IEA Bioenergy

Task 32 Biomass Combustion

The future role of Thermal Biomass Power in renewable energy systems

- study of Germany

CEBC 2020
Graz, 24 January 2020

Morten Tony Hansen
Ea Energy Analyses

EUDP
Energiteknologisk udvikling og demonstration

iea Energy Technology Network

Ea Energy Analyses

- Analyses and advanced modelling of energy systems and measures to integrate renewables
  - Please see www.eaea.dk for reports in English/Danish

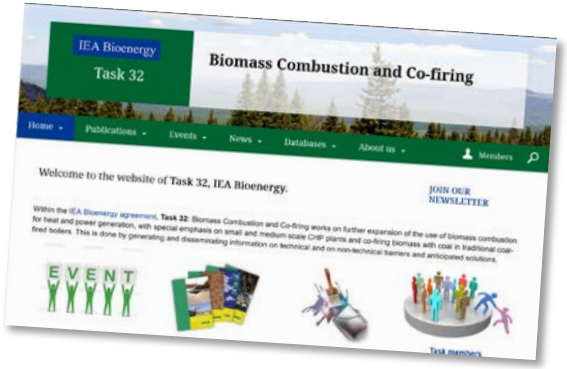
- Bioenergy projects - examples:
  - Generation costs for retrofitted CHP units
  - Technology data to catalogues for the Danish Energy Agency
  - Biomass price projections for the DEA and for energy companies
  - Market intelligence for energy companies and authorities
  - Switching from fossil fuels – technology based strategic advice for utilities and heating companies
  - Integration of bioenergy technologies in the energy system via models

What is Task 32?

IEA Bioenergy

- IEA Bioenergy is an IEA Technology Collaboration Programme (TCP)
  - Several tasks on technology and deployment
- Task 32 focuses on combustion, ash, emissions
  - From logwood stoves to utility scale
- Austria - Canada - Germany - Japan - the Netherlands Norway - Sweden - Switzerland - Denmark (lead)
- Activities cover:
  - Sharing experiences between members
  - Sharing knowledge with stakeholders in target group
  - Collaboration with other groups inside/outside IEA

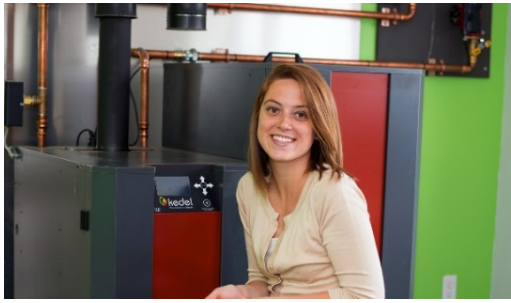
Task 32 projects 2016-2018



- Biomass for heating - 15 hot cases
  - Investment cases and policy cases
- State of the art innovative CHP concepts
  - Biomass heat and power generation in small scale
- Advanced Test Methods for Firewood Stoves
  - Comparison of test methods and real life performance of stoves
- **Options for increased use of ash from biomass combustion and co-firing**
  - Overview of present practices in ash management
- Updated co-firing database
  - Web based database of biomass co-firing and biomass combustion plants
- Fuel pretreatment of biomass residues (Intertask)
  - Task 32 case: Steam explosion for cofiring and full conversion
- **The future role of Thermal Biomass Power in renewable energy systems**
  - Scenario modelling project on the role of biomass power, case Germany

Task 32 projects 2019-2021

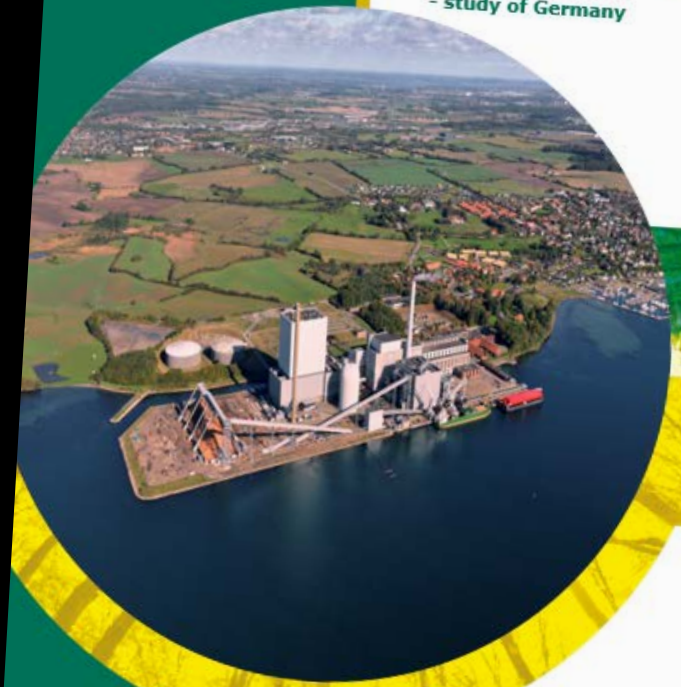
- **Small scale biomass - stoves and boilers**
  - Testing methods and real life performance for pellet stoves (AT)
  - Guideline for log wood stove design (DK)
  - National strategies for emissions reductions (DE)
  - Workshop on improved small scale combustion (AT)
- **Biomass for industry**
  - High temperature heat for industry applications (NL)
- **Large biomass CHP plants**
  - Flexibility and system integration (SE) - feed in to Task 44 Flexible Bioenergy and System Integration
  - Workshop on experiences with combustion of pulverised non-wood fuels (CA)
  - Workshop on experiences with wood chip combustion in large units (DK)



May 2020 in Copenhagen

The future role of Thermal Biomass Power in renewable energy systems

- study of Germany



Skærbæk CHP plant, Denmark. Photo: Ørsted

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IEA Bioenergy: Task 32: 2019: 03
Biomass Combustion and Cofiring

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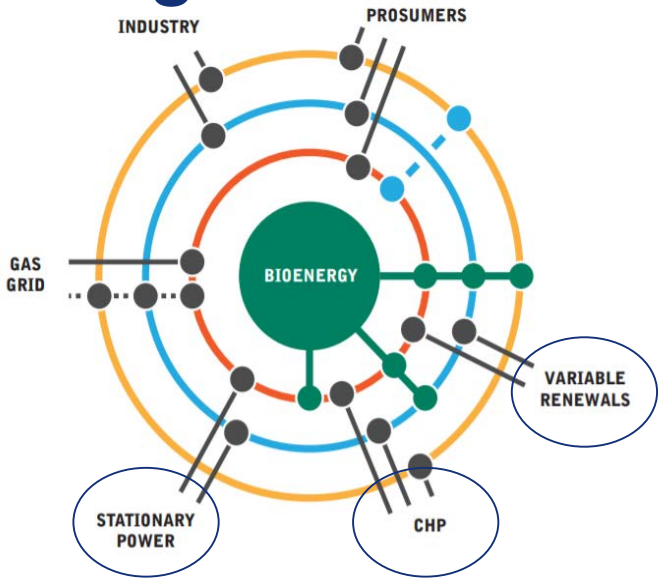
Main conclusions

- The market alone will hardly drive any thermal biomass power into the German energy system 2040 due to competition from fossil fuels and wind/solar
- Special framework conditions or low feedstock prices are needed before we see significant investments in thermal biomass power

- With high CO_2 prices and low feedstock prices thermal biomass plants substitute coal and gas and some PV
- Then biomass CHP will play the dominant role in the district heat supply
- System flexibility is primarily delivered by hydro, pumped storages and gas power plants

Previous work on grid integration

- Bioenergy grid integration studies already carried out focused mostly on:
  - Biogas/Biomethane integration
  - District Heating networks
  - Distribution networks



Survey results on the future of IEA Bioenergy (2017)

Most voted topic: ***"Bioenergy in future energy systems / systems analysis"***

*"Scenarios can be developed, analysing the specific **role of bioenergy** in the future energy system. This requires a **system approach**, considering what are the main assets of bioenergy in specific markets and how it can create synergies with other (variable) renewable energy forms"*

The Balmorel model

- Analyses of the evolution of the combined heat and power sectors
- Calculates least-cost solution for investment and dispatch by linear optimization
- Contains existing capacities and allows investments in all thinkable technologies
- **Characteristics:** Open-source, Transparent, Scalable, Customizable

Website: www.balmorel.com
Paper: Wiese et al. *Balmorel open source energy system model* (2017)

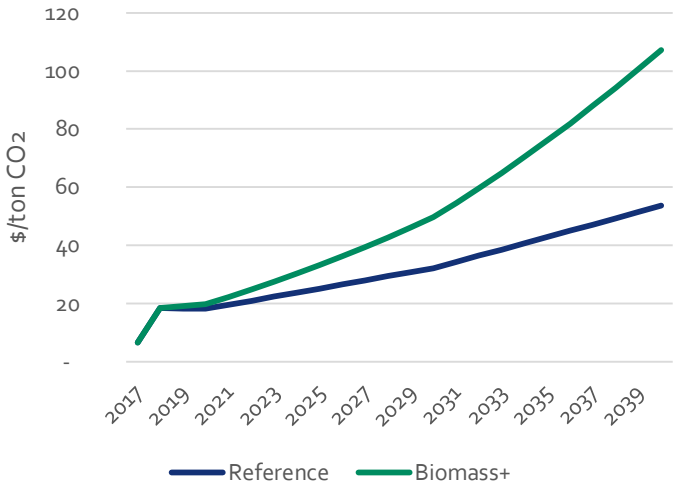
Two scenarios analysed

- **Reference**

  Best estimate of future demand, fuel prices, CO_2 costs, investment costs etc.

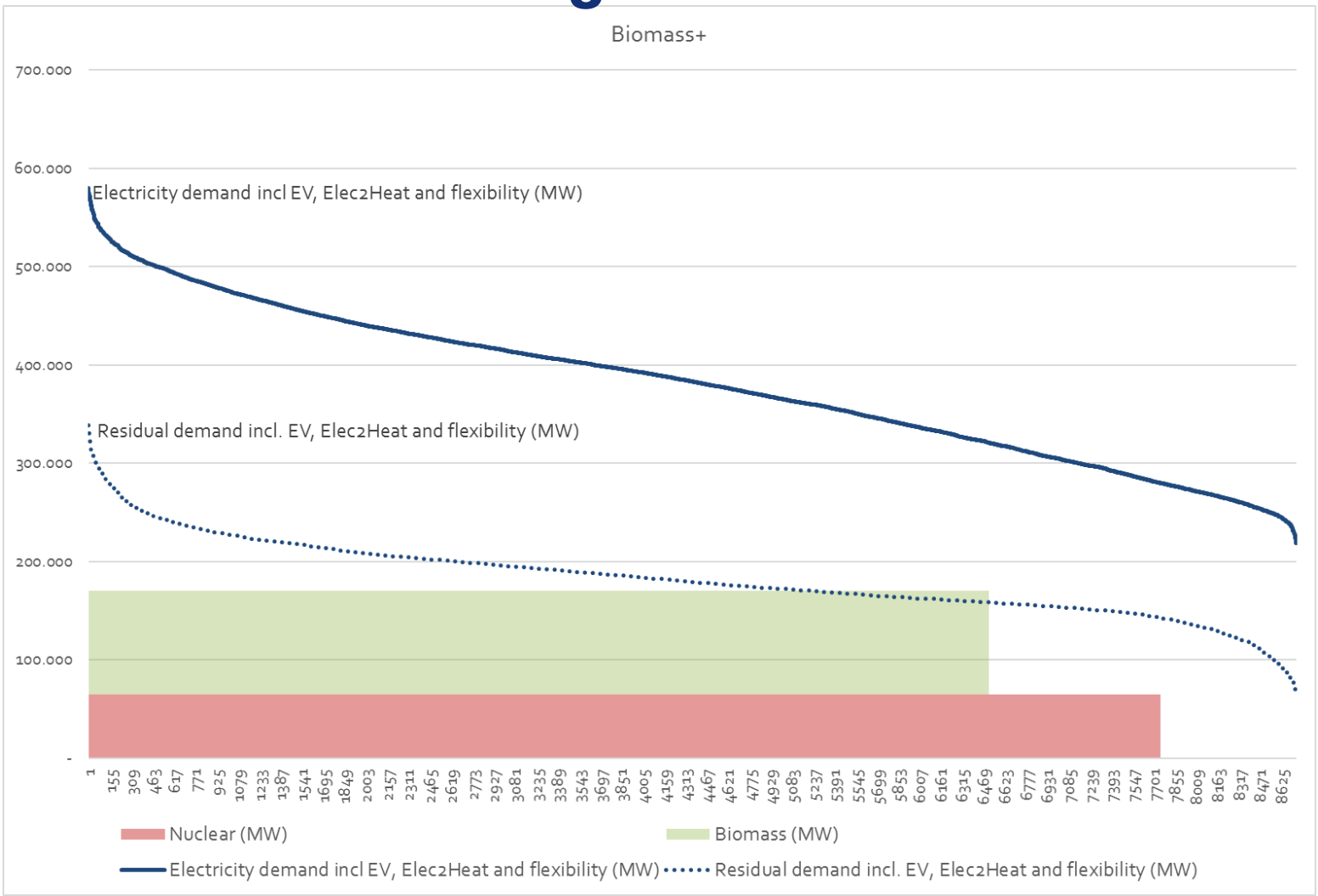
- **Biomass+**

  Higher CO_2 certificate price (double in 2040) and halved prices for biomass fuels

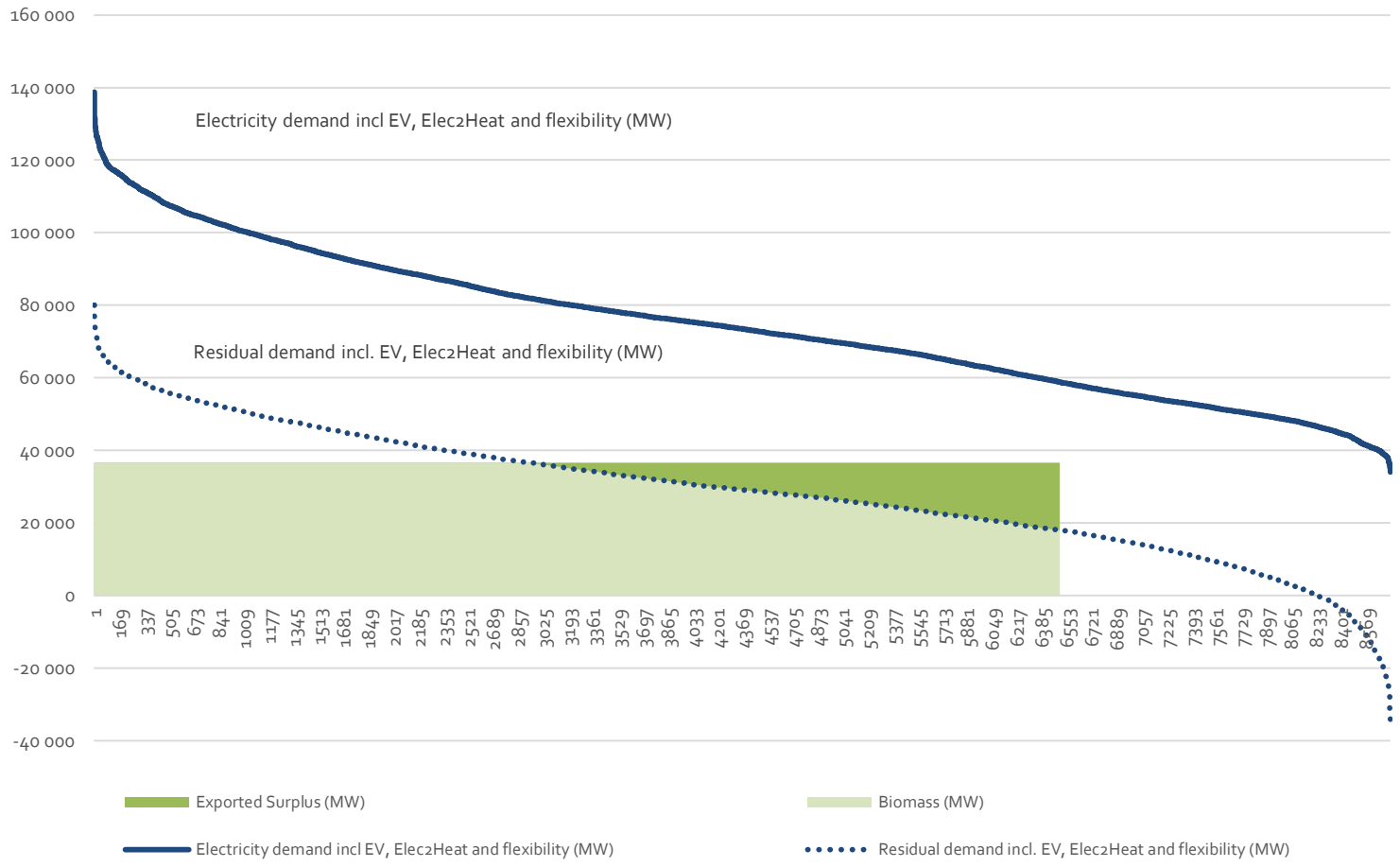


($/GJ)		2017	2020	2030	2040
	Coal	3.3	3.0	2.6	2.5
	Natural gas	6.5	8.0	8.0	8.6
	Fuel oil	8.2	9.5	12.5	11.3
Reference	Wood chips	7.7	7.8	8.3	8.4
	Wood pellets	8.8	10.5	10.6	10.5
Biomass+	Wood chips	7.7	3.9	4.1	4.2
	Wood pellets	8.8	5.3	5.3	5.3

Duration curve for demand
Whole model region - 2040



Duration curve for demand
Germany - 2040



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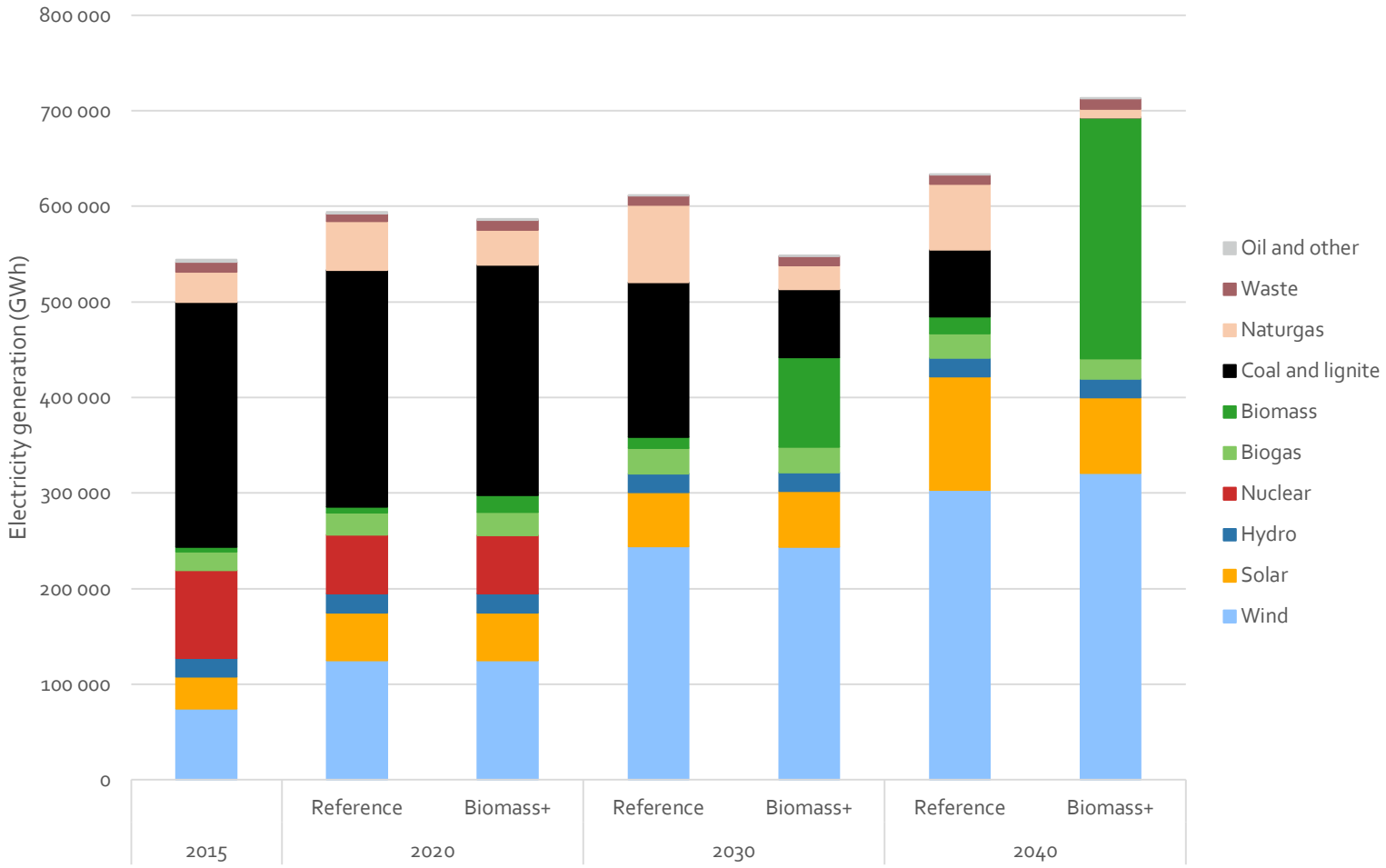
Electricity generation
Germany



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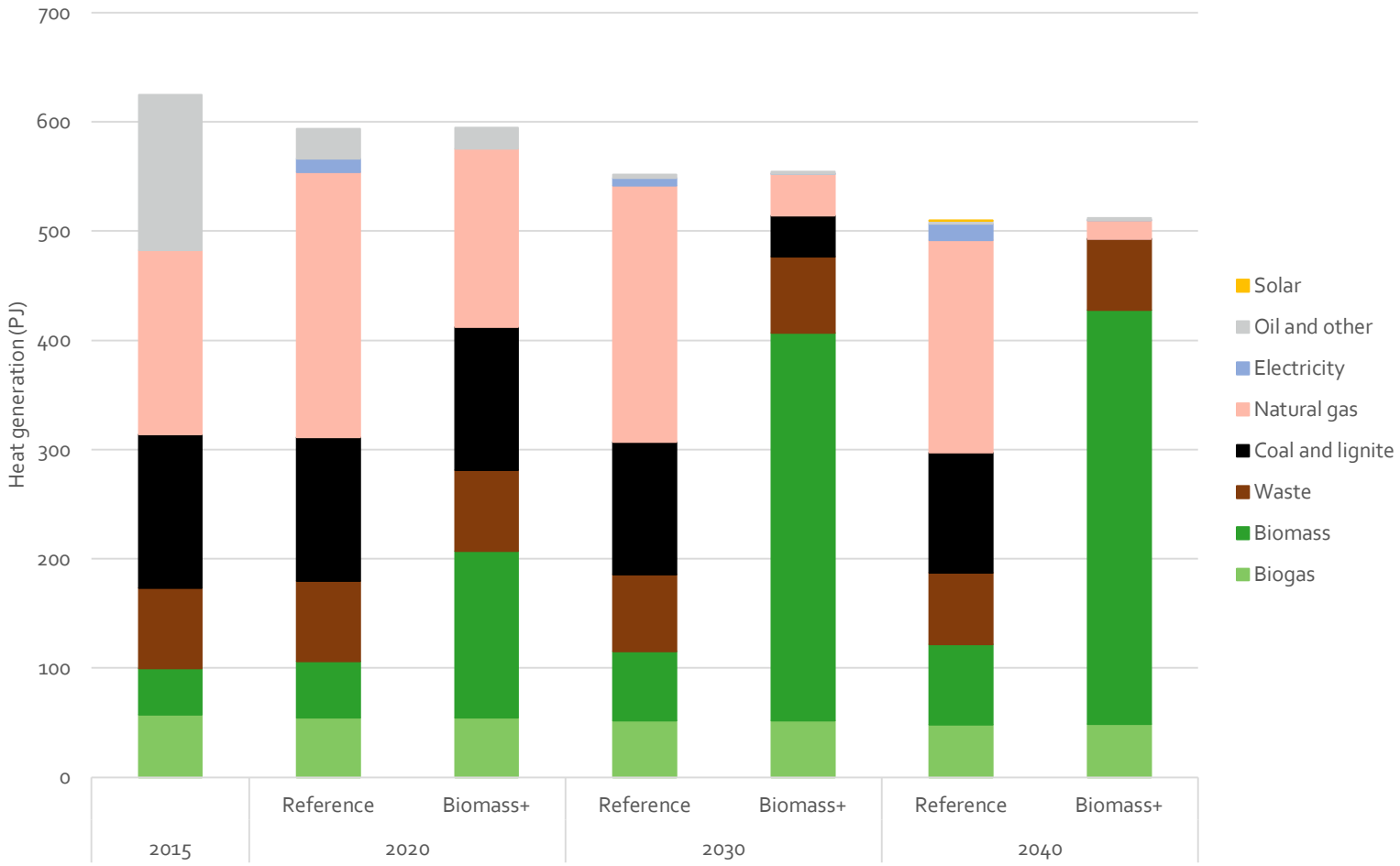
Heat generation
Germany



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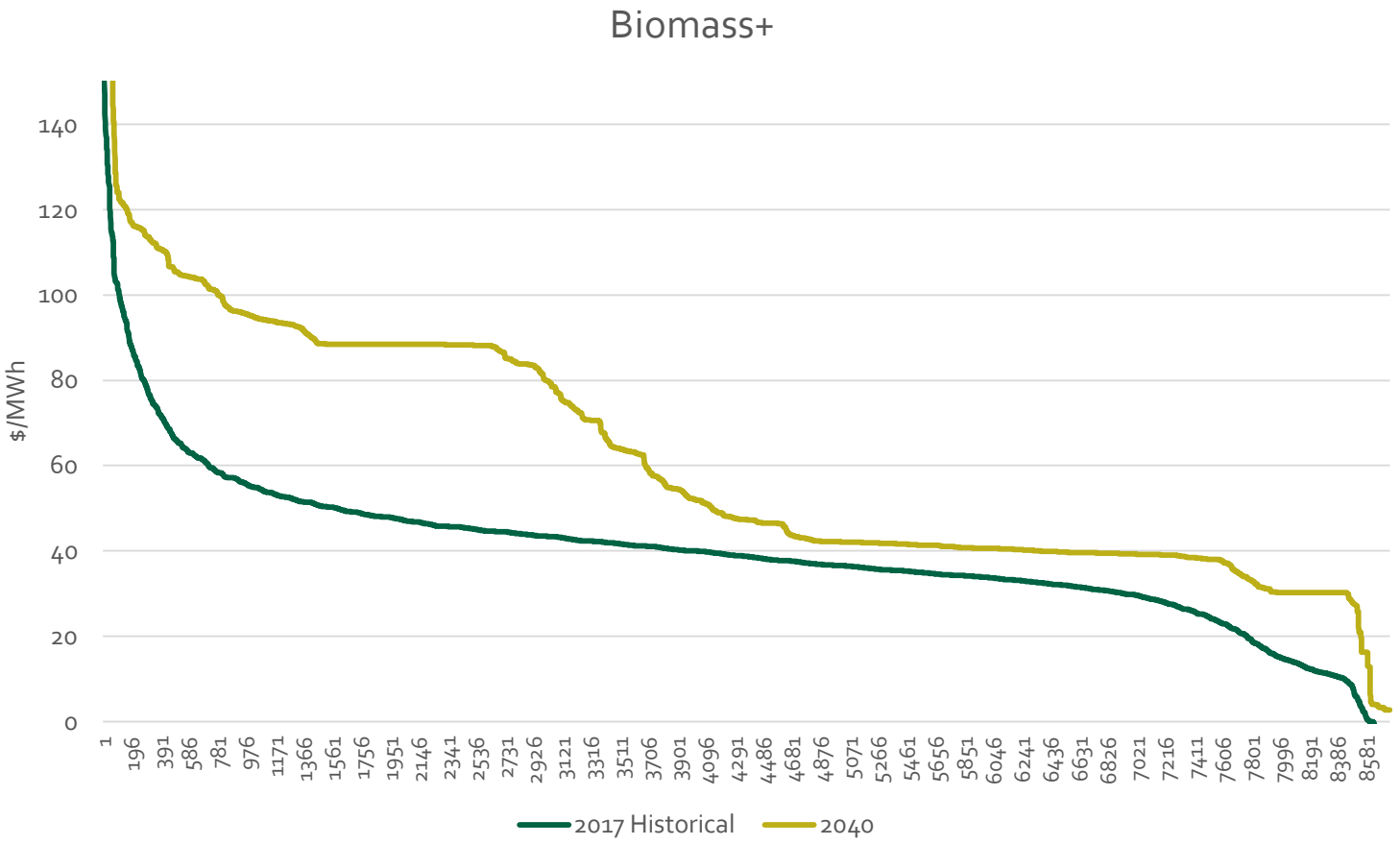
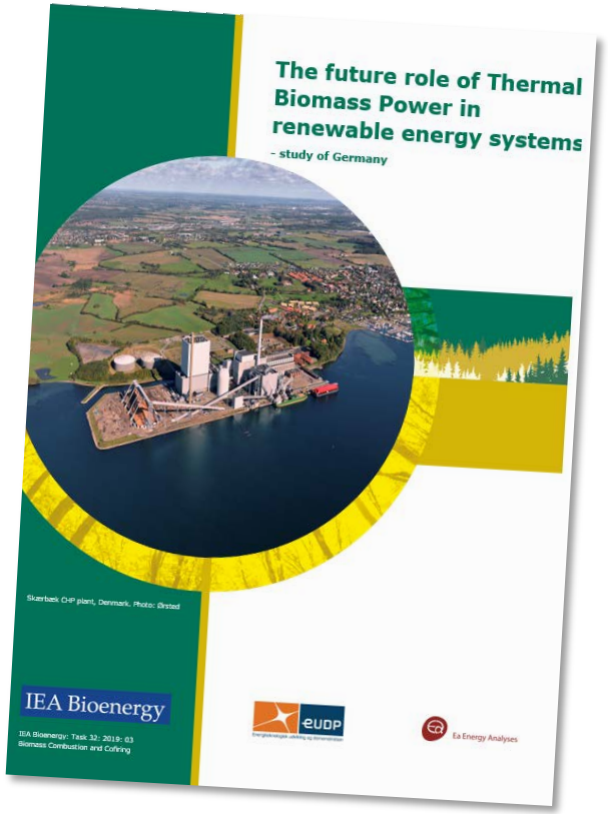
Electricity price duration curve Germany



Wrapping up

- Strong drivers needed before biomass plays large role in a future thermal-dominated power system like in Germany
- With high CO_2 prices and low feedstock prices, thermal biomass plants substitute coal and gas and some PV
- System flexibility is primarily delivered by hydro, pumped storages and gas power plants



Thank you!

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Additional slides

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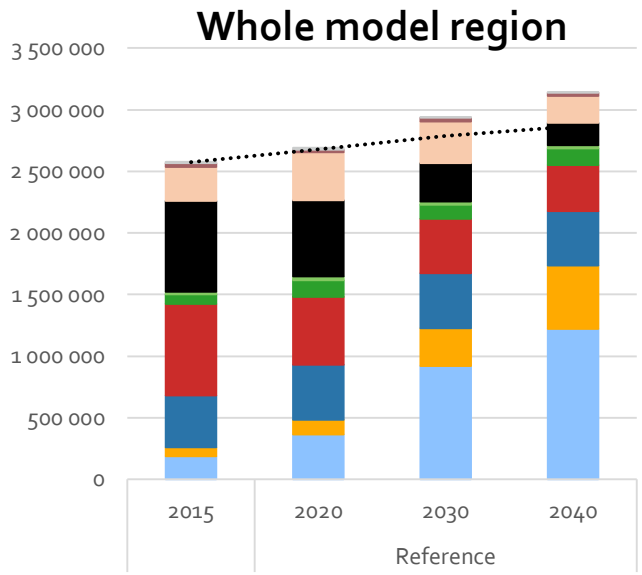
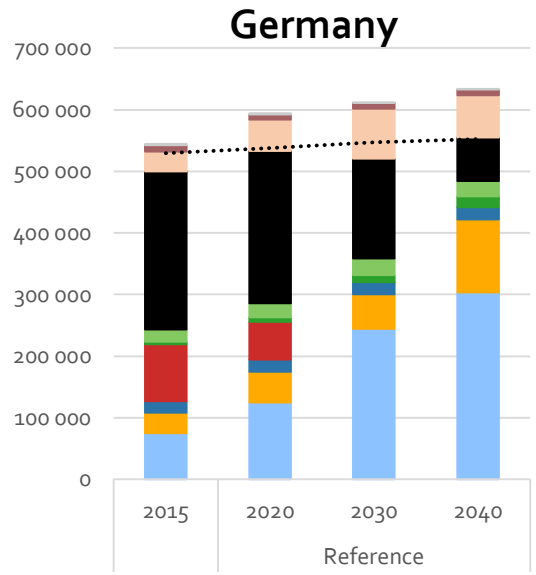
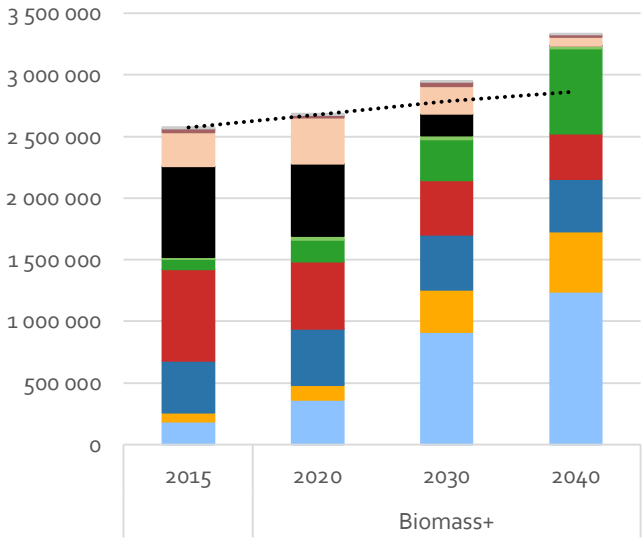
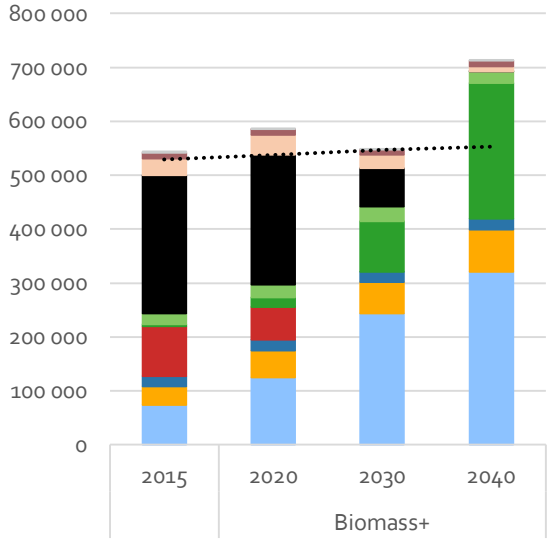
Contact Details

Electricity generation (GWh)









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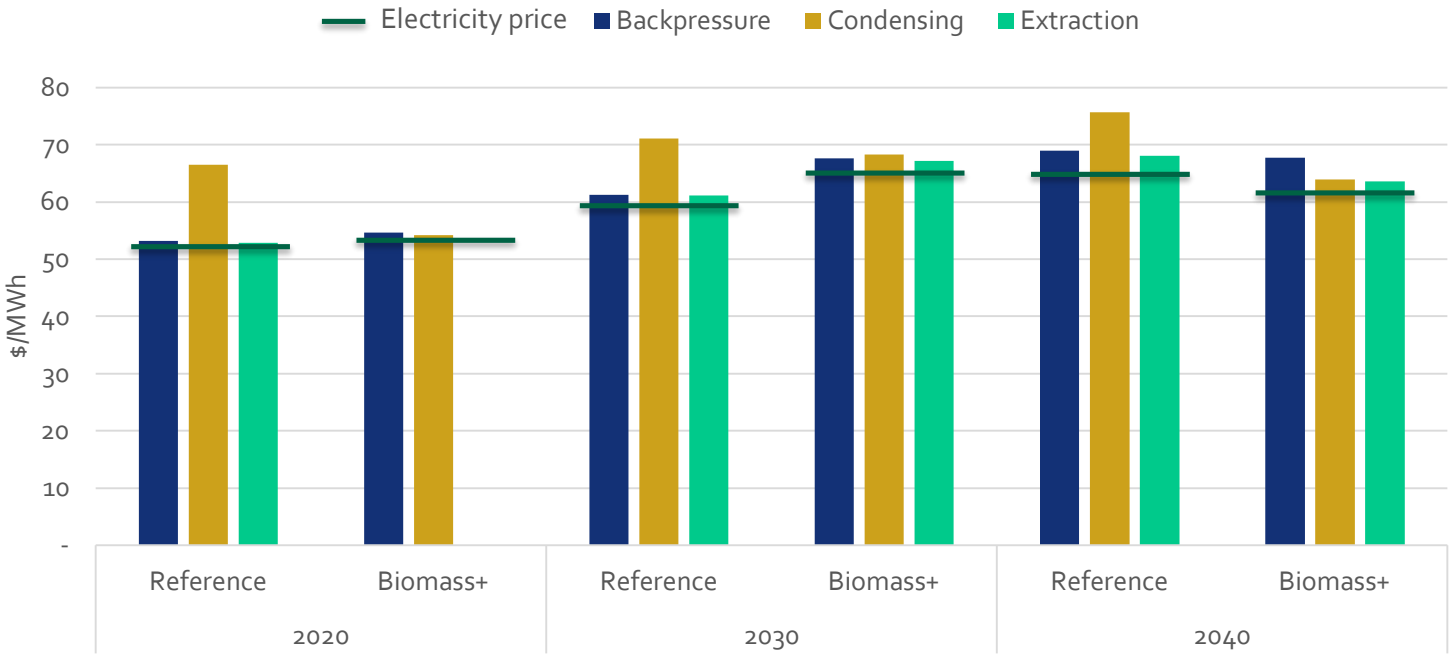
Capture prices Germany

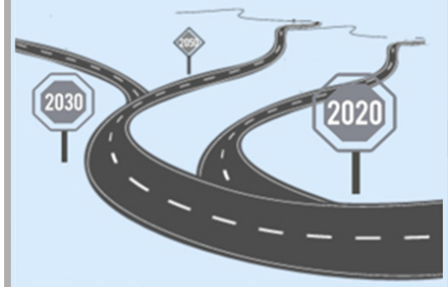


Full load hours*		2020	2025	2030	2035	2040
Reference	Backpressure	5,500	5,400	5,300	5,100	5,000
	Condensing	300	2,600	2,100	3,500	4,500
	Extraction	5,900	4,900	5,500	5,800	5,800
Biomass+	Backpressure	6,100	7,000	6,900	6,400	6,100
	Condensing	7,300	7,200	7,000	7,000	7,200
	Extraction	-	6,500	6,500	6,500	6,600

** Rounded to nearest 100*

Balmorel model structure

Model inputs



Model inputs include
- Demand prognoses
- Fuel prices
- Policy constraints
- Existing and committed generation capacity
- Existing and committed transmission capacity
- Investment catalogue for generation capacity
- Investment catalogue for transmission capacity

The model is designed to work with multiple scenarios, e.g. with more or less renewable energy or with variations of parameters such as electricity demand, fuel prices, CO2 prices etc.

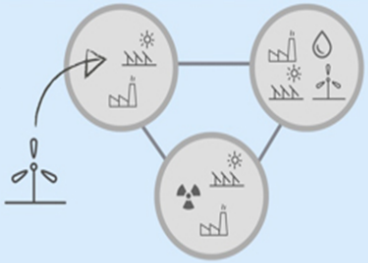
Least-cost dispatch

Each generator is represented with capacity (MW), fuel, efficiency and costs (operating costs and start/stop costs).

The model finds the optimal dispatch of each generator – given the available transmission capacity between areas. The optimal dispatch represents the lowest total costs for the entire model area.

Simultaneous optimization

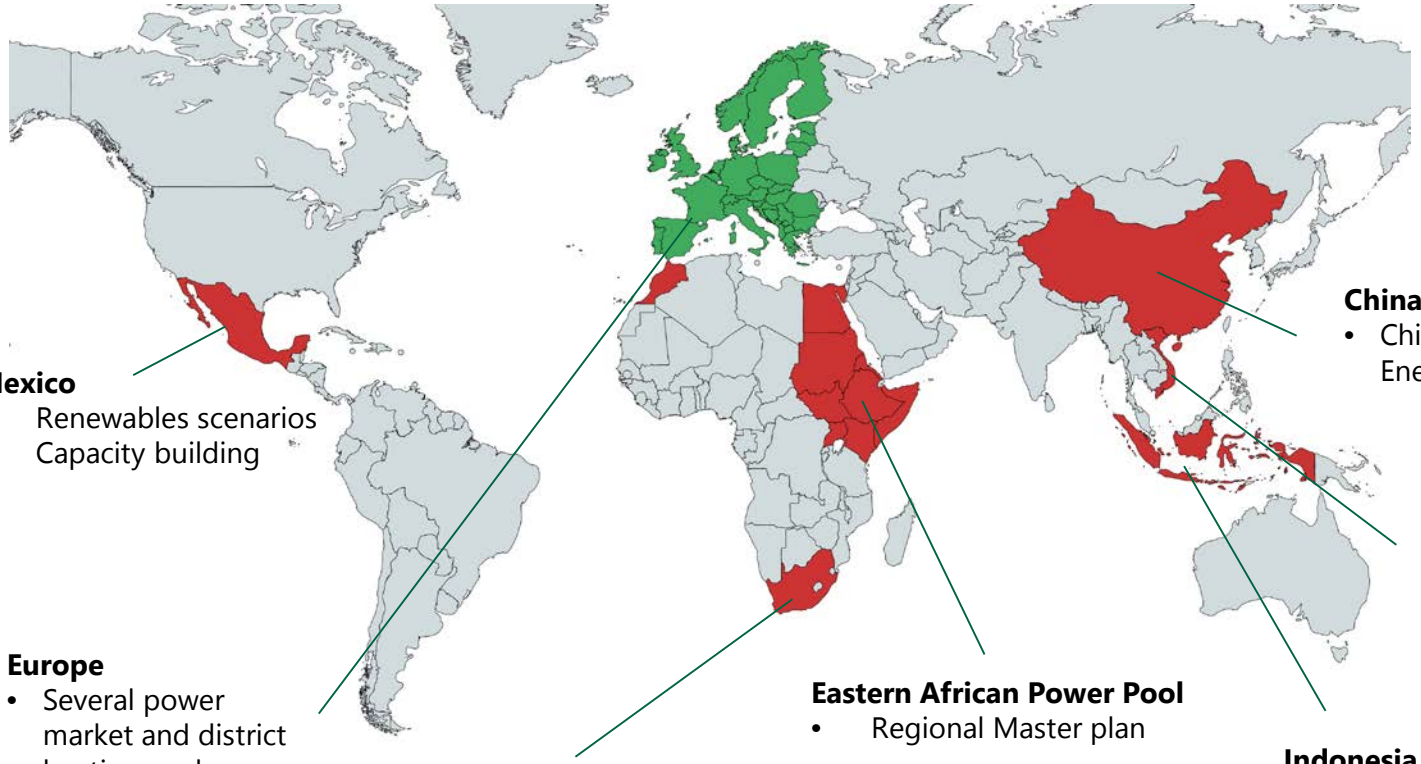
Least-cost investments



The model considers future investments technologies and potential locations. Refurbishments or shutdown of existing capacity can be part of the investment options.

Local and global limitations of resources and different geographical conditions are considered. The least cost investment is made while fulfilling requirements about CO2, renewable energy, firm capacity and policies.

Worldwide projects using Balmorel



Mexico
- Renewables scenarios
- Capacity building

Europe
- Several power market and district heating analyses

South Africa
- Cost-benefit of RE
- Security of supply analysis

Eastern African Power Pool
- Regional Master plan

China
- China Renewable Energy Outlook

Vietnam
- Wind mapping
- Vietnam Energy Outlook

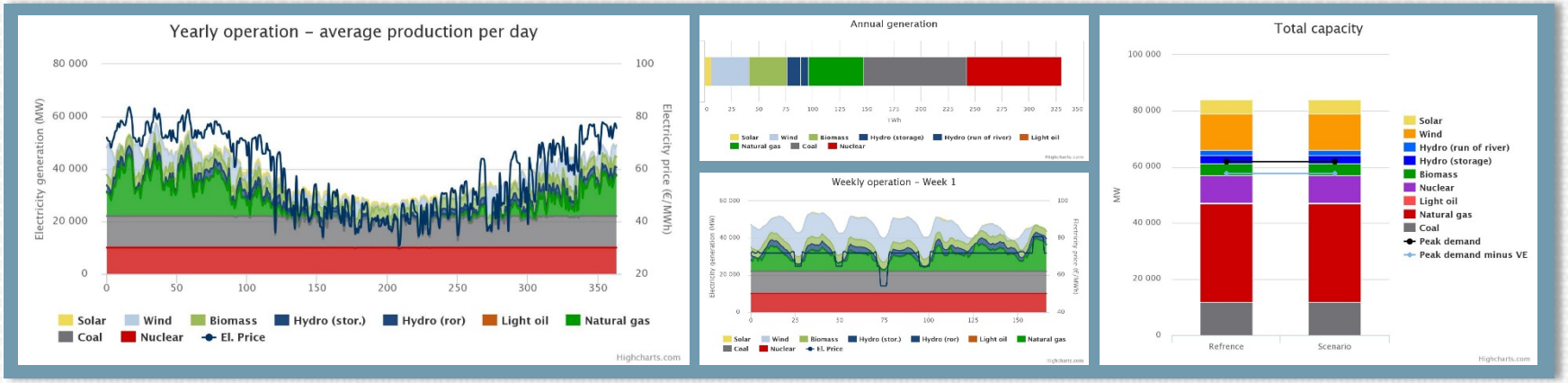
Indonesia
- RE integration studies
- Indonesian Energy Outlook

Balmorel Lite

Electricity system analyses

Make quick analyses of an electricity system. Tailor the input for your own system – existing or future!

A web-based tool that give users a visual and interactive introduction to the type of analysis and results that Balmorel can achieve - providing a good basis for reflection on next step activities and modelling opportunities.



Balmorel Lite is based on the Balmorel model and developed for the Danish Energy Agency by Ea Energy Analyses A/S (http://www.balmorellite.dk/)