Foto: Bo Dahlin

20 findings

Summary report

Status, November 2013

NEPP
north european power perspectives

20 findings and conslusions, Summary, November 2013

The purpose of this progress report is to present some of the analyses, results and conclusions that have emerged during the last year of the NEPP project. The findings are presented in three publications:

- Progress Report, Part 1
- Progress Report, Part 2
- Summary Report [this report]

The two progress reports present analyses and results divided into chapters with a scope ranging from complete reports of 50 pages or more to short papers dealing with very specific issues. The chapters should be seen as individual texts, without direct relation to the proceeding or succeeding chapters. Together they illustrate the recent work performed within the NEPP project.

Part one of the progress report focuses on issues like electricity market design, smart grids, balancing of variable generation and demand response, while part two of the progress report focuses on policies and electricity generation, challenges in the transformation of the energy system, how the transport sector might influence the electricity system and, finally, potential of and demand for biomass. The table of contents gives further guidance in terms of the issues covered by the progress report. Some of the chapters are written in English while others, at this stage, are written in Swedish.

The summary report [this report] presents 20 findings from the recent NEPP analyses. The findings are typically key results extracted from the studies presented in more detail in the two progress reports. The majority of the 20 findings will be studied further in coming analyses and syntheses within the NEPP project.

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- Profu
- Sweco
- IVL Swedish Environmental Research Institute

Read more about the project: *www.nepp.se*

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finding/conclusion 1

The European electricity market is at a crossroads – more market or more planning?

The development of the electricity market might take different directions (market design). National capacity markets and support systems for renewables are pushing for more planning and nationalisation of the market. At the same time, EU is promoting an integrated European electricity market, with the implementation of network codes and a European market model (target model) already by 2014. The reformation of the electricity market aims primarily at securing the future supply of electricity, in EU as well as in the Nordic region. The Nordic electricity market is mainly structured to ensure that existing sources are used as efficiently as possible. The ability to re-place large parts of the electricity system to lowest possible cost was not an explicit goal when building the market. The introduction of subsidies for, first of all, renewable power generation has brought further challenges to the market when it comes to conventional generation. It is reasonable to believe that a majority of the coming investments will be subsidised in one way or another.

finding/conclusion 2

Balancing generation and consumption will pose an ever increasing challenge for the future electricity system

We must have a stronger focus on the installed capacity, to safeguard the continuous supply of electricity in the Nordic and the European system. Renewable power often has a lower capacity credit and is more complex to implement. It is still not clear how a massive expansion of wind power and solar power will affect the need for reserve- and regulating power. Balancing generation and consumption will pose an ever increasing challenge for the future electricity system, and smart grid technologies are part of the solution. In conclusion, there are three principal challenges that the market and its actors will face:

Challenge # 1 – Managing the continuous balancing of the system.

Challenge # 2 – Designing the system for reliable supply even during the hours when wind and solar power give a small contribution, but demand is high.

Challenge # 3 – Designing the system so that hours with high wind/solar generation and low electricity consumption, is not leading to locked-in generation and price collapse. The challenges, as can be seen, consist of utilising existing resources efficiently as well as of dimensioning the system optimally.

finding/conclusion 3

Capacity markets influence the location of new investments and the need for new transmissions

Access to peak load capacity will partly replace transmission capacity. Properly handled, capacity markets can be implemented without any additional costs for the customers. The increased cost associated with paying for capacity will be balanced by reduced electricity prices of the same magnitude. There might though, be a redistribution of revenues among producers.

finding/conclusion 4

The transformation of the energy system towards climate neutrality will raise the price of CO_2 and electricity

In those scenarios that include extensive support systems for renewable electricity generation (e.g. electricity certificates), our analyses show electricity prices of up to 800 SEK/MWh by 2050, if all consumers are obliged to carry certificates. The price of the certificates is then more than half of the electricity price. If, like today, only parts of the consumers are covered, the price of electricity might be as high as 1200 SEK/MWh by 2050, in a scenario with a very large proportion of renewable electricity generation. Other customers, e.g. energy intensive industries, will pay relatively low electricity prices (as today or even lower). In the scenarios not including support systems for renewables, the most important policy instruments is rather the CO_2 price. In our analyses, as well as those made by the EU in their roadmap work, the CO_2 price ends up at up to 150 - 280 Euro/ton in the scenarios with reduction of carbon dioxide by 70-90 % in 2050. Even with these extremely high CO_2 prices, electricity prices will in these scenarios stop at moderate increases, and will be around 700 SEK/MWh by 2050. An increased use of electricity generation with low CO_2 emission will thus result in a weaker link between the price of electricity and the price of CO_2.

finding/conclusion 5

With a larger share of wind and solar power, electricity prices will, in the long run, vary more

More variable generation results in a more volatile electricity price This is a shared view, by NEPP as well as by other studies. But exceptions exist: The result from the massive German expansion of solar power is so far a levelling-out of electricity price during the day, with a declining difference between high load time (daytime) and low load time (night time).

finding/conclusion 6

Fossil fuels and nuclear power will dominate European electricity generation for the next 20 - 30 years

The existing electricity generation system is the starting point for the development to come and will for a long time influence the structure of the system. Even with the renewable proportion expanding massively in our NEPP scenarios, a large part of the power generation in Europe will be based on fossil fuels by 2050. To, at the same time, reach a low level of CO_2 emission, CCS has to become commercially viable and widely accepted. Today this looks uncertain.

finding/conclusion 7

The expansion of the European transmission grid is a critical element in the transformation

The expansion of renewable power requires an extensive and rapid expansion of the European transmission grid, since the grid is overloaded already. As for CCS, a huge expansion of the electricity grid is associated with great uncertainty and thereby it is a critical element in the transformation.

finding/conclusion 8

Sweden may become a dominating exporter of electricity in Northern Europe, with a net export of 20 - 40 TWh

Continued investments in renewable generation in Sweden, together with maintaining our nuclear power, will soon lead to a surplus. If, however, nuclear power is phased-out, this surplus will not occur.

For the Nordic region as a whole, the picture is slightly diffe-rent. The Nordic net export of electricity to the Continent is growing significantly more in the scenarios including extended support systems for renewables, compared to the other scenarios. In the scenarios including "renewable support systems" the net export from the Nordic region can add up to as much as 80 - 90 TWh by 2040. This volume of export is also independent of whether we keep the Swedish nuclear power or not. If the nuclear power is phased-out, the combination of renewable policy instruments and the higher electricity prices without nuclear power will drive new electricity generation at the same time as the demand will be reduced. In the scenarios without enhanced renewable policy instruments the Nordic electricity export will in the long run top out at less than 30 TWh.

Large Nordic volumes of electricity export requires a sub-stantial expansion of the transmission system. If the capacity of today is kept, the net export will stop at approximately 20 TWh. Coming analyses in the project will study the effects on the Nordic electricity export from possible electricity market reforms inside and outside the Nordic region.

finding/conclusion 9

The German nuclear power phase-out will in the short term only result in a moderate electricity price increase

The German nuclear power phase-out will in the short term result in a moderate increase in electricity prices, approximately 5 EUR/MWh in Germany, even less in the Nordic region, 3 EUR/MWh. In the long term, the effects on prices in Germany will be even lower, according to the model calculation approximately 3 EUR/MWh. The reason behind the limited increase in price is that essentially the same electricity generation can be found on the margin. Other studies indicate the same or higher price increases, 2 – 16 EUR/MWh. When all nuclear power is phased out by 2022, it is replaced in the model scenarios by a combination of coal and natural gas based electricity generation. If coal power is fitted with CCS or not depends on the future price of CO_2. In the next 15 years, Germany will, according to our calculations, become a net importer of electricity, as a consequence of the nuclear power phase-out. With nuclear power kept in operation, Germany would rather have been an exporter of electricity during the full period up to 2050.

finding/conclusion 10

The challenges in the transformation to a climate neutral energy system are very large

The challenges in the transformation to a climate neutral energy system in Sweden, the Nordic region and the EU are huge, so huge that it can be argued that the likelihood to fully succeed in the transformation to 2050 is low. Even a more moderate rate and scope would be challenging. The challenges are roughly of the same magnitude regardless of which path (scenario) is chosen, and the challenges for Sweden and the Nordic region are of the same order as for EU as a whole. Industry and transport are the sectors with the largest and most challenging transformation in Sweden.

finding/conclusion 11

The climate goals in the Nordic region (and in the EU) are more far-reaching than those set by IEA in their ETP 2012

ETP 2012 shows that the EU ”only” has to reduce the carbon dioxide emission by 60 % by 2050 to reach the 2 degree target. For the Nordic region 70 % is estimated. In our collaboration with IEA in the sub-project ”Nordic ETP”, we have, from an IEA perspective, analysed the Nordic countries' more far-reaching goals for climate neutrality by 2050. This analysis shows that, for the Nordic region to reach the goal, we must take the lead, and to some extent go our own way and implement more extensive measures. This will include very large investments in better energy efficiency, wind power in the electricity system, CCS in the industry and biofuels and electricity in the transport sector. At the same time, the massive expansion of power infrastructure, also in IEA's Nordic ETP-scenarios, leads to a situation where the Nordic region also may become an important net exporter of electricity to the Continent.

finding/conclusion 12

Thesis: The emission of greenhouse gases will decrease at a lower rate if all emissions are considered

The reduction of greenhouse gas emissions might be slower than in our scenarios and roadmaps. This since all transformation of the energy system claims resources and results in emissions. In an extended analysis we have added these emissions to our transformation scenarios. Our highly preliminary results from these extended scenarios lay the foundation for the following general hypothesis: The emission of greenhouse gases will, in the “climate neutral” scenarios, decrease at a lower rate if all emissions associated with the transformation are considered. This also means that the accumulated amount of greenhouse gases in the atmosphere will be higher and therefore the date when the ”climate goals” can be achieved is delayed many years.

finding/conclusion 13

Is the global climate effort under a "fossil fuel curse"?

Our earth holds vast quantities of fossil fuels. To slow down the greenhouse effect we must refrain from exploiting large parts of them (or invest heavily in CCS). The observed development in the countries rich in fossil fuels contradicts this. Therefore, we must ask ourselves if the development can take another route or are we under a "fossil fuel curse" hindering us to succeed in the global climate ambitions. In the EU we can see a positive trend today, with fossil fuels being replaced by renewable energy. But our analysis shows that the fossil fuel rich countries, e.g. China, Russia and India increase their use of fossil fuel much more than they increase the use of renewable energy.

finding/conclusion 14

Analysis: The policy instruments of today will not be enough for the transformation to 2050

One task assigned to the project is to study the effect of different policy instruments and a subtask is to predict which instruments that can be the result from the political goals after 2020 and 2030. It is obvious that the policy instruments of today will not be enough to succeed in the transformation described in the EU roadmap or in the Swedish authorities' analyses of a roadmap for 2050. New and more powerful instruments are necessary to reach the large reduction of emissions included in these scenarios. For the transformation to be fully realised, very powerful political governance will be needed, including much more rigorous and firm policy instruments. If the political readiness for such actions is weak, we will have to be content with more modest climate ambitions.

finding/conclusion 15

The challenges in the transformation of the industry sector are very large

A branch by branch analysis of Swedish industry shows that, with conventional measures, the emission of today can only be reduced by 5 – 10 % in branches like refinery/ chemistry and cement industry. Reaching further will call for CCS and also a shift of raw materials, which will require a radical structural change with very uncertain profitability as a consequence. The challenges for the iron and steel industry are also significant, while the transformation of the pulp and paper industry is less challenging.

finding/conclusion 16

Electric vehicles have an important role to play in the future, and the increase in electricity demand is limited

Swedish analyses indicate that an 80 % reduction of the use of fossil fuels in the transport system by 2030 is possible. But, to achieve this, much more powerful policy instruments than those already existing, are needed. Electric vehicles have an important role to play in such a transformation, even if it is far from the only measure needed to be taken. The EU believes in a much slower transformation of the transport system, with a very limited electrification during the coming 20 years. The Nordic and European demand for electricity will increase marginally, < 10 % , even with a massive introduction of electric cars in the long term. It is thus not the supply of electricity that limits the electrification, rather the characteristics of the vehicles, the economy and the charging infrastructure.

finding/conclusion 17

Biofuel is an important component in the transformation, but a large increase may exhaust the EU resource base

Biofuel is, together with for example electrification, an important component in a substantial reduction of the CO_2 emission from the transport sector. Other important areas of measures are reduction of transportation demand, modal switch to other means of transportation, and more energy efficient vehicles. But, if the increase in biofuels is based on European resources, the expansion will be limited by the availability of biomass. Our scenarios indicate an increased European use of biomass of little more than 2000 TWh in 2030 (EU-27), if biofuels stand for a large part of the measure mix for an 80 % reduction of the use of fossil fuels in the transport sector by 2030. This would mean almost a tripling of the current use of biomass for energy purposes in the EU. Biofuels would thereby exhaust the remaining potential fully, and no other additional use of biomass for energy purposes, e.g. generation of electricity or heat, would be possible. This is not reasonable. Either the role of biofuels in the transformation of EU's transport system has to be limited, or the biofuel supply has to be based largely on import to Europe.

finding/conclusion 18

The global biomass resource is large, and can contribute to a stabilisation of the CO_2 emissions

In the type of analyses referred to above, biofuels are usually assumed to have no net emissions of CO_2. Research has revealed however, that biofuels are not always fully climate neutral. A study regarding wood fuels (felling residues) shows that they give some net emission of CO_2. Primarily, the net emission is considerable in the short perspective, but there are small effects even in the long run. Moreover, there are emissions related to the extraction and production of the biofuels. Still, biofuels are obviously very important in an energy system characterised by a small climate gas emission. On a global level, there is a sufficient amount of biomass to stabilise the CO_2 emission. This is apparent if biomass potential calculations are compared to usage scenarios with stabilised CO_2 emission as a goal. In these scenarios, increased biofuel use is one of several necessary measures. The challenges associated with the production and the use of biofuels are very large, since the volumes must be increased many times compared with today.
In Europe the biomass resources are small compared to the future demand. Europe would consequently have to import biomass in a future with powerful policies to stabilise the CO_2 emission.

finding/conclusion 19

Should we walk in step with the world around us, or should we take the lead?

Sweden and the Nordic region have a very high climate ambition, higher than the surrounding world. Which requirements and challenges will this lead to for our transformation, compared to the outside world's? How likely is it that we will succeed? Which development do we expect if we fail? It is obvious that we are not fully in control in many aspects of the transformation. Our climate and energy policy is becoming less and less a matter of national decisions. Energy markets and their regulation are international. The industry is acting on a global market, and the development of vehicles is something we hardly can influence at all. To take the lead in political ambitions regarding global sectors such as electricity, industry and transportation is not trivial. To what extent Sweden and the Nordic countries will really be able to take a leading position in the long run, is an open question. It is therefore important to be prepared for different development scenarios.

finding/conclusion 20

The actors in the electricity system will face different challenges in the transformation

Finally, we can conclude that the actors in the electricity system will face different challenges in the transformation. The largest challenge is probably faced by the producers. The introduction of renewable power, supported by specific subsidies and to a large degree characterised as intermittent, takes the place of other generation and creates, at least initially, a downward pressure on prices on the market. This is undermining the economy of the existing power plants, and also has the effect that the time when the renewable technology will become viable without specific subsidies is delayed. The biggest challenge for the transmission system operator is to expand the network fast enough. There is an obvious risk that renewable power will be trapped-in in some regions. From a regulatory perspective there are three overall challenges: The first one is to create the economic incentives required for the necessary regulatable power. The second one is to create the incentives that stimulate effective investments in the networks. The third challenge is to create the incentives needed for the potential flexibility of demand to be utilised. Smart grid is much about having the customers contribute to the balancing of the electricity system and thereby reduce the need of regulating power and grid extensions.

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