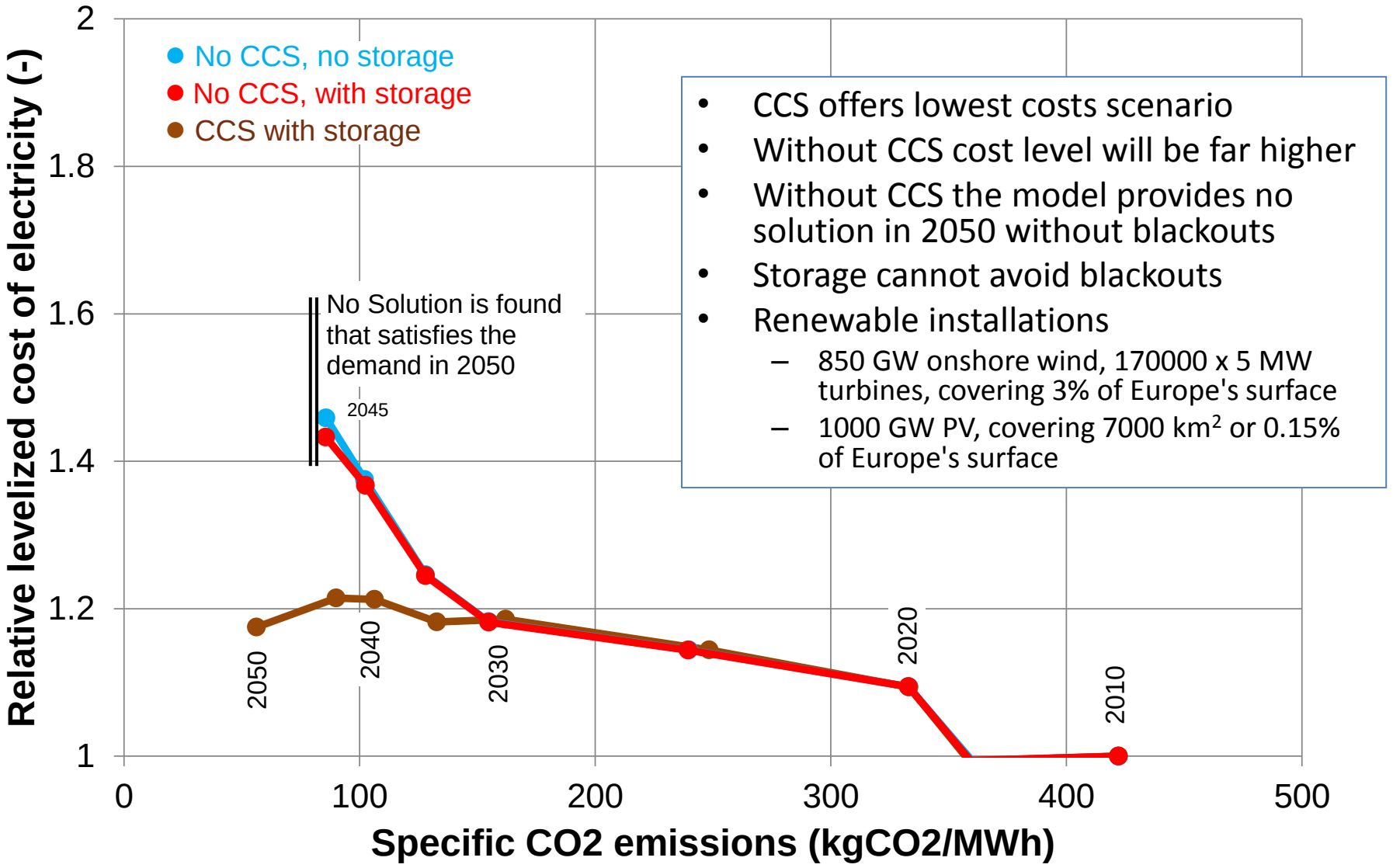
CCS and Electricity Market –
Additional calculations of value of CCS in reducing emmisions of CO2 in Europe

September 2014

80% absolute CO_2 reduction in 2050

Low PV costs of 200 €/kW in 2050, weak constraints on onshore wind and PV

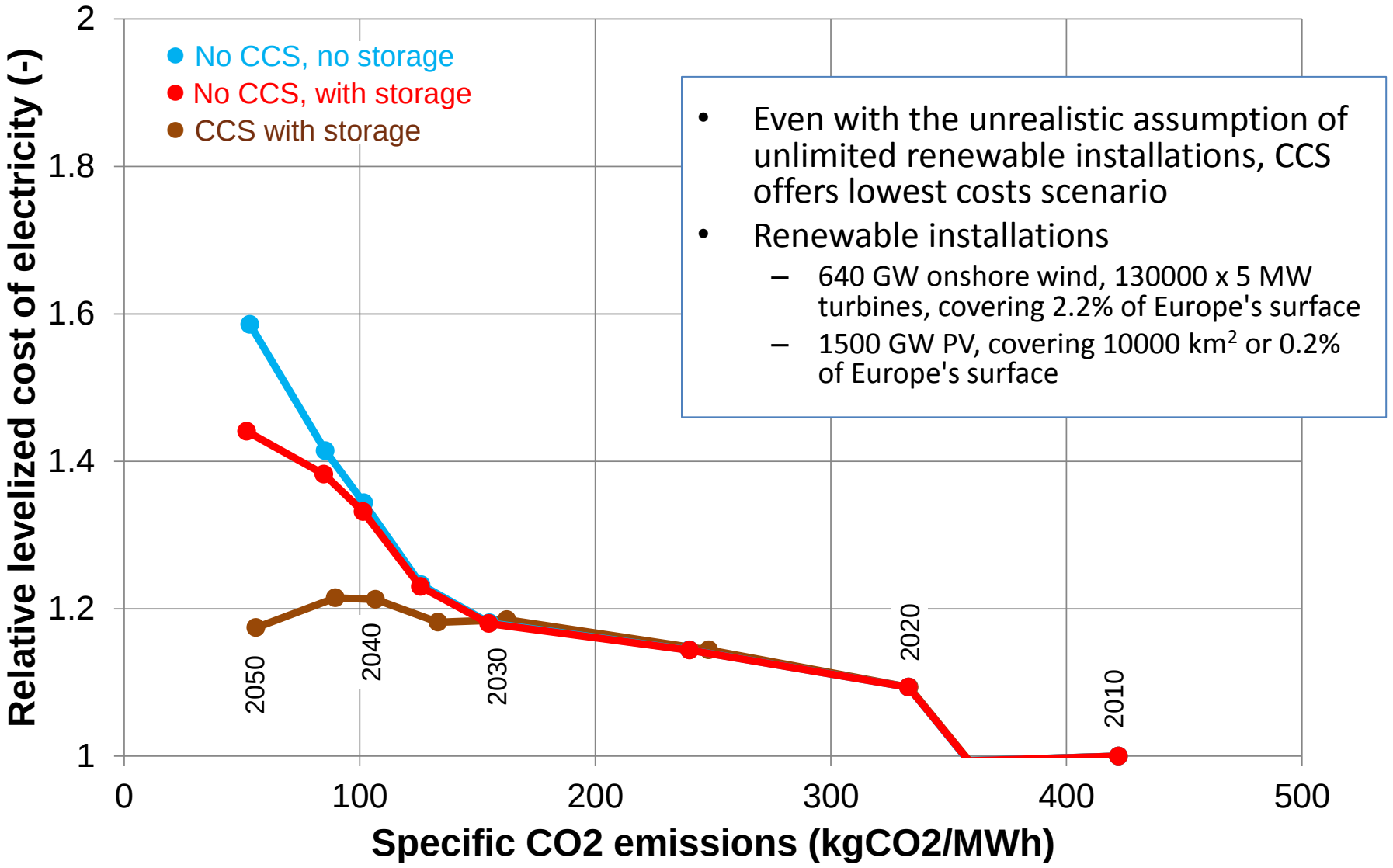


- CCS offers lowest costs scenario
- Without CCS cost level will be far higher
- Without CCS the model provides no solution in 2050 without blackouts
- Storage cannot avoid blackouts
- Renewable installations
  - 850 GW onshore wind, 170000 x 5 MW turbines, covering 3% of Europe's surface
  - 1000 GW PV, covering 7000 km^2 or 0.15% of Europe's surface

80% absolute CO_2 reduction in 2050

Low PV costs of 200 €/kW in 2050, no limits on onshore wind and PV

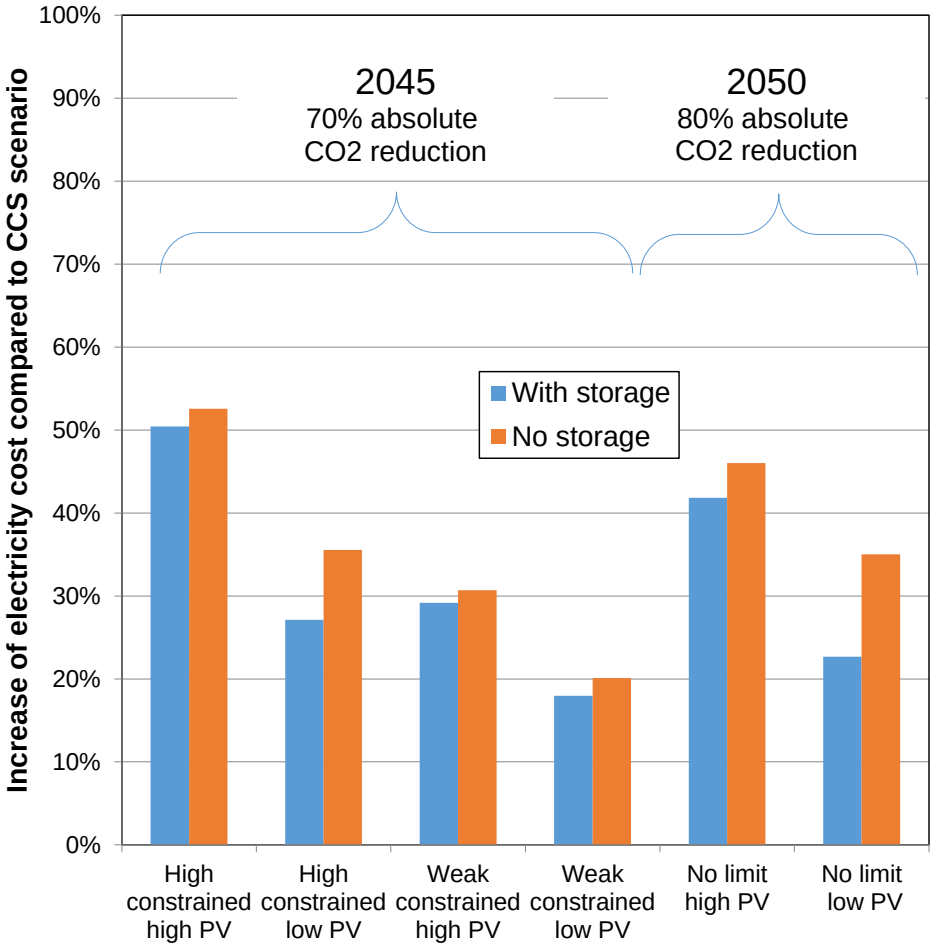
Blackout



- Even with the unrealistic assumption of unlimited renewable installations, CCS offers lowest costs scenario
- Renewable installations
  - 640 GW onshore wind, 130000 x 5 MW turbines, covering 2.2% of Europe's surface
  - 1500 GW PV, covering 10000 km^2 or 0.2% of Europe's surface

Sensitivity analysis

Variation of PV costs in 2050 (200/1000 €/kW), limits on onshore wind and PV



- A variety of scenarios were computed
- CCS always lowers the cost of reducing absolute CO2 emissions by 80% in 2050
- Without CCS the model provides no solution in 2050 (80% absolute CO2 reductions) without blackouts
- Without CCS the cost of electricity in 2050 will be 20 – 50% higher
- Without CCS the cumulative extra expenses for electricity generation from 2010 to 2050 in Europe will amount to 2-4 trillion €
- Europes industrial sector spends approx 150 b€ per year on electricity

Conclusions

- Building on the work done in 2013 and the report presented in December, ZEP has conducted further analysis using the model of the European Electricity Market. The original work showed that Carbon Capture and Storage, together with wind, solar and other technologies, has an important role in the lowest cost route to an 80% absolute reduction in CO2 emissions from power generation in Europe by 2050. The new results respond to questions and observations made by the EC and other stakeholders earlier in the year.
- In order to understand the additional cost to Europe of not using CCS, we ran cases where CCS technology was not available to be selected. To give a comparison, we imposed on these cases the same high level of emission reduction that the CCS cases achieve, which is 80% absolute, by 2050. What we saw was that by 2045 the demand in Europe was not met because without CCS, the low emissions targets and the demand could not be both achieved .
- One comment that we had received was that our cost for PV in 2050 was too high. So we ran cases with the cost of PV reduced by a factor of 5 to 200 $€_{(2010)}$/kW installed in 2050, an ambitious level that we consider would require a further breakthrough in technology to realise. In these cases too, the demand in Europe was not met after 2045 and for these 4 scenarios the cost of electricity in Europe in 2045 was between 20 and 50% higher than the cases with CCS.
- In order to see if this result was robust we relaxed the constraints on the amount of Wind and PV generation installations. We ran three levels including cases with no physical limit on PV and Wind. In these cases up to 1500 GW of PV and 640 GW of onshore wind is calculated to be installed by 2050, for the low PV cost scenario. Assuming the original 1000 $€_{(2010)}$/kW PV costs in 2050, the installations amount to 600 GW for PV and 1000 GW for onshore wind. This represents 2-4% of Europe's surface area covered with wind turbines and 0.1-0.2% covered with PV. The cost to Europe of these cases is between 35 and 45% higher than the equivalent cases with CCS.
- We also evaluated the impact of electricity storage on the model and cases were run which permitted the model to select electricity storage to help integrate the renewables. Electricity storage was calculated to play a small role in reducing cost, the largest effect being in the cases with the low PV cost.
- Over all the calculation shows that having CCS, (together with renewables), as an important part of the generation mix reduces the cost of electricity generation for Europe in 2050 in the range 20 to 50%. This cost saving cumulative to 2050 is some 2-4 trillion Euro, a substantial amount.