

# **Criteria for introduction of hydrogen in Norway - a modeling approach using MARKAL and infrastructure models**

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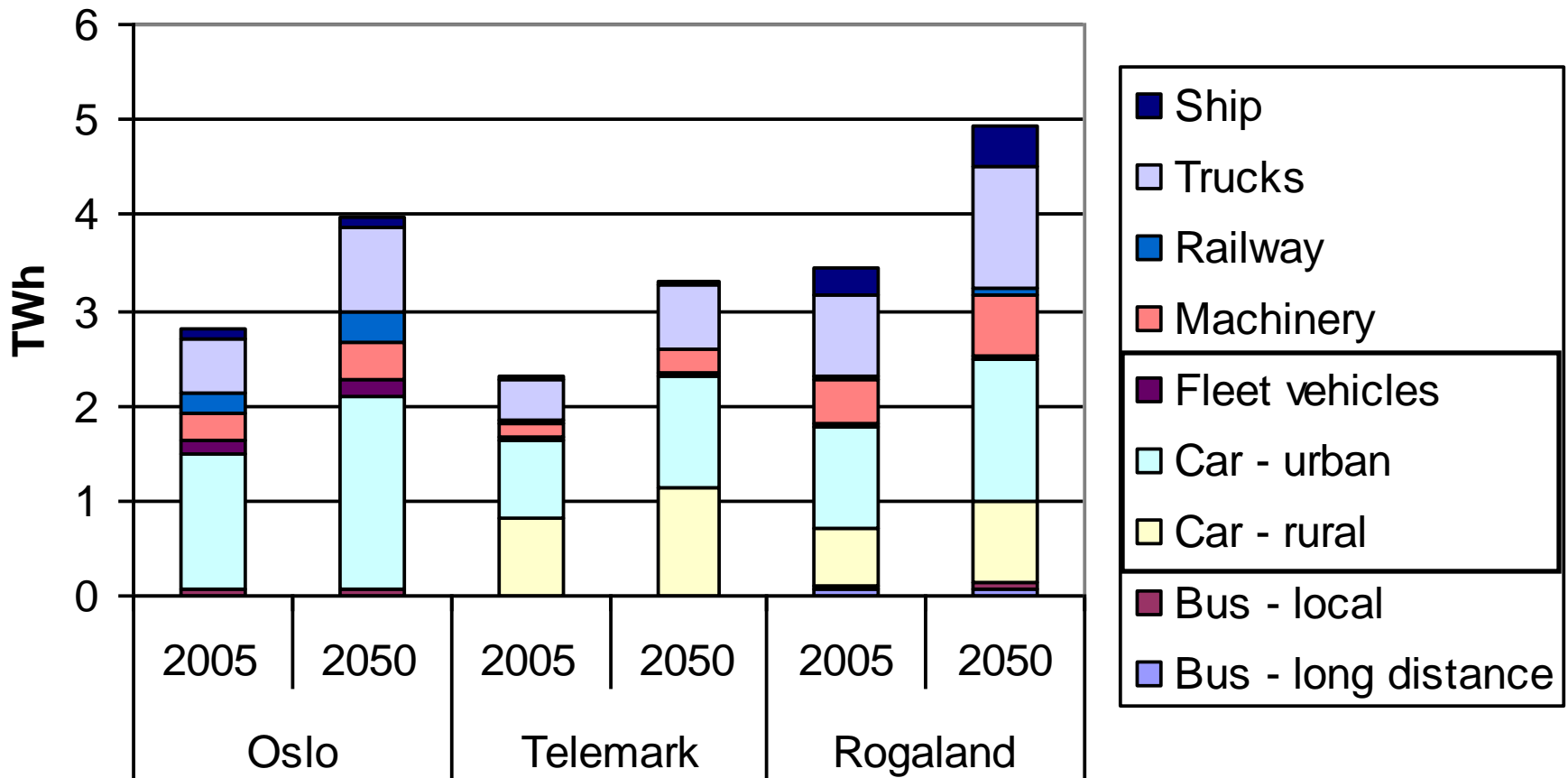
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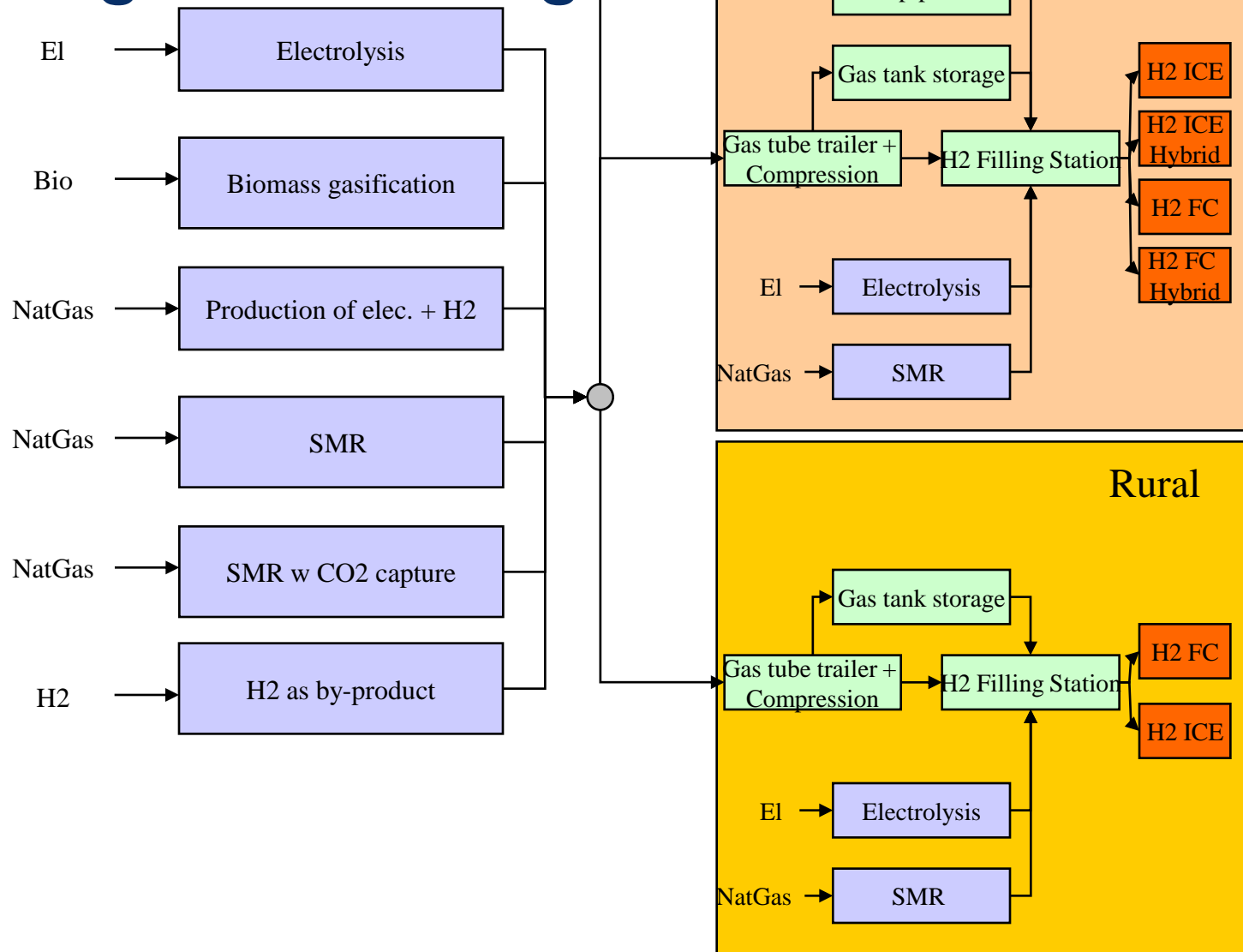
# Three regions selected for detailed analysis



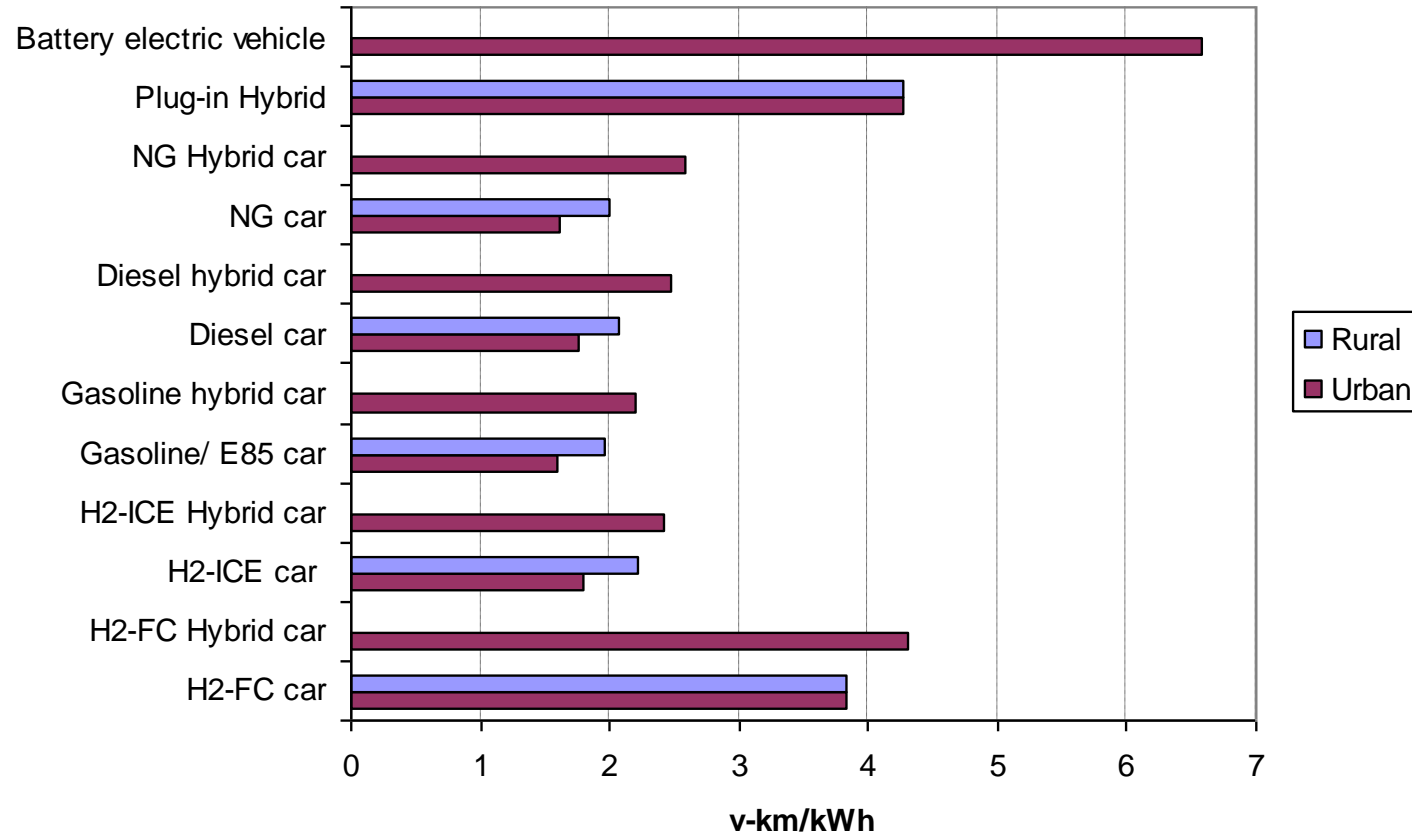
# Energy demand - transport sector



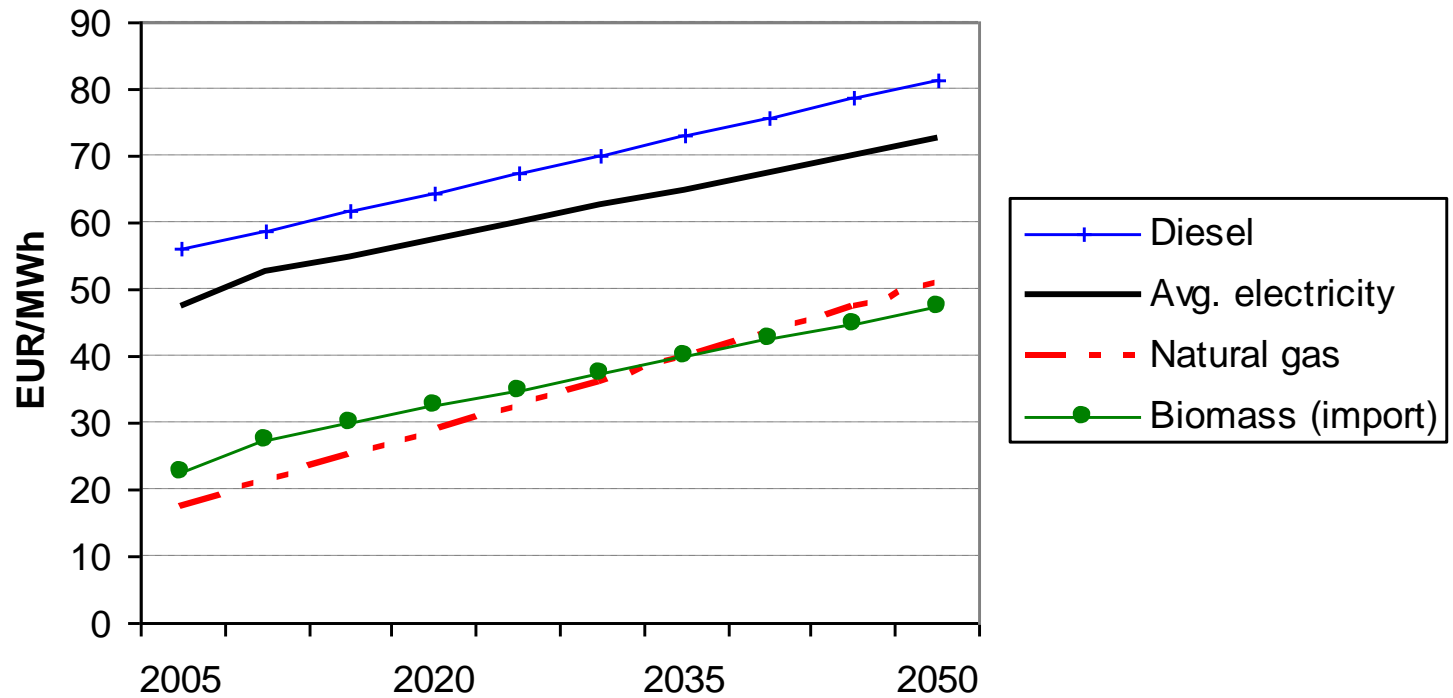
# Hydrogen modeling



# Car efficiencies- urban vs rural

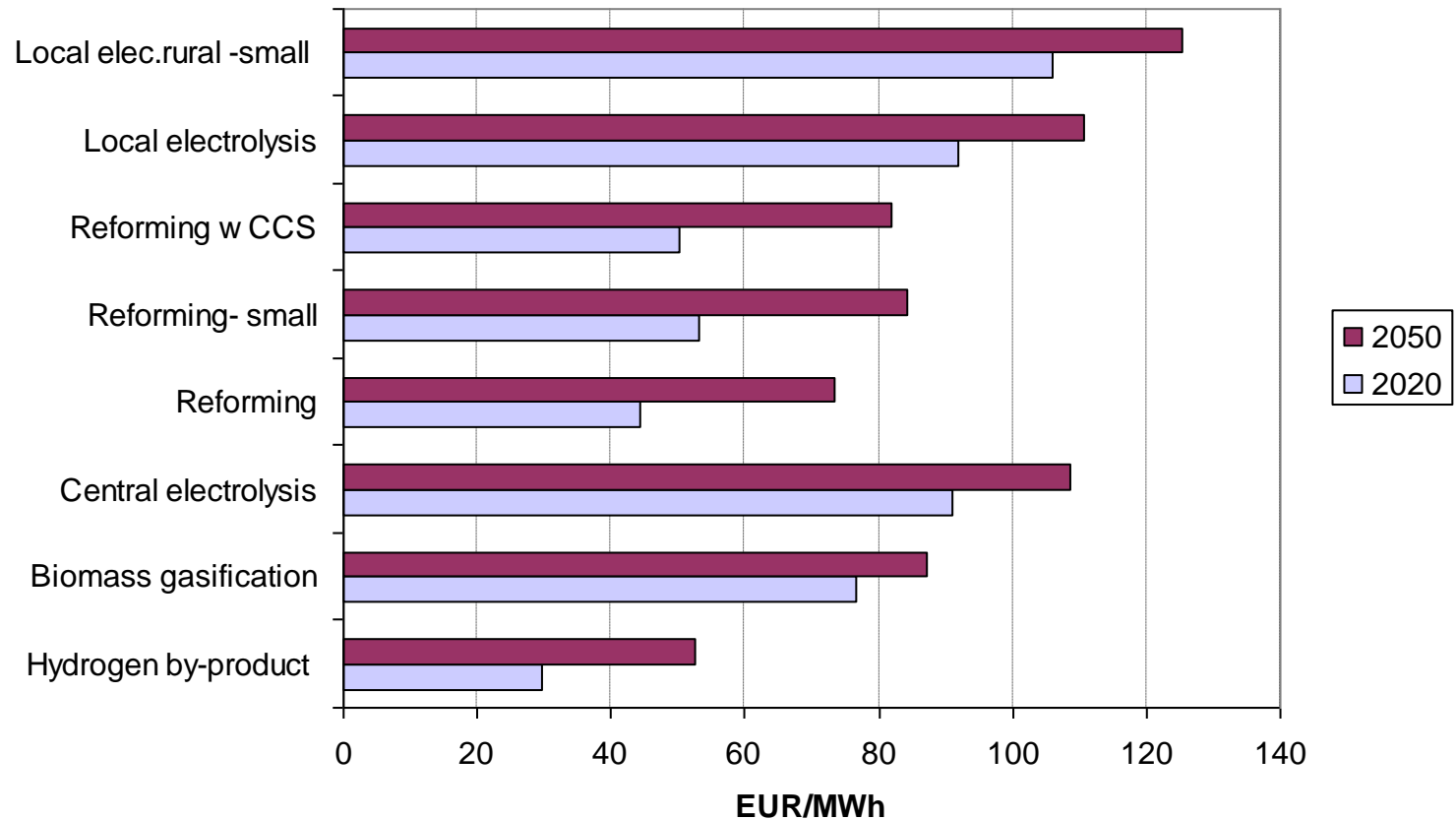


# Future energy prices

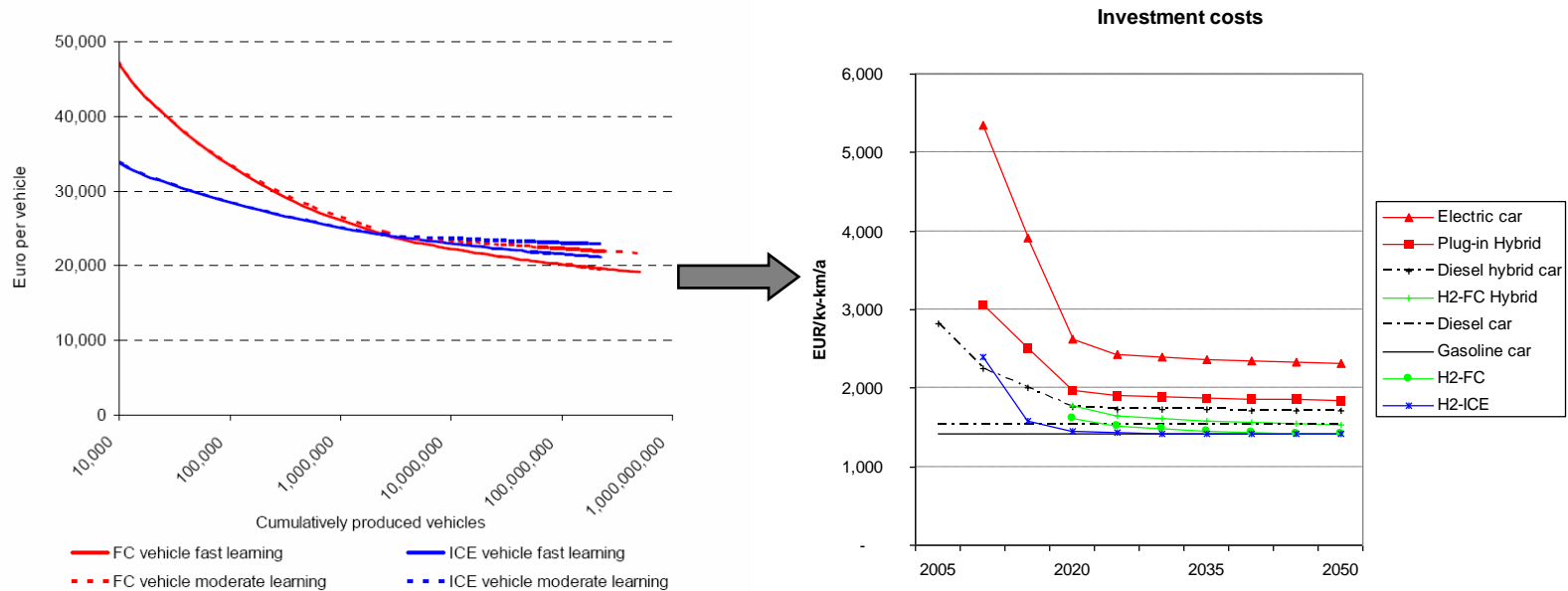


Source: WETO H2 and NorWays-project

# Hydrogen production costs

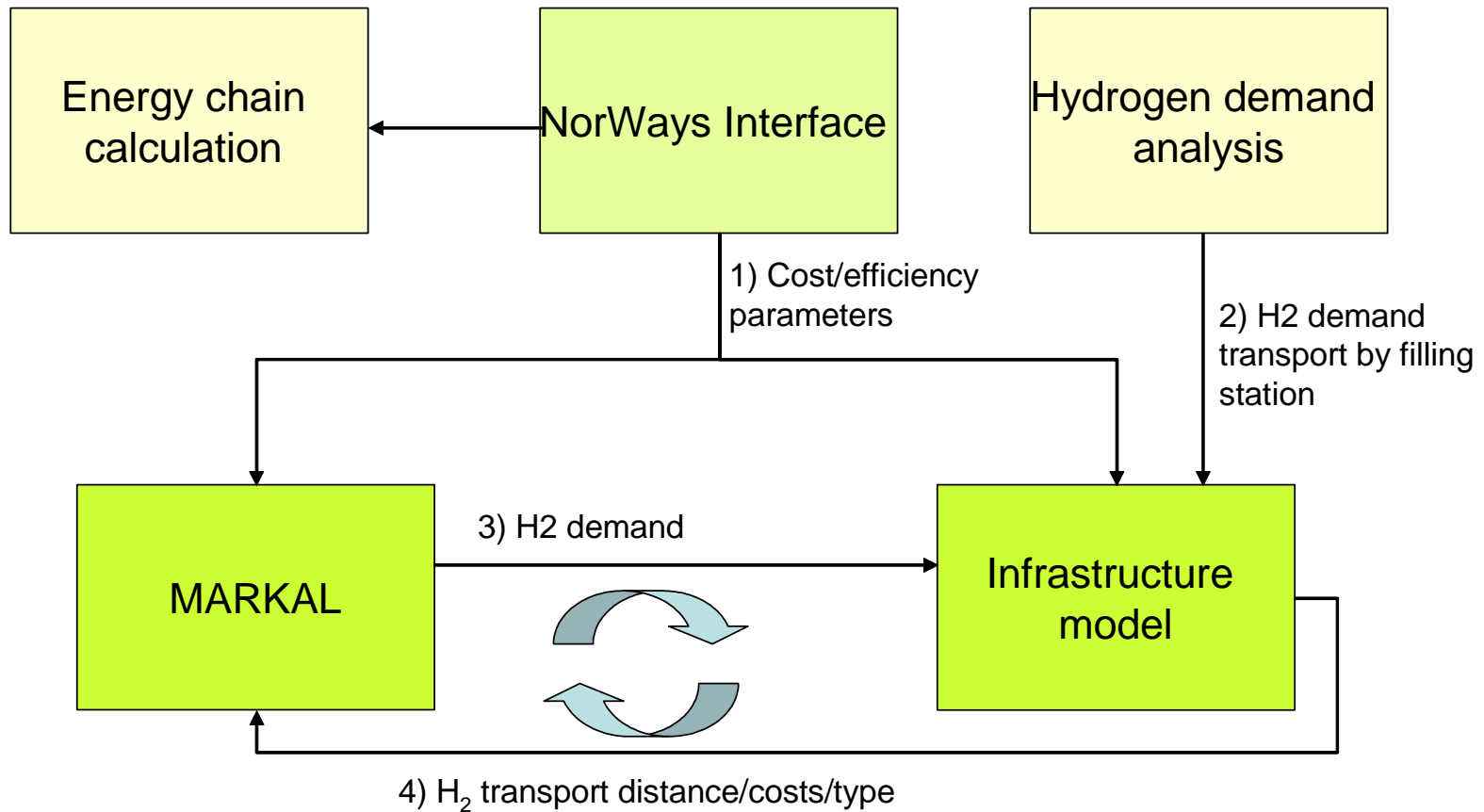


# Learning curves and deployment rates hydrogen cars



(Source: HyWays, The European Hydrogen Roadmap, [www.hyways.de](http://www.hyways.de))

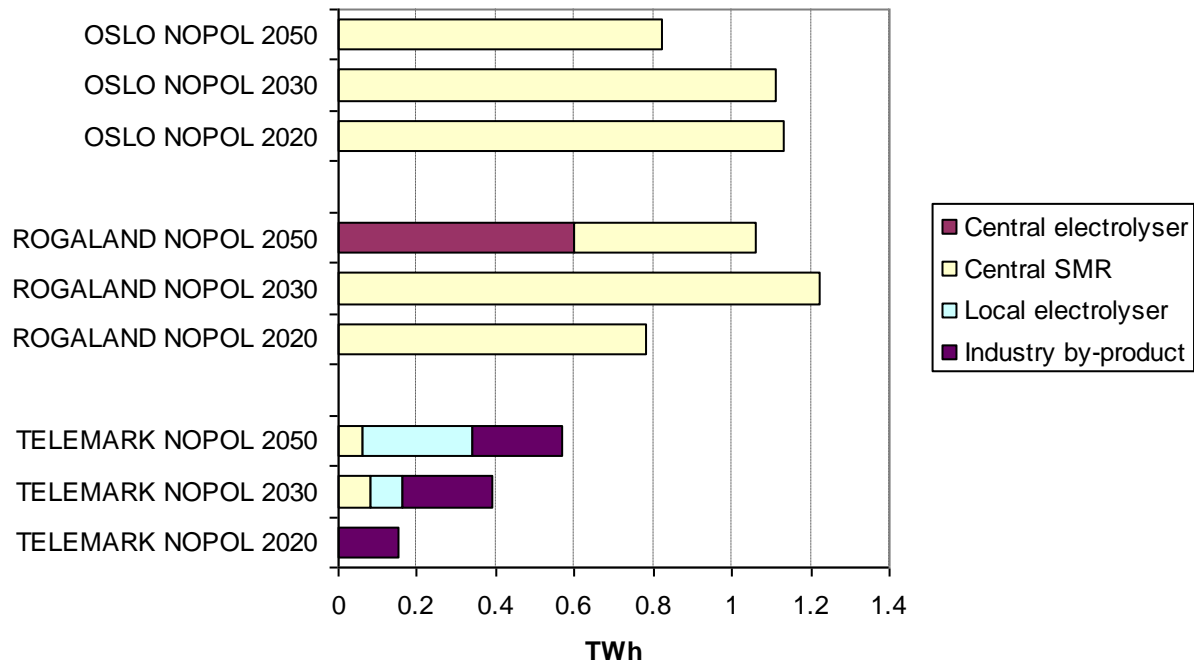
# Iteration method



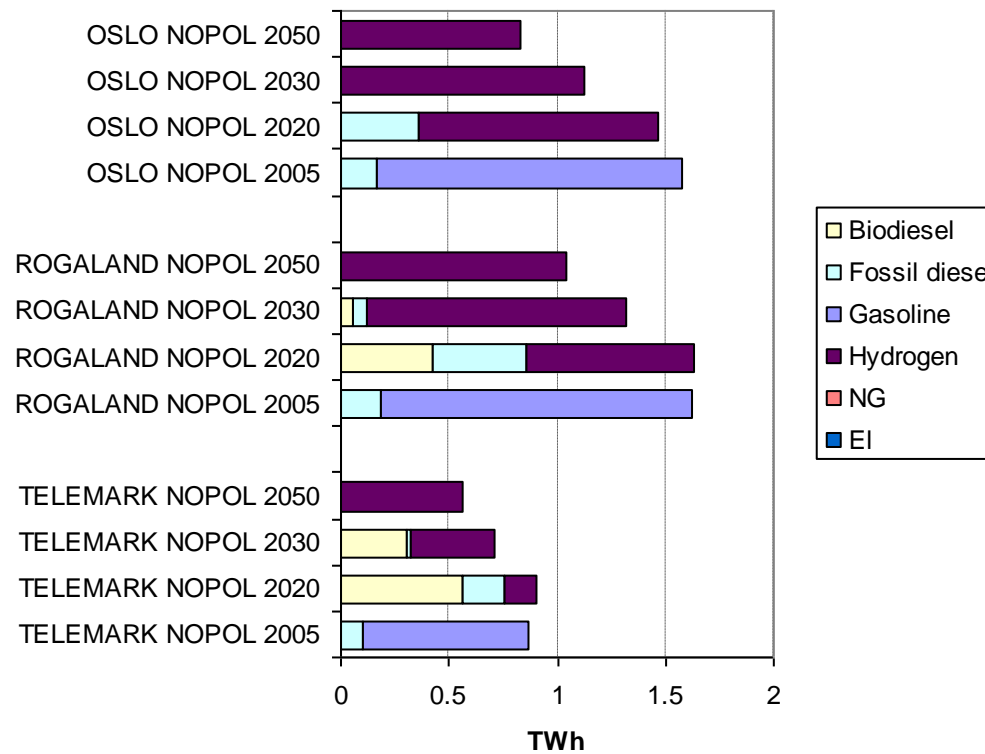
# Scenarios

- No policy changes (basic assumptions) **NOPOL**
- Taxation of the transport sector ("revenue neutral") **TAXNO**
- CO2 reduction scenario (75% by 2050) **CO2-R**
- Sensitivity analysis on the No policy changes
  - Oil and gas prices (eg oil price increase to 200 \$/bl) **OIL200**
  - Investment cost of cars (increased H2 and reduced EV) **CARSENS**
  - Hydrogen production costs and availability
  - Biomass availability (eg import restrictions/by-product)

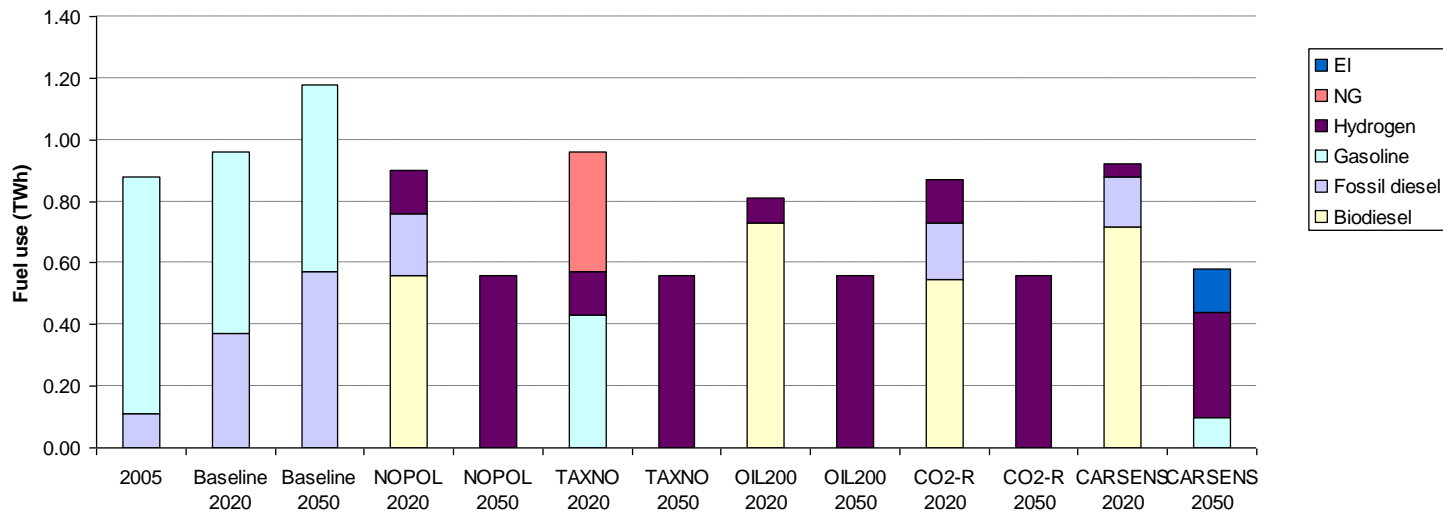
# Hydrogen production- all regions



# Transport energy use- all regions



# Transport energy use in Telemark - scenarios



# Conclusions (all regions)

- Large efficiency gains in the transport sector are foreseen due to use of hybrids and H2 FC
- With learning curves and deployment rates applied here; H2 FC in all regions by 2050
- With less optimistic deployment rates → biofuels and (plug-in) hybrids the predominant options
- Production of hydrogen from SMR is an intermediate option if sufficient electricity is available in the region