Possible Development of the Croatian Energy Sector until 2050 under Carbon Dioxide Emission Constraint

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Which Possibilities offer Renewable Energy Sources in Croatia?

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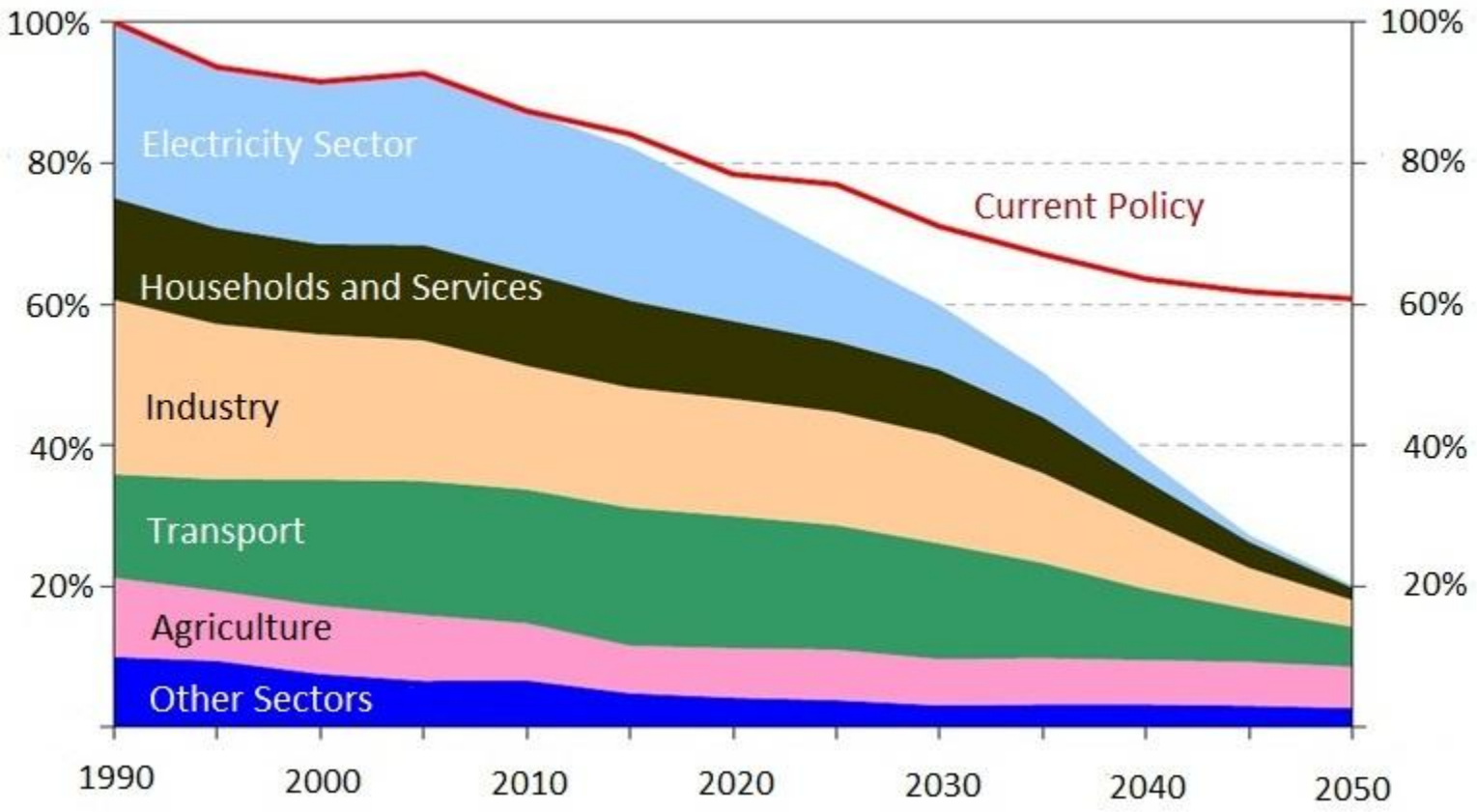
Reduction of CO_2 Emission vs. Development

- ***Is it possible and with what consequences to reduce CO_2 emission by 80 % until 2050?***
- The answer is **YES;** early identification of goals and conditions for their realisation until 2050, opens a possibility to create Development Strategy for science, economy and technology based on new technologies and innovations.

EU Vision for Emission Reduction

- EU goals till 2020
  - At least 20-20-20
  - More if other UNFCCC parties accept the initiative
- EU plans till 2050
  - To reduce GHG emission by 80% compared to the base 1990
  - To adequately value costs of impacts on environment and depletion of natural resources

Existing Policies in EU are not Enough



Source: European Commission, A Roadmap for Moving to a Competitive Low Carbon Economy in 2050, 2011

Achieved and Needed Emission Reduction

	2005	2030	2050
Electricity Sector	-7%	-54 do -68%	-93 do -99%
Industry	-20%	-34 do -40%	-83 do -87%
Transportation	+30%	+20 do -9%	-54 do -67%
Households and Services	-12%	-37 do -53%	-88 do -91%
Agriculture	-20%	-36 do -37%	-42 do -49%
Other	-30%	-72 do -73%	-70 do -78%
Total	**-7%**	**-40 do -44%**	**-79 do -82%**

Source: European Commission, A Roadmap for Moving to a Competitive Low Carbon Economy in 2050, 2011

- Key role of electricity
  - Increased usage in all categories of consumption
  - Electricity generation without CO_2 emission

An Analysis of Croatian Energy Sector

- Simulation-optimisation model for development of Croatian energy sector till 2050
  - Simulation of final energy consumption scenarios and applications of measures in different sectors
  - Optimization of electricity production system
  - Achieve by iterations desired 80% reduction of CO_2 emission compared to 1990

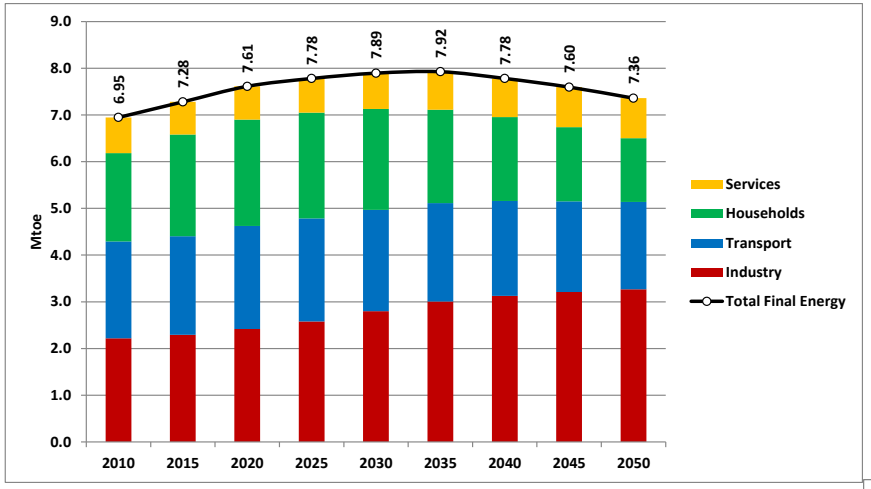
Demand and Development Assumptions until 2050

- Gradual decrease in population to 3.86 million (*UN Population Division*)
- GDP per capita increases by 5.5 times to 30 000 USD_{2000}
- Increase of useful energy demand in industry as the main driver of economy
- Electricity and CNG in freight transport
- Share of electrical cars of 50%
- Half of the household dwellings are newly constructed and half have increased thermal insulation. Heat losses are decreased to 27kWh/m^2 of heated area
- 90% of households use modern biomass, heat pumps or district heating systems for space heating; 30% of hot water preparation is by solar-thermal systems
- Area of service sector will increase and heat losses should decrease to 25kWh/m^2

Main Guidelines for Development of Electricity Generation

- Allowed increase of CO_2 emission till 2025 (up to about 7.8 Mton) and then gradual decrease to 0.5 Mton in 2050
- Nuclear option was not explored
- Remaining hydro potential to be developed
- Up to 5000MW in wind; Off-shore locations beyond 2030
- Commercial use of CCS in thermal plants beyond 2020
- Thermal-solar power plants (CSP) after 2020; Potential till 2050 estimated to 1500 MW; Specific investment costs decrease by 40%

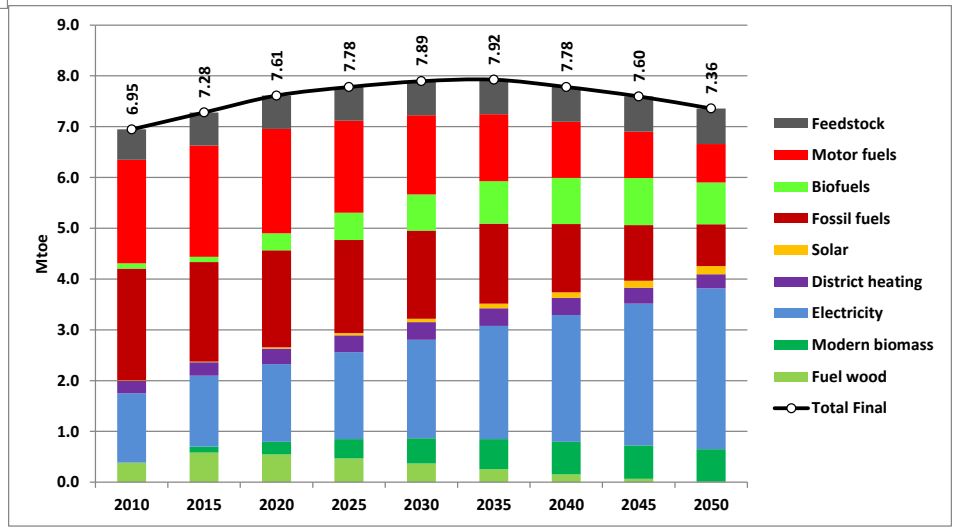
Final Energy Demand



Final energy demand in various sectors; Source: EIHP

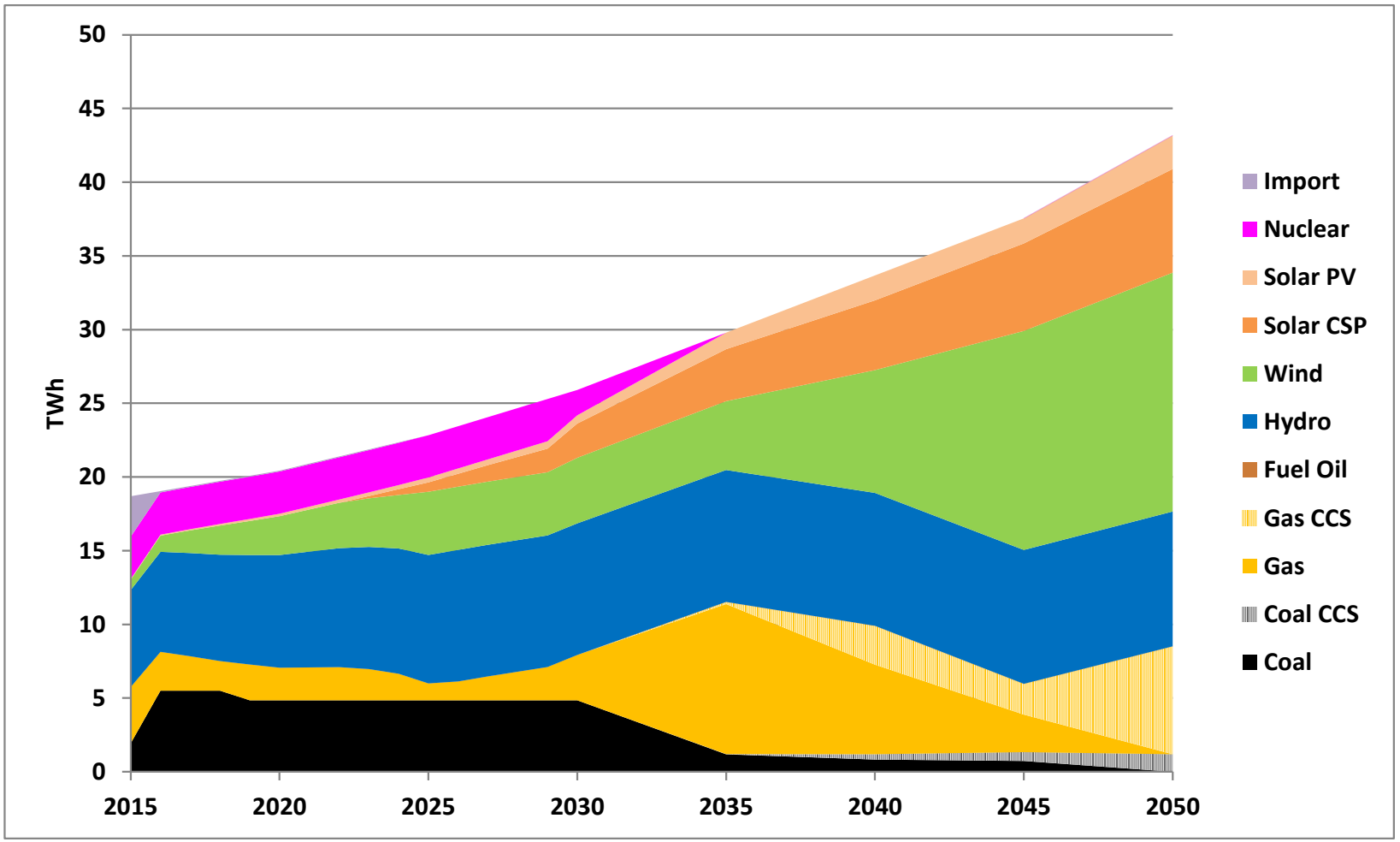
- Slight increase of final energy till 2035
- In 2050 final energy demand is 5.9% higher compared to 2010
- Decrease of final demand in transport and households; Increase in service sector
- Highest increase in industry

- Final electricity demand increased by 130% or by 2.1% annually
- Share of biofuels in transportation has to increase to 80%
- Modern biomass substitutes fuel wood
- RES share in final consumption is 22.2% (total 55.3%)



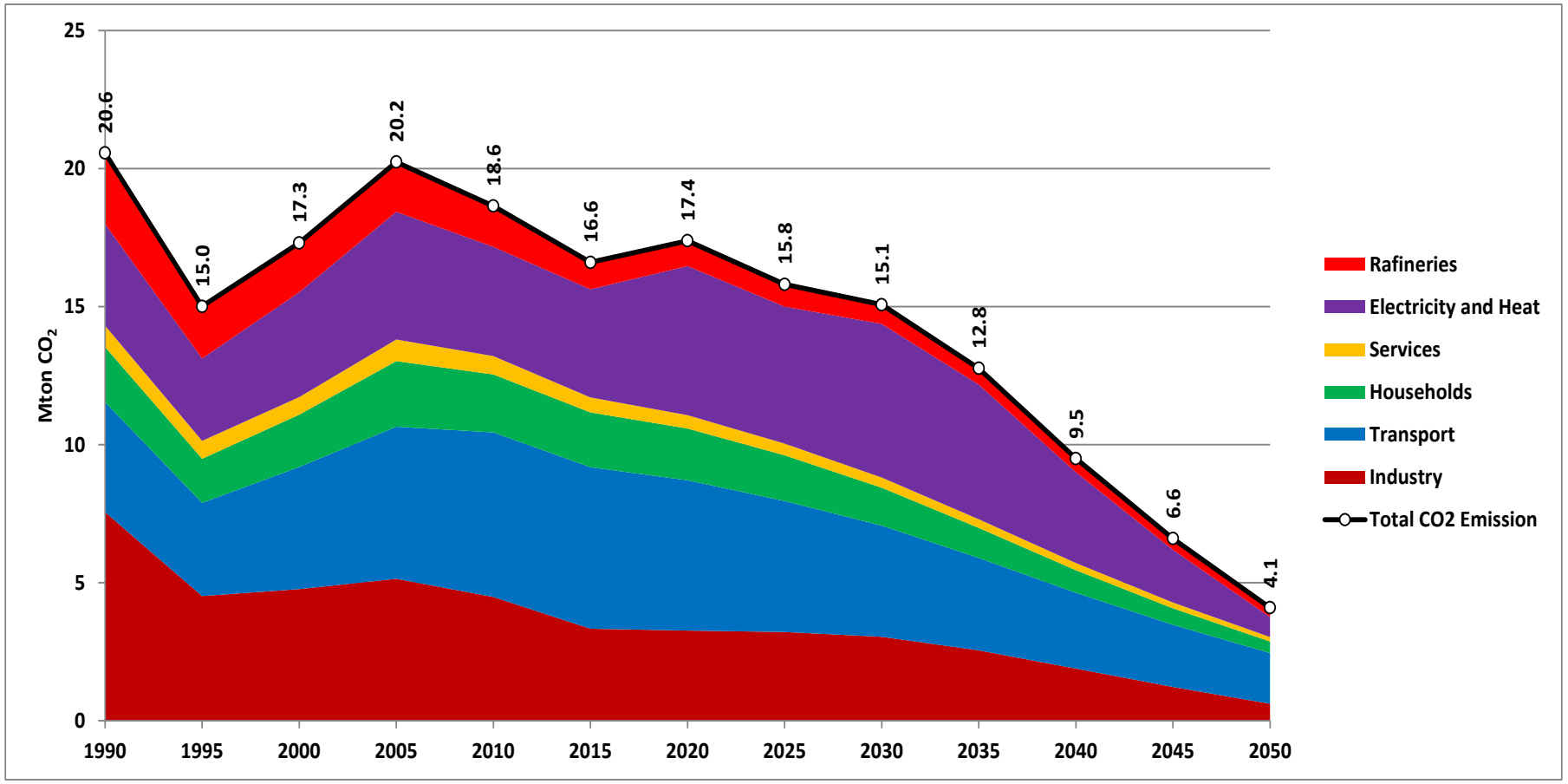
Final Energy Demand in various fuels; Source: EIHP

Structure of Electricity Generation



Source: EIHP

CO_2 Emission from Electricity Generation



Source: EIHP

Messages of the Analysis

- Improvement of thermal insulation will require strong legislation and significant incentives
- Increased use of modern biomass, geothermal and solar energy at demand side will also require incentives
- Share of biomass, geothermal and solar energy in district heating systems has to be increased to 80% by 2050
- 50% of electrical cars in 2050 requires complete change of transportation infrastructure and adjustment of electricity system
- In 2050 share of biofuels in transportation reaches 80%
- There is a turn around in oil refineries operation, which gradually decrease throughput to only 1.23 Mtoe of crude oil by 2050
- Industries using natural gas should increase penetration of CCS technologies to 80% by 2050

Electricity System

- In 2050 all power plants are based on technologies without, or with very low CO_2 emission (wind, solar, hydro and CCS in fossil fuel based plants)
- CO_2 emission from electricity and heat generation is decreased by 80% compared to the base year (i.e. to 0.72 Mt)
- Investment into power plants until 2050 estimated to 31.9 billion EUR, of which 75% beyond 2030
- Total investment in RES technologies till 2050 estimated to 26.5 billion EUR
- Average cost of electricity generation in 2050 increases by 140% compared to 2015
- ***Dynamics of required CO_2 emission reduction in electricity generation beyond 2030 is extremely demanding in terms of preparation activities, investments volumes, changes needed in system and identification of a sustainable electricity market model and organisation which should enable such a fast and significant structural evolution***

Conclusions

- Concept of energy sector development almost without CO_2 emissions will drastically change energy sector from the choice of primary energy forms, energy generation, transmission, transportation and distribution to energy consumption
- From technical and technological point of view it is possible to achieve reduction of CO_2 emission by 80% until 2050 compared to the base 1990
- Necessary conditions
  - Existence of unified energy market in the Europe and unified global approach to the problem of CO_2 emission reduction;
  - Leaving behind current model of financing RES and giving them better position on the market, emission trading and financing of energy efficiency and taxing of certain emission levels;
  - Creating unified system of taxing of CO_2 emission as a measure of achieving the goal of climate protection;
  - Creation of a specific fund from taxing CO_2 and financing measures and technologies for CO_2 emission reduction as energy efficiency, RES, CCS technologies, new technologies in transport, etc.

Thank you for your attention!

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