Green Jobs? Economic impacts of renewable energy in Germany

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The political question

What are the economic effects of an increase of renewable energy in Germany?

⇨ How many people currently work in the sector?

⇨ How many jobs will be created in the sector by 2030? (Gross effect)

⇨ How many jobs will be lost? (Net)

⇨ How will the domestic market influence economic effects?

⇨ How will international markets influence economic effects?

The research question

How can we measure this?

⇨ What is the „renewable energy industry"?

⇨ How does it fit into our economic framework with I/O tables and the existing 59 sectors?

⇨ What is our baseline?

⇨ On a national level?

⇨ On an international level?

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How do we quantify the effects?

Investment in Renewable Energy (RE), O&M

Export of RE facilities

Import of RE facilities

Base year 2007: statistical data, survey

Future: Scenarios

=> Resulting gross employment ➡ **Input-Output-Tables (extended with vectors for RE)**

Impact on economic indicators, balance

= > net effect ➡ **Macro-econometric model: PANTA RHEI**

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Modeling Gross and Net effects

◈ **Looking at the simulation results for 1 Scenario:**

   ⇨ Gross effects,

      ■ e.g. GDP, its components (exports, imports, investment, consumption), employment, structural effects

◈ **Comparison of simulation results for 2 scenarios:**

   ⇨ Net economic effects.

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Scenario definition

Prices (fossil)

- High ($\$_{2008}118$)
- Low ($\$_{2008}92$)

Domestic investment

- Fossil (only)
- Renewable 35%

Exports

- Min (6 bil.)
- Slow
- Optimistic
- Max (59 bil)

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Effects from Exports

Prices (fossil)

- high
- low

Domestic investment

- Fossil
- Renewable 35%

RE-Exports

- Min
- Slow
- Optimistic
- Max

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Fossil price effects

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- high
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Fossil price effects

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Impacts of RE increase

Prices (fossil)
- high
- low

Domestic investment
- Fossil
- Renewable 35%

Exports
- Min
- Slow
- Optimistic
- Max

Impacts of RE increase

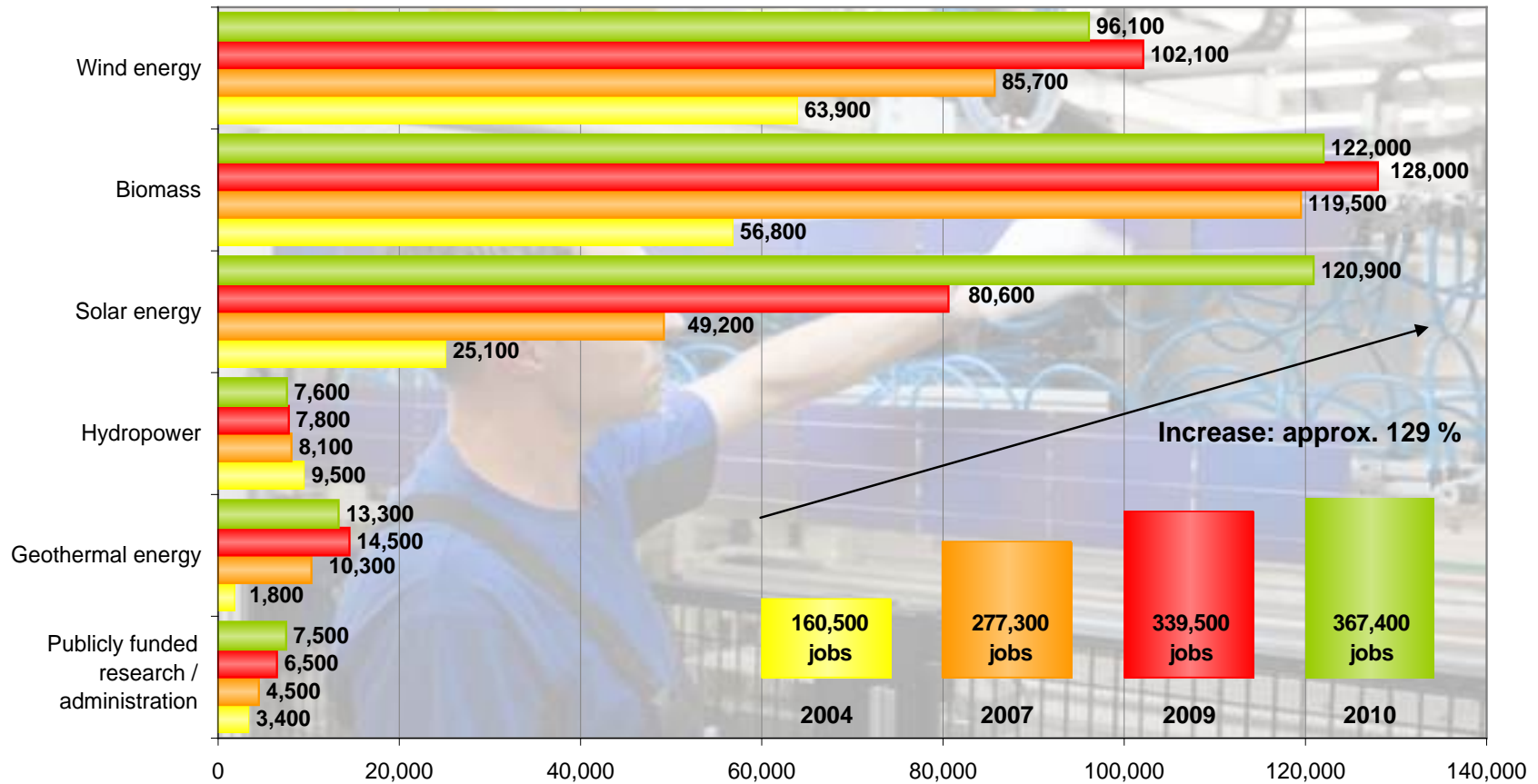## Prices (fossil)

- high
- low

Domestic investment

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Jobs in the renewable energy sources sector in Germany

Wind energy
- 96,100
- 102,100
- 85,700
- 63,900

Biomass
- 122,000
- 128,000
- 119,500
- 56,800

Solar energy
- 120,900
- 80,600
- 49,200
- 25,100

Hydropower
- 7,600
- 7,800
- 8,100
- 9,500

Geothermal energy
- 13,300
- 14,500
- 10,300
- 1,800

Publicly funded research / administration
- 7,500
- 6,500
- 4,500
- 3,400

Increase: approx. 129 %

| 160,500 jobs | 277,300 jobs | 339,500 jobs | 367,400 jobs |
| 2004 | 2007 | 2009 | 2010 |

Scale: 0 — 20,000 — 40,000 — 60,000 — 80,000 — 100,000 — 120,000 — 140,000

Figures for 2009 and 2010 are provisional estimate; deviations in totals are due to rounding;
Source: O'Sullivan/Edler/van Mark/Nieder/Lehr: "Bruttobeschäftigung durch erneuerbare Energien im Jahr 20010 – eine erste Abschätzung", as at: March 2011; interim report of research project „Kurz- und langfristige Auswirkungen des Ausbaus erneuerbarer Energien auf den deutschen Arbeitsmarkt"; image: BMU / Christoph Busse / transit

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Our Approach: Environmental-economic model PANTA RHEI

Integrated model: economic core module INFORGE
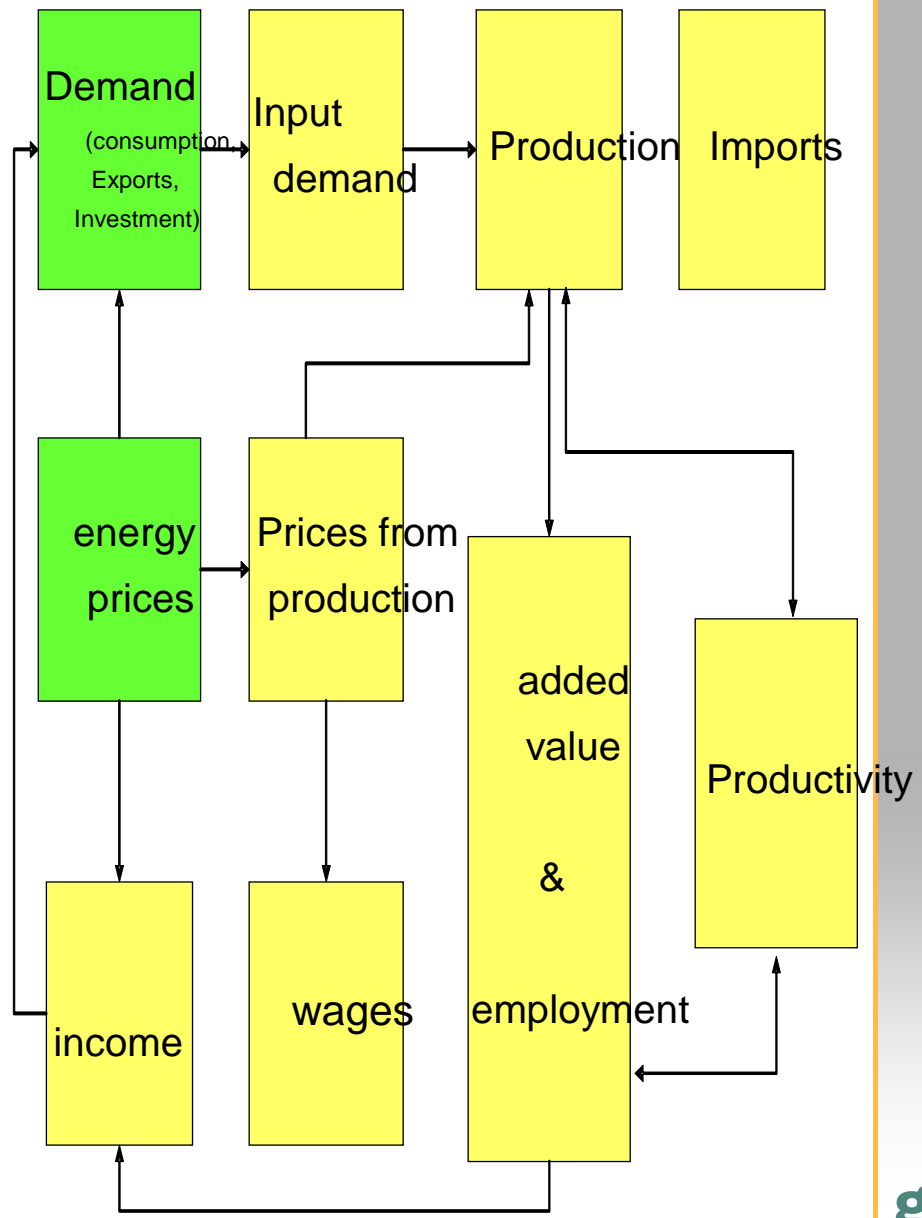
◆ **Basic dataset: input-output tables and national accounts**

◆ **Bottom-up structure**

⇨ 59 sectors determine macro-economic aggregates

◆ **Total integration**

⇨ interdependences between sectors and macro-economic development

⇨ Accounting consistency is guaranteed („closed system")

⇨ Iterative solution (simultaneous solution of non-linear functions)

◆ **Econometric estimation of parameters**

⇨ Limited rationality of economic agents

⇨ Imperfect market forms

⇨ Prices are partially sticky

◆ **Main features:**

⇨ Demand and supply side are equally considered

▪ Production is determined via the Leontief-equation

▪ Demand depends on relative prices

⇨ Variable input coefficient determine technological change

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INFORGE is supplemented by five modules modeling the energy system, residential and non-residential buildings, transport, land-use and material use.

Energy module

⇨ Energy balances and econometrically estimated energy demand

User friendly graphical interface

Demand (consumption Exports, Investment) → Input demand → Production | Imports

energy prices → Prices from production

added value & employment

Productivity

income | wages | employment

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North America	Investment in RES		in bil. €
Electricity	2020		87,92
	2030		85,41
Heat	2020		21,57
	2030		40,12

Europe without Germany	Investment in RES		in bil. €
Electricity	2020		39,87
	2030		42,71
Heat	2020		10,03
	2030		28,04

Transition countries	Investment in RES		in bil. €
Electricity	2020		17,01
	2030		24,69
Heat	2020		16,10
	2030		17,76

China	Investment in RES	in bil. €
Electricity	2020	48,25
	2030	81,41
Heat	2020	13,49
	2030	18,83

India	Investment in RES	in bil. €
Electricity	2020	19,76
	2030	33,95
Heat	2020	10,01
	2030	18,31

Other Asia	Investment in RES	in bil. €
Electricity	2020	15,34
	2030	26,25
Heat	2020	14,18
	2030	15,53
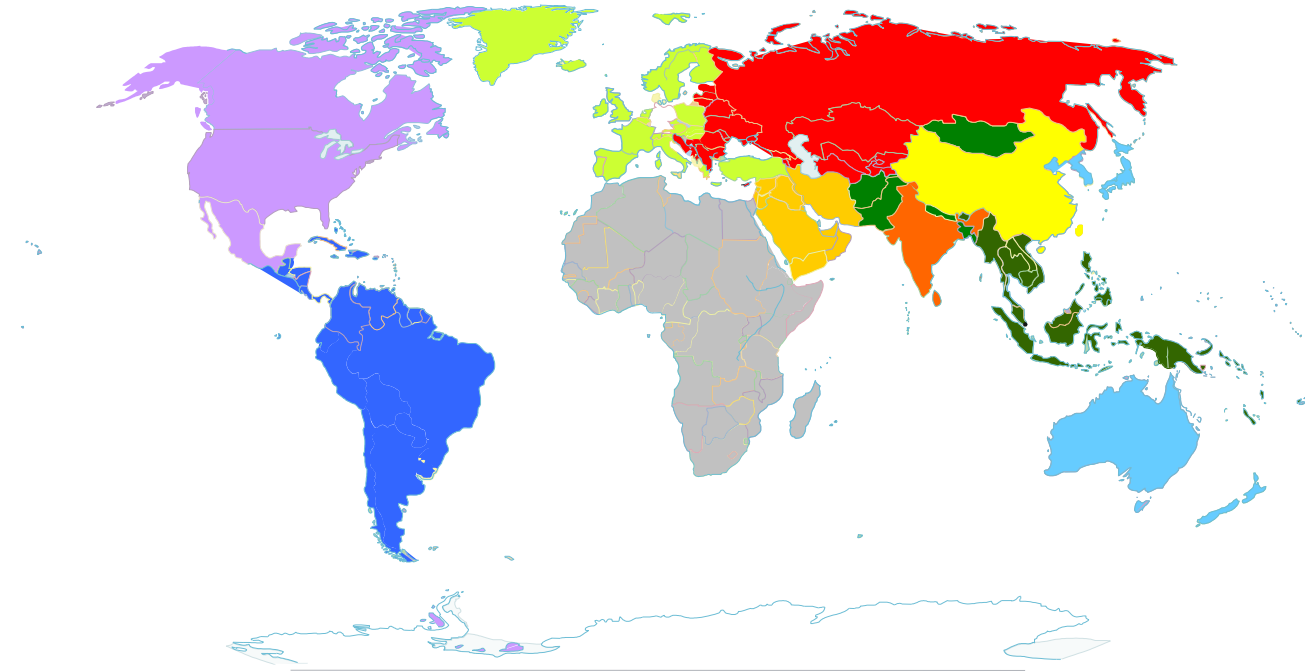
Lateinamerica	Investment in RES		in bil. €
Electricity	2020		20,99
	2030		30,53
Heat	2020		9,74
	2030		8,91

Africa	Investment in RES		in bil. €
Electricity	2020		8,33
	2030		21,29
Heat	2020		9,12
	2030		10,59

Middle East	Investment in RES		in bil. €
Electricity	2020		9,22
	2030		29,12
Heat	2020		10,70
	2030		13,45

| Pazific	Investment in RES	in bil. €
Electricity	2020	14,74
	2030	21,07
Heat	2020	8,16
	2030	8,99

Development of gross employment

◈ **World demand for RES => Export opportunities**

◈ **Domestic investment increases stronly until 2020**

◈ **In some world regions demand increases after 2020**

◈ **Concentration on high tech science based technologies**

◈ **Gross employment will reach 500.000 to 600.000 people by 2030 under moderate or optimistic export scenarios**

◈ **Steepest rise between now and 2020 (340.000 today to 450 – 580.000 people).**

◈ **The doubling of employment within 5 years is not to be expected in the future due to cost degression and automated work processes.**

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Do the benefits justify the costs? – net effects

Employment in 1000, Differences to Reference
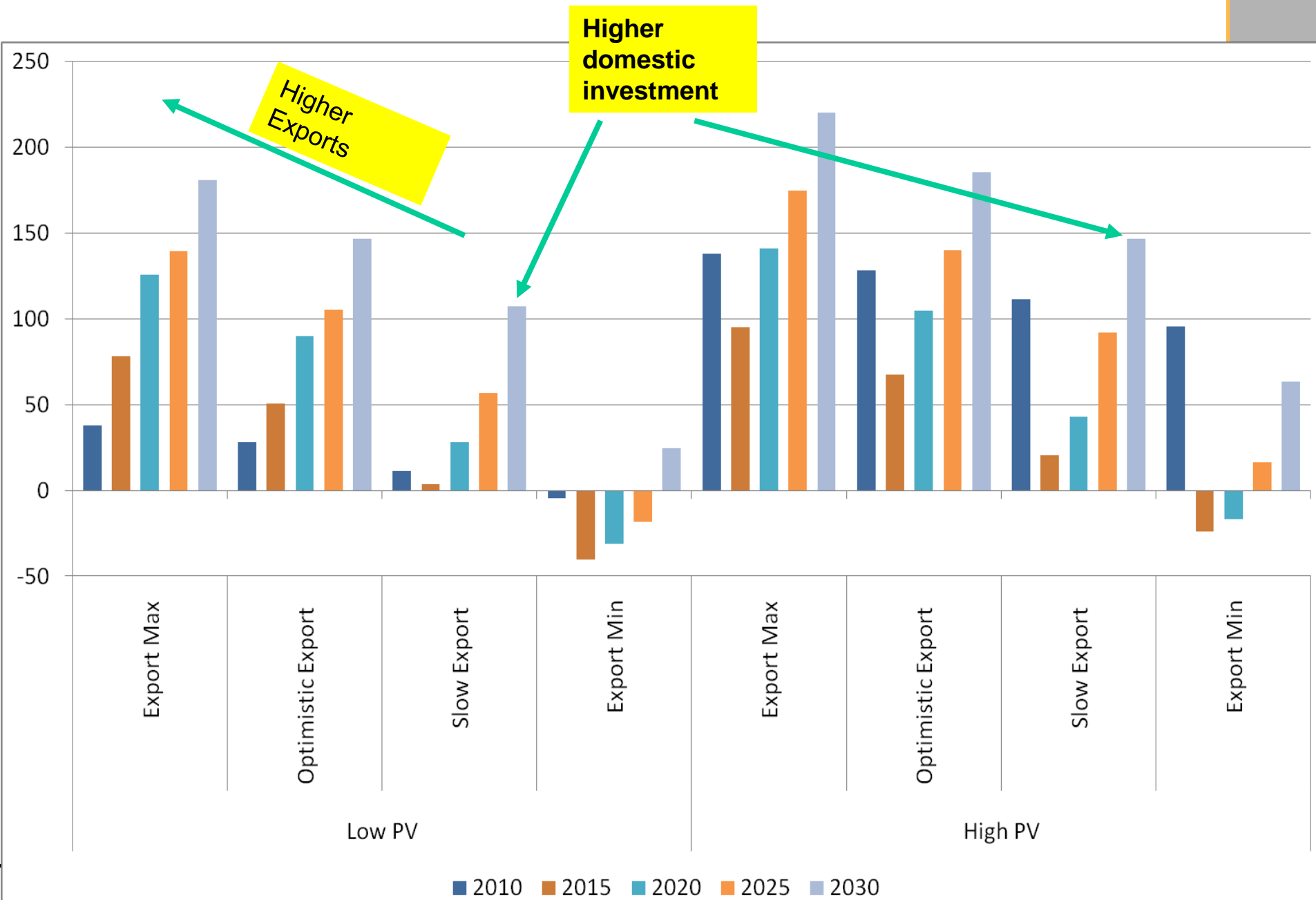
Thank you for your attention!

	Years	max	optimistic	slow	min
Germany					
Investments in RES (bn € 2005)	2020	16.6			
	2030	14.0			
Additional costs compared to the refenrence scenario (bn € 2005)	2020	13.6			
	2030	3.7			
World					
Investments in RES (bn € 2005)	2009	102.7			
	2020	418.9			
	2030	589.7			
Total revenue of German producers (bn € 2005)	2009	16.4			
	2020	52.3	43.5	29.7	16.3
	2030	72.8	60.1	43.3	14.7
Exports (bn € 2005)	2020	41.3	32.9	19.9	7,.
	2030	59.1	47.8	32.7	7.1
Employment					
Gross employment (1000)	2009	340			
	2020	656	582	458	339
	2030	699	610	500	298
Net employment (1000)	2020	141.04	104.93	42.68	-16.64
	2030	220.05	185.62	146.31	63.20

Gross employment – positive by definition

domestic demand   **foreign demand**

operations
and
maintenance

domestic inputs   for the   domestic production

domestic production
of in Germany
installed facilities

domestic production
of facilities
for the export

gross employment

indirect employment

direct employment

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