



# **100% renewable electricity by 2050: climate friendly, secure, affordable**

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German Council of Environmental Advisors (SRU)

Copenhagen, September 1<sup>st</sup>, 2010



## Structure of the presentation

- **The SRU scenarios**
- **The potential for renewable electricity generation**
- **Structure of a 100% renewable electricity generation**
- **Security of supply and the cooperation with Norway and Denmark**
- **Costs of the system in 2050**
- **The pathway from 2010 to 2050**
- **Cost comparison: Conventional versus renewable electricity**
- **Conclusions**



# 100% renewable electricity

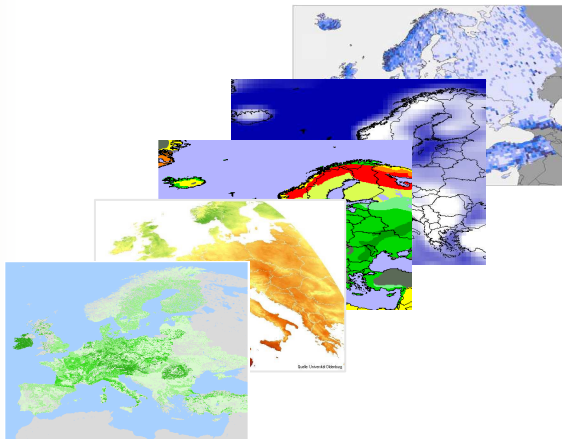
## The eight SRU scenarios

	Demand DE 2050: 500 TWh/a	Demand DE 2050: 700 TWh/a
<b>Autonomous Germany</b>	Scenario 1.a DE-100 % SV-500	Scenario 1.b DE-100 % SV-700
<b>100% REN production in Germany Exchange with DK/NO</b>	Scenario 2.1.a DE-NO/DK-100 % SV-500	Scenario 2.1.b DE-NO/DK-100 % SV-700
<b>15% Net import max. from DK/NO</b>	Scenario 2.2.a DE-NO/DK-85 % SV-500	Scenario 2.2.b DE-NO/DK-85 % SV-700
<b>15 % Net import from EU-North Africa</b>	Scenario 3.a DE-EUNA-85 % SV-500	Scenario 3.b DE-EUNA-85 % SV-700

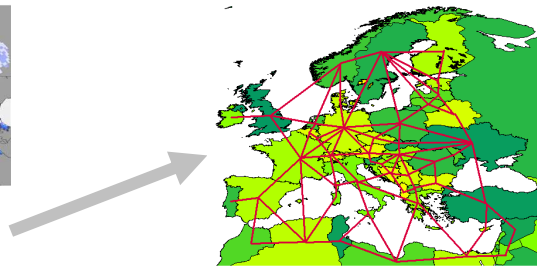
# The REMix-Europe model of DLR

## REMix-Europe (Renewable Energy Mix for Sustainable Electricity Supply in Europe)

Inventory of REN-  
resources  
GIS, C



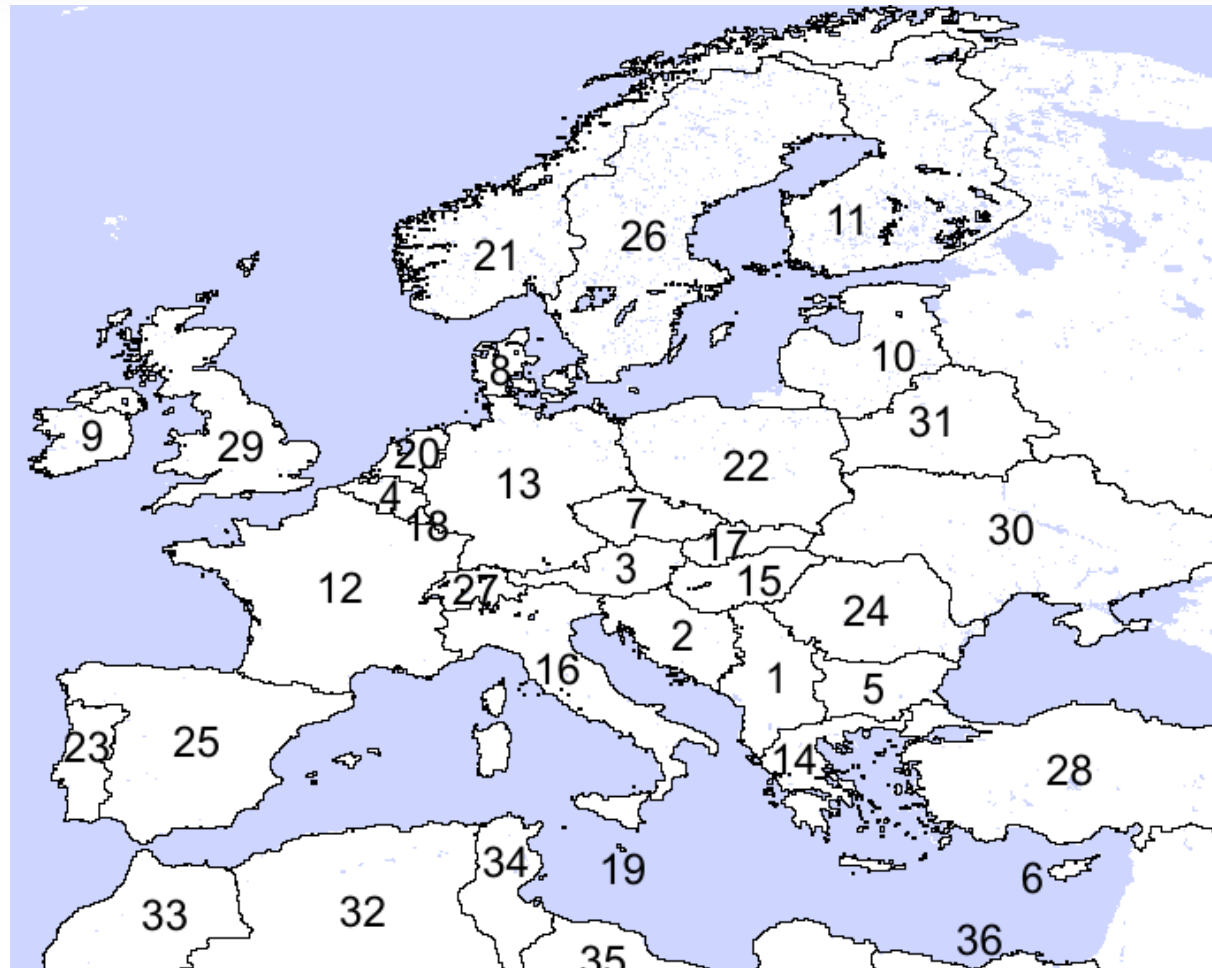
Electricity demand  
GIS, C



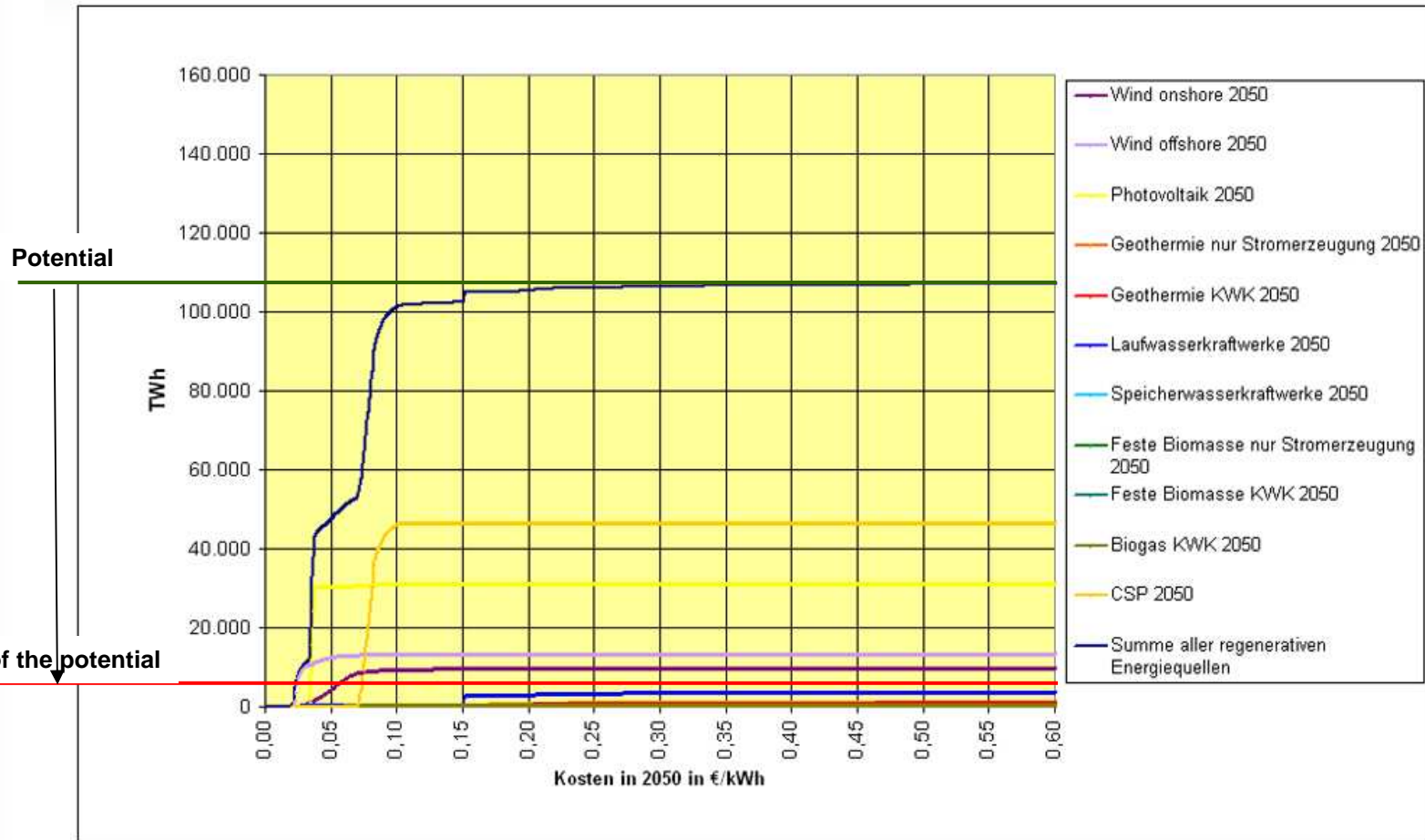
Linear optimization model  
GAMS (General Algebraic Modeling  
System)

Source: Krewitt 2009

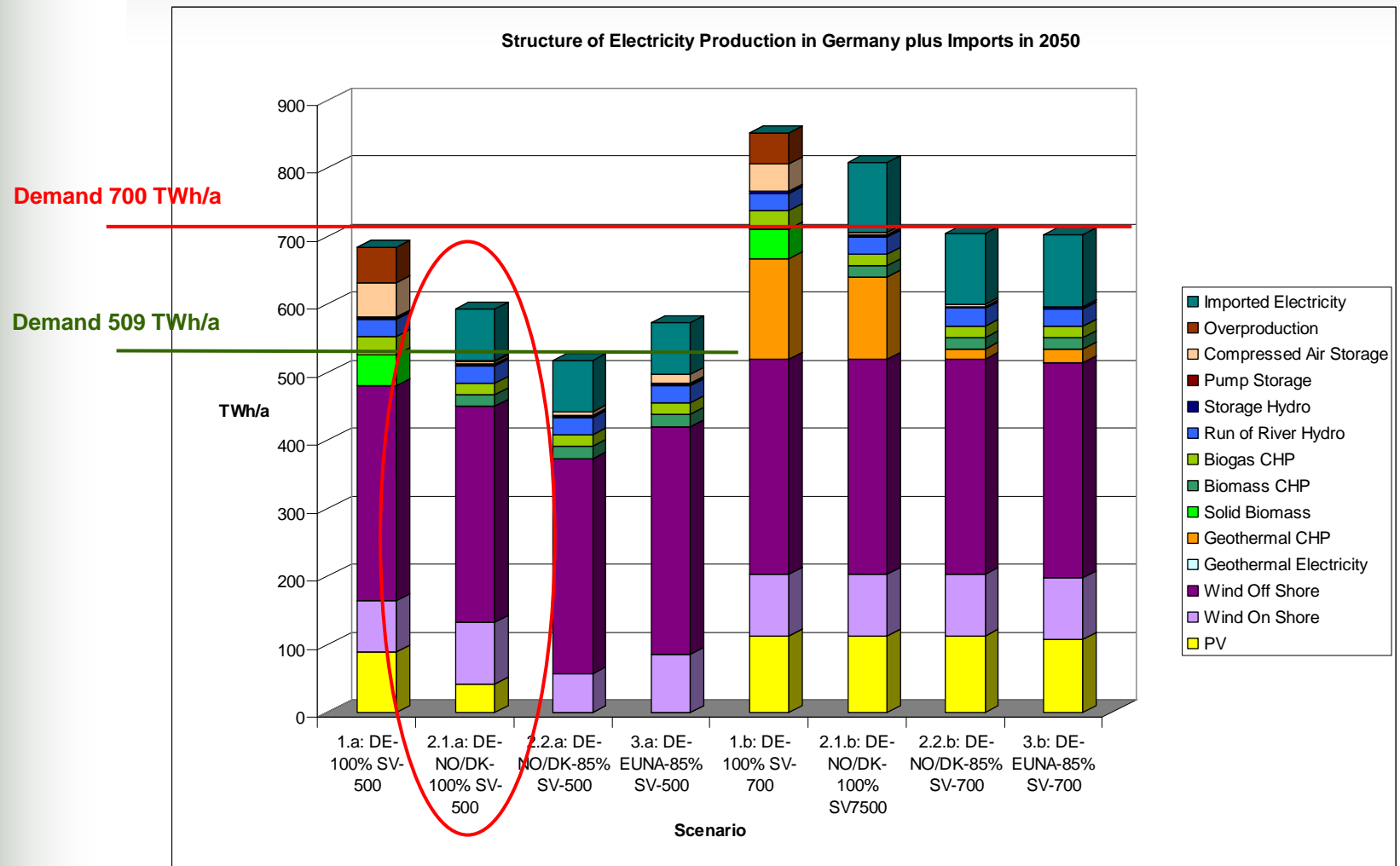
## The analyzed region Europe-North Africa



# The potential for renewable electricity production in EU-North Africa (TWh/a)



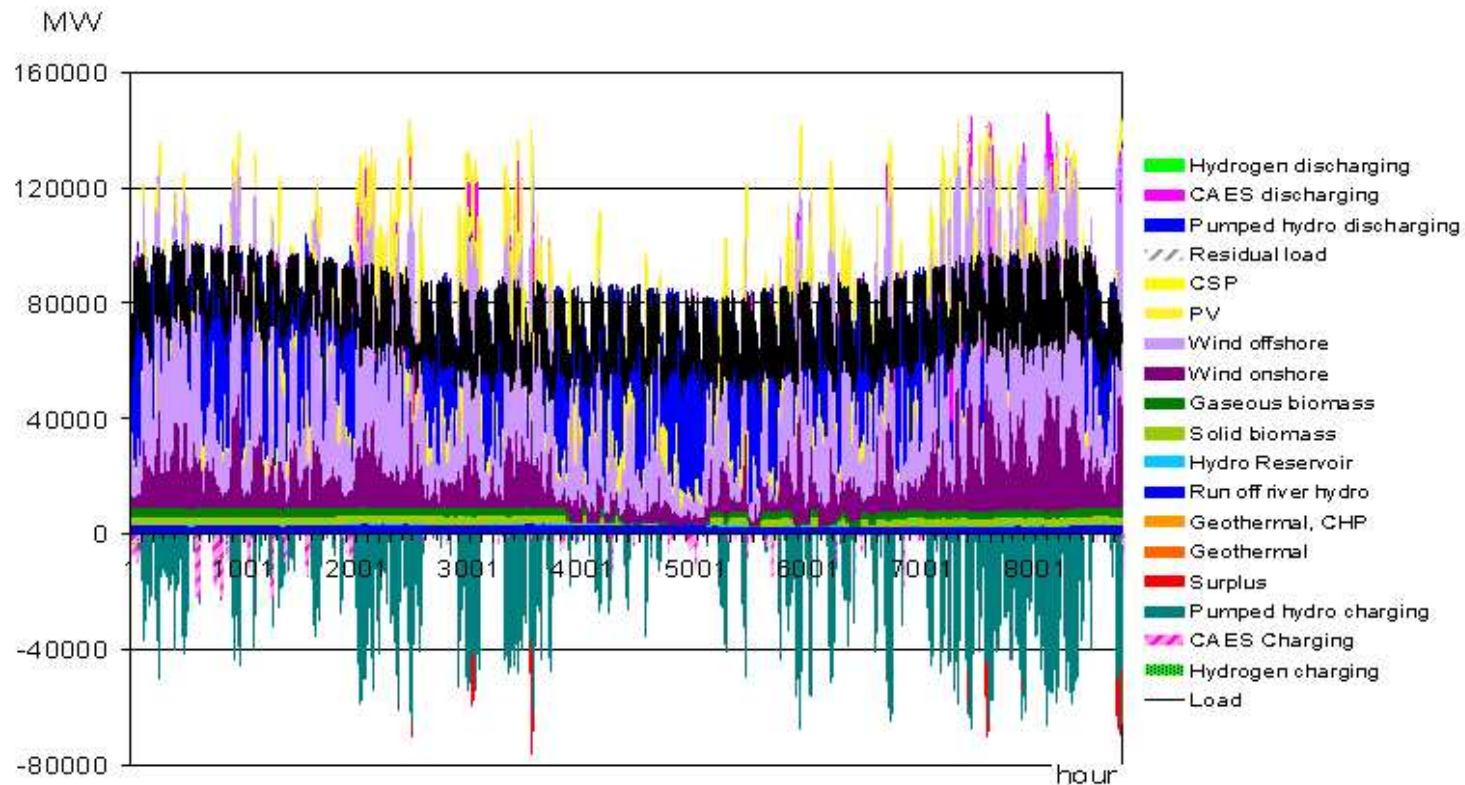
# 100% renewable electricity is possible under all scenarios (example Germany)





# Security of the electricity supply is guaranteed in every hour of the year (Scenario 2.1.a DE/DK/NO)

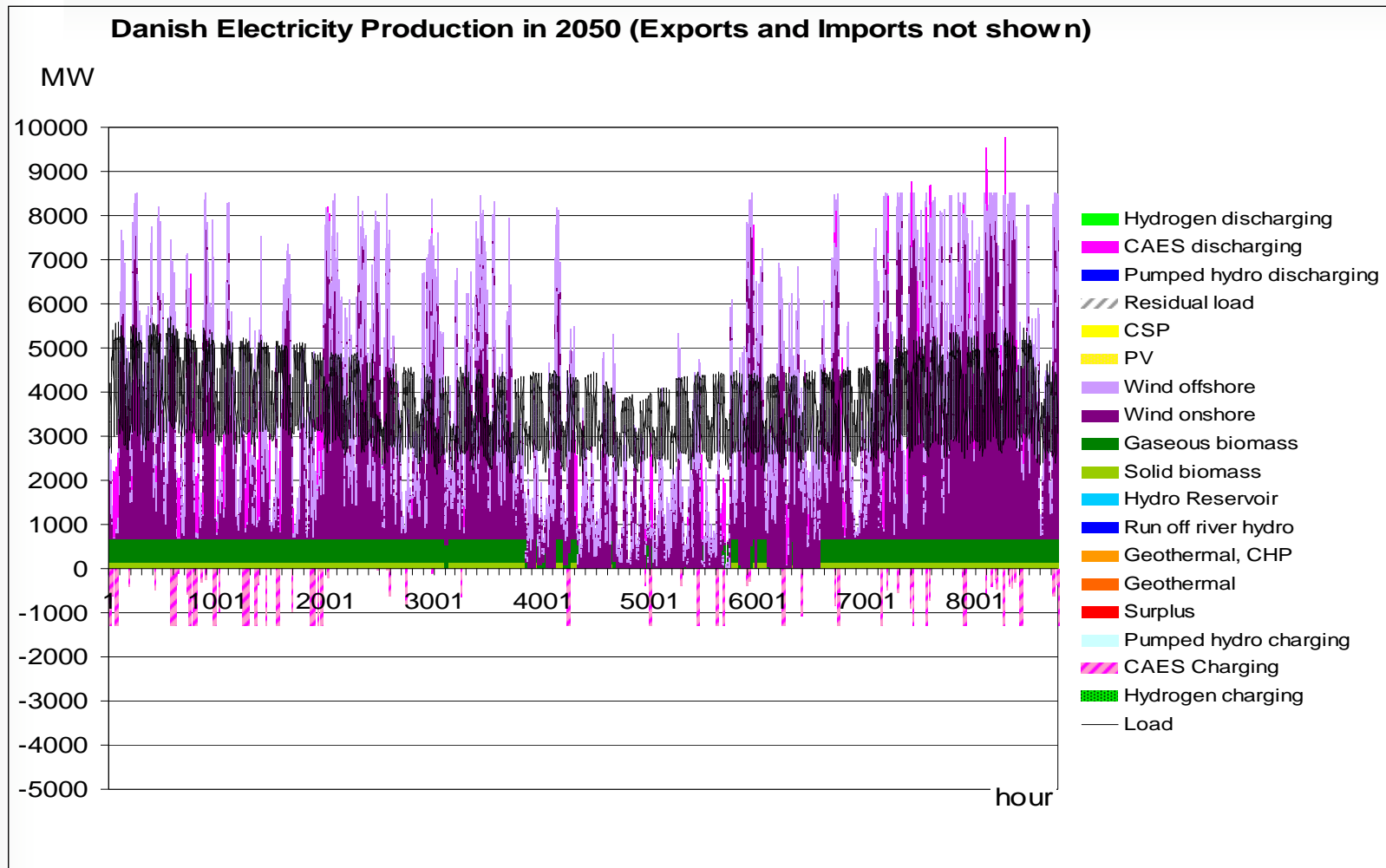
Szenario 2.1.a: DE-DK-NO 100% EE / 100% SV, max. 15% Austausch / 509 TWh



The cooperation with Norway and Denmark guaranties the necessary storage!

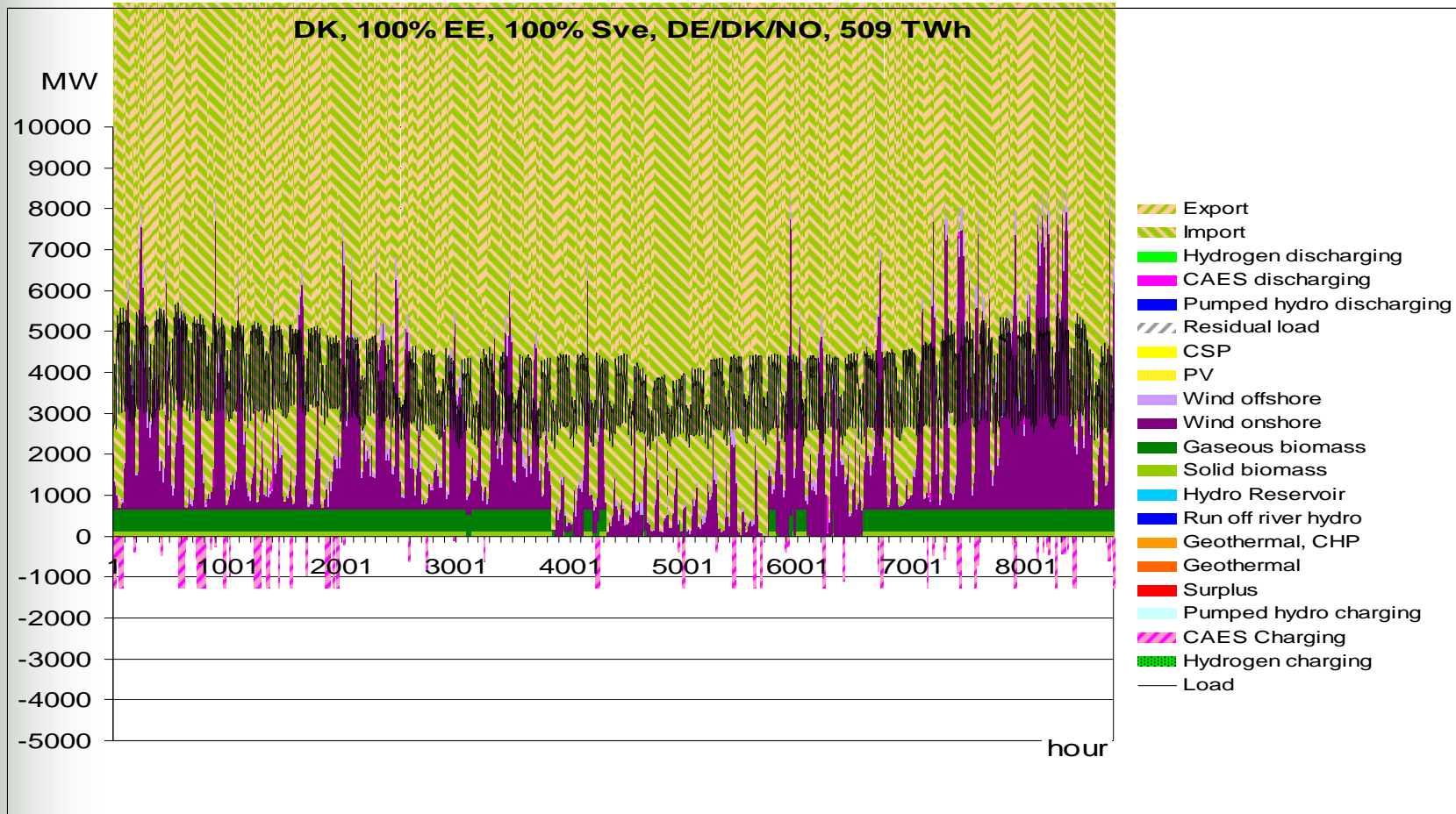


# The Danish situation in 2050 with 100% national renewable electricity (2.1.a)





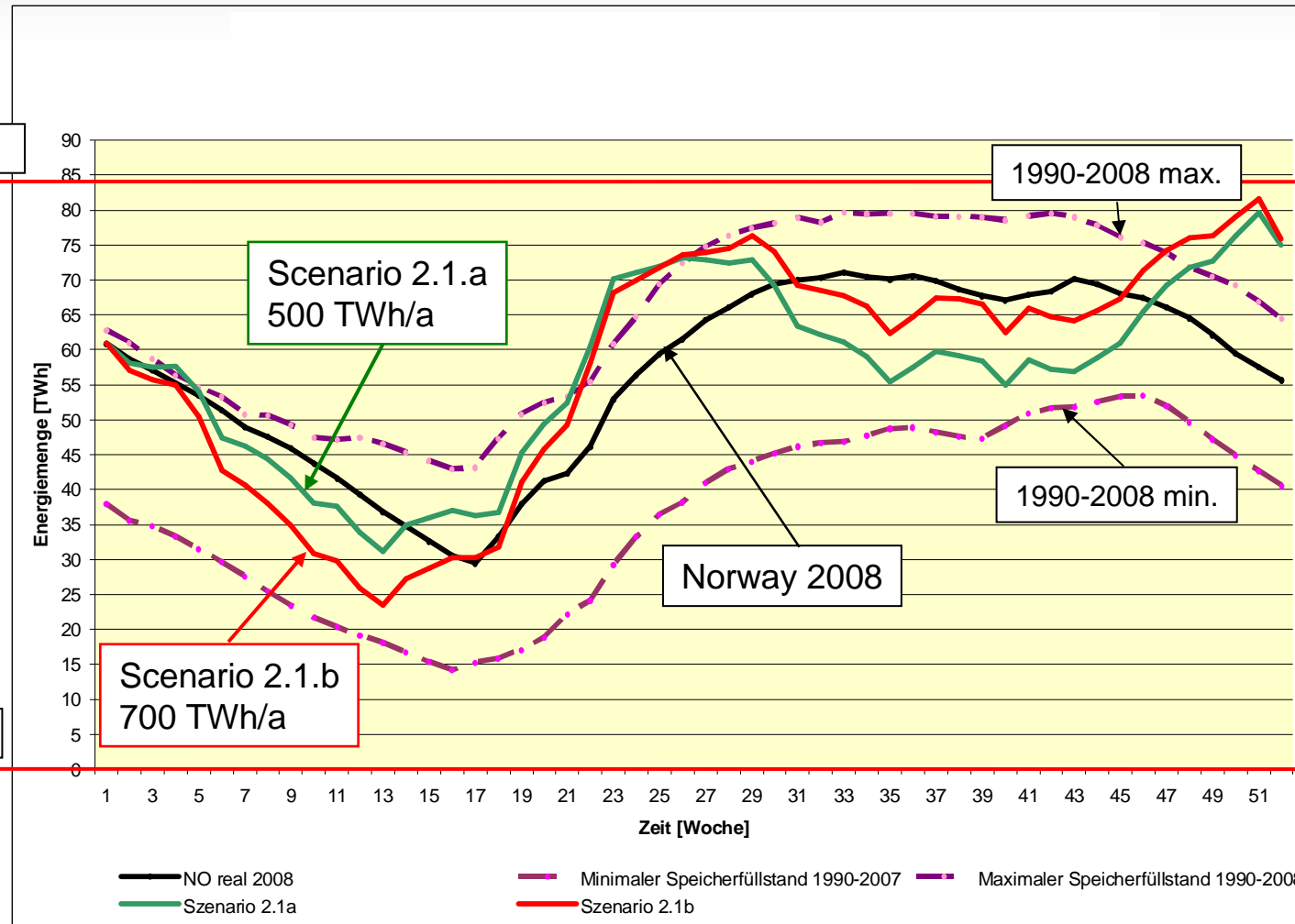
# The Danish situation in 2050 with with exports and imports shown(2.1.a)





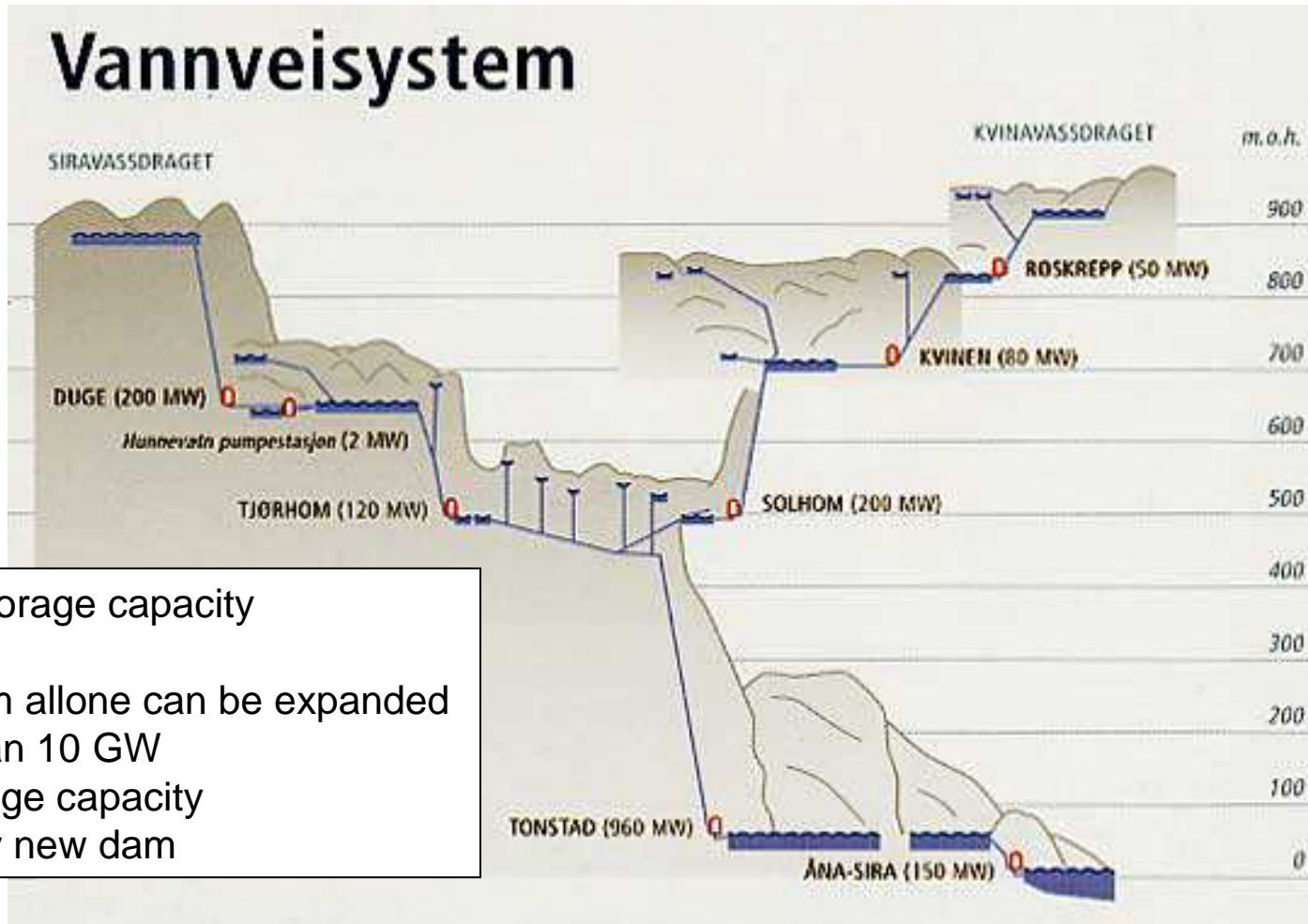
# Impact on Norwegian hydro storage in 2050 (Scenario 2.1.a compared to 2008)

Max. level 84 TWh



Min. level 0 TWh

# A typical Norwegian hydro power complex (Sira-Kvina: 1760 MW)



5,6 TWh storage capacity

This system alone can be expanded to more than 10 GW pump storage capacity without any new dam

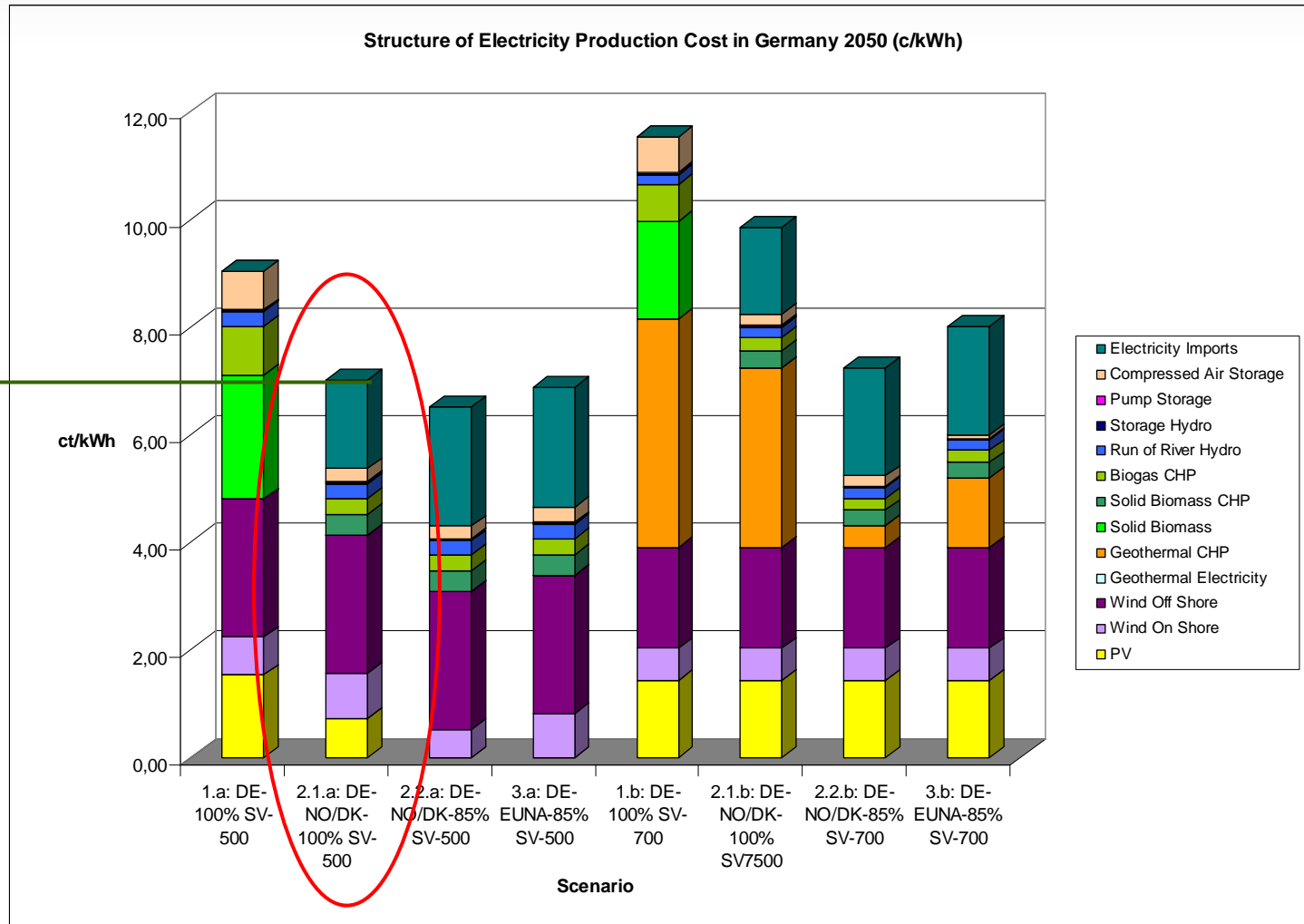
# The necessary grid capacity (Scenario 2.1.a)

Maximale Übertragungskapazität in GW  
DE-DK-NO 2050 (Szenario 2.1a)



# Electricity costs of less than 7 Cent per kWh in 2050 (Germany)

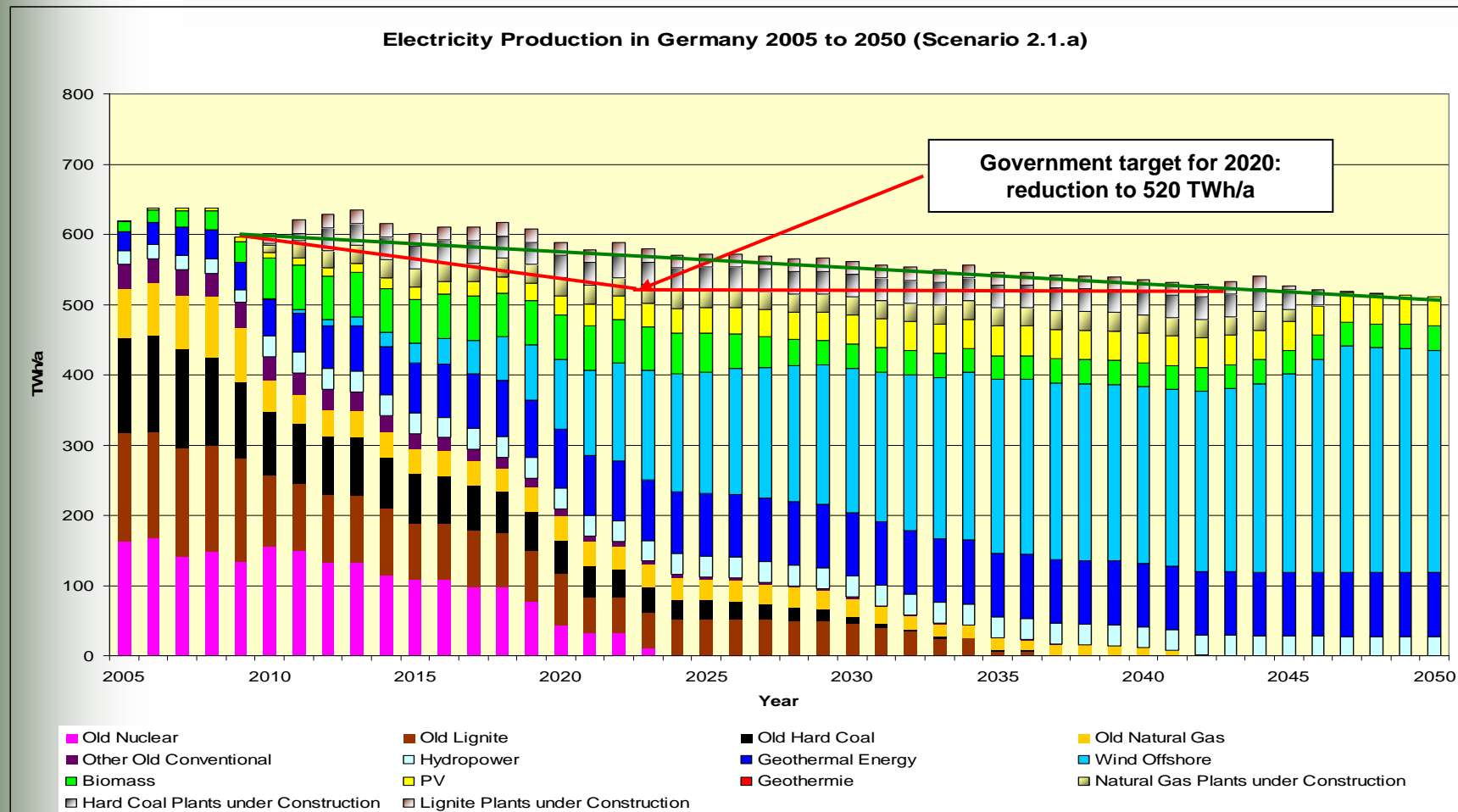
7,0 ct/kWh





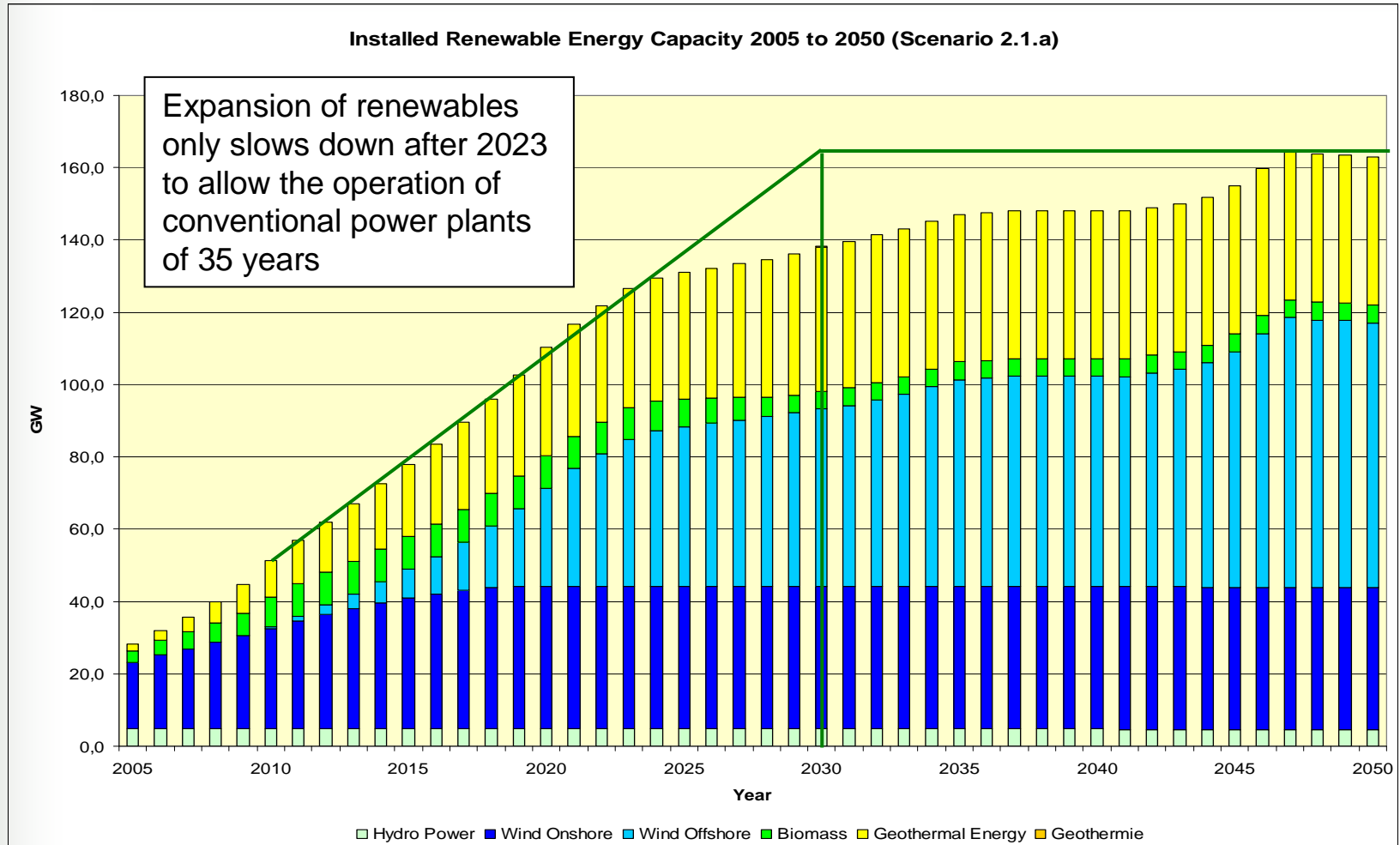
# The German pathway 2010 to 2050

## No additional coal plant, phase out of nuclear by 2023 (2.1a)



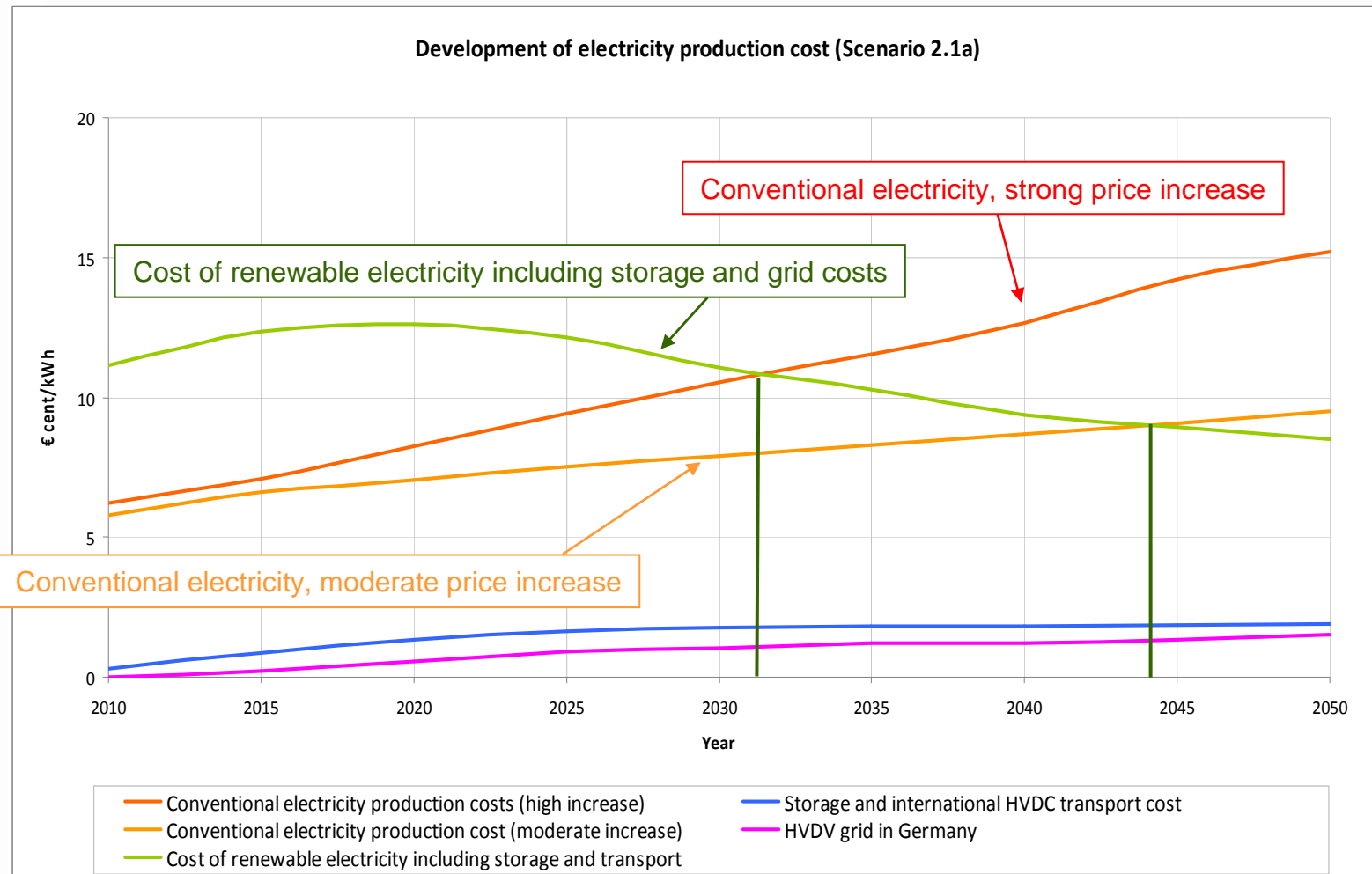


# 100% REN is possible by 2030 (based on scenario 2.1.a for Germany)



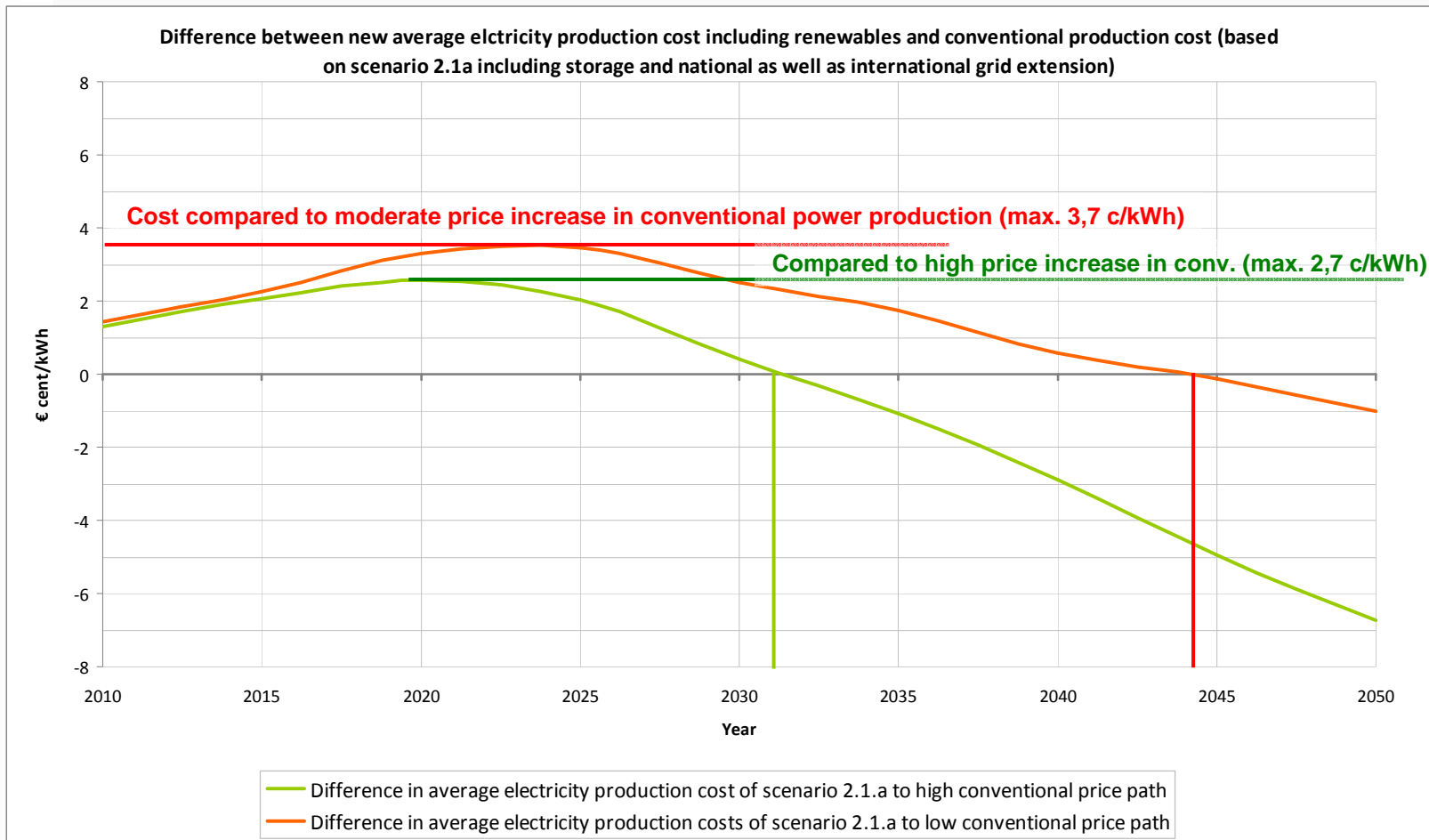


# Renewable electricity is the lowest cost long term solution (2.1.a Germany)





# Cost of climate protection 2,7-3,7 €c/kWh during the most expensive years (The German case)





## Conclusions

**100% renewable electricity:  
the best way of climate protection in all European  
countries**

**→ Decisions need to be taken today.**

**Challenges for policy makers:**

- **We need clear political targets**
- **We need to speed up the use of renewable energy sources**
- **We need to scale down conventional power generation**
- **We need to built a new grid infrastructure (national and international)**
- **We need to develop and built new storage**
- **We don't need new coal fired power plants with or without CCS or nuclear energy!**



**Thank you very much for your attention**