
HIGH RESOLUTION RENEWABLE ENERGY SCENARIOS & KOMMOD MODEL APPLICATION

Introduction



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Seminar on Provincial Renewable
Energy Scenarios and its implication
for National and Regional Energy
Planning

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Why energy modelling: Growing risks on our energy systems require long term planning

Climate change

The increase of average global temperature must be limited to 2 °C in order to avoid existential consequences for countries and societies



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Security of supply and price stability

Resources of fossil and nuclear fuels are limited, peak-oil is happening locally, growing import dependency from politically unstable regions



Nuclear disasters cannot be prevented

The frequency of accidents can be reduced, but in no technology accidents can be prevented by 100%
→ countries must weigh the level of acceptable risk



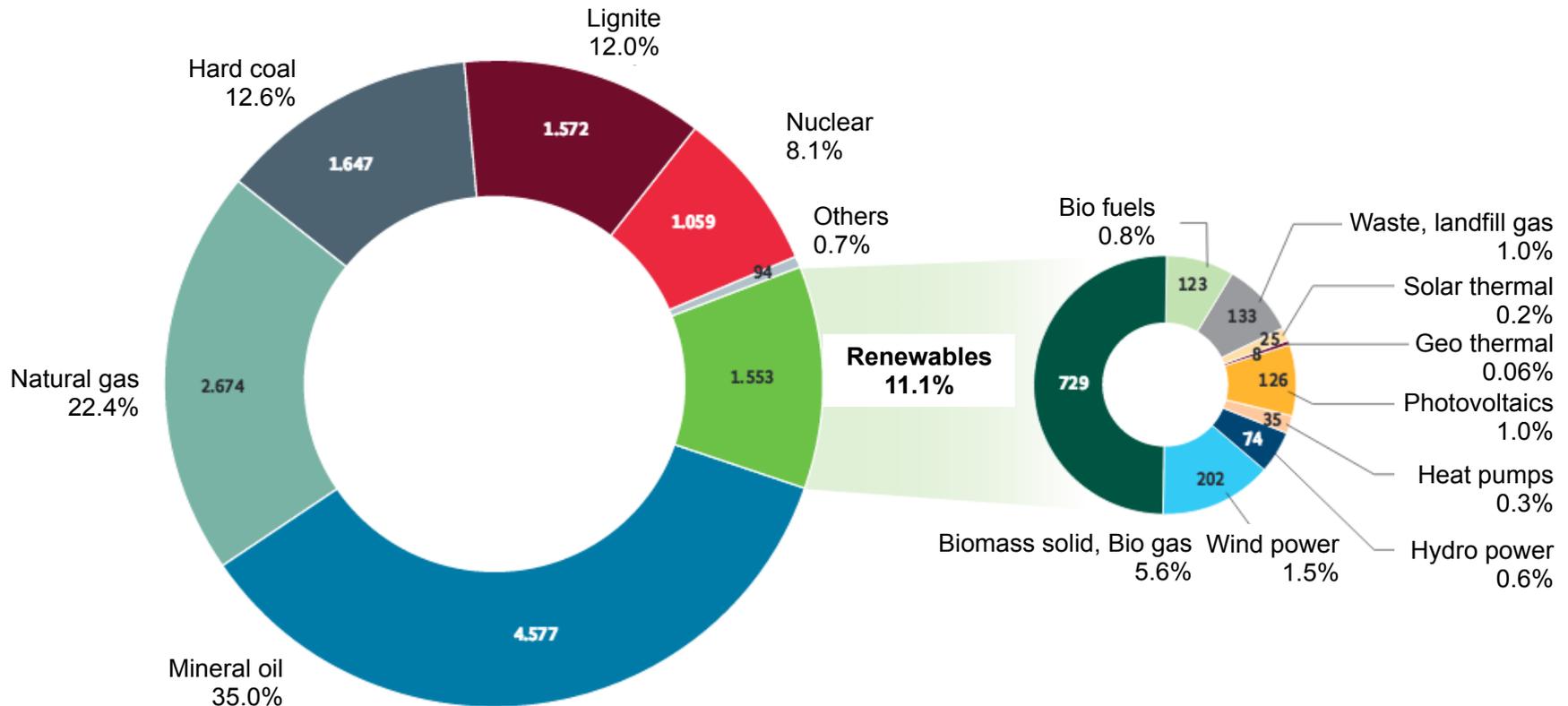
European and German energy policy targets

| | Basic year | 2020 | 2050 |
|--|-------------|------|--------------|
|  EUROPEAN UNION | | | |
| Reduction of Greenhouse Gas | 1990 | 20% | at least 80% |
| Increase of Energy Efficiency | 1990 | 20% | |
| Share of Renewable Energies | 2009: 11.6% | 20% | |
|  GERMANY | | | |
| Reduction of Greenhouse Gas | 1990 | 40% | 80-95% |
| Increase of Energy Efficiency | 2008 | 20% | 50% |
| Share of RES total | 2011: 12.2% | 18% | 60% |
| Share of RES on electricity | 2011: 20.0% | 35% | 80% |

=> The energy system must be transformed fundamentally

Primary energy demand in Germany 2014

Primary energy demand: 13,077 PJ (preliminary)



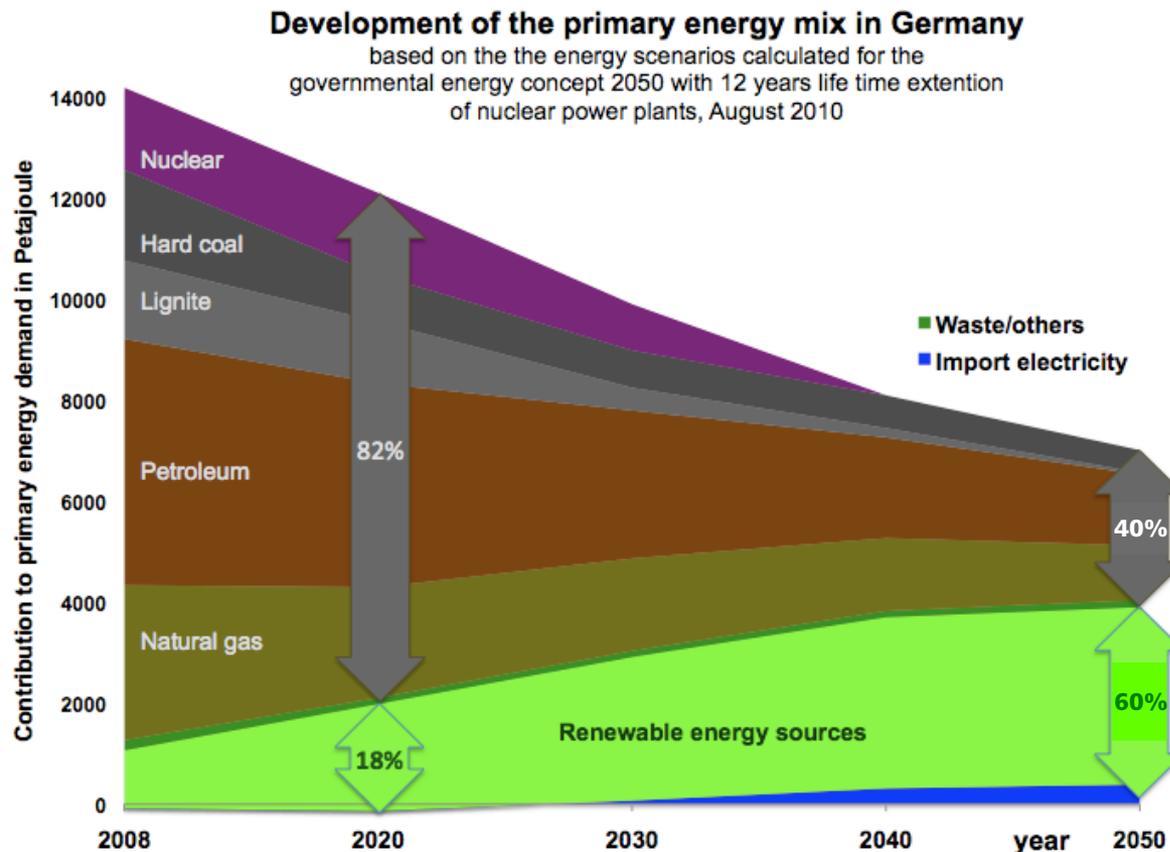
Quellen: Arbeitsgemeinschaft Energiebilanzen (AGEB), Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat)

German governmental plan of the future energy mix

German government agreed in Sept 2010 on the energy concept 2050

■ Targets for 2050

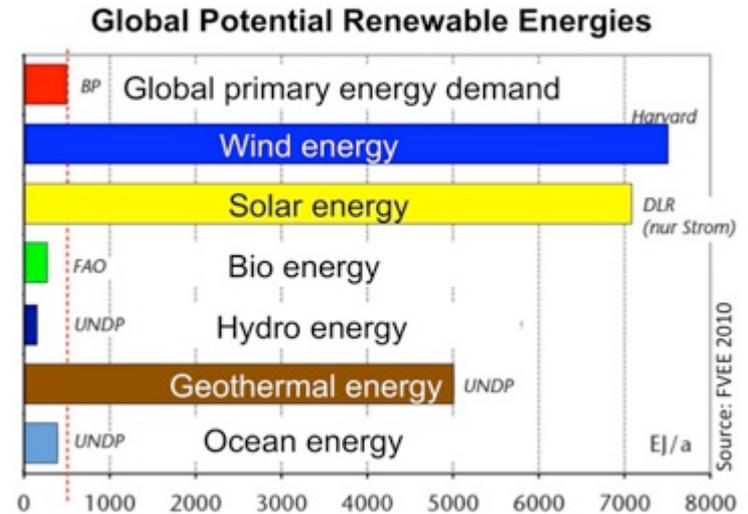
- Primary energy reduction by 50%
- 60% RES on primary energy
- 80% RES on electricity production
- After the disaster in Fukushima, the German government decided to fade out nuclear power until 2022



Perspectives for renewable energy sources (RES)

Benefits

- RES reduce import dependency
- RES stabilize energy prices
- RES increase local added value
- RES create jobs
- RES mitigate climate change



Challenges

- RES are usually more expensive (but becoming cheaper and cheaper)
- RES need to be integrated within an intelligent energy system with storage to compensate fluctuations



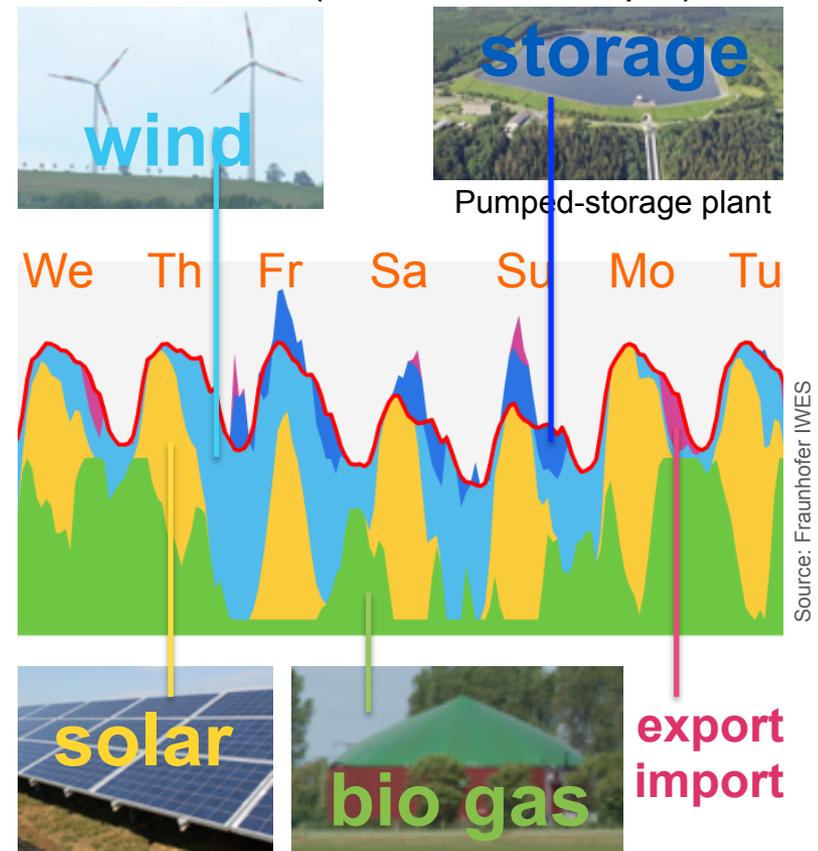
Main Challenge: variation of solar and wind energy

Secure electricity supply with the right RES mix and intelligent operation

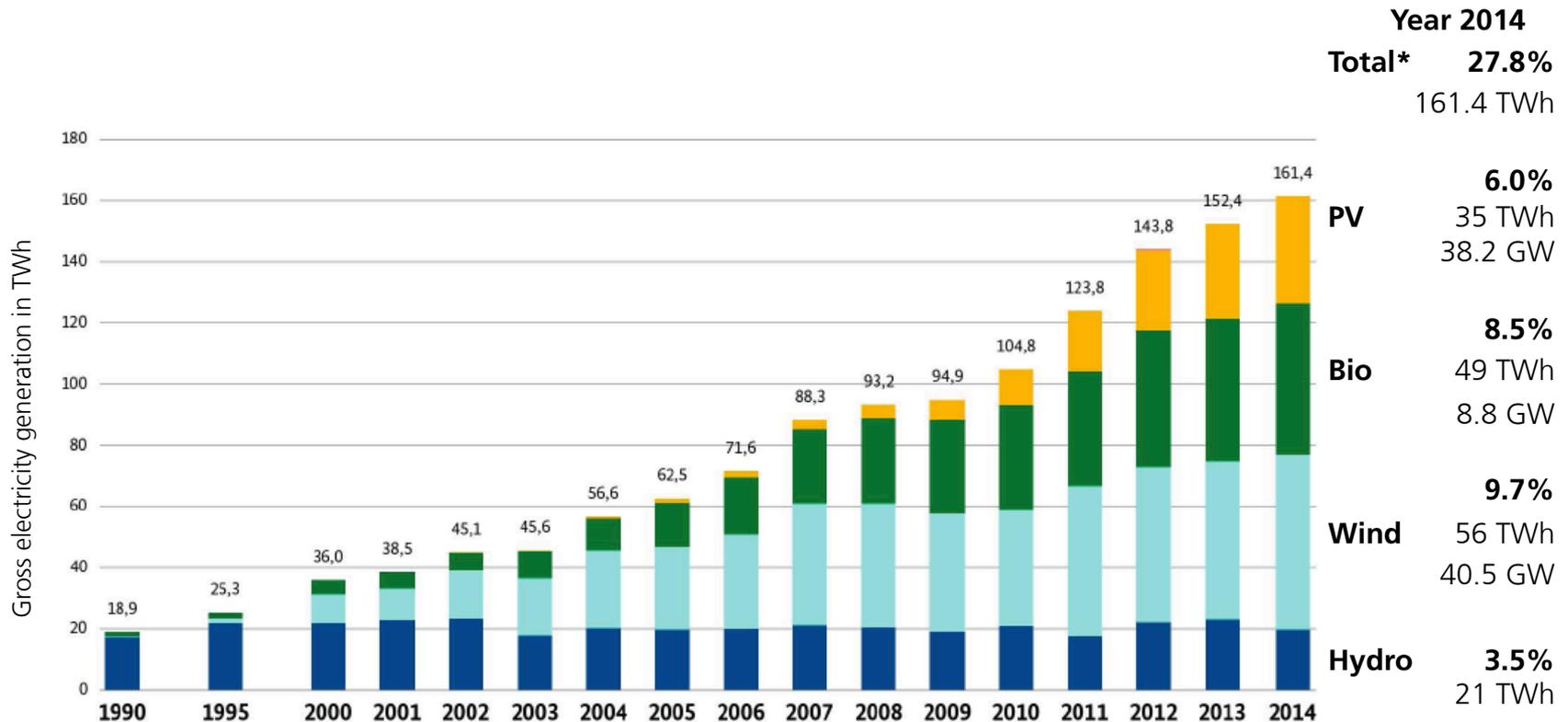
Measures to secure electricity supply:

- **Optimal mix of RES**
- **Expansion of the distribution grid**
to capture solar electricity and balance differing regional solar electricity generation
- **Expansion of high-voltage grid**
to bring wind electricity to consumers and balance differing regional generation
- **Dynamic energy management**
- **Smart Grids**
- **Demand-side management**
“consumption follows generation”
- Build up **short time storage capacities**
for peak shaping
- Build up **seasonal storage capacities**

Following a typical load curve with RES (one week example)



Electricity generation by renewable energy sources in Germany 2014



* Gross electricity demand

Electricity generation by PV and wind in Germany 2014

Monthly electricity generation by PV and wind in 2014

Annual electricity generation:

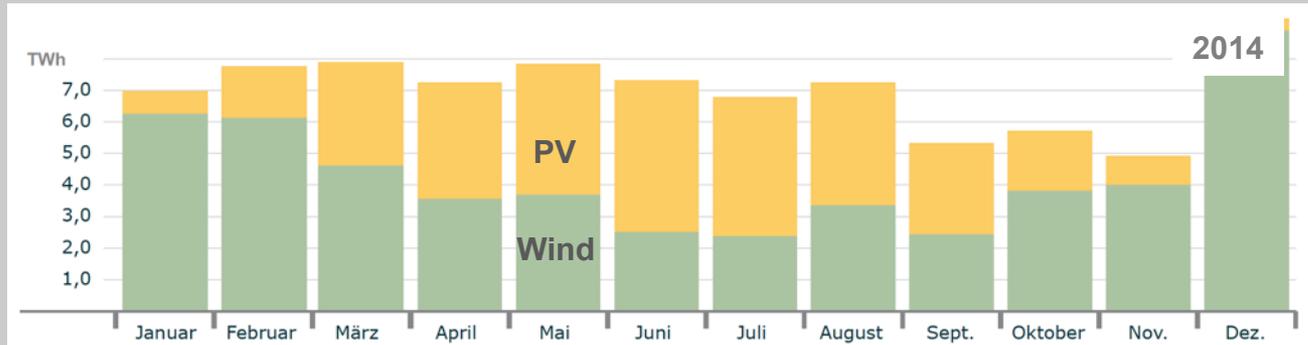
PV: 32,8 TWh

Wind: 51,4 TWh

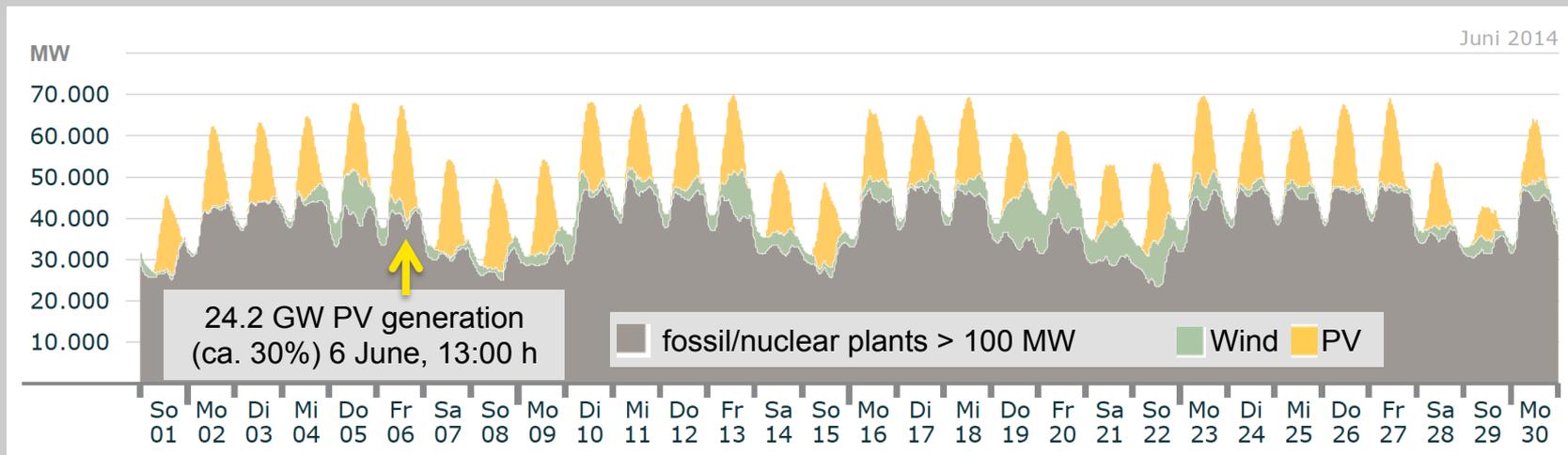
Share on el. demand:

PV: 6.0%

Wind: 9.7%

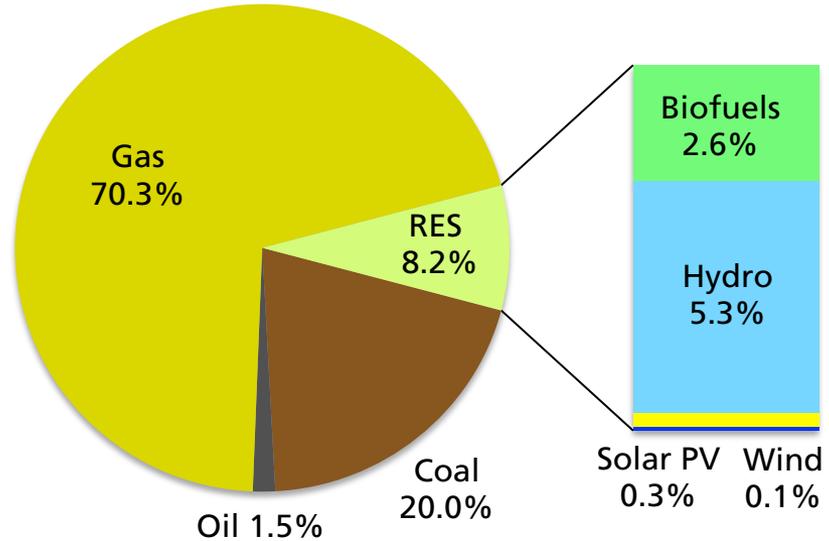


Electricity generation June 2014: Wind, PV and fossil / nuclear power plants > 100 MW



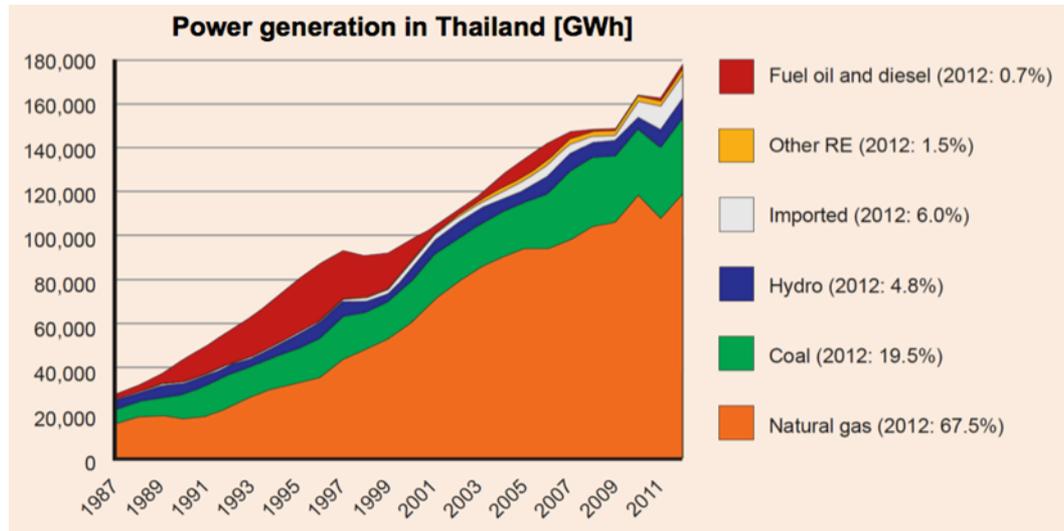
Electricity generation Thailand

Electricity Generation in Thailand in 2012



Source: IEA

- Total electricity demand in 2014: 166,621 GWh
- High dependency on natural gas and coal 90.3%
- Share on renewable energy sources (RES): 8.2%
- Main RES: Biomass and Hydro power
- Share of Solar PV and Wind is increasing

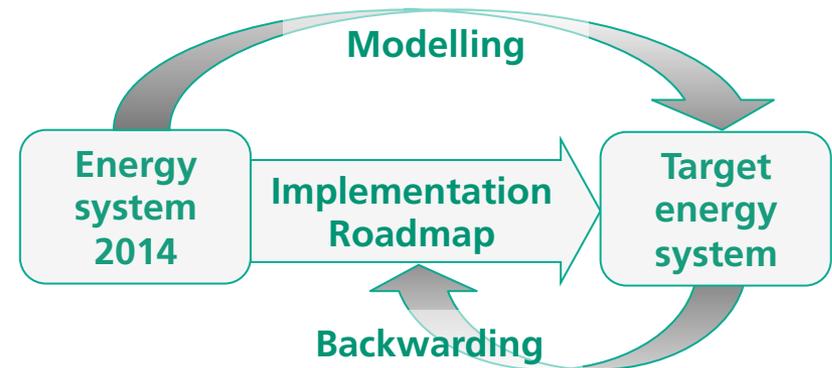


Modelling as a first step on the way to the Implementation Roadmap

■ Characteristics of sustainable urban and regional energy systems:

- High **efficiency**
- High share of **fluctuating** generation
- **Decentral** generation
- High **interdependency** of electricity, heating, cooling and mobility sectors
- Use of thermal and electrical **stores**

➔ **Temporal highly resolved modelling is needed to find the most cost-effective target energy system**



■ Way of proceeding:

- 1) Modelling target energy system
- 2) Roadmap development by backwarding

Objectives of RES4THAI

- **Evaluation of the possible renewable energy source (RES) share** for the provinces Phuket, Rayong and Nan with RES generated in the provinces
- **Identification of cost-effective structures of future energy systems** for specific targets and boundary conditions
- **Calculation of costs and CO₂-reductions** by the different scenarios

Conditions:

- Only the **electricity system** is considered
- **Calculations are done in an hourly resolution** to assure a secure electricity supply for each hour of one year, although PV and wind energy is used

RES4THAI team

GIZ Thailand

Sponsor, consultant on energy system development

- Thomas Chrometzka, director renewable energy
- Wiriya Puntub, project management

Fraunhofer ISE, Germany

Data processing, modeling of the energy system, energy concept development

- Gerhard Stryi-Hipp, senior scientist, project leader
- Sattaya Narmsara, scientist, data management
- Annette Steingrube, scientist, modeling

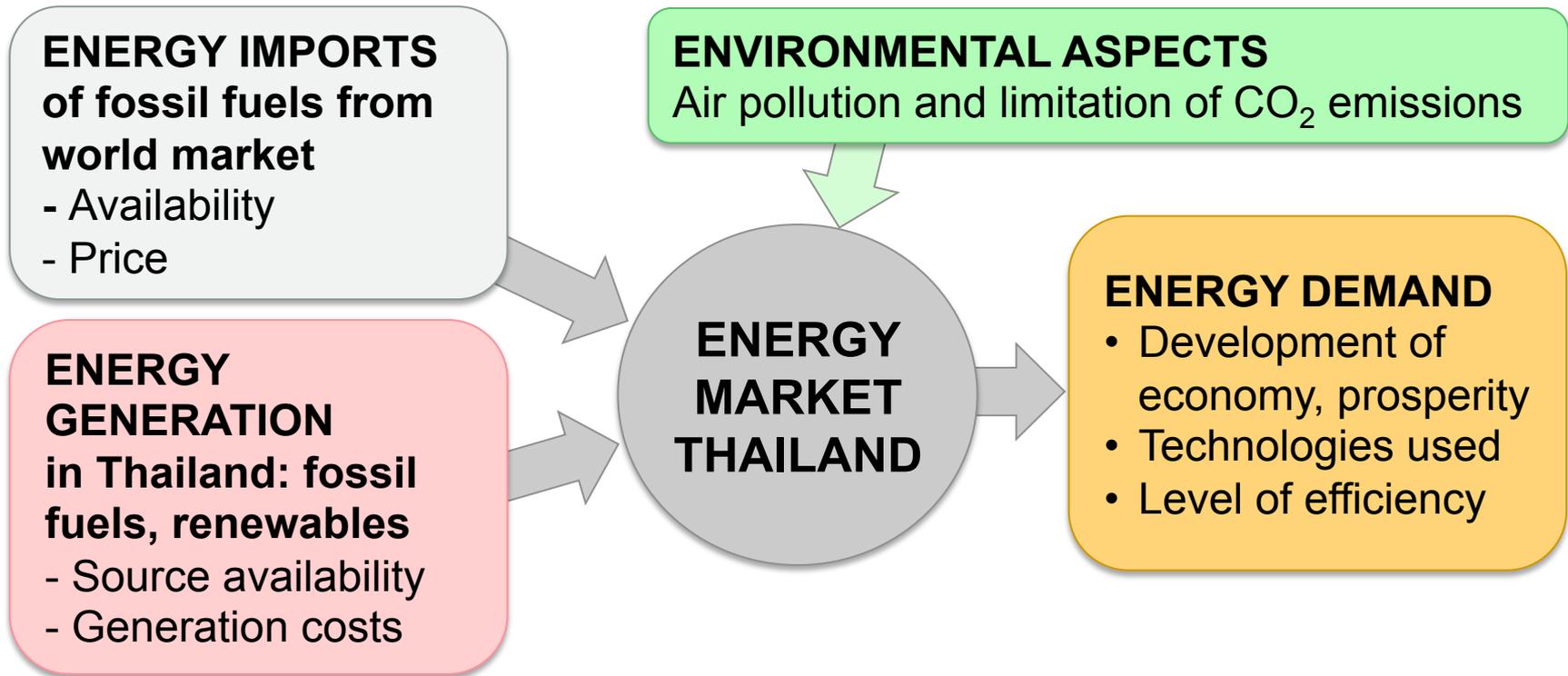
Joint Graduate School of Energy and Environment

Data gathering, energy concept development

- Prof. Dr. Christoph Menke
- Dr. Athikom Bangviwat



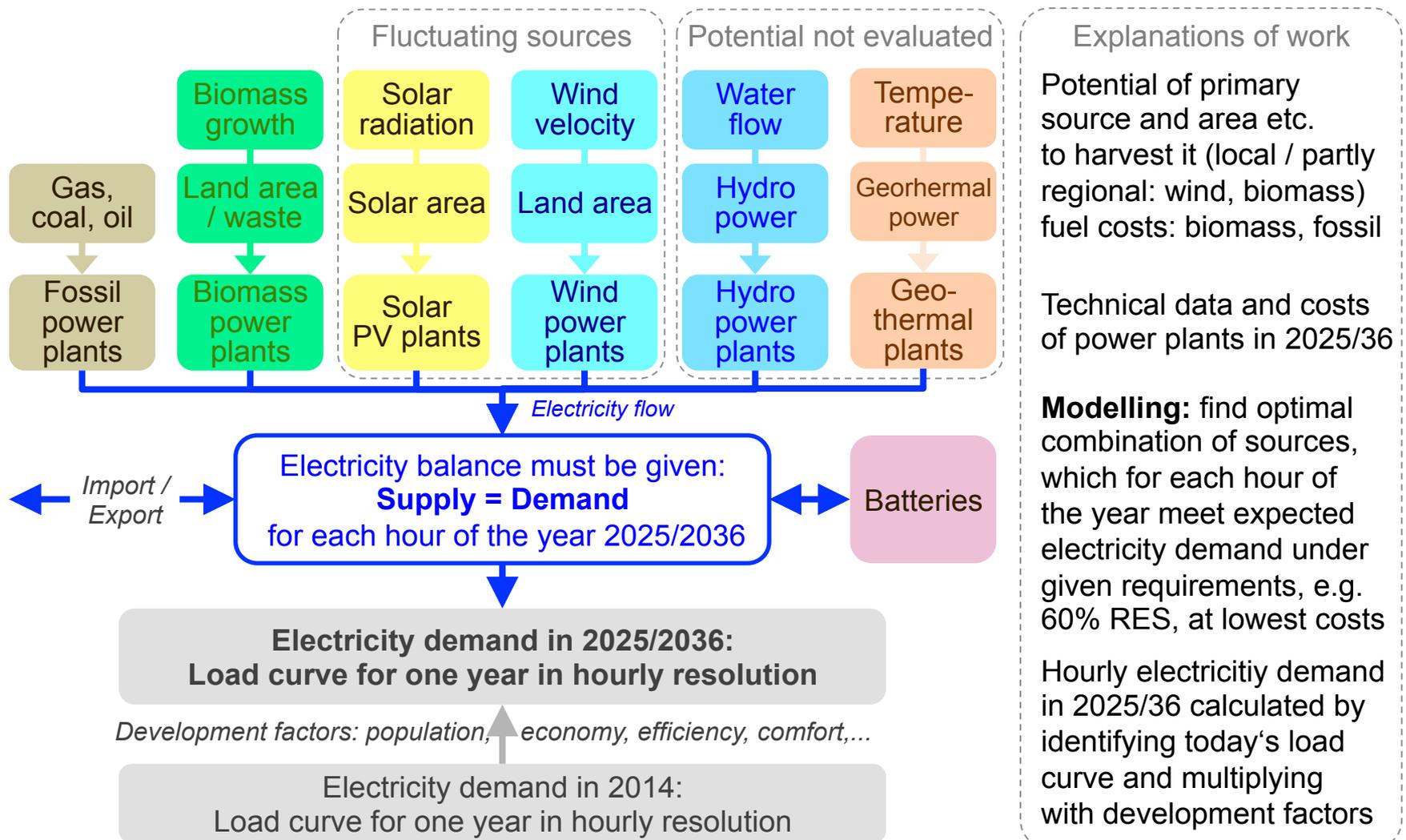
Challenges of energy planning



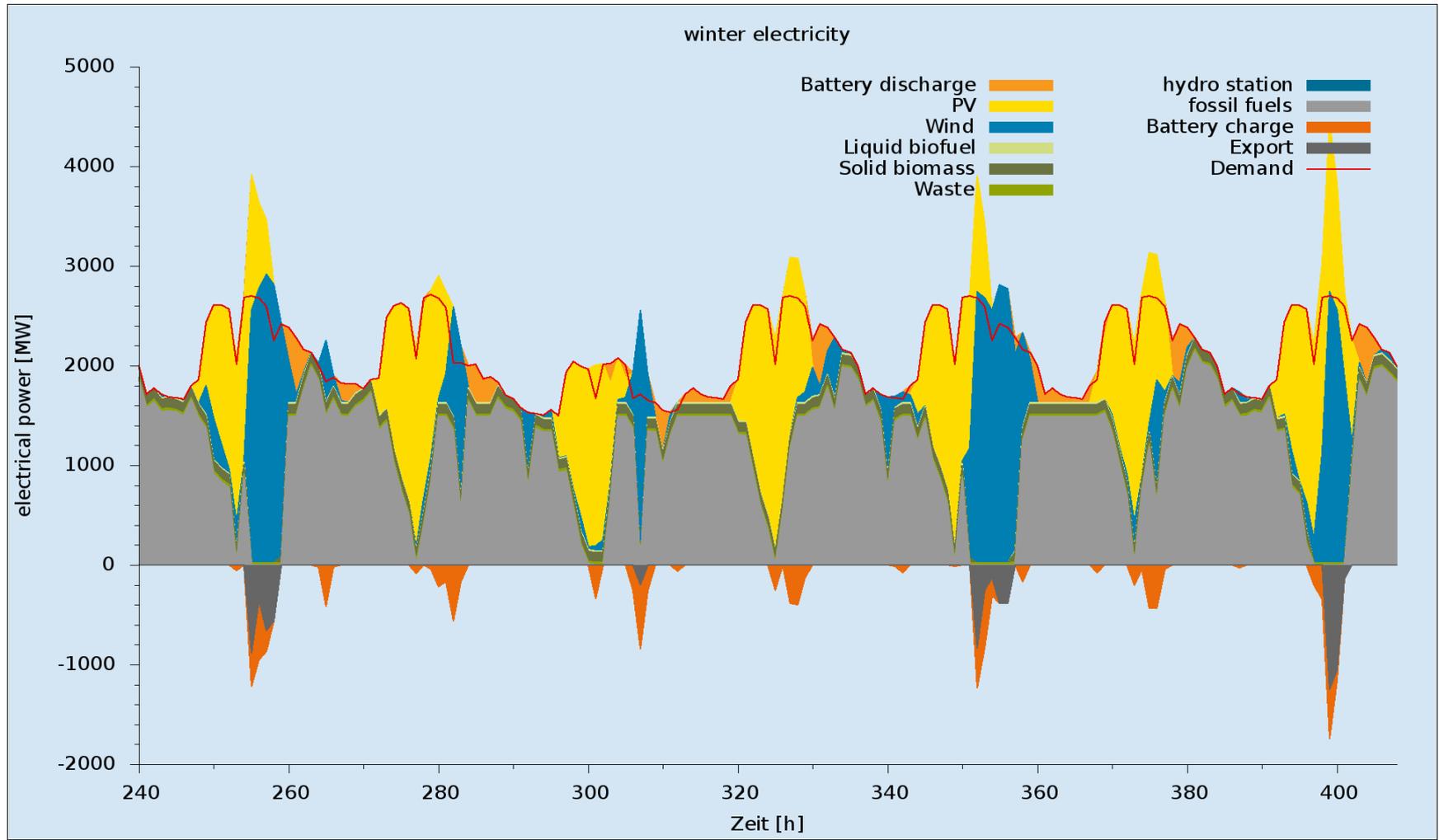
High uncertainties on the development of all aspects over the time

But renewable energie sources increasing security as local resources: secure, stable costs, don't harm the environment, generate added value

Structure of energy system modelling



Time series example: 40% RES in Rayong

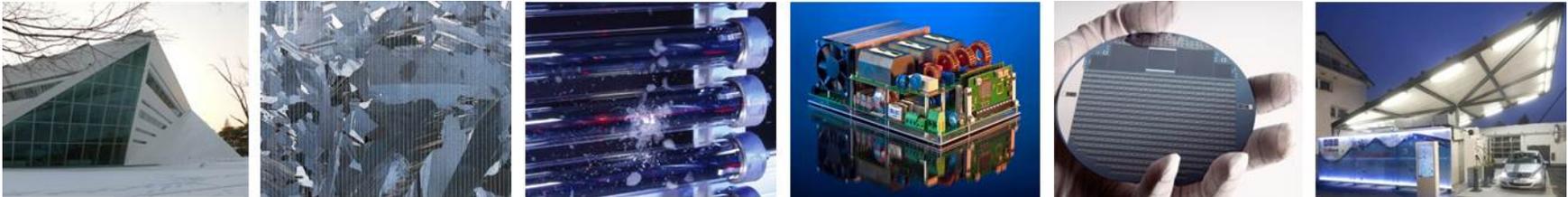


Conclusions

- Computer modelling of energy systems is an **important instrument** to identify, how energy systems with significant shares on RES should be designed cost-effective
- **Energy systems must be optimized on local and regional level**, if increased RES shares shall be targeted, since RES are decentralized sources
- The scenario modelling is based on several basic **input data and assumptions** on electricity demand and cost development, these data were gathered and assumptions were made carefully, however, further work is needed to improve the quality of data, especially if implementation roadmaps shall be developed



Thank you very much for your attention!



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