Cross-sectoral Analysis of Future Energy Systems with REMix

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Solar photovoltaic and wind power are increasingly contributing to electricity supply in Europe and worldwide. Due to their intermittent nature, questions of balancing power demand, system stability and the interconnection of electricity, heat and transport sector have become a major focus of energy system research. The bottom-up energy system model REMix (Renewable Energy Mix) has been developed with the aim of providing a powerful tool for the development and assessment of future supply scenarios in high spatial and temporal resolution [1-3].

Methodology
- REMix is a multi-sectoral energy system model using a linear optimization approach.
- The model relies on a global high resolution renewable energy (RE) resource assessment.
- The modular structure of REMix provides high flexibility in model usage.
- A user interface allows for quick changes in geographical and technological detail.
- REMix currently comprises around 20 technology modules.
- CHP, CSP and conventional power plants are represented in detail.
- REMix is moreover focused on modelling flexible electric loads in all demand sectors.
- Hourly operation of all generation, storage and transmission assets is assessed.
- REMix applications include least-cost greenfield capacity expansion analysis, long-term scenario validation and impact assessment of balancing options on RE integration.

Renewable power integration with thermal energy storage in CHP supply
- Power-controlled CHP operation with heat storage (TES) and electric boilers reduce RE curtailment in Germany by up to 47% [4]
- In an 80% RE system, electric boilers provide up to 10% of district heat supply.
- Up to 13% of produced heat are stored.

Balancing impact of demand response and controlled electric vehicle charging
- Relying on an extensive assessment of the European demand response potential [5]
- Hourly values of load flexibility considered.
- Annual load shift in Germany 2050 up to 30 TWh, peak load reduction up to 10 GW.
- Load shifting predominantly from morning and evening to midday and night.

Short-term RE integration and expansion planning in MENA countries
- Detailed unit-specific modeling of RE and conventional power plants [6]
- Identification of niche markets for RE and short-term integration strategy.
- Addressing specific characteristics of power supply systems in MENA.
- RE are competitive in the short-term.
- CSP as backbone of future systems providing strongly required dispatchable and firm RE capacity.

Figure 1: REMix model set-up

Figure 2: Impact of TES usage on RE curtailment in Germany for different scenarios

Figure 3: CHP supply structure and TES utilization

Figure 4: CHP-TES filling level during the year

Figure 5: Theoretical DR potential in Europe for the year 2010

Figure 6: Hourly demand response operation

Figure 7: Capacity expansion for Jordan from the year 2012 to 2022

Figure 8: Hourly dispatch including intermittent PV and wind power and dispatchable CSP

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