Introduction by Felix Finkbeiner

Slide 1

- Thank you for the invitation to COY13 in Bonn! It is a pleasure to take you now on a virtual journey to the world's deserts!

Slide 2

- This is the world at night.
- Here you can see where people turn night into day. In these cities, people drive to work by car, heat or cool their homes, produce products and use electricity for all kinds of purposes.
- Here mankind consumes its energy all year long.
- This energy is still produced mainly from limited nuclear and fossil fuels.

Slide 3

- The useable desert regions of the earth and the centers of consumption of mankind can be seen together on one map.
- Thanks to today's available technologies, it is possible to use clean energy also from deserts worldwide to supplement the power supply with renewable energy around the clock – so called dispatchable energy.
- In places that are particularly rich in renewable energy sources, it is usually uncomfortable for people to live in. This is the case for sunny and dry regions like deserts but also for windy and stormy regions like the North Sea or jungle areas with high biomass potential.
- We have now a deeper look on the region Europe, Middle East and North Africa called **EUMENA**. This region has with about 1.3 bn. people 17% of today's global world population. A cooperation using the dispatchable energy for local demand and for an export to Europe can be a WIN-WIN situation.

Slide 4

- In the Middle East and North Africa the demand rises for energy, water, food, labor and income for further 300 million people until the year 2050.
- How can such a demand be covered? The consequence of no answer to this question might be an emigration of people from MENA to Europe. Refugees still come to Europe caused by local conflicts and war. Climate change can still make such situations worse caused by desertification.
- One solution can be a suitable use of the renewable energy potential in deserts by solar power and water desalination plants!
- This can lead to new living area making live in deserts regions possible. An export of renewable dispatchable energy, which is in Europe hardly available, can help to finance new solar power plants.

Slide 5

- How do such solar plants look like?
- One configuration is a solar tower power plant.
- Mirrors on the ground collect the direct sunlight and focus on a tower. This technology is therefore called **concentrating solar power**.
- Here the solar energy heats a medium for a steam cycle process. Thus the power plant works like a coal fired power plant just carbon neutral!
- Such kinds of power plants are operating in the USA in southern California since the year 2014.

Slide 6

- Another configuration of concentrating solar power is parabolic trough.
- Such kinds of power plants collect the direct sunlight with parabolic mirrors which heat a medium in a heat pipe for a steam cycle process.
- This power plant configuration is todays most implemented one and such power plants are built for example in southern Spain operating since 2009.
- However, the space in southern Europe is often conflicted by agricultural use and the availability of direct sunlight is only seasonal and not constant over the year. This makes it less efficient for CSP in southern Europe than for example in North Africa.

Slide 7

- The last configuration of concentrating solar power is linear Fresnel. This technology works like the parabolic trough configuration. It focuses the direct sunlight on a heat pipe for driving a steam cycle process.
- Such a power plant is under construction in north western India.
- Solar Tower, parabolic trough and linear Fresnel are configurations to produce dispatchable energy according to demand.

Slide 8

- But how can such concentrating solar power plants provide dispatchable energy according to demand when the sun is not shining?
- Collecting the direct sunlight a heat medium is used for a steam cycle process and for storing heat in a thermal storage. When the sun is not shining, the thermal storage can provide energy or in any case a co-firing option for example with biomass can be used in some hours. This allows an energy provision around the clock!
- Water desalination and pipelines can bring renewable water to desert regions to provide water for the workers in the power plants but also for agricultural use.

- Dispatchable energy can be used locally but also for an export via high voltage direct current (HVDC). This technology has low losses and can transport energy over thousands of kilometers.

Slide 9

- Here we can see a linear Fresnel technology underneath an agricultural use is possible.
- Sensible plants such as tomatoes, salad or flowers can grow in a protected but still sunny area and supply local demand.
- Agricultural studies are still needed to simplify water demand and nutrient needs and to create the know-how for a sustainable and efficient agricultural use.

Slide 10

- One international project which copes with a realization of an agro-energy-water use in desert regions is the Sahara forest project.
- Here we see an illustration with concentrating solar power, photovoltaic, green houses and trees!
- Trees are very import to stabilize the ground and to make shadow.
- But how can such concepts be realized without suitable financing?
- One option might be the income by exporting dispatchable energy to Europe.

Slide 11

- The German Aerospace Center analyzed such an export potential with ongoing research.
- Trans-Mediterranean Renewable Energy Cooperation - TREC 2003.
- Sustainability Scenario - TRANS-CSP 2006.
- Corridor analysis - REACCESS 2009.
- Model Analysis with Solar Power Imports - Dissertation Stetter 2012.
- Model of a first CSP-HVDC connection - Diploma thesis Hess 2013 and EU-BETTER 2012-2015.
- The value of CSP in EUMENA - Dissertation Hess 2017.

Slide 12

- How can we measure a sustainable low carbon future energy system?
- At the DLR and other research institutes an energy system model is applied to specify the configuration of an energy system and its shares of energies.
- Such energies can be classified into dispatchable energies such as … .
- and fluctuating energies such as … .
- Flexibility options are also important. These are … .
- Today one import target is a sustainable energy system with low cost. Therefore we minimize system cost in the model.

- Using future scenarios we can make conclusions of the value of a certain technology.

Slide 13

- The value of a transfer of electricity from concentrating solar power from MENA to Europe is therefore analyzed systematically in two scenarios.
- One scenario uses this technological option and the other excludes this option.
- The results show that using CSP in MENA for Europe reduces future cost uncertainty and facilitates infrastructural needs and operation of the energy system in EUMENA.
- Such a transport can therefore be seen as a valuable supplemental option for EUMENA to reach climate protection targets efficiently in combination with all other renewable energies and flexibility options.
- But how can such a business case look like?

Slide 14

- A first political framework for a transmission of renewable dispatchable energy could be Morocco and the four Motors for Europe,... .
- Morocco has the potential for CSP and the Four Motors to use it as supplemental supply due to their economic character.
- Each of the regions in Europe could have a separate but bundled energy infrastructure to supply its energy demand.
- A common water pipeline can be built to supply the power plants and to cultivate desert regions.

Slide 15

- But how can we transmit dispatchable energy efficiently? Can we use the grid or are single HVDC lines better?
- Therefore we make the experimental game “SUPERGRID”
  (The game is created by Dr. Franz Trieb made for an office Christmas party in 2014)

Slide 16

- The initial situation shows the current transmission grid in EUMENA.
- It has the aim to balance power, allowing power plants to be used efficiently between regions and countries with limited transmission capacity.
- Can we therefore just build a stronger grid with higher capacity on top of the old one? A SUPERGRID?

Slide 17

- Part one: We're building a SUPERGRID

- Starting in "Northern Europe", a meshed SUPERGRID is stretched up to North Africa. Ensure strong networking!
- Two demand centers in Europe are defined (red caps).
- Local standby power plants are equipped with electrons (CD'S) in case of breakdowns.
- Two locations of concentrating solar power plants in North Africa are defined and equipped with electrons (CD's with slots). They must not leave the network on their way, otherwise they must be restarted. The slots in the electrons are there to overcome nodes in the network.
- The demand centers simultaneously announce power requirements.
- A chronometer determines how long it takes for the electrons to reach the demand centers. The time in seconds is proportional to the energy losses in % (quantum mechanics ;)) (Result of needed time: 90 sec.)
- If a breakdown occurs, local standby power plants transfer their electrons to the demand centers.
- The SUPERGRID is deconstructed and set aside for later analysis.

Slide 18

- Second part: We build a point-to-point transmission line.
- Starting in North Africa, a line from the two concentrating solar power plants power plants in NA to the two demand centers in the EU is built.
- The demand centers announce power requirements at the same time.
- The chronometer is used to determine how long two electrons take to reach the demand centers. The electrons do not have any slots, as they do not have to cross knots and therefore cannot leave the line. The time in seconds is proportional to the energy losses in %. (Result of needed time: 10 sec.)
- The two paths are deconstructed and the associated material requirements are compared with those of the SUPERGRID.

Slide 19

What can we / I do now?

- Many MENA countries are interested to export dispatchable power of CSP. However, the EU member states are not interested to import renewable energy from MENA because it is today a political No-Go in EU!

  ➔ Talk to your politicians in EU that you **support the idea of a strong and valuable energy cooperation between EU and MENA for using <u>dispatchable</u> power** in EUMENA!

- A pilot study is needed to specify a project to transfer CSP electricity from MENA to EU.

  ➔ Need of support from institutions, companies or private persons for **financing the pilot study**!