

UNIVERSITEIT-STELLENBOSCH-UNIVERSITY



Renewable Energies in Germany – Status and Development of Energy Markets and Politics

Prof Wilfried Zörner Ph.D. 19.08.2015



Outline





Institute of new Energy Systems

Outline



I. Ingolstadt Technical University & Institute of New Energy Systems

- II. Renewable Energies in Germany
- III. Contact



Technische Hochschule Ingolstadt Overview





Established:	1994	
Students:	~ 5.500	
Professors:	110	
Faculties:	3	E
Degrees:	Bachelor, Master	
Staff Admin:	169	
Staff Research:	65	



- THI Business School:
 4 Bachelor's / 7 Master's degree programmes
- Faculty of Electrical Engineering and
 - **Computer Sciences:** 4 Bachelor's / 5 Master's degree programmes
- Faculty of Mechanical Engineering:
 6 Bachelor's / 3 Master's degree programmes
 ⇒ B.Eng. programme (in German)
 Renewable Energy Technologies



Institute of new Energy Systems (InES) Overview



Established:	2001
Research Staff:	18
Professors:	4
Current Research Projects:	12
Current Research Grants:	€ 3.5m
Publications:	> 120
Co-operation Partners:	> 30









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Institute of new Energy Systems (InES)





Bioenergy Technology

- Wood-Fired Power Stations
 - → Flexible Operation on Demand (Electricity/Heat)
 - → Closed Loop Supply of Industrial Parks

• Biogas Research

- → Ecological and Economic Plant Optimisation
- → Controllable Electricity Production
- → Biogas Upgrading



Energy Systems Technology

- Local / Regional Energy Concepts
- Local / District Heating Systems
- Combined Heat and Power and Cooling Systems
- Energy Efficiency in Industry
- Electricity Grid Integration
- Energy Storage Technologies



Solar Energy Technology

- Photovoltaics
 On-grid and Off-grid
- · Solar Heating and Cooling
- Solar-Thermal Collector Research
 - → Conceptual and Design Optimisation
 - → New Materials and Production Processes
 - → Solar Collector Testing

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Academic & Research Co-Operation in Africa – Motivation and Aim

Co-operative research and higher education projects with science and business centres in Africa



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NEED: Network of Excellence in Renewable Energy Technologies for Development



POLYTECHNIC
OF NAMIBIA
University of Zambia

Overview NEED	Project
Location	Zambia, Namibia and Botswana
Duration	36 months
Total Project Budget	€ 1.2 m
Start	01 March 2014

Challenges

- Development and application of renewable energy technologies (RET) in Southern African countries still undermined
- Despite ambitious renewable energy plans in BW, NAM and Z and numerous activities in the past, there is still a lack of knowledge and skilled workforce
- Although the potential of renewable energies has been recognised, governments remain resistant – mainly small-scale research and enterprises have developed

Overall Objective

Inter-link policy makers, research institutes and stakeholders of the private sector to promote innovation in RET

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Renewable Energies in Germany (1) Global Use of Renewable Energies (1)





Renewable Energies in Germany (2)



Global Use of Renewable Energies (2)





physical energy content method

2)

Including biogenic fraction of waste

Renewable Energies in Germany (3) Global Use of Renewable Energies (3)



Top Ten Investors in the Renewable Energy Sector

Rank	Country	2011 EE-Investment ¹⁾	2010 EE-Investment ¹⁾	
		[bn USD]		
1	USA	48.0	33.7	
2	China	45.5	45.0	
3	Germany	30.6	32.1	
4	Italy	28.0	20.2	
5	Rest of EU	11.1	15.2	
6	India	10.2	6.6	
7	Unit. Kingdom	9.4	7.0	
8	Japan	8.6	7.0	
9	Spain	8.6	6.9	
10	Brazil	8.0	6.9	

1) Private-sector investment

Top Ten Countries/Regions Related to Installed Renewable Energy Capacity 2011

Country	Total renewables-based power capacity	Capacity per capita	Total renewables-based power capacity
	excluding hydropower		including hydropower
	[GW]	[kW/inhabitant]	[GW]
China	70	0.05	282
USA	68	0.22	147
Germany	61	0.75	65
Spain	28	0.60	48
Italy	22	0.37	40
India	20	0.02	62
Japan	11	0.09	39
EU	174	0.35	294
World	390	0.06	1,360

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Ed.) (2012) *Renewable Energy* Sources in Figures – National and International Development. Berlin, July 2012, p 90

Renewable Energies in Germany (4) Germany's Situation at a Glance (1)



Energy (rough 2013 figures)

□ <u>Total final energy consumption</u>: 2,575 TWh – of which

~ 60 % heating/cooling purposes		~ 37 % mechanical energy
~ 30 % industry	~ 30 % mobility	~ 25 % private households
Total power consumption	<u>n</u> : 630 TWh – of which	
~ 45 % coal	~ 15 % nuclear	~ 10 % natural gas

□ Energy import rate: 71 % – equivalent to ~ ZAR 1,100 bn (2008; + 53 % against 2005)

Natural Resources

- □ <u>Bio-energy</u>: densely populated, very limited area of cultivable land
- □ <u>Solar energy</u>: low irradiation (~ 950...1,100 kWh/m²·a)
- □ <u>Wind energy</u>: densely populated, short coastline

Renewable Energies in Germany (5) Germany's Situation at a Glance (2)



□ Part of European Framework for Climate and Energy (→ partly more ambitious than EU!):

- climate protection: reduction of CO₂ emissions by 40 % (2020) compared to 1990
- share of renewable energies of final energy consumption: 18 % (2020), 30 % (2030)
- share of renewable energies of power production: 35 % (2020), 50 % (2030)
- □ <u>Nuclear phase-out</u>:
 - 8 power stations in 2011 (8.8 GW_{el}), 9 power stations by 2022 (12.7 GW_{el})
 - search for nuclear waste repository still ongoing (→ limited options)
 - Decommissioning of power plants to be taken over by operators (≥ ZAR 500 bn!)
- Current government: pro-business

Economy

- Energy markets (electricity, gas, oil, heat): completely liberalized
 - $(\rightarrow 4 \text{ big private electricity producers with 85 \% share of production})$
- German economy: still growing despite global crisis



Renewable Energies in Germany (6) Development of Renewables in Germany





Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (Ed.) (2014) *Klimaschutz in Zahlen – Fakten, Trends und Impulse deutscher Klimaschutzpolitik*. Berlin, June 2014, p 37

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Renewable Energies in Germany (7)

Development of Renewable Electricity Generation in Germany (1)



Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Hrsg.) (2013) Erneuerbare Energien in Zahlen – Nationale und internationale Entwicklung. Berlin, Juli 2013, S. 15

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Renewable Energies in Germany (8)

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Development of Renewable Electricity Generation in Germany (2)

Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act - EEG)

<u>Target</u>: Accelerated market launch of technologies for electricity production from renewable energy sources, i.e. wind energy, solar energy, biomass, geothermal energy, hydro power, also landfill and sewer gas



Renewable Energies in Germany (9)



Development of Renewable Electricity Generation in Germany (3)



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Renewable Energies in Germany (10)



Development of Renewable Electricity Generation in Germany (4)



* incl. solid and liquid biomass, biogas, biomethane, sewage gas and landfill gas as well as the biogenic fraction of waste, from 2013 incl. sewage sludge

Bundesministerium für Wirtschaft und Energie (Ed.) (2015) Development of Renewable Energy Sources in Germany 2014. Berlin, February 2015, p 19

Renewable Energies in Germany (11)



Development of Renewable Electricity Generation in Germany (5)



Bundesministerium für Wirtschaft und Energie (Ed.) (2015) Development of Renewable Energy Sources in Germany 2014. Berlin, February 2015, p 19

Renewable Energies in Germany (12)

Development of Renewable Electricity Generation in Germany (6)





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Renewable Energies in Germany (13)



Development of Renewable Heat Generation in Germany (1)

Development of Heat Consumption from Renewable Energy Sources in Germany



* incl. biogenic share of waste, ** incl. biodiesel used in farming, *** Biogas, biomethane, sewage gas and landfill gas

Bundesministerium für Wirtschaft und Energie (Ed.) (2015) Development of Renewable Energy Sources in Germany 2014. Berlin, February 2015, p 21

Renewable Energies in Germany (14)



Development of Renewable Heat Generation in Germany (2)



* incl. biodiesel used in farming, ** incl. biogenic share of waste, *** biogas, biomethane, sewage gas and landfill gas

Bundesministerium für Wirtschaft und Energie (Ed.) (2015) Development of Renewable Energy Sources in Germany 2014. Berlin, February 2015, p 19

Renewable Energies in Germany (15) Economic Dimension of Renewables in Germany (1)





Renewable Energies in Germany (16) Economic Dimension of Renewables in Germany (2)





Renewable Energies in Germany (17) Roots of Success of Renewables in Germany

Population

□ Very sensitive regarding environmental and health issues

- Green Party elected into government end of 1990s
- government forced to abandon nuclear power after Fukushima disaster



Transition from Nuclear / Fossil-Based to Renewable Electricity Production → 'Energiewende'

Despite high cost, <u>92 % support the increased use of renewable energies</u> (2014)!

Government

- □ Very <u>consequently implemented liberalisation of German energy markets</u> end of 1990s
 - $(\rightarrow$ electricity and gas, production and distribution)
- □ Generated '<u>Renewable Energy Sources Act</u>' (end of 1990s), not based on tax financed subsidies but distribution of extra cost between all electricity consumers
- Generated <u>financial support programme to enable private investments</u> in renewable power generation

Renewable Energies in Germany (18) Latest Developments in Germany (1)



Massive Over-Capacities in Electricity Production

❑ Additional installation of renewable-based power stations, however, no reduction of conventional electricity generation ⇒ EEX prices drop dramatically



Kuhlmann A. (2014) Entwicklung des Kraftwerksparks in Deutschland und Bayern. Energiedialog Bayern AG 4 "Versorgungssicherheit - Strombedarf, gesicherte Leistung, dezentrale vs. zentrale Versorgungsstrukturen", München, 21.11.2014, p 5 Prof Wilfried Zörner Ph.D. | Page 27

Renewable Energies in Germany (19)



Latest Developments in Germany (2)

Massive Over-Capacities in Electricity Production (cont.)

□ Low emission certificate prices support coal firing

⇒ high-efficient natural gas power stations pushed out of the market



Kuhlmann A. (2014) Entwicklung des Kraftwerksparks in Deutschland und Bayern. Energiedialog Bayern AG 4 "Versorgungssicherheit - Strombedarf, gesicherte Leistung, dezentrale vs. zentrale Versorgungsstrukturen", München, 21.11.2014, p 4 Prof Wilfried Zörner Ph.D. | Page 28

Renewable Energies in Germany (20)

Latest Developments in Germany (3)

Massive Over-Capacities in Electricity Production (cont.)

0

1990

1995

2000

2005

2010

2012

□ (Highly profitable) coal firing threatens German goals of CO₂ emission reduction! ⇒ Ministry of Energy announces 'National Action Programme for Energy Efficiency' ⇒ Ministry of Energy announces extra duty on 'old' soft coal fired power plants (→ 18-20 \in /t CO₂, beyond applicable power plant individual allowance) \Rightarrow massive resistance from Mio. t CO. plant operators, industry and German states with 100% 458 extensive soft coal industry 400 396 80 % 394 383 377 Germany massively 368 300 increases electricity 60% exports (\rightarrow mainly coal) 200 40% **Development of German CO₂ Emissions** 100 20%

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0%



Renewable Energies in Germany (21) Lessons Learnt and the Future (1)



(International) Integration of Conventional and Renewable Electricity Generation

- □ Integration of conventional and renewable electricity generation neglected
 ⇒ more emphasis must be put on integration, including modifications of electricity grid(s)
- □ Integration of power, heat and mobility complex, hence completely neglected
 ⇒ Integration bears enormous potential, more research urgently needed
- <u>Energiewende still only German project</u> no coherent political strategy within EU
 European perspective of electricity generation and transmission urgently needed

(National) Government Policies

- □ Single-sided focus on renewable electricity generation, even though heat is predominant in Germany (→ 'heat EEG' only for new buildings!) ⇒ wider perspective necessary
- □ <u>'Big 4' heavily under economic pressure</u> ⇒ fundamental changes in energy markets need to accepted, even against resistance of the established stakeholders
- □ <u>Energy policy needs a long-term perspective</u> ⇒ wide social consensus indispensable

Renewable Energies in Germany (22)

Lessons Learnt and the Future (2)





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Renewable Energies in Germany (23) Lessons Learnt and the Future (3)



Germany has just started transition
 from a nuclear / fossil-based to a renewable-based society
 There still is a long way to go – all stakeholders of the society need to be involved to make it a success story

,The energy business as we all know it, becomes a bygone chapter of industrial history.'

,As we realise today, the changes of the past were only the prelude of much more fundamental changes – a revolution of the energy world, that started to overthrow everything that has been certain for more than a hundred years.'

,Where and how we produce energy, how it is being transported – all of that dramatically changes just now.'

Johannes Teyssen, CEO of E.ON SE, Düsseldorf (Germany), on the occasion of E.ON's annual stockholders meeting 2015





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Many thanks for your kind attention

Any questions