Technische Hochschule Ingolstadt

Institute of new Energy Systems

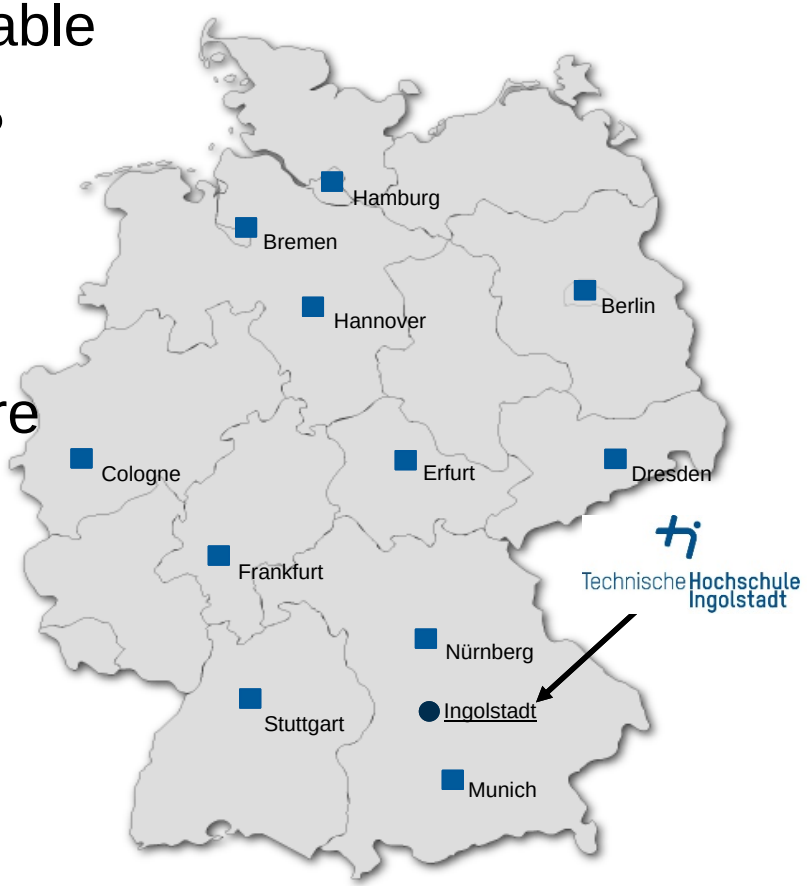
Why are Renewables so Successful in Germany?

Prof Wilfried Zörner Ph.D.

Stellenbosch, 17.03.2017

Overview

- Development & Status of Renewables in Germany
- What Is / Was in Favour of Renewable Electricity Generation in Germany?
- Supportive Legislation in Germany
- Challenges & Chances of the Future
- Conclusions



Ingolstadt Technical University (THI)

Overview

1994 Founding of the University

5,300 Students

54 Course Programmes

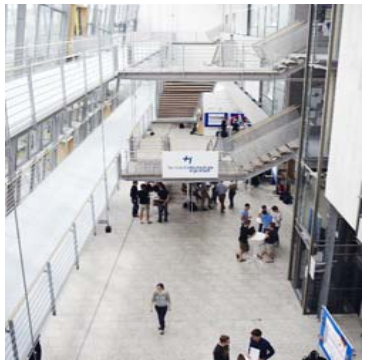
3 Faculties

135 Professors

120 Research Staff

750 Bachelor Graduates

80 PhDs



260 Master Graduates

€39 m Annual Budget

€14 m Construction Investments

Thereof *€12 m* Third-Party Funding

Institute of new Energy Systems (InES)

Overview

2001 Founding of the Institute

5 Working Fields

6 Professors

20 Research Staff

7 PhD Graduates

17 Current Research Projects

€5.5 m Current Research Grants

> 150 Scientific Publications

> 40 Industry Partners

Institute of new Energy Systems (InES)

Working Fields

Networking and Knowledge Transfer

- Regional and International Networks
- Technology Transfer
- Stakeholder Involvement
- Academic and Industrial Collaboration

Solar Energy Technology

- Photovoltaics Applications (On- and Off-grid)
- Solar Heating and Cooling
  - Solar-based Energy Supply Systems
  - Solar-thermal Collectors
  - Solar Heating Networks
  - Measurements according to Standard

Bioenergy Technology

- Flexibilisation of Power & Heat Generation
- Biogas Plant Engineering
  - Ecological and Economic Plant Optimisation
  - Biogas Upgrading
- Wood-Fired Power Stations

Geothermal Technology

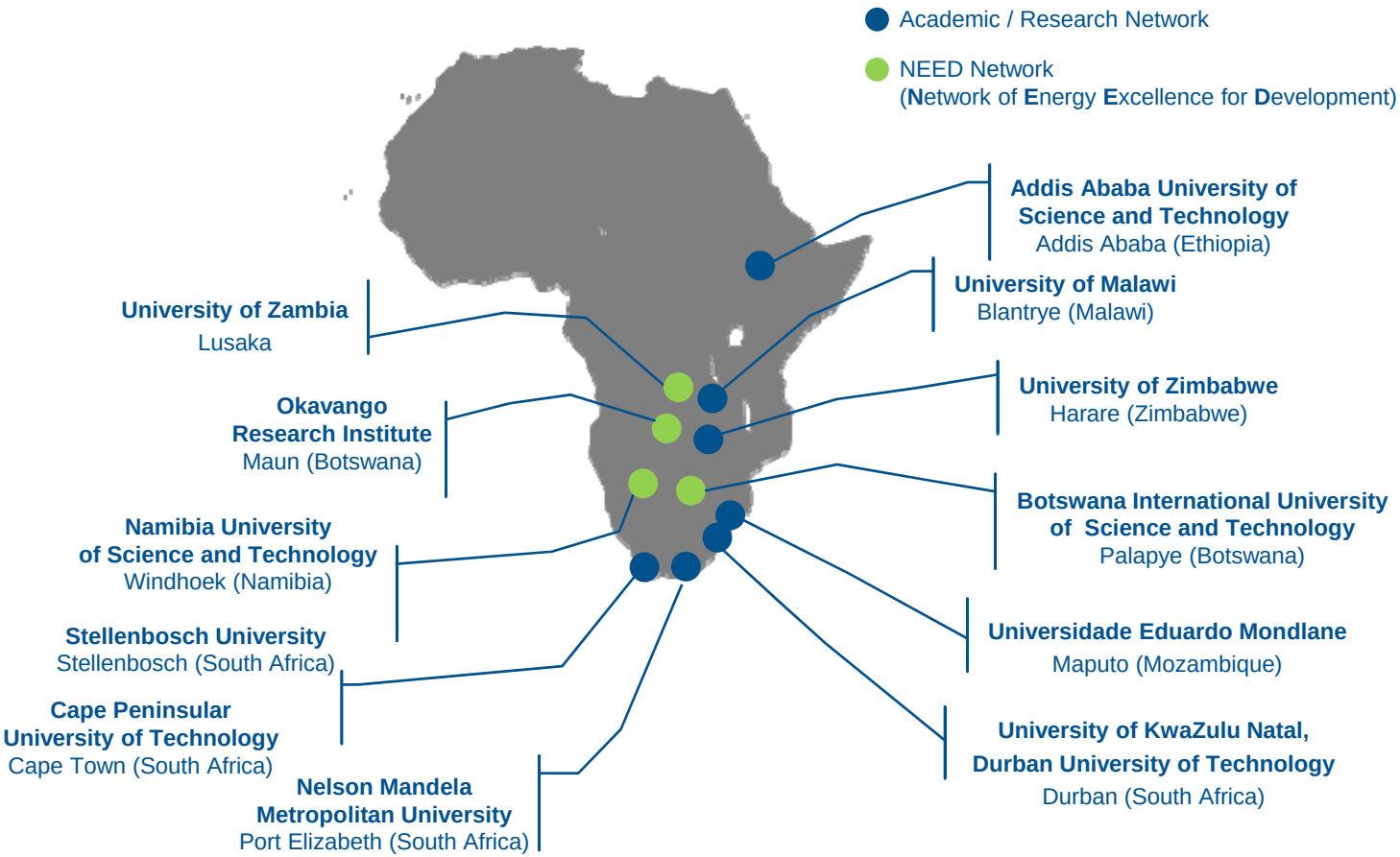
- Power & Heat Generation
- Hydro-geothermal Energy
- Geothermal Probe Systems
- Energy Piles and Thermal Component Activation
- Underground Heat and Cooling Storage
- Integration of Geothermal Energy in Energy Systems

Energy Systems Technology

- Coupling of Heating/Cooling, Power and Mobility Sectors
- Energy Supply on Demand
- Energy Storage Technologies
- Local/Regional Energy Concepts
- Energy Efficiency in Industry
- Electricity Grid Integration

Institute of new Energy Systems (InES)

Academic & Research Co-Operation in Africa



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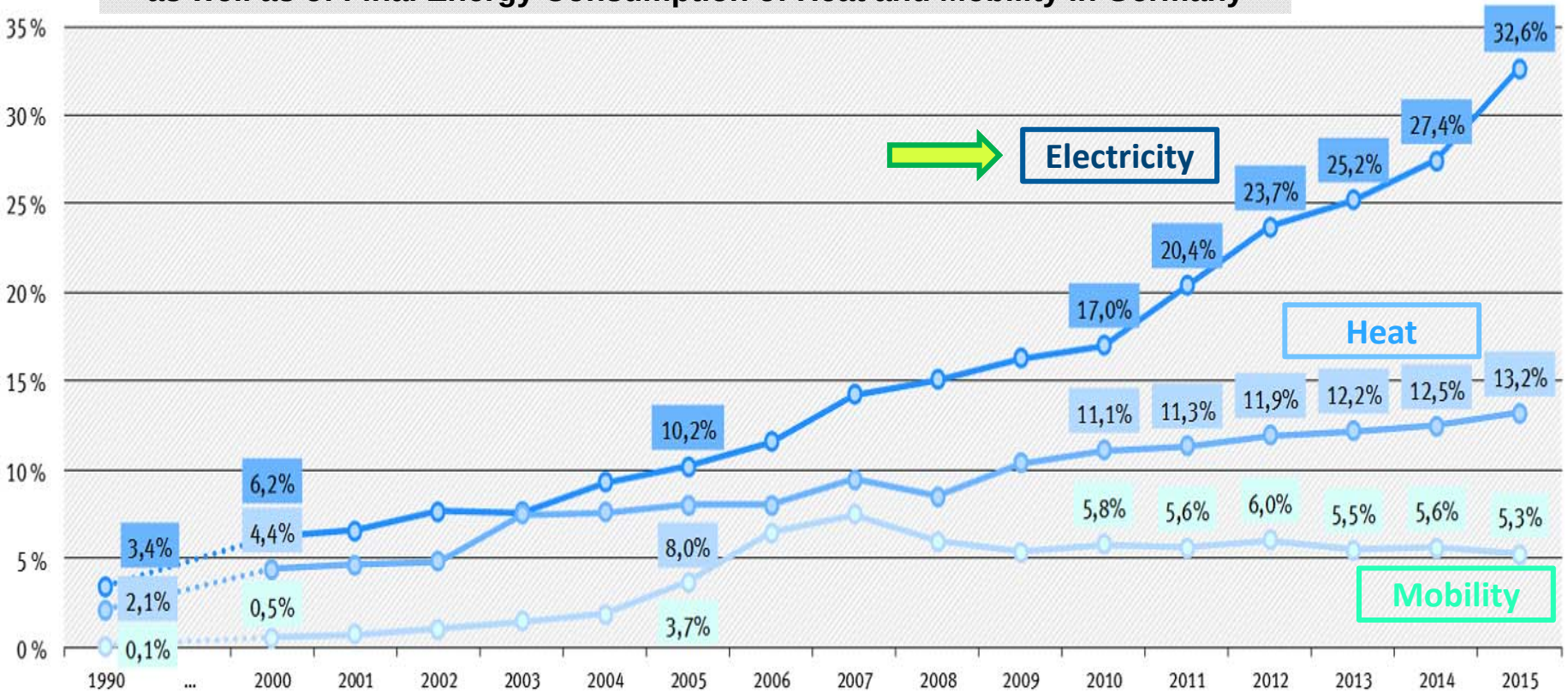
Development & Status of Renewables in Germany

Renewables in Electricity, Heat & Mobility

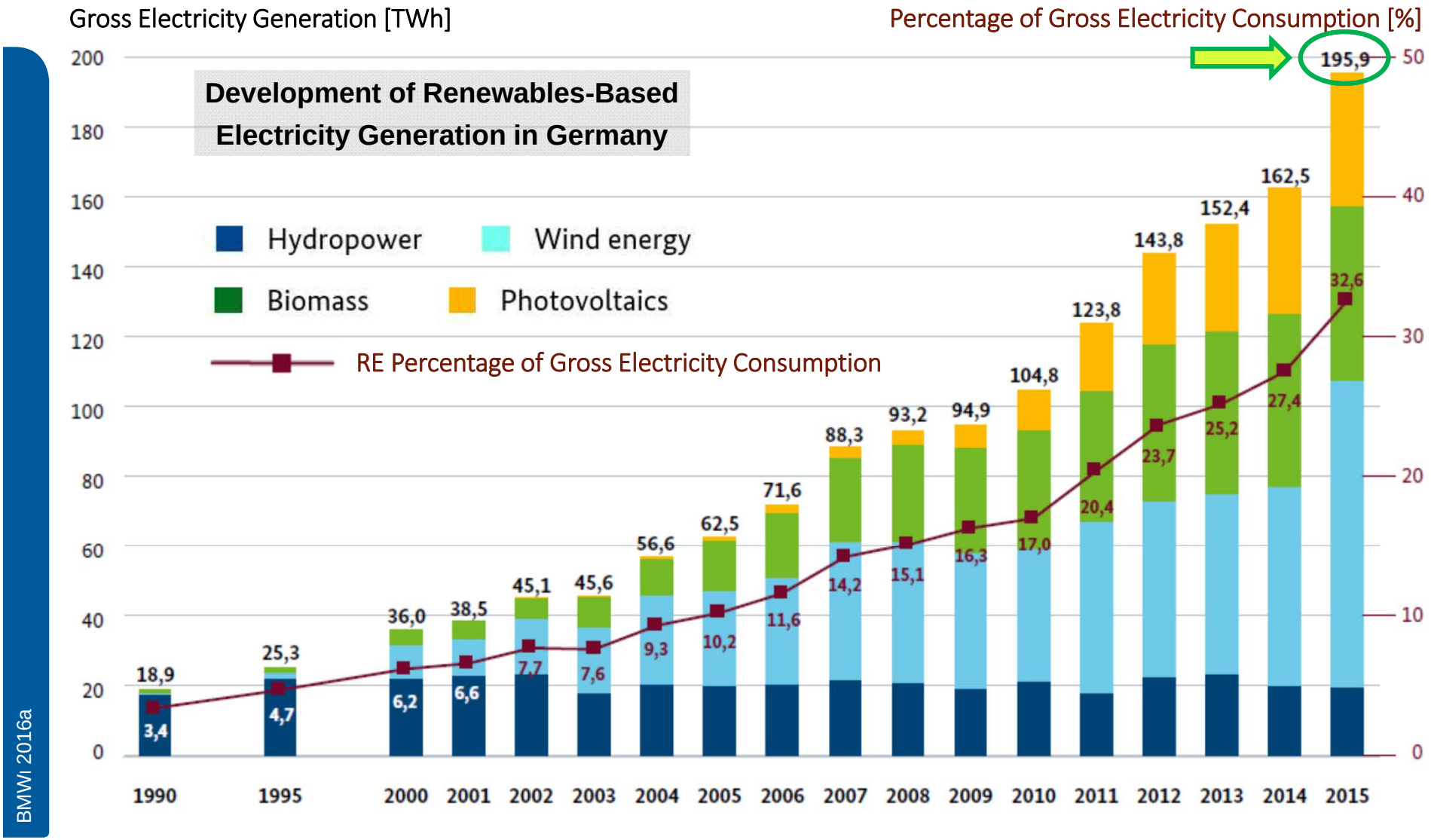
Development of Percentage of Renewables of Gross Electricity Consumption as well as of Final Energy Consumption of Heat and Mobility in Germany



UMWELTBUNDESAMT 2016

Development & Status of Renewables in Germany

Renewables in Electricity

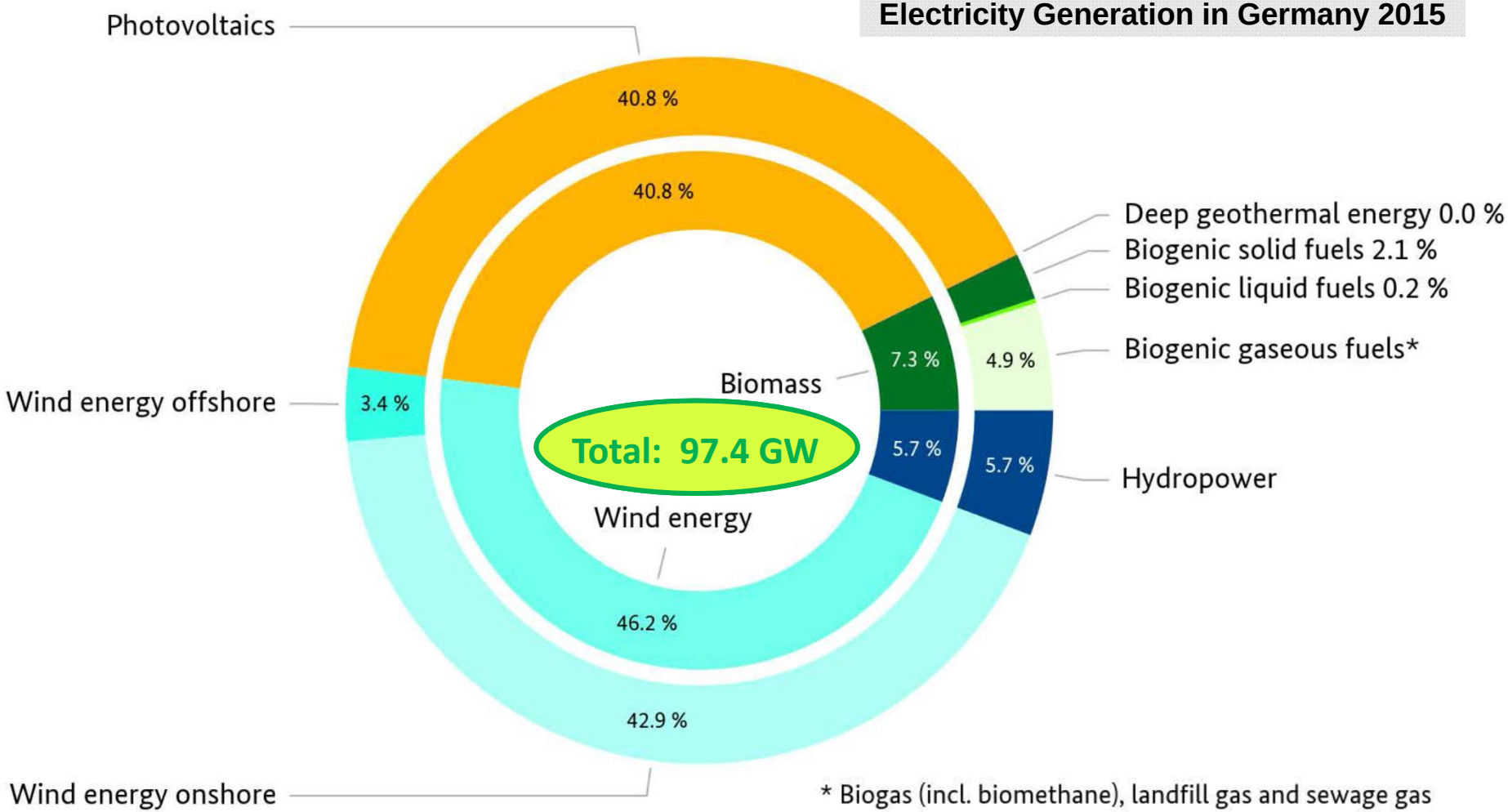


BMWi 2016a

Development & Status of Renewables in Germany

Renewables in Electricity

Installed Capacity of Renewables-Based Electricity Generation in Germany 2015

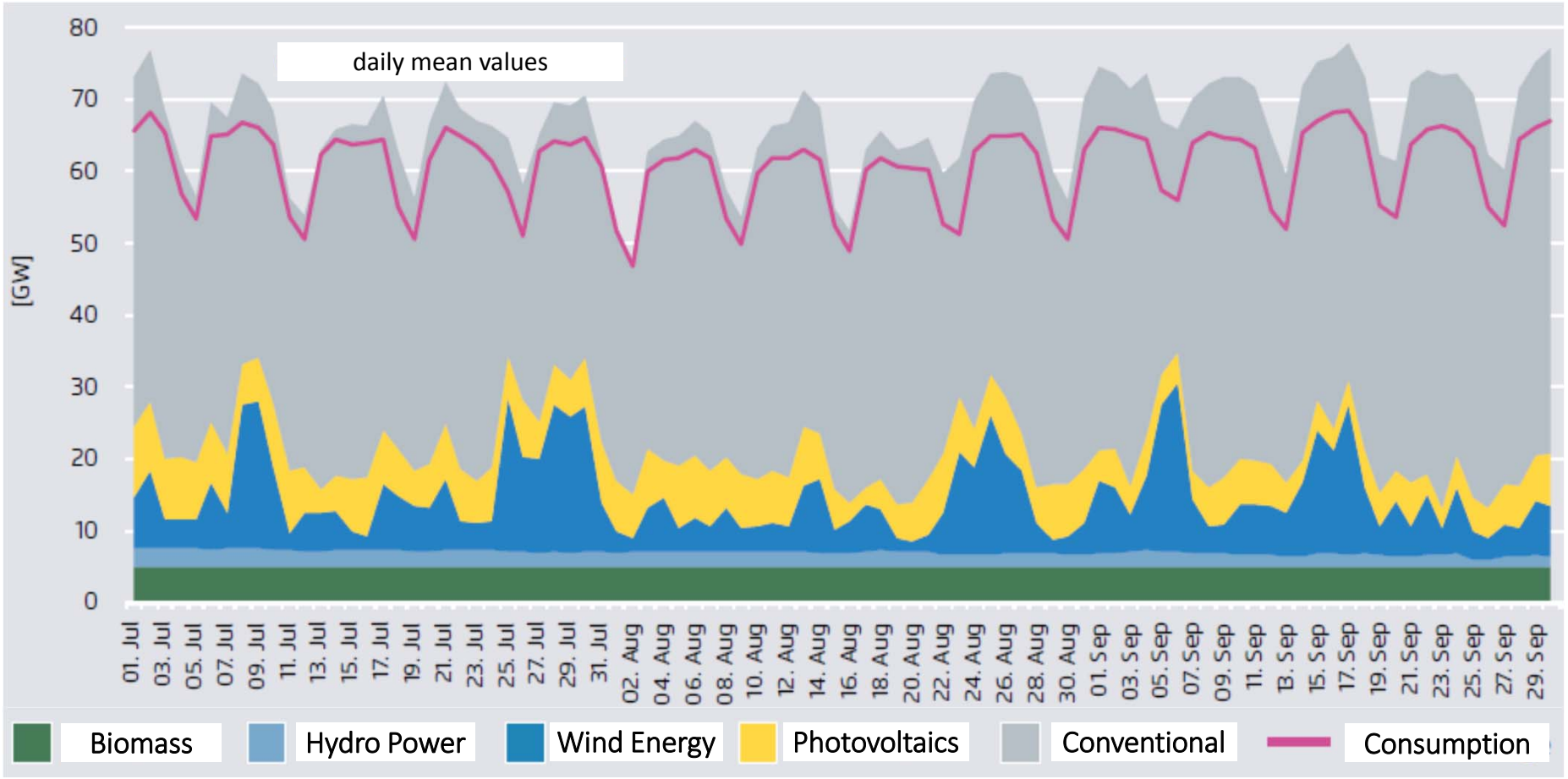


BMWi 2016b

Development & Status of Renewables in Germany

Renewables in Electricity

Net Electricity Generation and Consumption in 3. Quarter of 2015

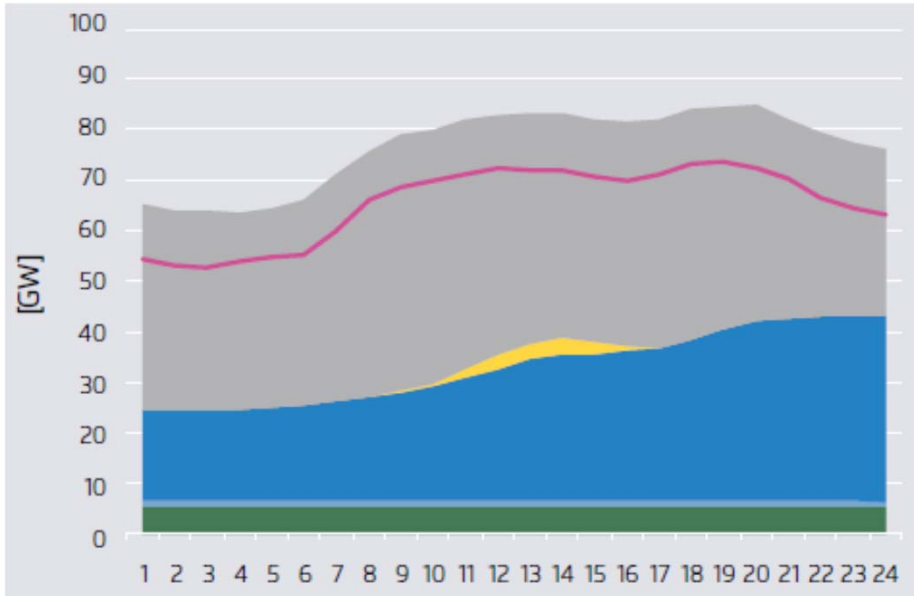


AGORA 2016a

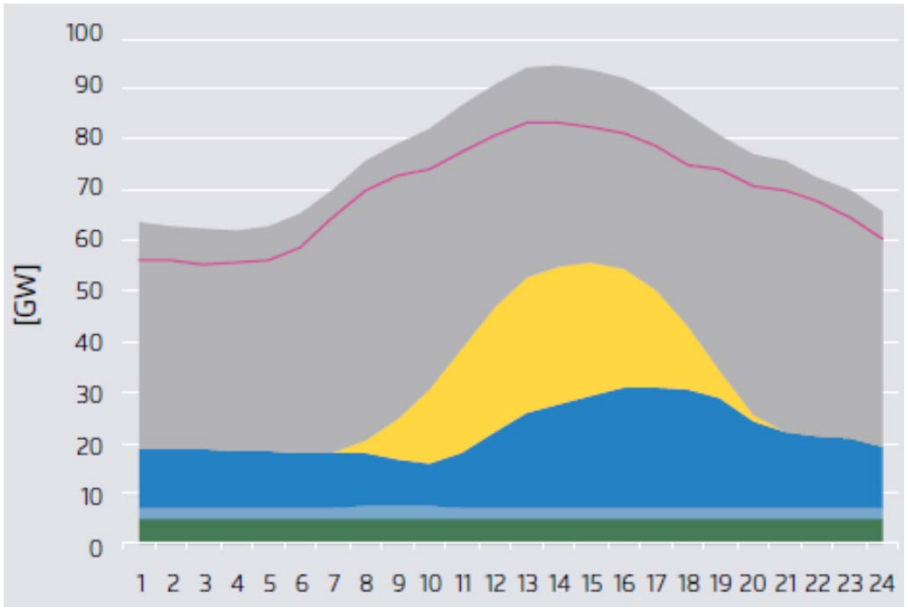
Development & Status of Renewables in Germany

Renewables in Electricity

Maximum Wind Energy Grid Input
21.12.2015, 23:00: 36.7 GW



Maximum Solar Energy Grid Input
21.04.2015, 13:00: 28.5 GW

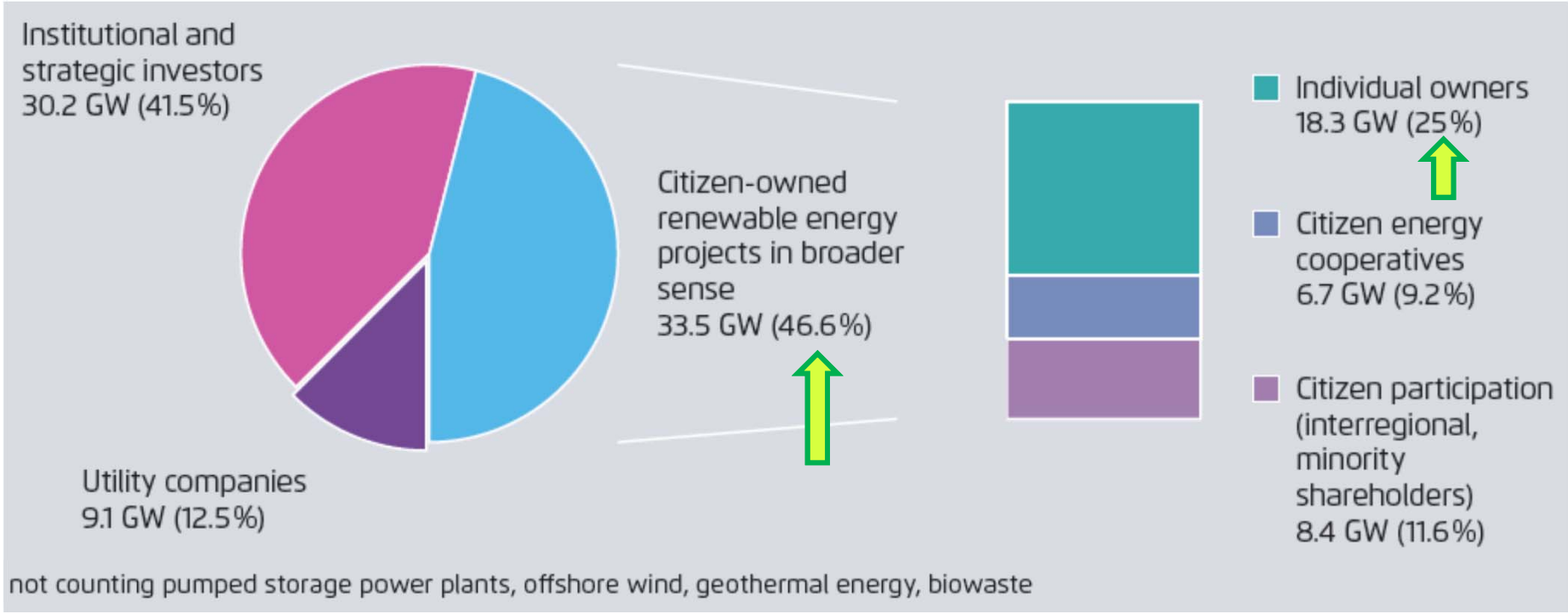


AGORA 2016b

Development & Status of Renewables in Germany

Renewables in Electricity

Ownership of Renewable Energy Installations in Germany 2012



AGORA 2015

Development & Status of Renewables in Germany

Renewables in Electricity

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What Is / Was in Favour of RE Electricity in Germany?

What Is Not in Favour of RE electricity in Germany?

- Germany has poor natural resources and is densely populated
  - Low solar irradiation
    - ⇨ Germany: ~ 1,000 kWh/m²·a; limited usable land area to install PV plants
    - ⇨ Botswana, Namibia, South Africa: up to 2,500 kWh/m²·a; vast uninhabited land areas
  - Limited wind resources
    - ⇨ Germany: short usable coastline, part of it is inland sea resp. national park
    - ⇨ Mozambique, Namibia, South Africa: abundant wind resources along scarcely inhabited coastline
  - Limited land area to 'grow' energy (→ energy crops & agricultural waste)
    - ⇨ Germany´s land area & population: ~ 348,000 km², ~ 229/km²
    - ⇨ South Africa: ~ 1,214,000 km²,~ 42/km², Zambia: ~ 743,000 km², ~ 19/km²

What Is / Was in Favour of RE Electricity in Germany?

Origin & Support

- Success of RE electricity generation in Germany originates from
  - Europe´s resp. Germany´s climate protection policy
  - Germany´s wish to avoid risks associated with nuclear power
  - Germany´s wish to increase energy security while guaranteeing competition & developing new technologies as new sources of growth and employment
- Politics & civil society support RE electricity generation
  - 85% of Germany´s MPs voted for the ‘Energiewende’ (energy transition policy)
  - 100% of Germany´s political parties in parliament reject nuclear power
  - 90% of Germans agree with the goals of the ‘Energiewende’

What Is / Was in Favour of RE Electricity in Germany?

Landmarks

- Europe´s resp. Germany´s <u>climate protection policy</u>
  - Kyoto protocol means a 8% reduction of greenhouse gas emissions for Europe resp. 21% for Germany by 2020 (→ compared to 1990)
  - Germany´s own goals are more ambitious: -40% by 2020, -80…95% by 2050
  - Europe (-23% in 2012) resp. Germany (-27% in 2015) reach Kyoto goals
  - Renewables have more than compensated for the nuclear phase-out
  - Germany, however, will have to take additional steps to reach its own 2020 goals
    ⇨ shut-down of out-dated (soft) coal power plants
    ⇨ put more emphasis on mobility

What Is / Was in Favour of RE Electricity in Germany?

Landmarks

- Phase-out of nuclear power generation in Germany
  - Germans have protested against nuclear power for many years
  - Following the Fukushima disaster, 8 nuclear power stations were shut down (→ Germany´s oldest nuclear power stations; ~ 8.8 GW)
  - Remaining 9 nuclear power stations (→ ~ 12.7 GW) to be shut down step by step by 2022
  - Currently, intensive discussion on how to handle disposal of nuclear waste & dismantling of decommissioned power plants (→ cost estimates: ~ € 80bn!)
- In Europe: heterogeneous nuclear power policies, however, extremely high cost (nearly) prevents construction of new power plants

What Is / Was in Favour of RE Electricity in Germany?

Milestones

- Privatisation of European resp. German energy sector in 1998 following the 1996 EU Directive
  - Utilities with > 100,000 costumers have to unbundle electricity generation, distribution and sales to strengthen competition
  - Area monopolies are accepted for grid operation only – non-discriminating access to grid by any third party guaranteed
  - Grids are regulated by an independent agency
    ⇨ foundation of the German Federal Network Agency in 2005
  - Agency controls all aspects of grid access
    esp. usage rates levied by the grid operating companies
- Introduction of Renewable Energy Legislation in 2000

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Supportive Legislation in Germany

Renewable Energy Sources Act – Development

- 2000: Renewable Energy Sources Act (EEG) comes into force – it was the initial spark of an enormous boost of renewable energies in Germany
- Since EEG2000, 5 amendments have been executed – current status is EEG2017
- EEG2014 Section 1:
  „The purpose of this act is to enable the energy supply to develop in a sustainable manner in particular in the interest of mitigating climate change and protecting the environment, to reduce the costs to the economy not least by including long-term external effects, to conserve fossil energy resources and to promote the further development of technologies to generate electricity from renewable energy sources.“

Supportive Legislation in Germany

Renewable Energy Sources Act – Characteristics

- Investment protection
  - Priority feed-in and grid connection rights: grid operators have to take all necessary steps to ensure that RE electricity can be fed into the grid
  - Guaranteed feed-in tariffs: RE power plant operators receive a 20-year, consistent payment for their electricity generation – feed-in-tariff depends on type of technology, year of commissioning & size of plant
- Support of RE innovation and industrialisation
  - Feed-in tariffs decrease in regular intervals to put cost pressure on manufacturers (→ 'degression' – RE technologies are becoming less costly)
- No subsidies, no charge to Germany's public finances
  - Feed-in remuneration is paid for by the consumers, not from taxes – as an 'EEG surcharge' that is included in every electricity bill

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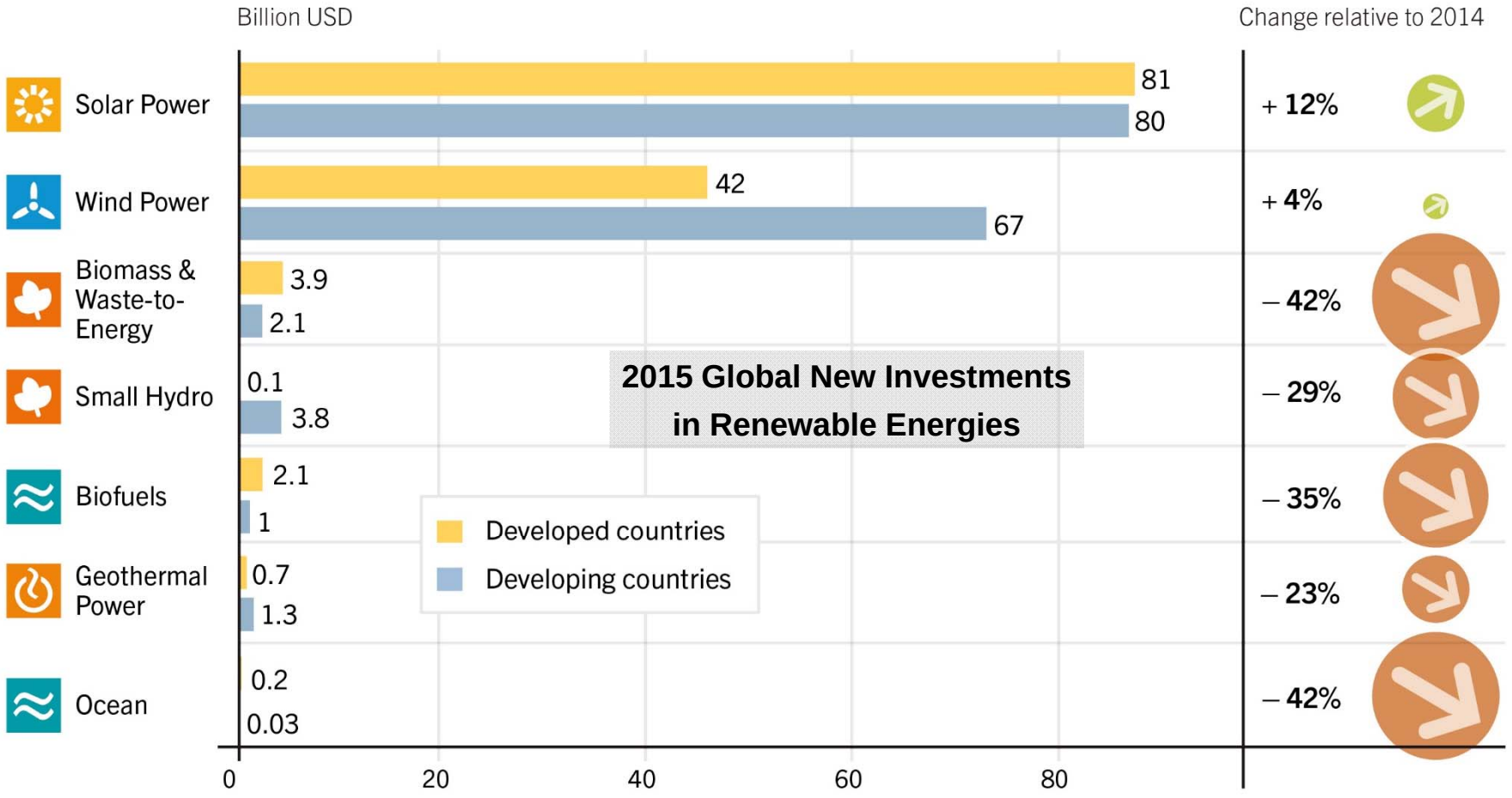
- Goal of German RE electricity policy: 40…45% by 2025, 80% by 2050 – wind & solar will be the backbone of German electricity generation

- Flexibility is the new paradigm of the German power system
  - Electricity markets & systems to be built around the variability of electricity generation from wind & solar
  - Baseload capacities not needed any more – fossil power fleet needs to become highly flexible
  - (Smart) grid infrastructure needs urgent development incl. transnational capacities
  - Further flexibility options need to be developed (→ bio energy power plants; demand-side-management; storage such as batteries, power-to-gas etc.)
  - Stronger coupling of the electricity, heating & transport sectors

Challenges & Chances of the Future

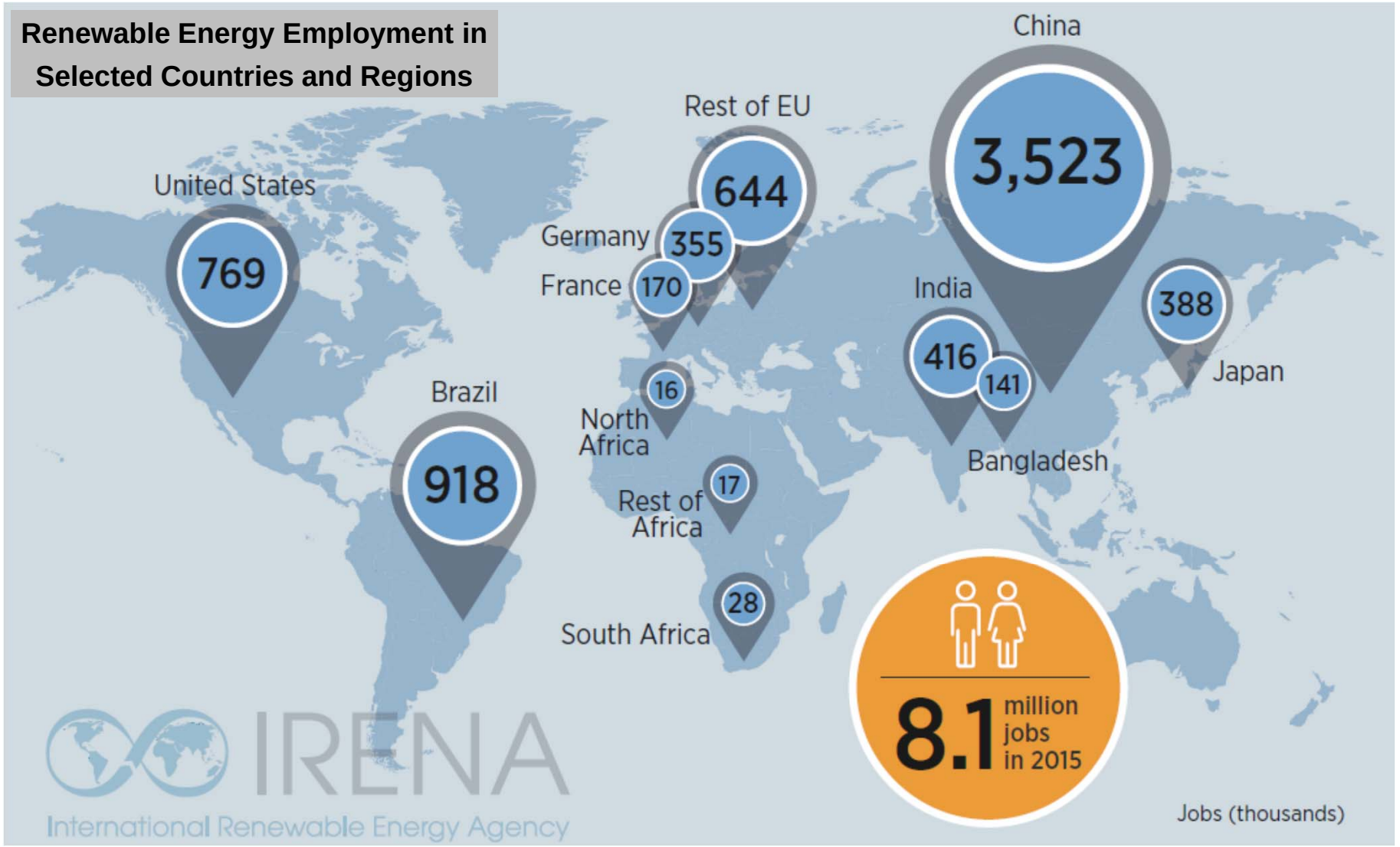
Chances: Investments in Renewable Energies



REN21 2016c

Challenges & Chances of the Future

Chances: Creation of Employment



IRENA 2016a

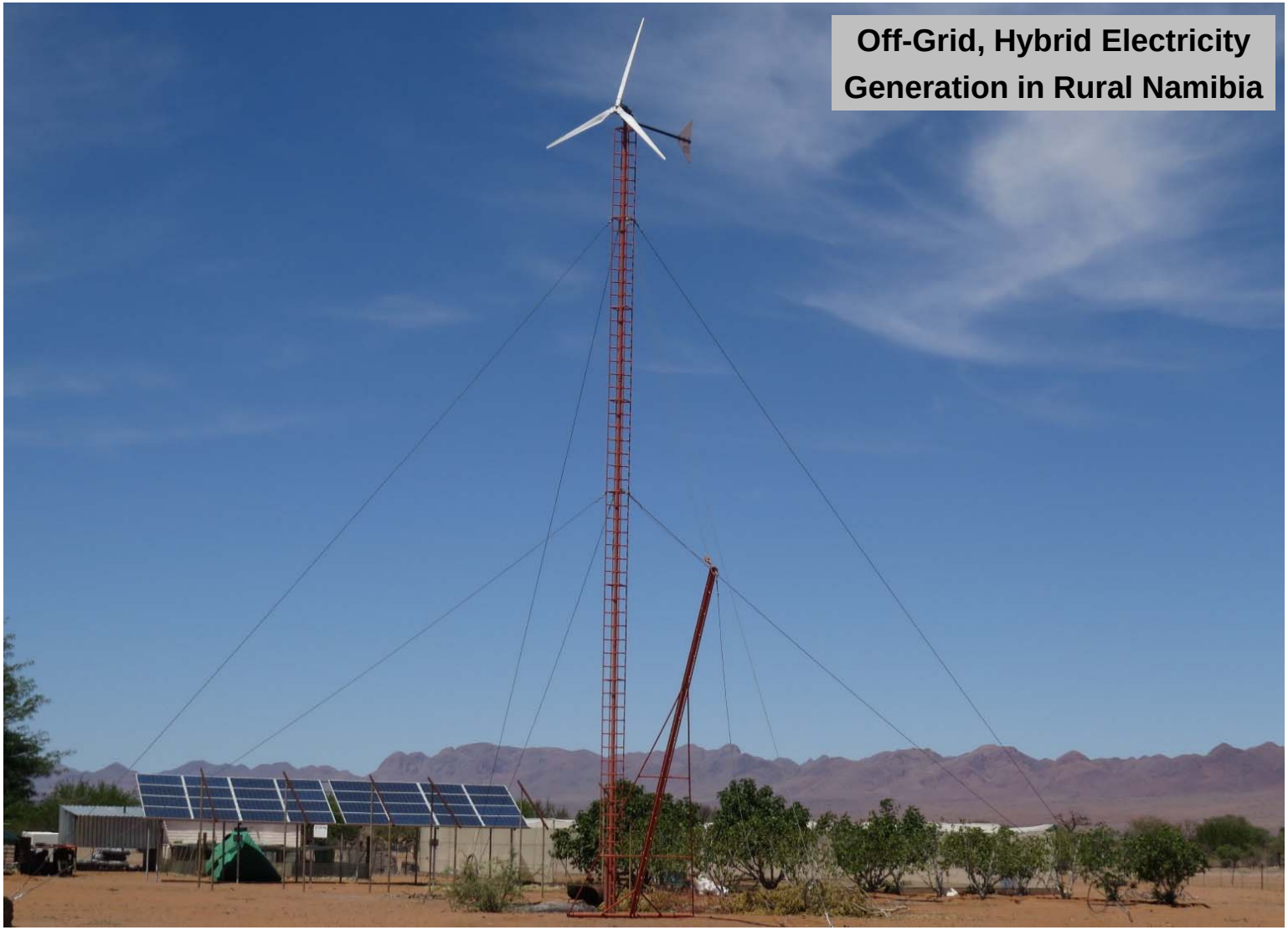
Challenges & Chances of the Future

Chances: On-Grid Electricity Generation

50 MW CSP Plant close to Upington/Northern Cape (Commissioned February 2016)

Challenges & Chances of the Future

Chances: Rural Electrification



Solar - The Best Way Under The Sun! (Continue from Page 1)

The goal of the Energy Security Game Changer is to ensure long-term energy security through the availability of reliable, diverse and low carbon energy to support economic growth and improve communities in the Western Cape.

Bayside Mall's Green Initiatives

Bayside Mall launched their "We're Going Green" sustainability initiatives in 2014, whereby the shopping centre is equipped with technologies to reduce its environmental footprint. One of the most significant interventions is the harvesting of rainwater, which involves the extraction, detaining, storage and utilisation of stormwater.

Harvested rainwater is being used for numerous non-potable purposes, particularly flushing toilets and landscape irrigation.

Stormwater is extracted directly from the adjacent canal. Harvested stormwater is screened before entering the main stormwater holding tanks. The main tanks have a holding capacity of 60kl, and provide a minimum of three consecutive days of toilet flushing. The stormwater is then sent to the various header tanks within the Mall to be used for toilet flushing. Cleaned storm water is also sent to the central irrigation manifolds to irrigate the mall's vegetation.

A 500kWp solar plant has been strategically positioned on the mall's rooftop. The electricity generated by the solar plant during the day feeds into the shopping centre's electricity grid and is used throughout the mall. The solar plant offsets approx.

5 – 10% of Bayside Mall's electricity consumption per annum. With that said, the solar energy generated at Bayside Mall during one day could supply a day's electricity to 150 households.

THE NEWSPAPER

stories that are life changing

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Conclusions

- The global climate situation as well as long-term effects show that the conventional power generation cannot serve as a model for Africa
- REs, however, provide a still underestimated chance for development especially in Africa (→ abundant natural resources!)
- Promotion of REs needs governments´ commitment
  - ⇨ design energy legislation to attract private investment into RE installations (→ especially small investors)
  - ⇨ guarantee grid access & provide attractive heat & power generation tariffs to investors (→ on-grid & off-grid)
  - ⇨ control fair competition, grid access & tariffs by independent institution
  - ⇨ invest into local capacity building (→ support RE industry development, RE education & RE research)
- Don´t copy but learn from Germany´s comprehensive RE experience

Thank you very much for following – I am happy to answer your questions and to receive your feedback

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Literature

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