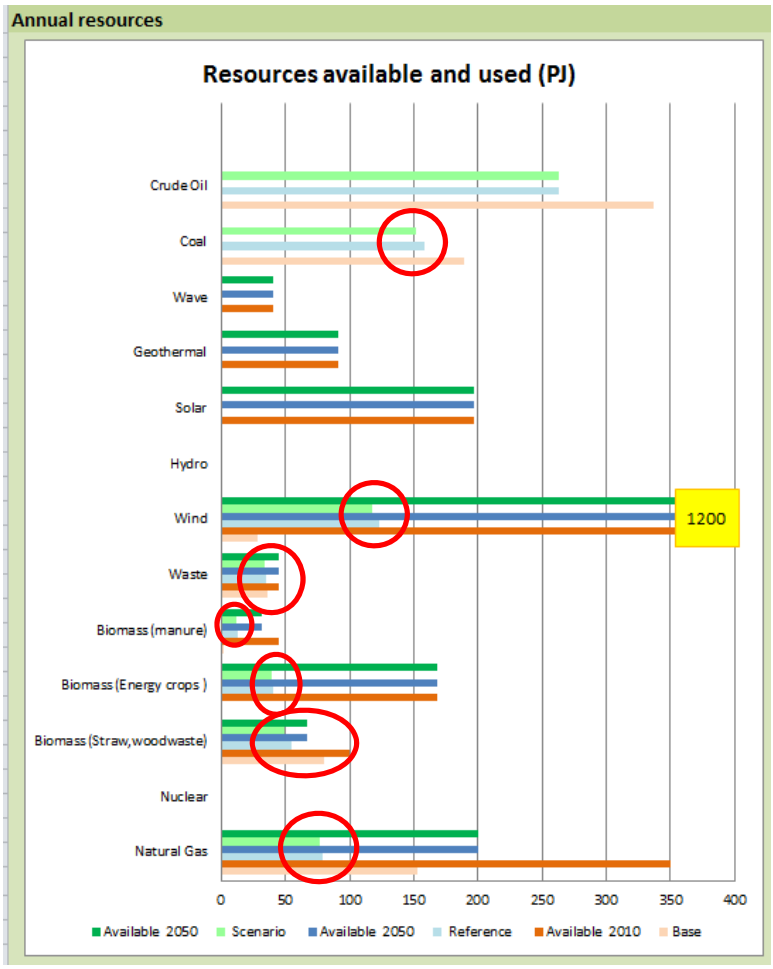
			Yearly savings		Costs of additional savings between scenarios		
Residential	Reference	Scenario	Reference	Scenario	Reference	Scenario	
Electricity appliances	46%	55%	1.55%	2.02%	54	54	€/GJ
Total Heat Supplied	43%	55%	1.42%	2.02%	200	200	€/GJ
Tertiary							
Electricity appliances	33%	33%	1.01%	1.01%	108	108	€/GJ
Total Heat Supplied	44%	44%	1.46%	1.46%	194	194	€/GJ
Industry							
Electricity appliances	38%	38%	1.20%	1.20%	108	108	€/GJ
Total Process energy	38%	38%	1.20%	1.20%	108	108	€/GJ

Fuel consumption:





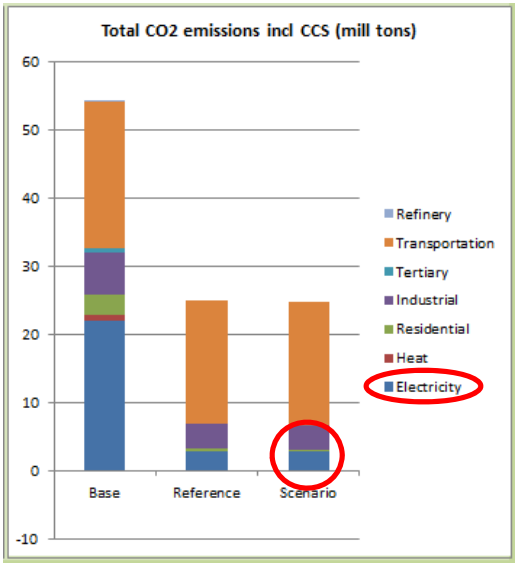
Resource Potential:



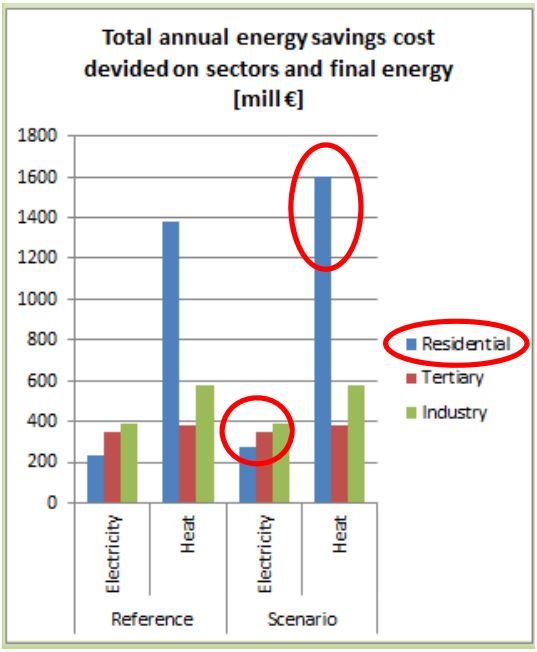
NB: Crude oil is only used for transport, therefore you can't see any change. (No oil boilers are assigned to individual boilers for heating).

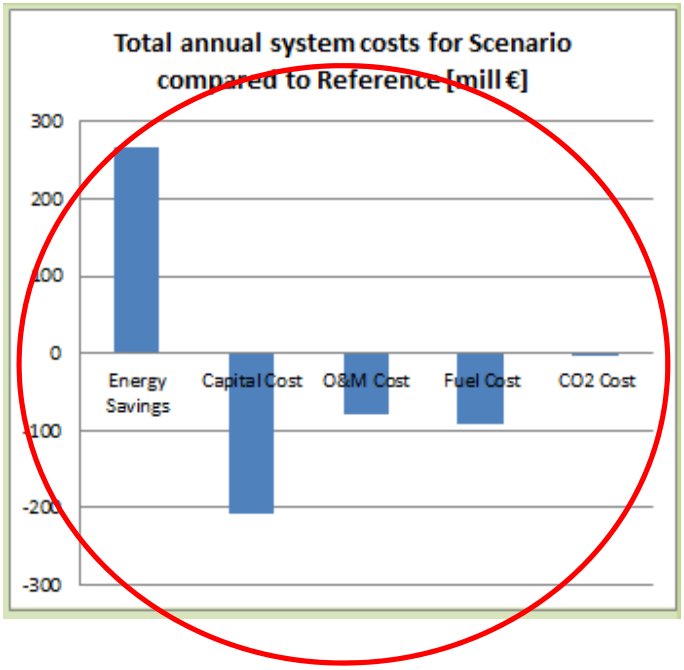
CO_2 emissions:

Only the CO_2 reduction caused by increasing the yearly savings for electricity appliances can be seen, because the district heat boiler production only consists of wood pellets boilers.



Costs:





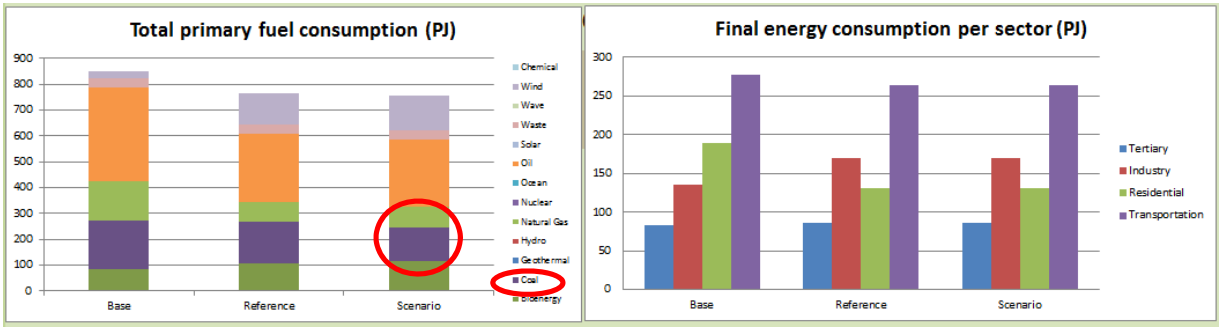
4. **Increase the production of electricity from onshore wind to 23% in the *Scenario* at the expense of electricity from coal. What are the effects?**

Change of electricity production:

The demand coverage in the red circle must be 100% in order to cover the entire electricity demand, so you should decrease the share of electricity consumption from coal by the same amount.

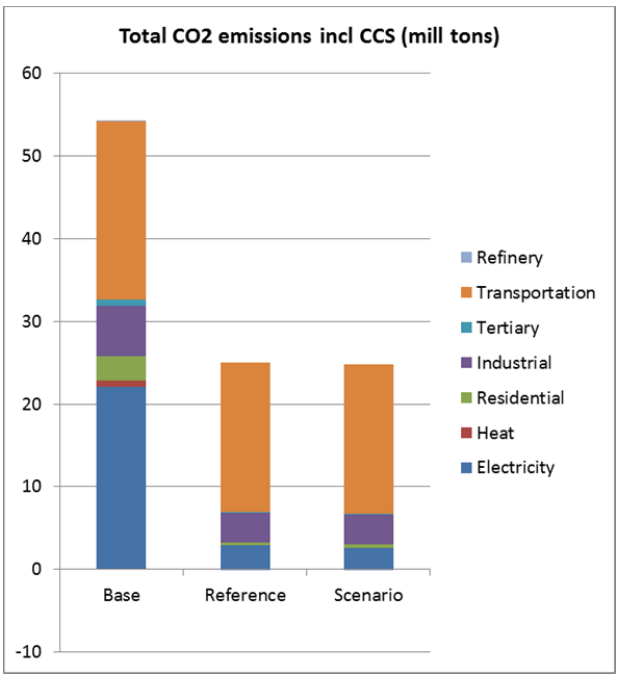
Eletricity production			formel
	Base	Reference	Scenario
Coal Plant	56%	0%	0%
CCGT	0%	0%	0%
Gasturbine	23%	7%	7%
Wind, offshore	4.3%	36%	36%
Wind, onshore	18%	18%	23%
Biomass	9%	2%	2%
Biogas	1%	5%	5%
Waste incineration	7%	4%	4%
Photo voltaic	0%	0%	0%
Nuclear	0%	0%	0%
Geothermal	0%	0%	0%
Wave power	0%	0%	0%
Natural gas incl. CO2-storage	0%	0%	0%
Coal incl. CO2-storage	0%	28%	23%
Biomass incl. CO2-storage	0%	0%	0%
Hydro	0%	0%	0%
Demand coverage	118%	100.0%	100.0%
Electricity imports	-18%	0.0%	0.0%
Enforced electricity export		0.0%	0.0%
Total demand	128.2	228.0	228.0
Total production	151.3	228.0	228.0
Demand w. enforced elec. export		228.0	228.0

Fuel consumption:



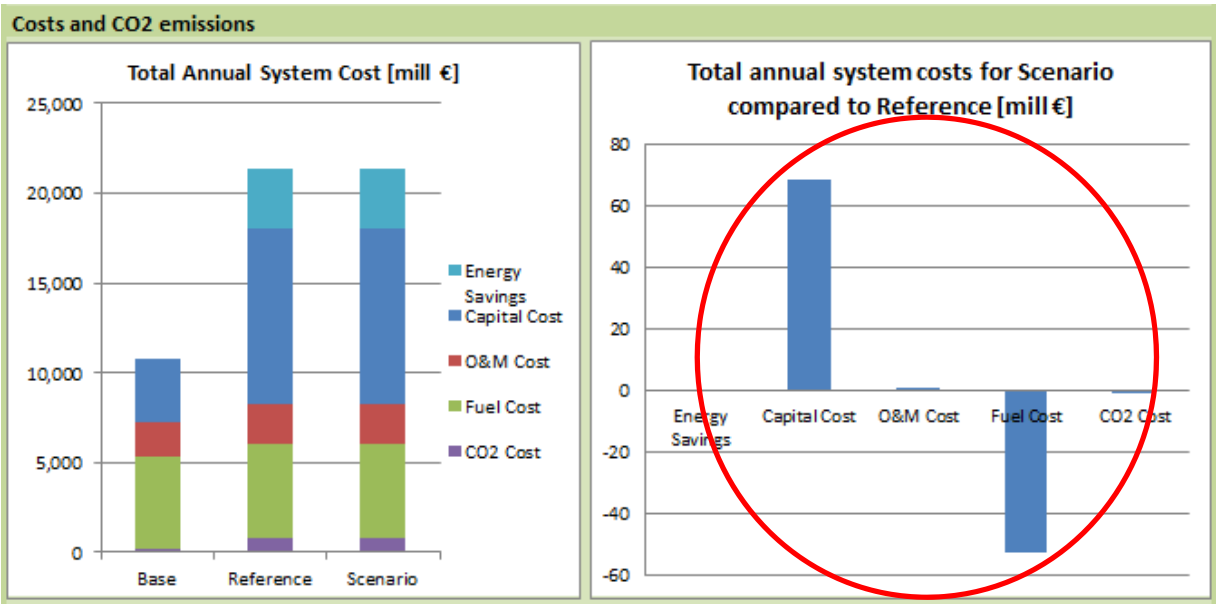
Resource Potential

CO_2 emissions:

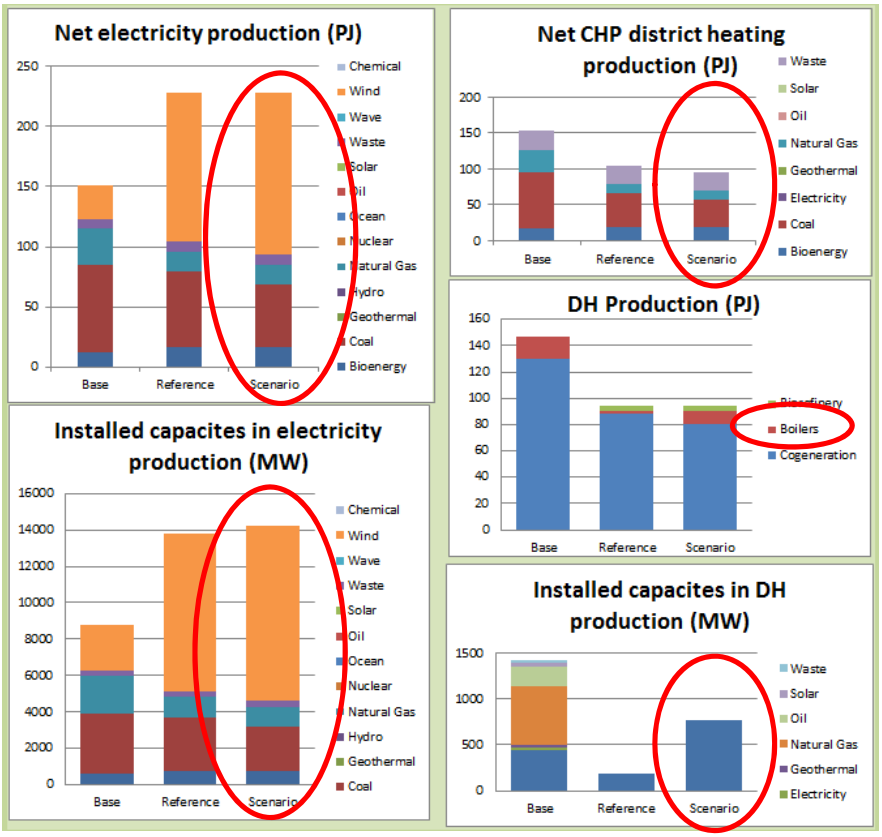


Small changes in CO2 emissions (25 mill tons in Reference and 24.7 mill tons in Scenario). This small different is due to the fact that CCS technologies captures up to 90% of the CO_2 emissions (See ***El-Tech*** sheet, ***CO_2 removal degree*** (columns P-R)); however, around a 10% is still emitted to the atmosphere. Decreasing the use of Coal CCS power plants, minimizes therefore emissions.

Costs:



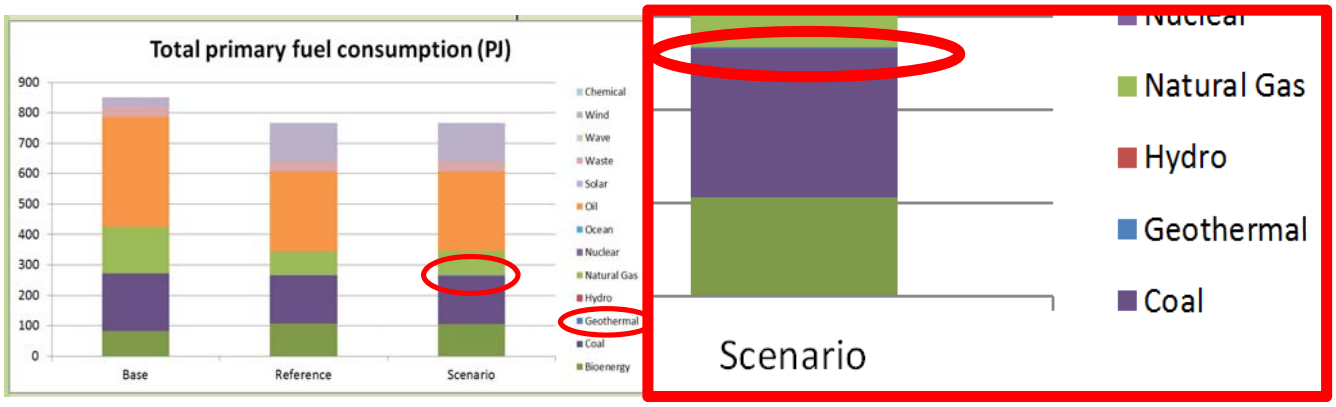
Notice also the changes in production of electricity and district heating



5. **Decrease the DH boiler production to 50% in the 2050 Scenario and increase the production from geothermal energy similarly. What are the effects?**

District Heat boiler production					formel	formel	
	Base	Reference	Scenario	Base	Reference	Scenario	
Coal boiler	1%	0%	0%	0.1	0.0	0.0	PJ
Natural gas boiler	47%	0%	0%	9.3	0.0	0.0	PJ
Geothermal	2%	0%	50%	0.4	0.0	1.3	PJ
Heatpump	0%	0%	0%	0.0	0.0	0.0	PJ
Wood pellet boiler	31%	100%	50%	6.2	2.6	1.3	PJ
Oil boiler	15%	0%	0%	2.9	0.0	0.0	PJ
Biogas Boiler	1%	0%	0%	0.1	0.0	0.0	PJ
Municipal waste	3%	0%	0%	0.5	0.0	0.0	PJ
Electric boiler	1%	0%	0%	0.1	0.0	0.0	PJ
Solar heat	1%	0%	0%	0.1	0.0	0.0	PJ
Heat imports	0%	0%	0%				
Total production	19.8	2.6	2.6				PJ
CHP	153	104	104	PJ			
Total DH	**172**	**106**	**106**	PJ			

Fuel consumption:

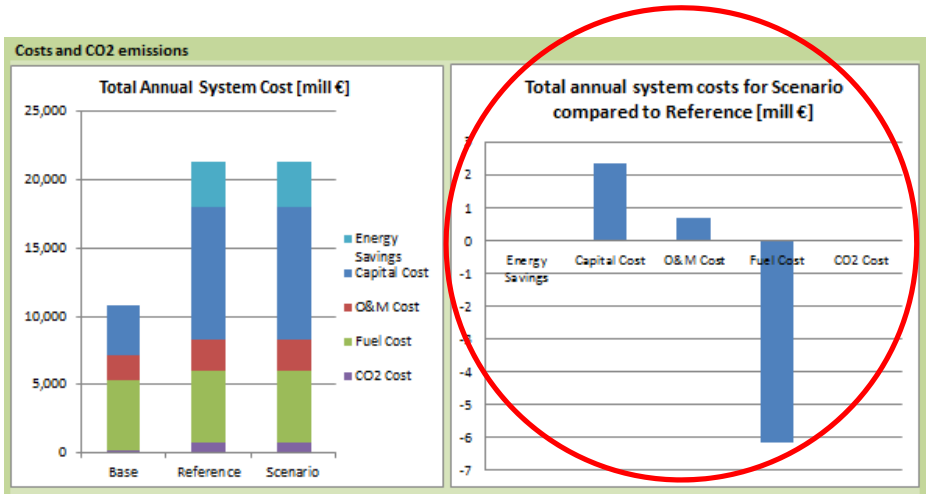


Resource Potential:

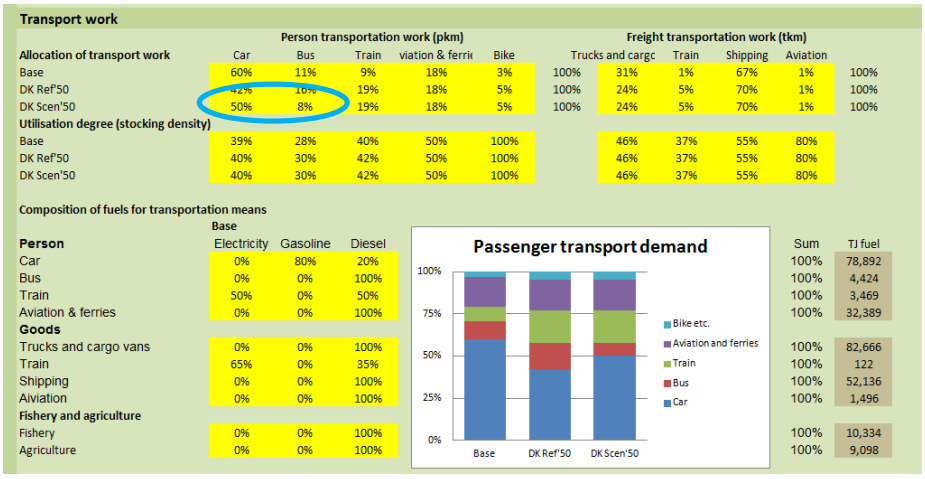
CO2 emissions:

There is no change in CO_2 emissions, because both geothermal and wood pellet boilers (biomass – straw, woodwaste) are assumed to have a CO_2 emission factor of zero.

Costs:



6. **In the transport sector increase the share of passenger transportation by car to 50% in the 2050 Scenario at the expense of bus transportation. What are the effects?**



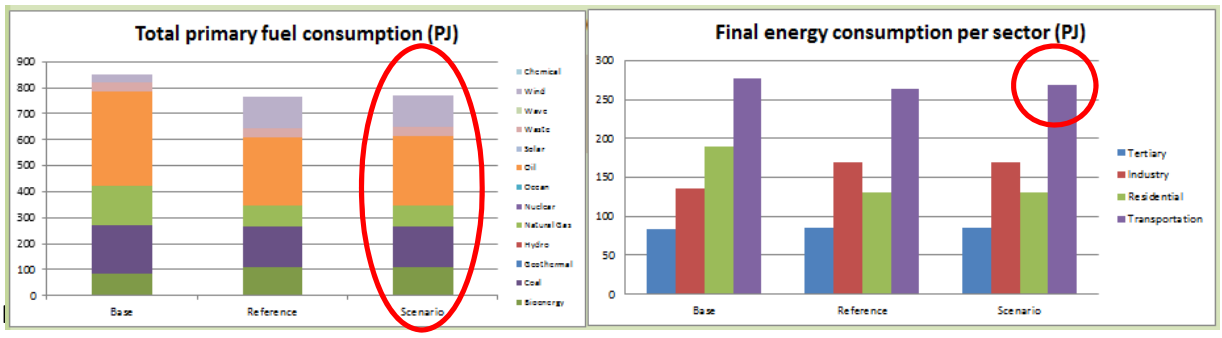
Transport work

Allocation of transport work	Person transportation work (pkm) Car	Bus	Train	viation & ferri	Bike	Freight transportation work (tkm) Trucks and cargo	Train	Shipping	Aviation	
Base	60%	11%	9%	18%	3%	100%	31%	1%	67%	1%	100%
DK Ref'50	42%	16%	19%	18%	5%	100%	24%	5%	70%	1%	100%
DK Scen'50	50%	8%	19%	18%	5%	100%	24%	5%	70%	1%	100%
Utilisation degree (stocking density)										
Base	39%	28%	40%	50%	100%		46%	37%	55%	80%
DK Ref'50	40%	30%	42%	50%	100%		46%	37%	55%	80%
DK Scen'50	40%	30%	42%	50%	100%		46%	37%	55%	80%

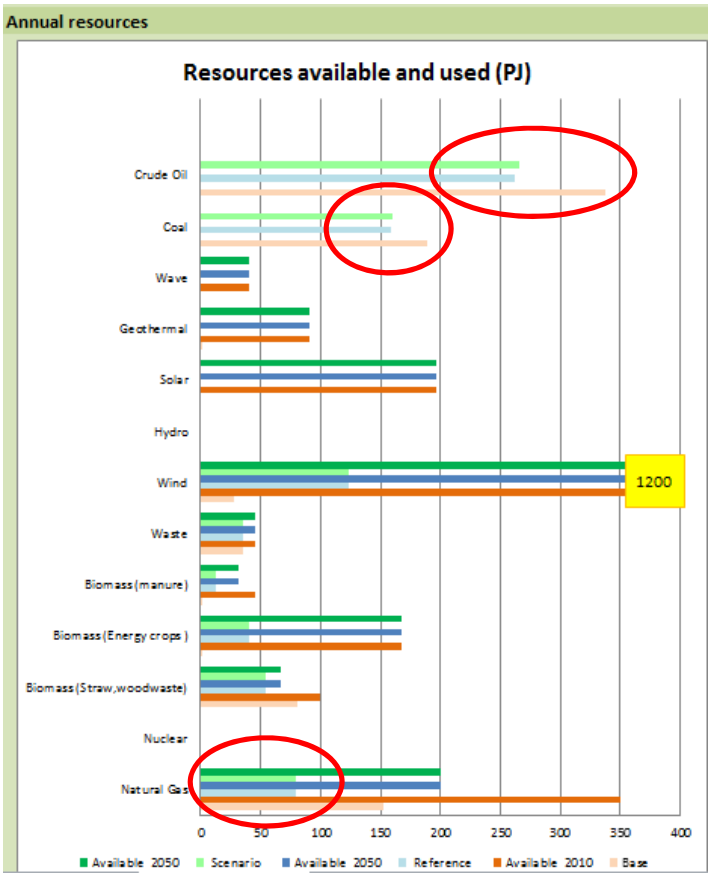
Composition of fuels for transportation means

	Base Electricity	Gasoline	Diesel	Sum	TJ fuel
Person					
Car	0%	80%	20%	100%	78,892
Bus	0%	0%	100%	100%	4,424
Train	50%	0%	50%	100%	3,469
Aviation & ferries	0%	0%	100%	100%	32,389
Goods					
Trucks and cargo vans	0%	0%	100%	100%	82,666
Train	65%	0%	35%	100%	122
Shipping	0%	0%	100%	100%	52,136
Aiviation	0%	0%	100%	100%	1,496
Fishery and agriculture					
Fishery	0%	0%	100%	100%	10,334
Agriculture	0%	0%	100%	100%	9,098

Fuel consumption:

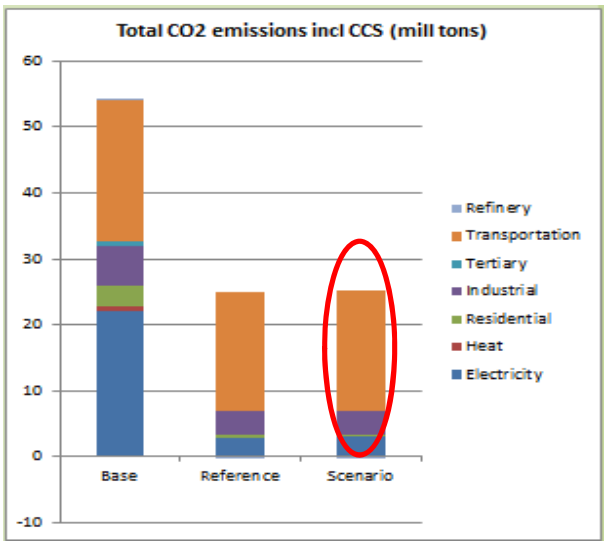


The use of fossil fuels increase slightly. Coal and natural gas usage increases because more electricity is used for cars than for buses in the 2050 Scenario.



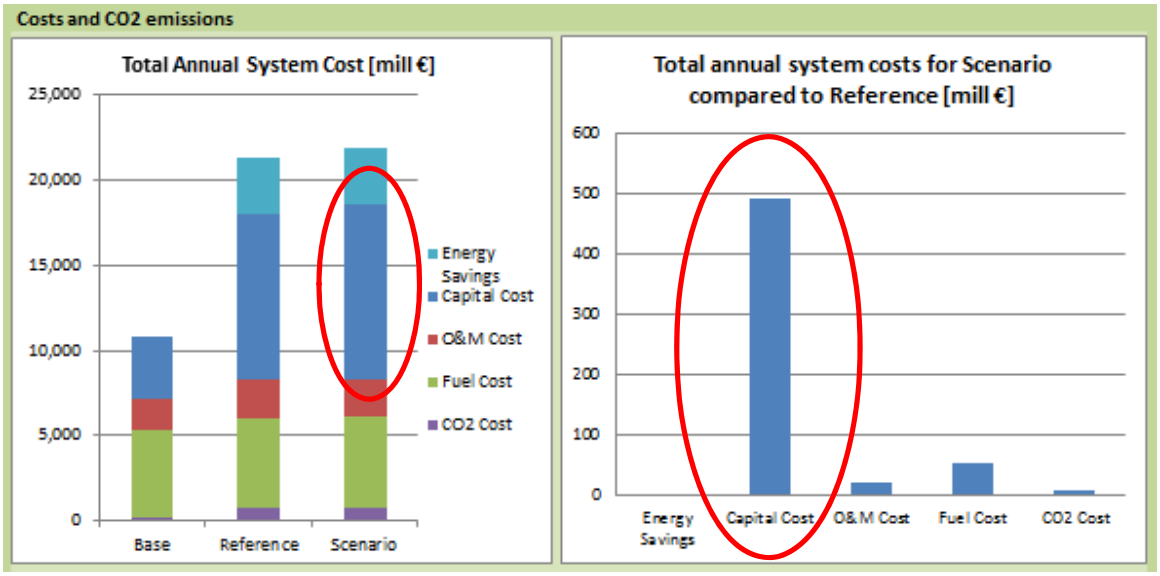
CO_2 emissions:

There is a slight increase in CO_2 emissions due to higher consumption of fossil fuel per person-kilometre.



Costs:

There is an increase in capital costs as cars are more expensive than buses per person kilometer.

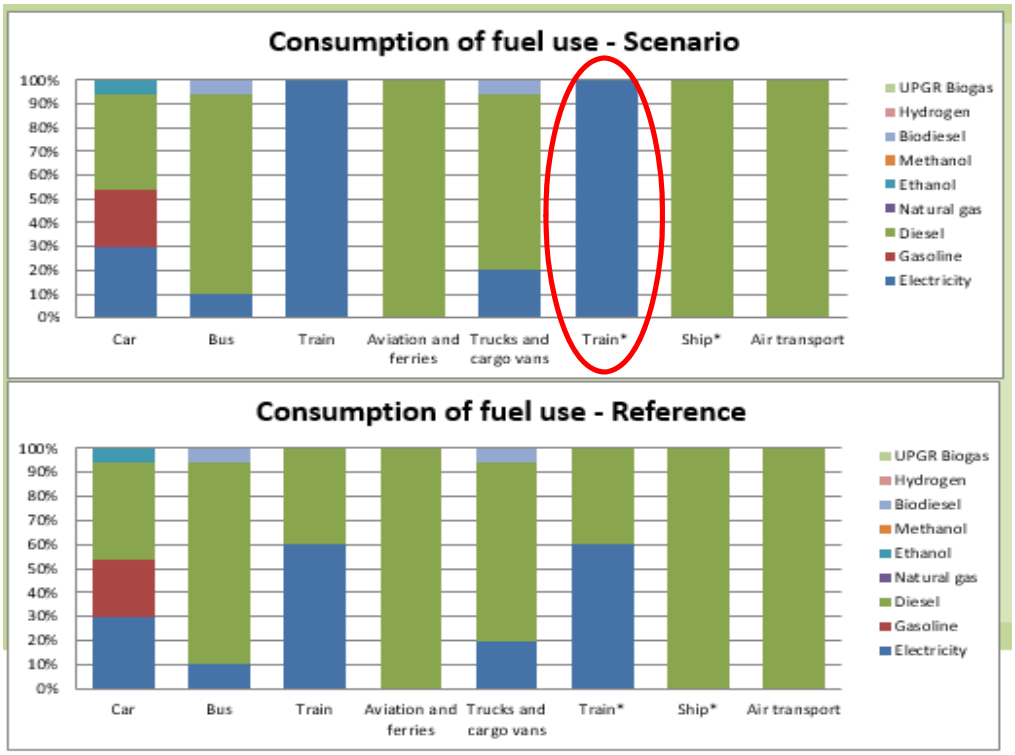


7. Increase the share of electricity used for trains to 100% in the 2050 Scenario. What are the effects?

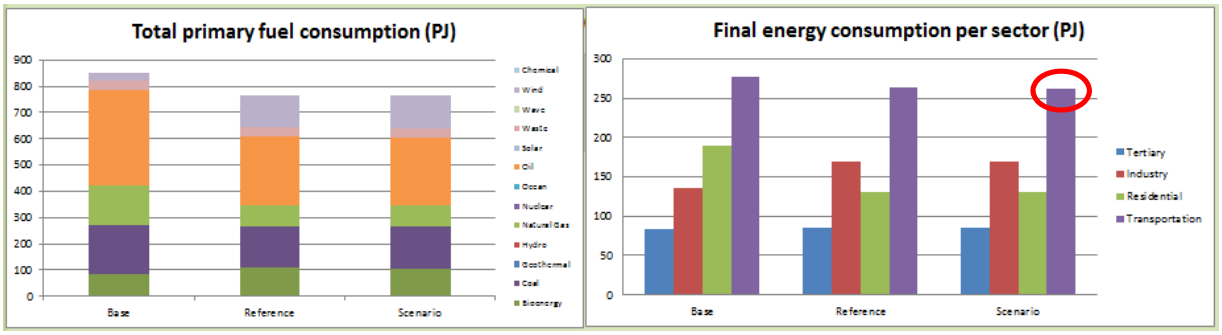
	Scenario										
Person	Electricity	Gasoline	Diesel	Natural Gas	Ethanol	Methanol	Biodiesel	Hydrogen	UPGR Biogas	Sum	TJ fuel
Car	30%	24%	40%	0%	6%	0%	0%	0%	0%	100%	40.032
Bus	10%	0%	84%	0%	0%	0%	6%	0%	0%	100%	6.487
Train	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	5.964
Aviation & ferries	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	27.148
Goods											
Trucks and cargo vans	20%	0%	74%	0%	0%	0%	6%	0%	0%	100%	86.171
Train	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	727
Shipping	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	60.136
Aiviation	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	1.652
Fishery and agriculture											
Fishery	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	17.866
Agriculture	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	14.889

Fuel consumption:

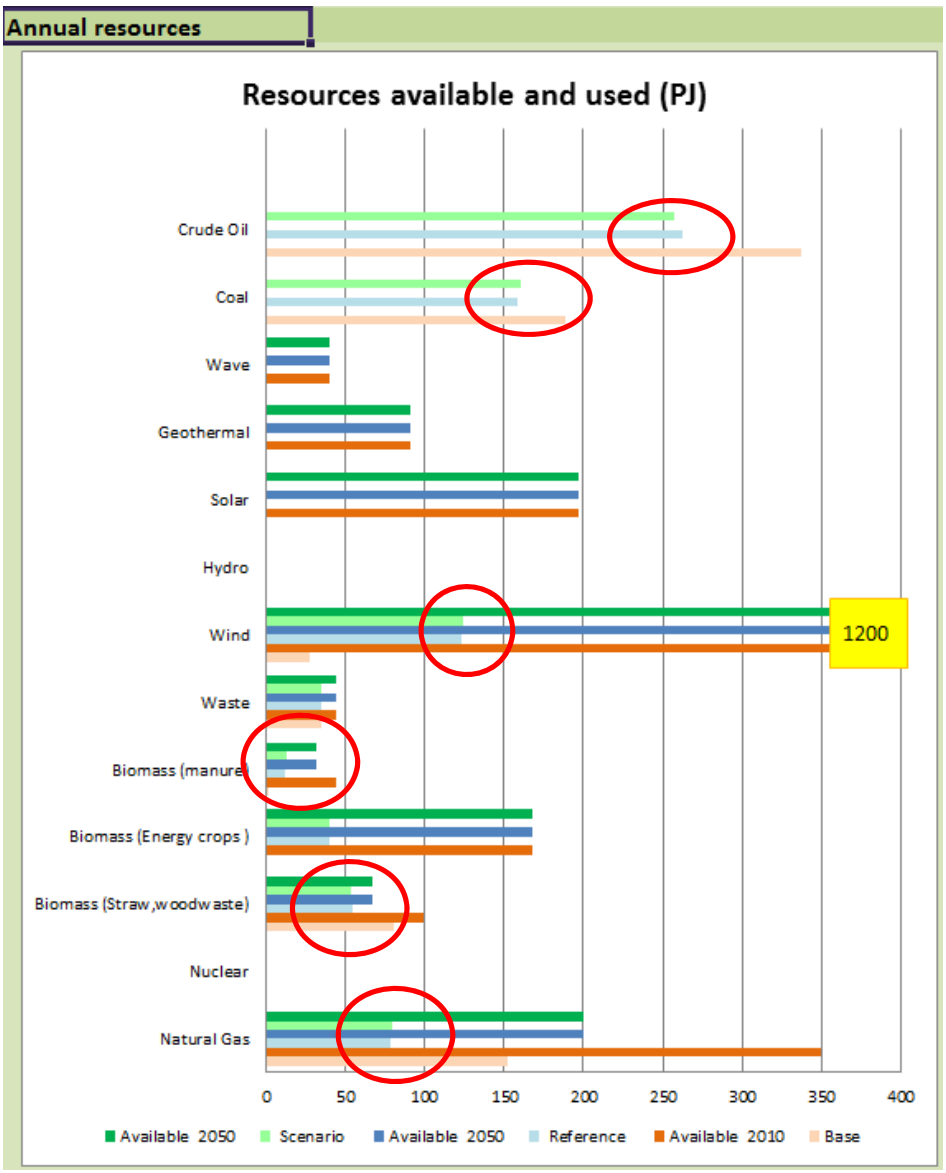
The change is obvious in the shares of fuel consumption for different vehicles.



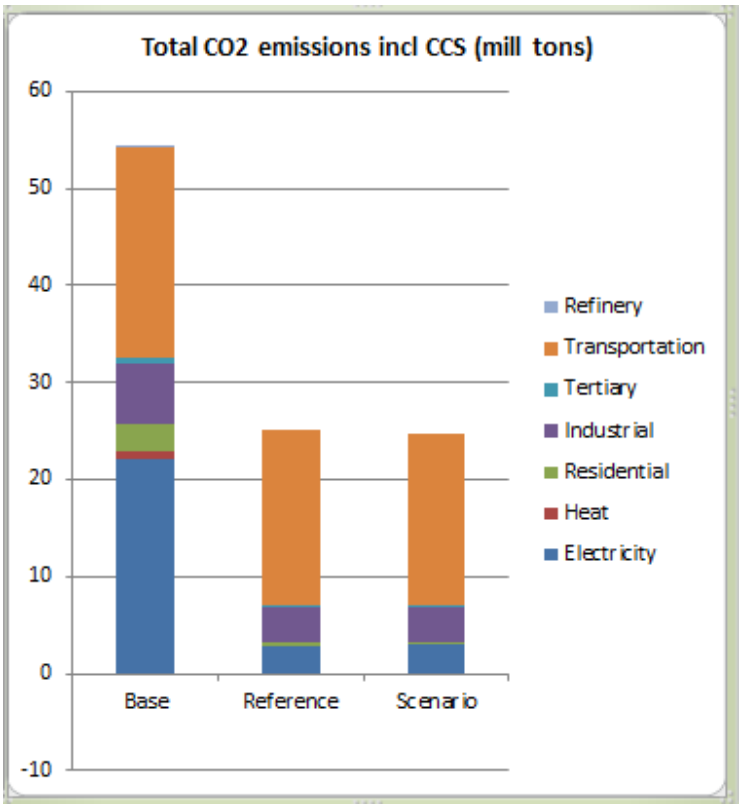
There is however only a small visible change in the fuel consumption.



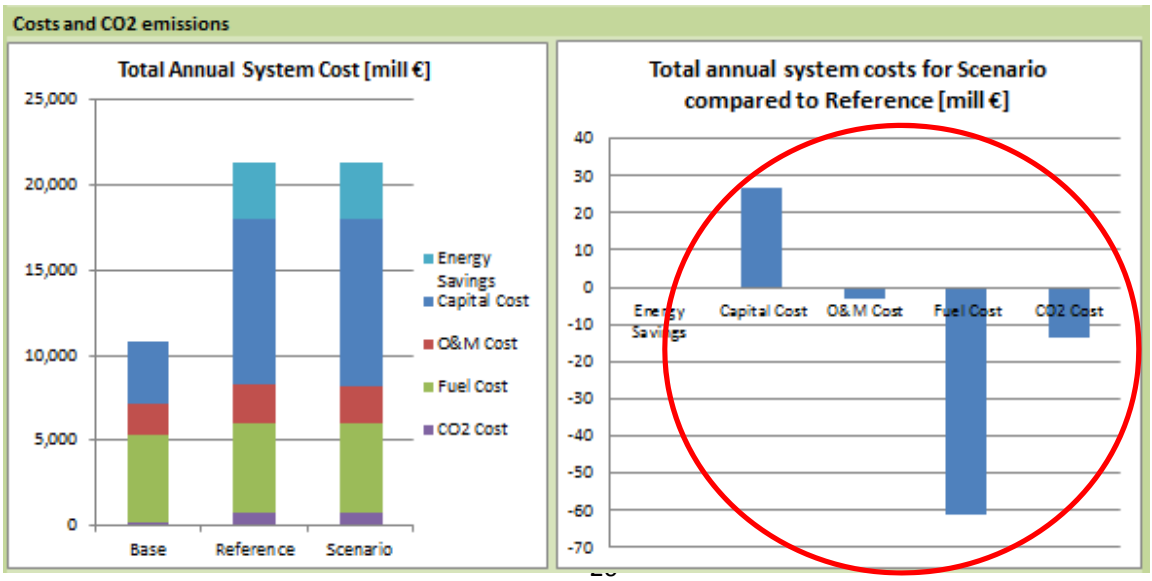
Resource Potential:



CO_2 emissions:



There is a slight decrease in CO_2 emissions; as electricity substitutes crude oil (diesel) and part of the electricity is provided by renewables sources (e.g. wind).

Costs:

The total costs are decreased due to lower fuel costs and emission costs in spite of higher capital costs.