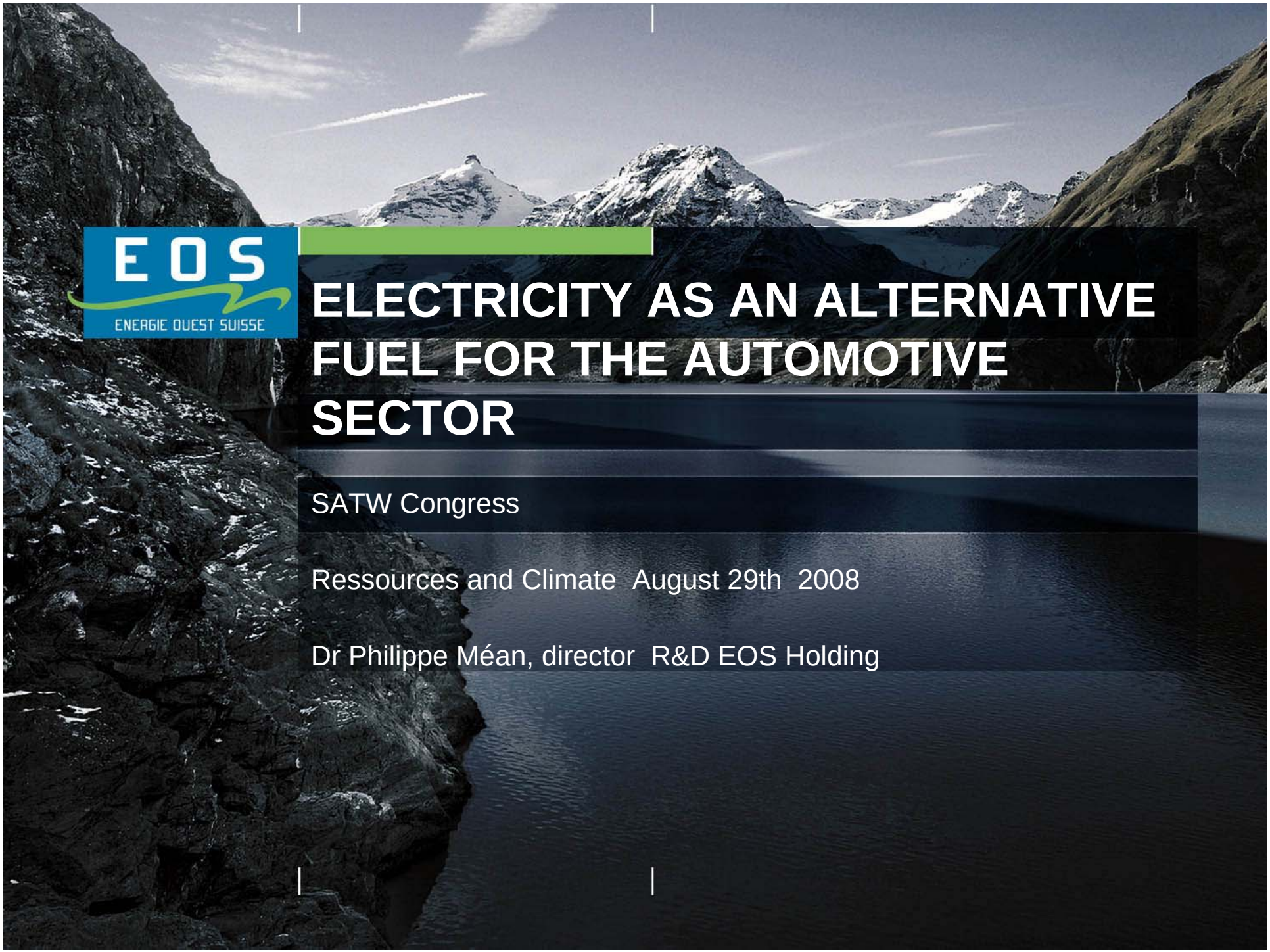


ELECTRICITY AS AN ALTERNATIVE FUEL FOR THE AUTOMOTIVE SECTOR

SATW Congress

Ressources and Climate August 29th 2008

Dr Philippe Méan, director R&D EOS Holding

EOS HOLDING


EOS Holding is a major Swiss company active in power generation, transport and marketing of electricity
85% of its Swiss fleet of generating units - one of the most flexible in Europe - are hydropower plants

Executive summary

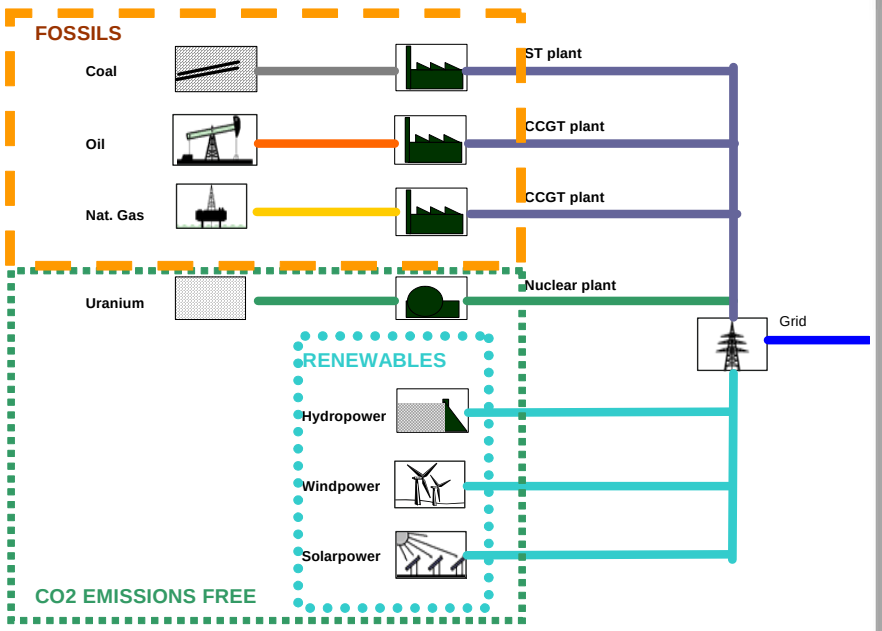
- **Battery Electrical Vehicles (BEV's) are a good solution for urban mobility**
- **Plug-in Hybrid Electrical vehicles (PHEV's) are a realistic alternative to current Internal Combustion Engine vehicles (ICEV's) for:**
  - **improving the well-to-wheel energy efficiency**
  - **reducing CO2 emissions**
  - **improving the air quality in urban areas**
- **The increased use of electricity in the transportation sector can contribute in mitigating the adverse effects of climate change and threats of peak oil, since electricity can be very :**
  - **flexible**
  - **energy efficient**
  - **environmental friendly**

FLEXIBILITY OF ELECTRICITY GENERATION

- **Electricity is not a primary energy**

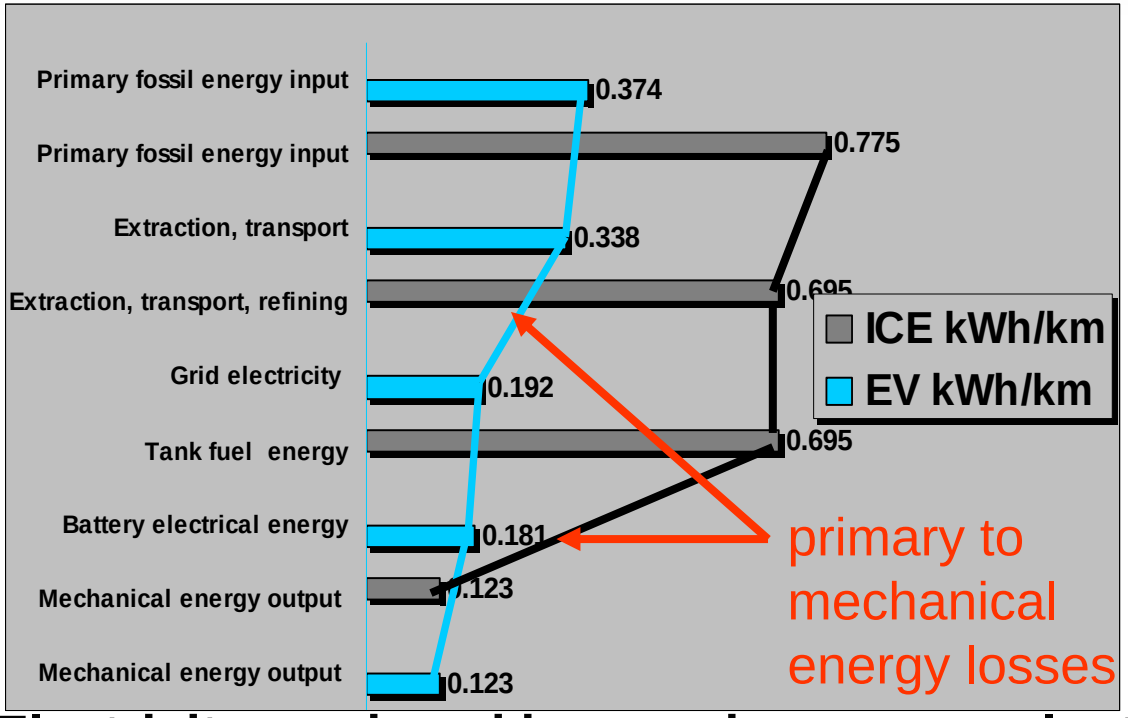
- **Electricity can be produced with all primary energies:**

  - ✓ **fossils**
  - ✓ **CO2 emission free**
  - ✓ **renewables**



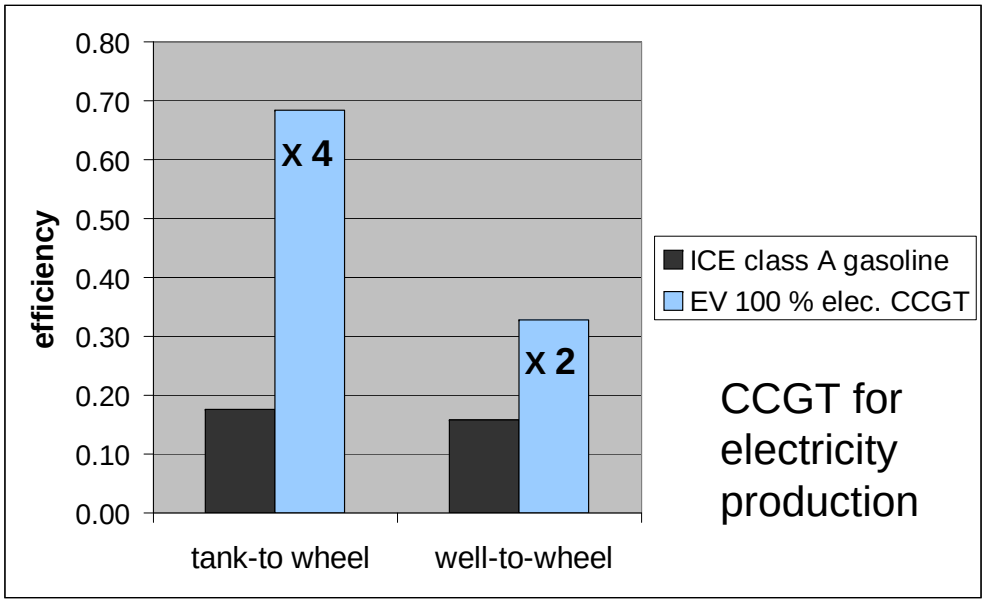
- **This flexible generation leads to a diversified production portofolio**
- **This diversification is by itself a serious risk mitigation against threats from peak oil & climate change issues**

EFFICIENCY IN THE TRANSPORT SECTOR



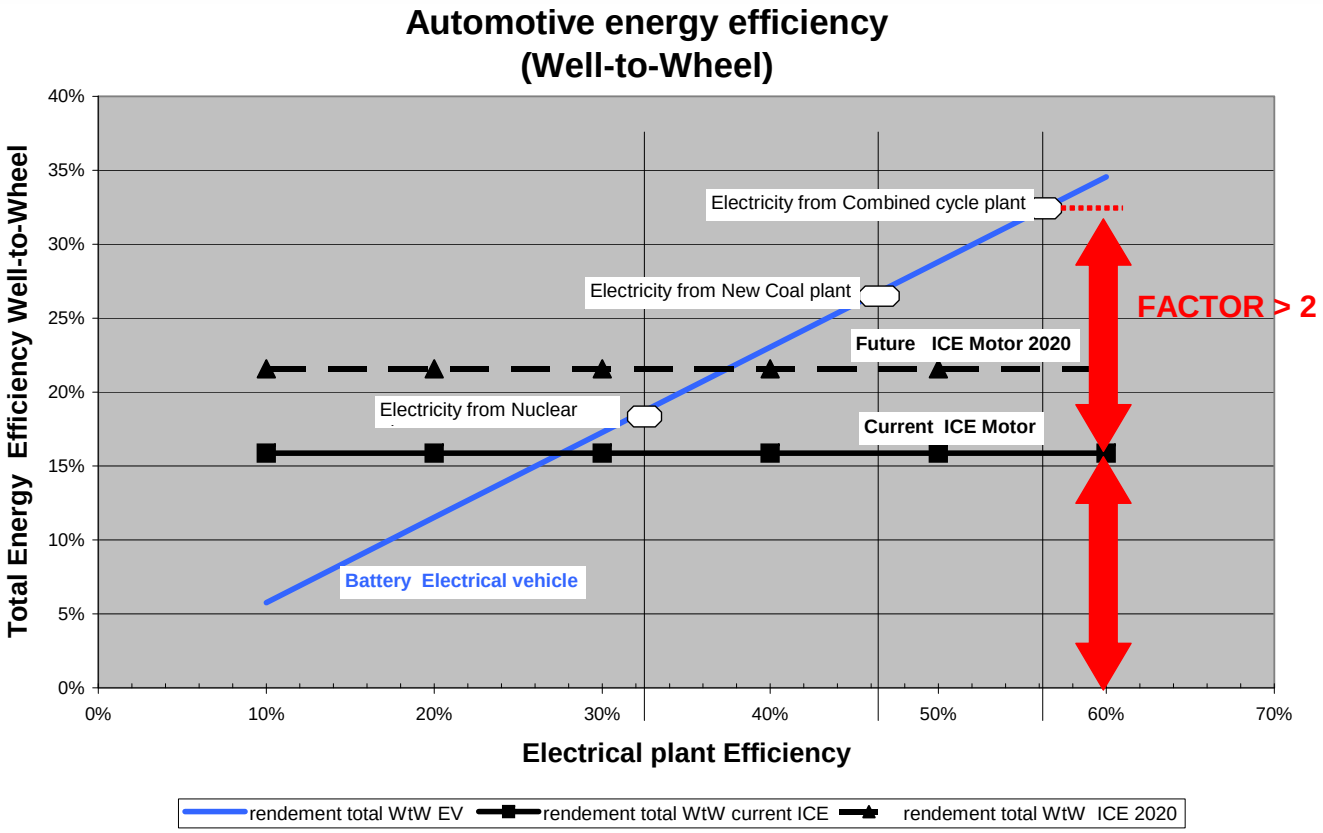
- **Electricity produced in a modern power plants is a very efficient way to power cars**
- **Example here: generation with a current gas fired Combined Cycle Gas Turbine (CCGT), class 400 MWe**

EFFICIENCY IN THE TRANSPORT SECTOR



- **Compared to standard ICE engine, electric vehicles (BEV's) are:**
  - **4 x more efficient tank-to-wheel**
  - **2 x more efficient well-to-wheel**

EFFICIENCY IN THE TRANSPORT SECTOR



- **With up-to-date generation technologies electricity remains very efficient in the transportation sector**

CO2 STABILIZATION CASE IN THE TRANSPORT SECTOR

For the International Energy Agency [1, in order to fight the adverse effects of climate change:

- ***"the savings in the transport sector should be achieved mainly through:***
  - ***improved efficiency of light-duty vehicles,***
  - ***increased use of bio-fuels .***
- ***the average car sold in 2030 should consume 60% less fuel than the average car sold in 2005***
- ***with current technologies, only plug-in hybrids are capable of such a reduction "***
- **(i.e. a car with only 3l / 100 km)**

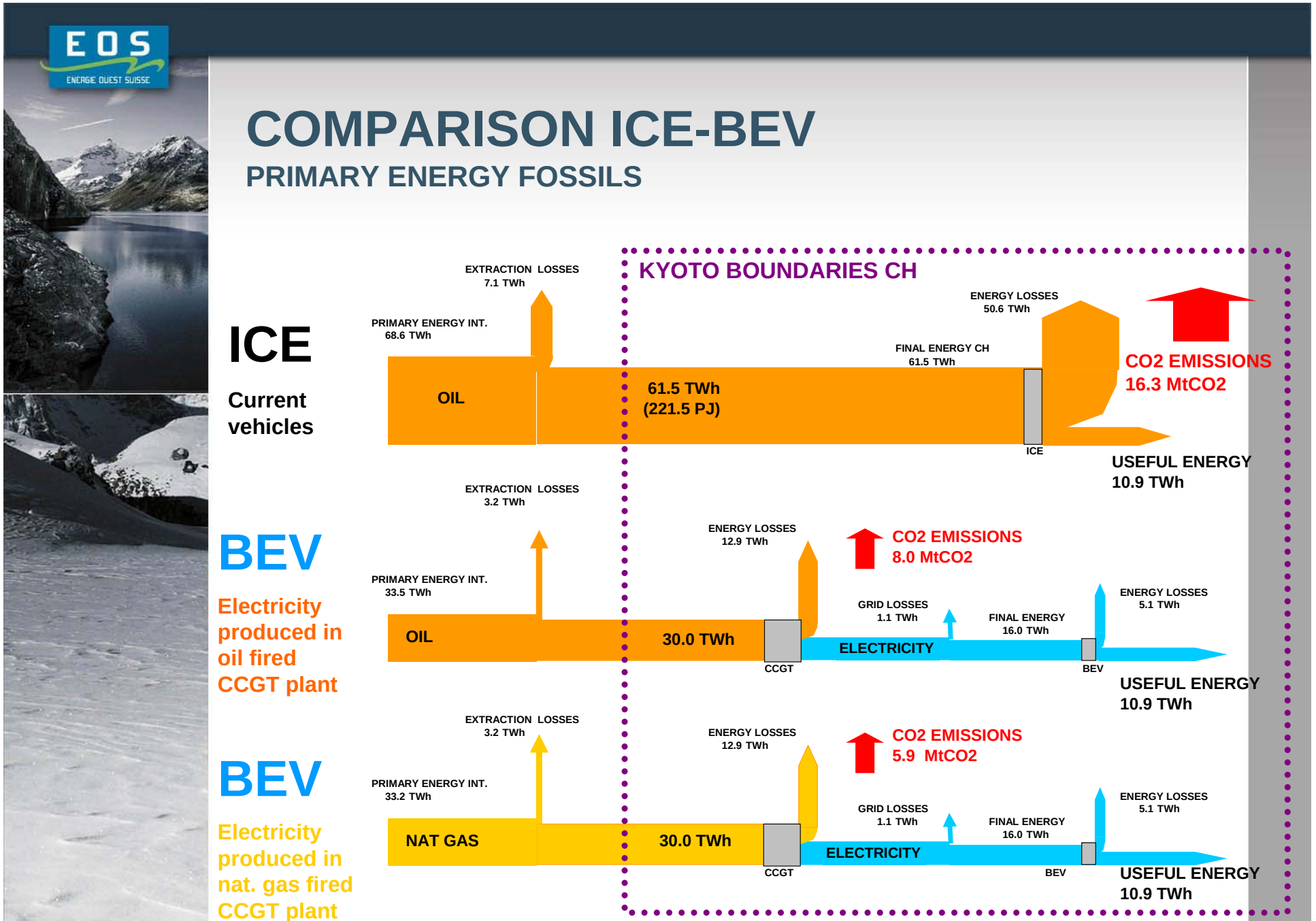
1) WORLD ENERGY OUTLOOK 2007 IEA 450 ppm stabilization case

ELECTRICITY AS AN ALTERNATIVE FUEL IN THE TRANPORT SECTOR

- **BEV's are 2 x more efficient well-to-wheel, but what does it really mean ?**
- **To fix ideas, the current Swiss situation 2007 in the transportation sector is compared with two theoretical cases:**
  - **100% of the 2007 demand in the automotive sector is covered with BEV's**
  - **same , but with PHEV's**
- **For clarity of argumentation only , the comparison is based on fossil primary energies.**
- **The 2007 energy demand for light-duty vehicles was 221.5 PJ (61.5 TWh) (public transports and international flights excluded**
- **The mechanical energy to meet the 2007 mileage demand is estimated to be 10.9 TWh (wheel useful energy)**

COMPARISON ICE-BEV

PRIMARY ENERGY FOSSILS

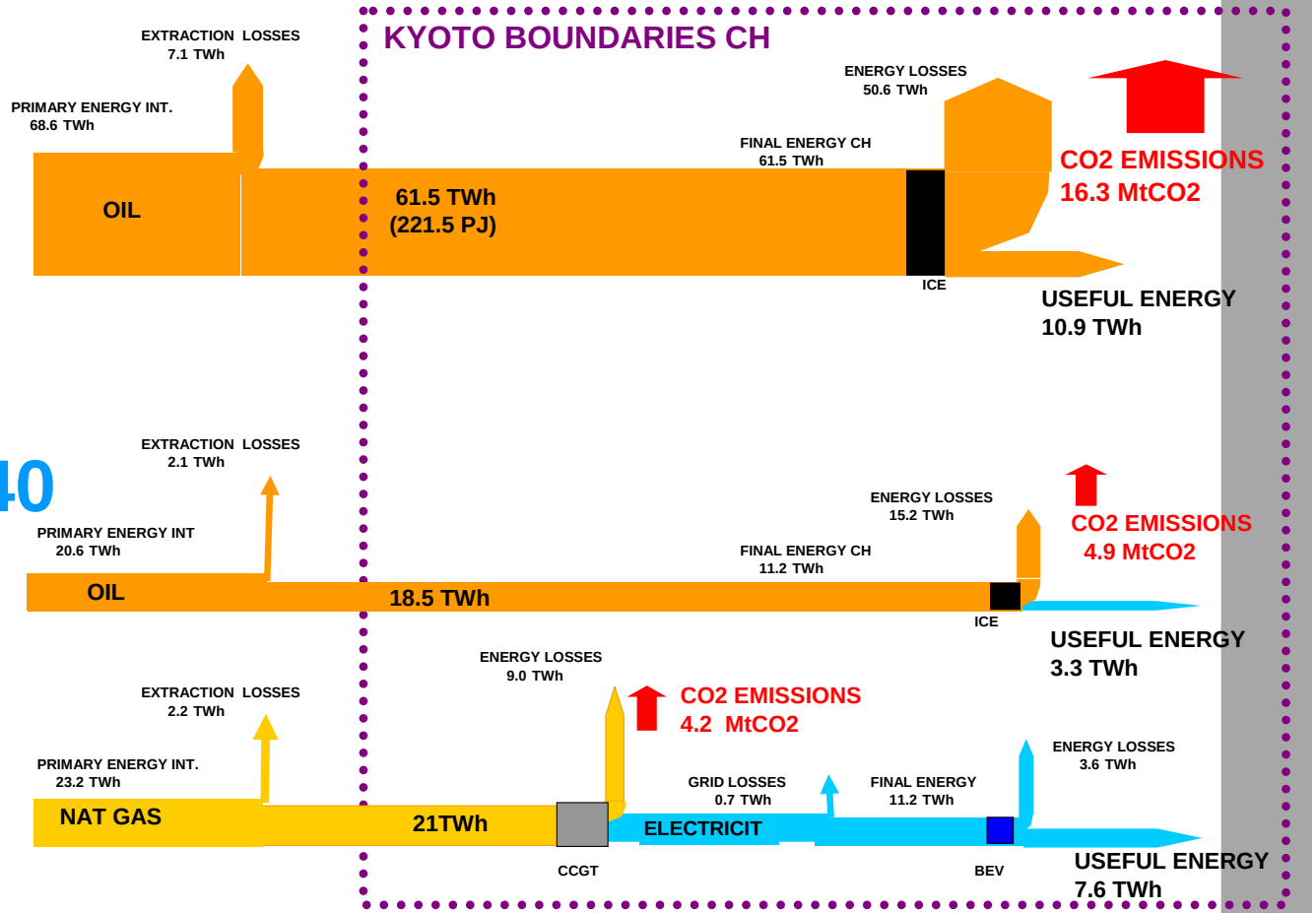


COMPARISON ICE-PHEV's

PRIMARY ENERGY FOSSILS

ICE

Current vehicles

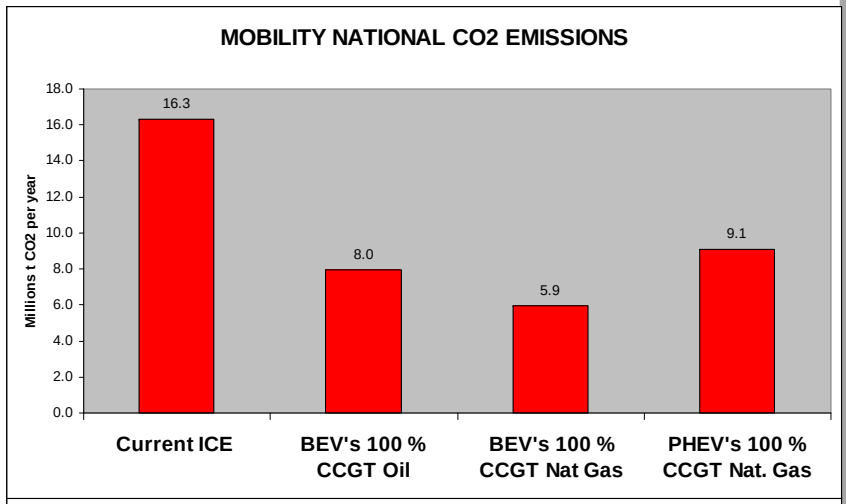


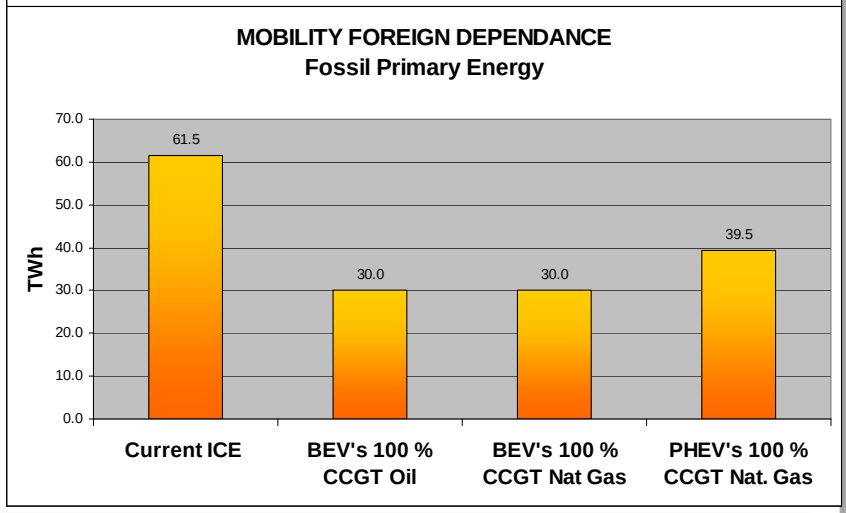
SIGNIFICANT IMPROVEMENTS

Even with fossile based state-of-art electricity generation, massive penetration of BEV's and PHEV's would allow:

•a drastical limitation of national CO2 emissions in the swiss transport sector

•a significant diminution of foreign dependance on fossil energies of Switzerland





REAL CASE 2020

- **Penetration of BEV's and PHEV's is a slow process.**
- **With optimistic asssumptions, the swiss total fleet of private cars could count 1 PHEV out of 4 ICE vehicles (that 25 % of 4 millions privates cars in 2007 conditions),**
- **the total emissions of CO2 (well-to-wheel) would be reduced by 11.4 % . This would meet the general CO2 reductions objectives set for the period 2010- 2020 by the Swiss Federal Government**
- **The increase in electricity consumption for the PHEV's would reach 2.9 TWh or 5 % of the end-use total electricity consumption in Switzerland (57 TWh)**

REAL CASE 2020

- **This increase of 2.9 TWh could be roughly produced by a 400 MWe modern combined cycle gas turbine (CCGT) fired on natural gas.**
- **Alternatives are possible :**
  - **with distributed photovoltaic electricity generation (for which the Solar Industry claims grid parity at 2020)**
  - **with 30 % of the production of a nuclear power plant producing no CO2 emissions;**
- **Optimum is probably a diversified generation portofolio, that is part CCGT(back-up for renewables and grid regulation), part photovoltaic (renewable) and part nuclear (low cost of production)**

CONCLUSIONS

- **Thanks to the high energy efficiency of PHEV's, electricity produced by fossil energy in modern power plants (i.e oil and natural gas in CCGT) offers a short term route to high volumes of "lower carbon fuel" in the transport sector**

- **Since it be produced with nearly all primary energies, electricity could also provide a path to shift to renewable and/or carbon free energy sources.**

- **For EOS, plug-in hybrid electrical vehicles (PHEV's) are indeed a realistic alternative for:**
  - **improving the well-to-wheel energy efficiency**
  - **reducing nationwide CO2 emissions**
  - **improving the air quality in urban areas.**