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Energy Economics Group

RETD

IEA - RENEWABLE ENERGY TECHNOLOGY DEPLOYMENT

IRENEC in Istanbul **28. - 30. JUNE 2012**

Methodological Guidelines for Estimating the Employment Impact of using RE Sources in Electricity Generation

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Outcome of the IEA-RETD project "EID-Employ"

Istanbul, 30. June 2012

Energy

How to assess employment impacts of RE deployment – methodology

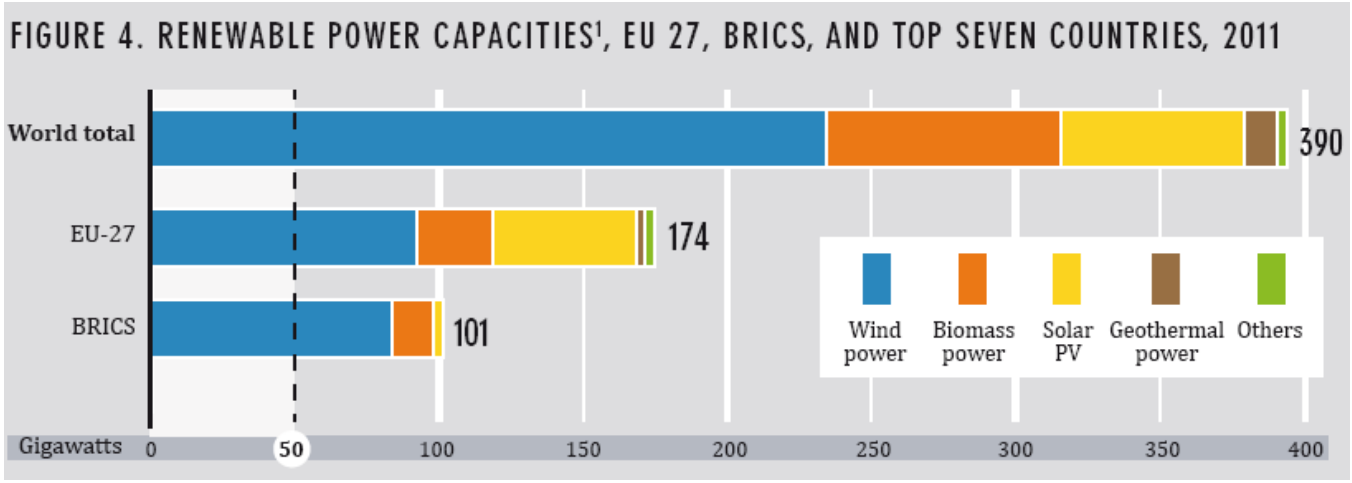
Content

- **Background information about the project**
- Principal approach
- Types of impact assessment studies
- Gross impact studies:
  - Employment factor approach
  - Gross IO-model approach
- Conclusion

Background

- Tremendous growth of RE capacities worldwide:
  - PV: 74% in 2011 (GSR, REN21 2012)
  - CSP: 35% in 2011 (dito)
  - Wind: 20% in 2011 and 26% between 2006 und 2011 (dito)

- RE power capacities in GW (source: GSR, REN21 2012):



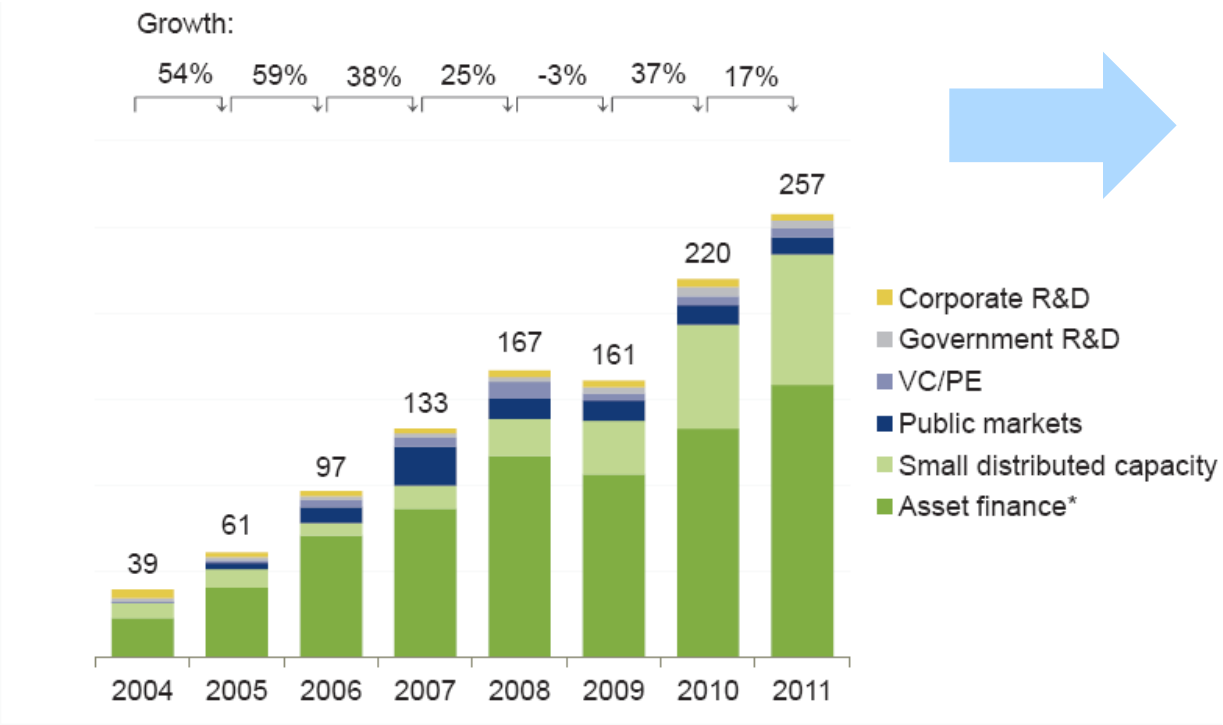
- China: 70 GW, USA: 68 GW, Germany: 61 GW.
- about 37% of newly installed power capacity is from non-hydro-RE in 2011

[1]= excl. hydropower; incl. hydropower: 1360 GW

Background

- Investments in RE* in billion $ (from: Global Trends in RE Investments 2012, UNEP & Frankfurt School 2012):

*including small hydropower



What are the economic implications of investments in / deployment of RE ?

*Asset finance volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

Background

To answer this question the IEA-RETD* initiated and funded a project:

- The Economic and Industrial Development (EID)-Employ project:
  - provide a better understanding of **key parameters and mechanisms** that determine/influence the impacts of RE on employment;
  - **review** employment impact studies and elaborate **guidelines** to assess employment impacts. This includes the identification of data sources and other inputs;
    - Objective: to get comparable results based on a consistent and homogenous approach; to define impacts or types of impact study;
    - Target group: policy maker and analysts
  - assess **gross employment** of RETD countries where data is available by applying the guidelines and document the results of the project
- for further information on the EID-Employ see:
  - http://iea-retd.org/archives/ongoing/employ

* (Renewable Energy Technology Deployment with its current members Canada, Denmark, France, Germany, Ireland, Japan, Netherlands, Norway, and United Kingdom).

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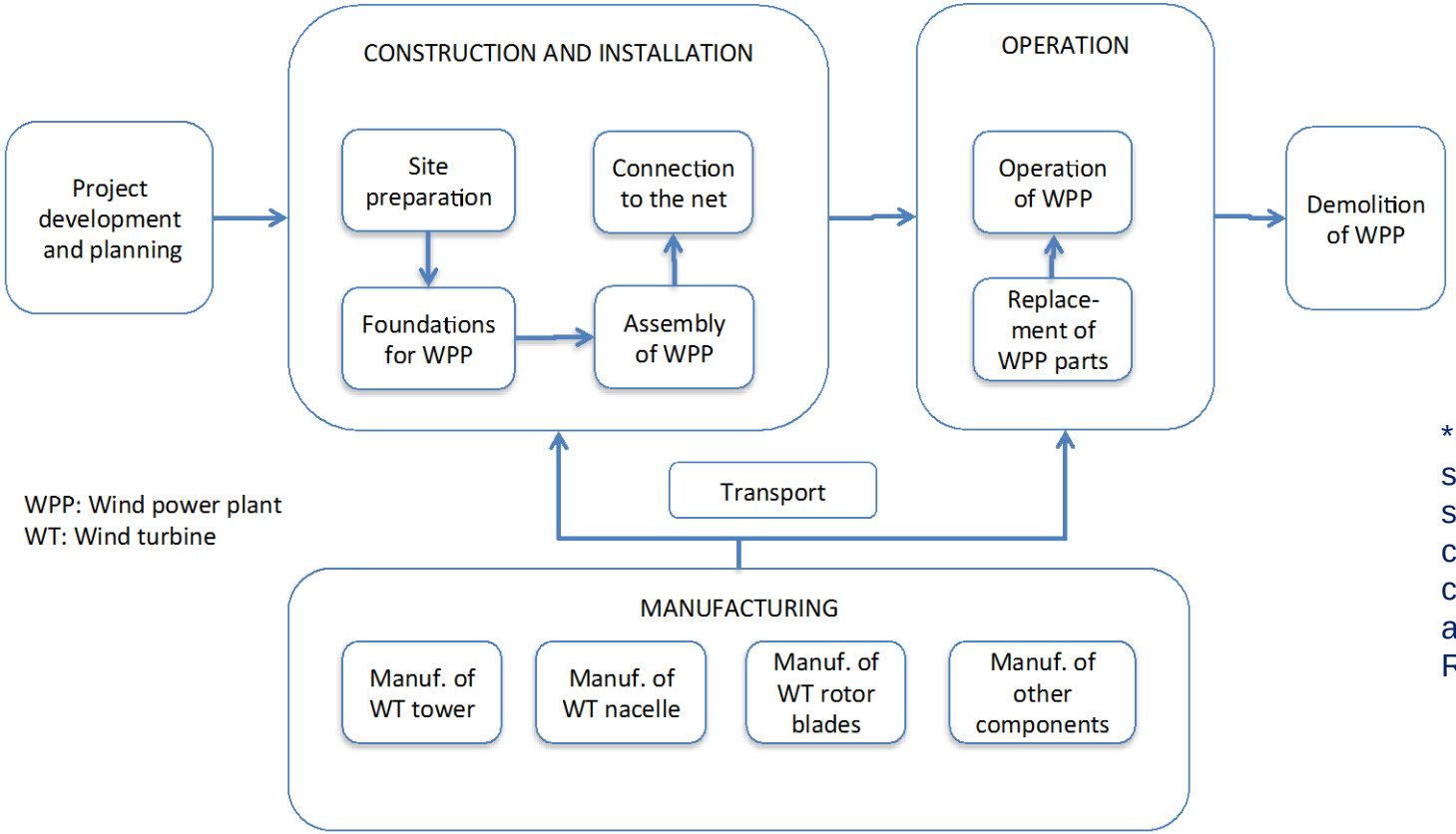
Principal approach: system boundaries of the RE industry* (example wind power plant (WPP))



WPP: Wind power plant
WT: Wind turbine

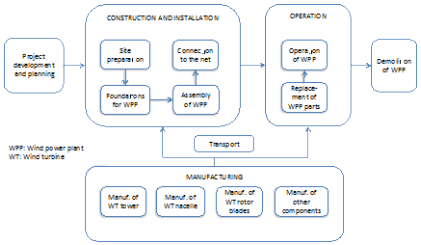
*RE industry: a cross-sectional industry (no separate NACE classification) that comprises all activities related to RE use

→ **basis of the assessment approaches are the life cycle phases of RE generation technologies**

Principal approach: Steps and elements - the functional chain

→ The life cycle phases of RE generation technologies are broken down into economic activities:

1	2	3	4
activities in RE (and CE) technologies	**impulses** (from domestic and foreign activities)	positive / negative **impact mechanisms**	**impacts**
R&D, manufacturing, construction, installation, operation and maintenance, fuel supply, ex/imports, ... for RE technologies as well as avoided activities in conventional energy (CE)	expenditures for investment, O&M, fuel supply and other services; income, cost or price impulse, trade, ... (alternatively: generation and capacities for approaches without models)	direct, indirect and/or induced effects	Δ employment

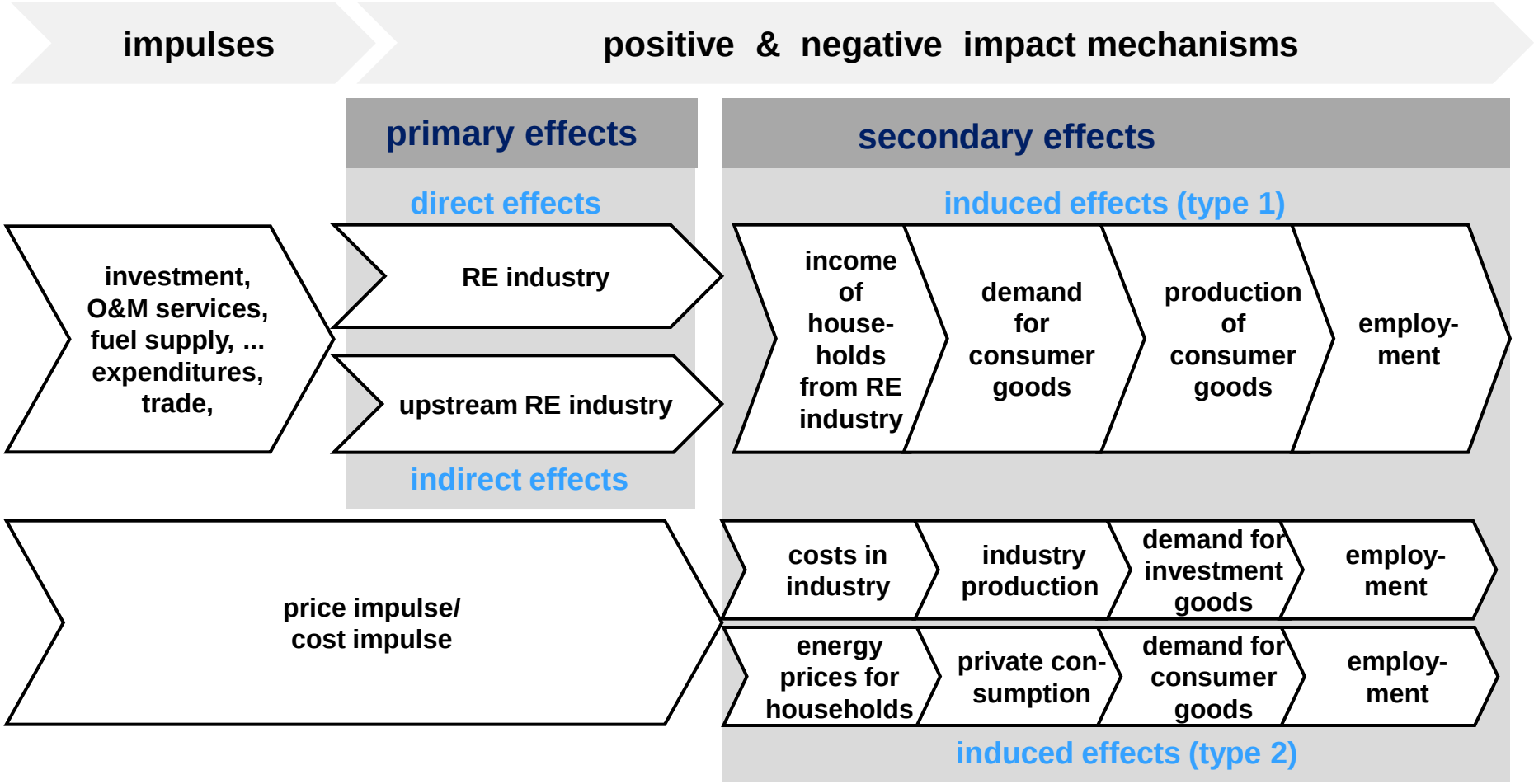


Principal approach: Steps and elements when conducting an impact assessment study

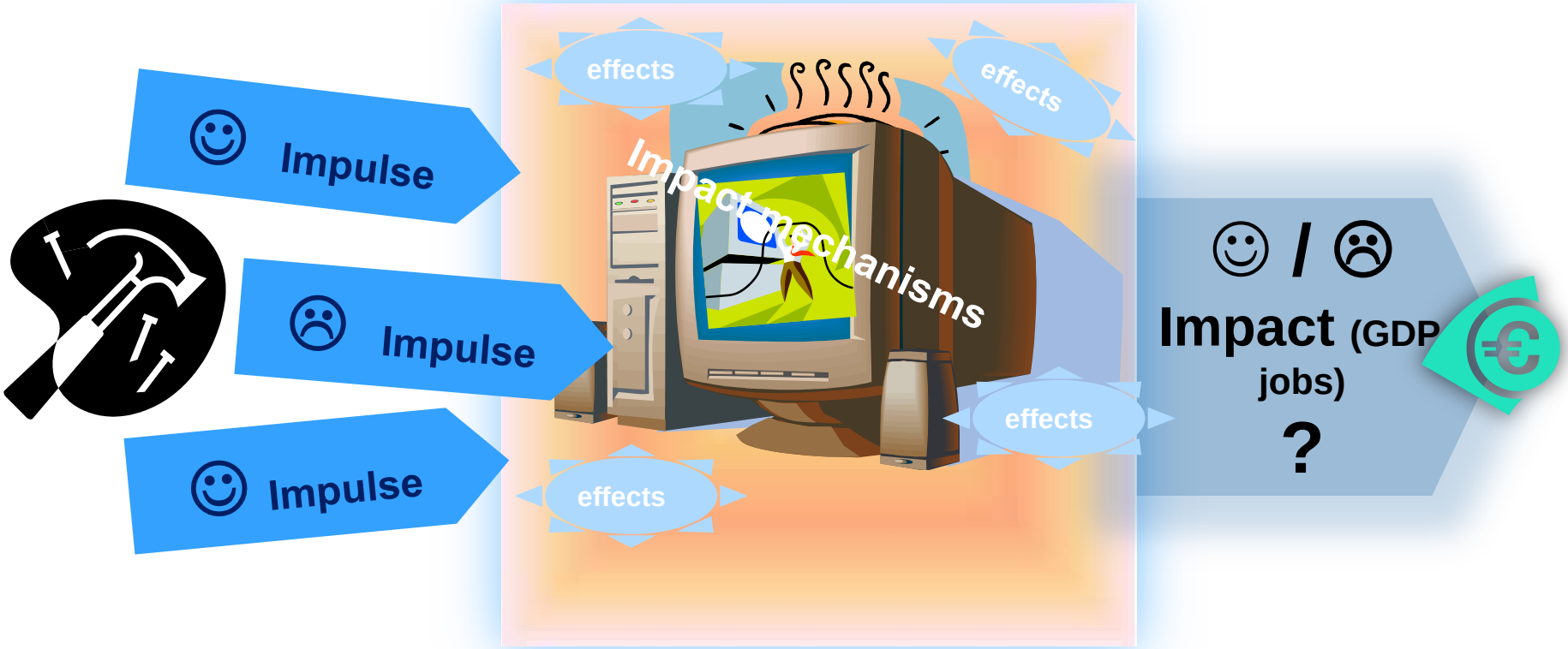
- activities generate economic impulses in form of expenditures for investment, fuel supply, O&M, other services and trade or, alternatively, from generation and capacities (for approaches without a model)
- further impulses could come from electricity prices and income generated in the (RE) industry*
- in addition, there could also be decreased impulses from the CE industry**
- impulses are translated into different economic effects via impact mechanisms
- effects can be
  - direct (within the RE industry*)
  - indirect (in the upstream industry of the RE industry*)
  - induced via prices and income from RE industry on sectors beyond the RE industry and its upstream industries
- effects add up to an impact

*RE industry: a cross-sectional industry (no separate NACE classification) that comprises all activities related to RE use
** CE industry: cross-sectional industry that comprises all activities related to CE generation

Principal approach: What are direct, indirect and induced effects?



How it should (not) work



→ **Based on the effects, we can distinguish between two main types of impact studies**

Content

- Background information on the project
- Principal approach
- **Types of impact assessment studies**
- Gross impact studies:
  - Employment factor approach
  - Gross IO-model approach
- Conclusion

Type of impact assessment studies:

impact assessment studies	
RE-industry jobs • effects: positive, in/direct • impact: gross	**Economy-wide jobs** • effects: positive & negative, in/direct and induced • impact: net

1. Sectoral impact - on **RE industry**: assessment of jobs in RE industry = **gross impact study**

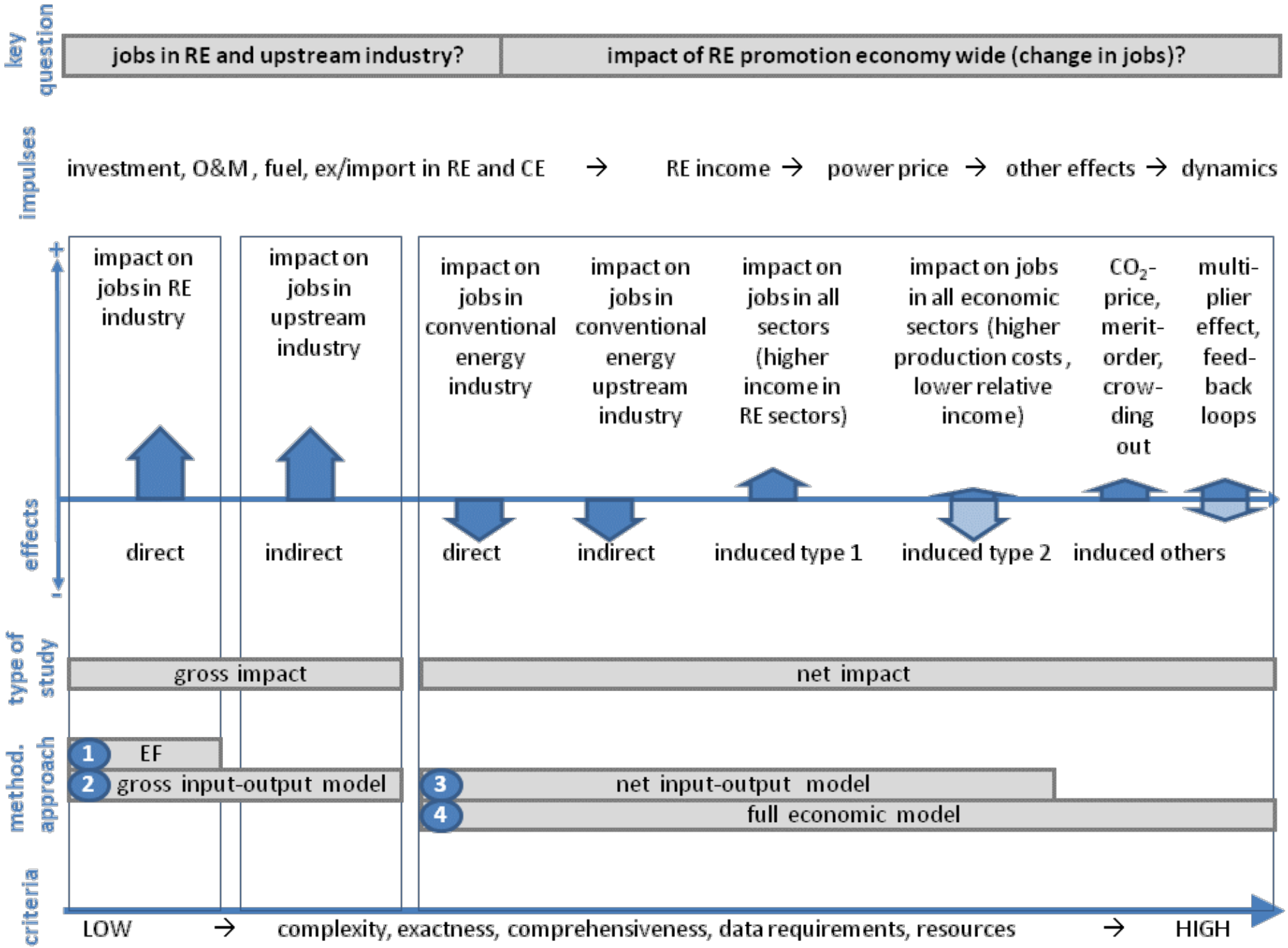
→ provides an idea about relevance and structure (technologies) of this industry,

→ the following questions can be answered:

- Which part of total employment in a country is related to RE use?
- Relevance of domestic RE use vs. RE technology exports for employment?
- Relevance of various RE technologies?
- Relevance of indirect employment in industries supplying the RE industry

Type of impact assessment studies:

2. **economy-wide impact**: assessment of changes in economy wide jobs (all economic sectors) by RE deployment = **net impact study**
   - → provides an idea about the overall economic impact including also negative effects of RE deployment
   - → requires a comparison between two situations: with RE (advanced RE deployment scenario) and without RE deployment (baseline scenario)
   - → represents the best approach for an overall cost-benefit assessment
   - → answers the question: what is the economy wide impact of RE deployment on jobs (change of jobs also in e.g. consumer goods industry)
   - → depends on assumptions about the following (relevant) issues:
     - fossil energy prices
     - exports
     - technology costs (learning curves)
     - RE deployment status of baseline scenario


key question
jobs in RE and upstream industry?
impact of RE promotion economy wide (change in jobs)?
impulses
investment, O&M, fuel, ex/import in RE and CE → RE income → power price → other effects → dynamics
effects
+
-
impact on jobs in RE industry
impact on jobs in upstream industry
impact on jobs in conventional energy industry
impact on jobs in conventional energy upstream industry
impact on jobs in all sectors (higher income in RE sectors)
impact on jobs in all economic sectors (higher production costs, lower relative income)
CO_2-price, merit-order, crow-ding out
multi-plier effect, feed-back loops
direct
indirect
direct
indirect
induced type 1
induced type 2
induced others
type of study
gross impact
net impact
method. approach
1 EF
2 gross input-output model
3 net input-output model
4 full economic model
criteria
LOW → complexity, exactness, comprehensiveness, data requirements, resources → HIGH

Type of impact assessment studies: selected approaches

impact assessment studies

RE-industry jobs
- effects: positive, in/direct
- impact: gross

Economy-wide jobs
- effects: positive & negative; in/direct and induced
- impact: net

EF-approach:
- data: employment factors (EF), capacity and generation
- complexity: low (direct effects)

gross IO-model:
- data: IO-coefficients, cost structures, investments, O&M
- complexity: moderate (direct & indirect effects)

net IO-model:
- data: IO coefficient, cost structures, MCI, O&M, electricity price
- complexity: complex (direct, indirect & induced effects)

full economic model:
- data:
  - macro-economic
  - energy sector
  - trade
- complexity: direct, indirect & induced effects, scenarios

Content

- Background information on the project
- Principal approach
- Types of impact assessment studies
- **Gross impact studies:**
  - **Employment factor approach**
  - **Gross IO-model approach**
- Conclusion

1. Employment factor approach: methodology

- Focus: direct employment, only in RE industry
- Employment factor = labour input needed to perform an activity in the RE facility life cycle (e.g. 2 FTE-years per MW wind power plant installed)
- Calculation steps:
  1. Determine system boundaries
  2. Determine activity values and employment factors:
     - Annual data on installed capacities, net capacity increase (MW), biomass fuel input and power generation (GWh) by technology
     - Data on import and export (shares) by activity
     - Employment factors by technology and activity (fte/MW or fte/MWh)
  3. Determine domestic activity level by incorporating imports and exports
  4. Calculate direct employment
  5. Document methodology and results

2. Gross IO modelling: methodology

- Focus: direct and indirect employment, namely on RE industry and its upstream industries
- Combines techno-economic data for RE technologies with economic input-output modelling
- Calculation steps:
  1. Determine system boundaries
  2. Determine expenditures for RE use, allocate to cost components and industries
     - Annual data on installed capacities, net capacity increase (MW) and power generation (GWh) by technology
     - Specific installation, O&M, fuel (and demolition) expenditures by technology (e.g. EUR/kW or EUR/MWh)
     - Cost structures: breakdown of specific costs by cost component per activity
     - Allocation of cost components to industries of IO-table
     - Input-output table (IOT) of a country and sectoral employment data
  3. Calculate domestic output by RE technology and by industry
  4. Calculate direct and indirect employment
  5. Document methodology and results

Content

- Background information on the project
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  - Employment factor approach
  - Gross IO-model approach
- **Conclusions**

Discussion of gross impact: Employment factor approach

- Strengths:
  - Potentially technology-specific, if reliable data available
  - Low-cost approach and easy to use, if employment factors available
  - Good for fast estimates and updates
- Limitations:
  - Reliable sources for country specific employment factors are scarce
  - Exports are difficult to integrate
  - Only direct employment

Discussion of gross IO modelling

- Strengths:
  - Comprehensive and consistent framework
  - Allows to calculate other economic impacts within the same framework (e.g. value added)
  - Open for integration of results from other sources (e.g. enterprise surveys)
  - Direct and indirect employment
- Limitations:
  - Aggregation bias due to assumption: industries in the IO model are adequate proxies for companies in the RE industry?
    but: detailed technology specific information can be integrated in the framework

Conclusion and results for the guidelines

- distinguish between the type of question to be answered:
  - employment in the RE industry (sectoral employment)
  - Economy-wide employment impact due to RE promotion
- decide on the methodological approaches
  - gross impact:
    - employment factor approach (direct)
    - gross input-output approach (direct and indirect)
  - net impact:
    - net input-output approach
    - full economic model (also best suited to assess future impacts)
- take into account your available budget and knowledge:
  - low budget/know-how → gross impact study or net input-output approach

Thank you very much for your attention

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IEA-RETD project EID-Employ:

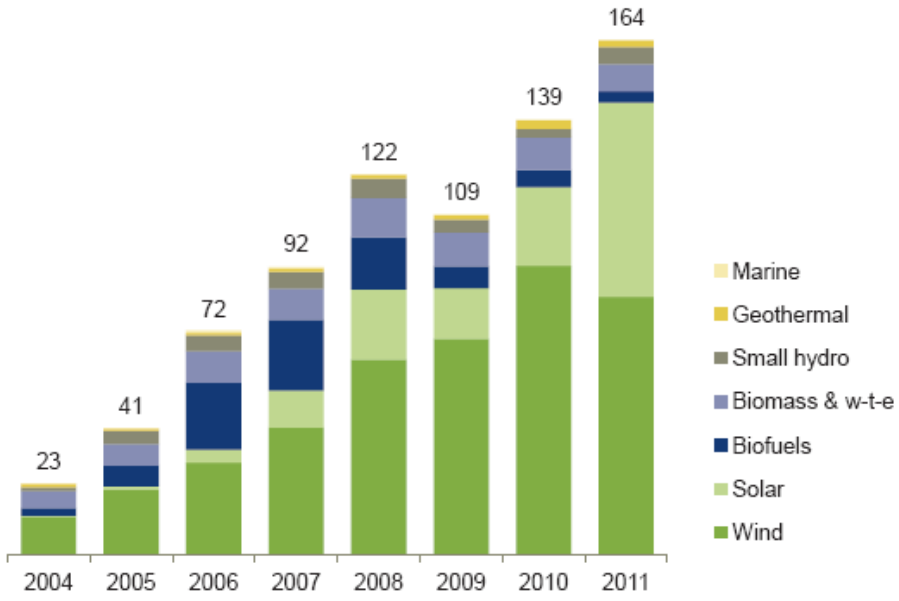
http://iea-retd.org/archives/ongoing/employ

Back-up slides

Background

- Asset financing of new investments in RE in billion $ (from: Global Trends in RE Investments 2012, UNEP & Frankfurt School 2012):

FIGURE 35: ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2011 $BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

1. Employment factor approach: example wind power plant

			Domestic share (incl. net exports)	Employ-ment factor	
Activity	**Activity level parameter**	**Activity value**		**Value**	**Unit**
Project development and planning	Net capacity increase	1,500 MW	100%	0.8	(FTE * a) / MW
Manufacture of WT towers	Net capacity increase	1,500 MW	80%	1.2	(FTE * a) / MW
Manufacture of WT nacelles	Net capacity increase	1,500 MW	110%	1.3	(FTE * a) / MW
Manufacture of WT rotor blades	Net capacity increase	1,500 MW	180%	0.7	(FTE * a) / MW
Construction and installation of WPP	Net capacity increase	1,500 MW	100%	3.0	(FTE * a) / MW
Operation of WPP	Total installed capacity	10'000 MW	100%	0.2	FTE / MW

This example shows exemplary employment factors and activity levels for the MCI and the O&M phase of a wind power plant.

Abbreviations:

- WT: Wind turbine
- WPP: Wind power plant
- FTE: Full time equivalent
- a: year
- MCI: Manufacturing, construction and installation

2. Gross IO modelling approach: example wind power plant

Variable	Unit	Value
Total installed capacity	MW	10,000
Net capacity increase	MW	1,500
Specific installation cost	EUR/MW	1,553
Specific O&M cost	EUR/MW	37
Specific capital cost	EUR/MW	147

This table shows exemplary input data for the calculations

2. Gross IO modelling approach: example wind power plant

This table shows exemplary input data for the calculations

Cost components	Cost shares	Import shares	Export shares	Allocation to industries of IOT
Construction of WPP	100%			
Planning	4%	0%	0%	Business services (74)
Manufacture of WT towers	15%	20%	30%	Man. of metal structures (28)
Manufacture of WT nacelles	37%	20%	100%	Machinery (28)
Manufacture of WT rotor blades	15%	30%	80%	Plastics processing (25)
Transport	4%	0%	0%	Ground transport (60)
Site preparation	3%	0%	0%	Construction works (45)
Foundations of WPP	6%	0%	0%	Construction works (45)
Assembly of WPP	6%	0%	0%	Machinery (28)
Connection to the net	10%	0%	0%	Electrical industry (31)

2. Gross IO modelling approach: example wind power plant (WPP)

This table shows exemplary results of the calculations

Variable	Unit	Construction of domestic WPP	Operation of domestic WPP	Export	Total
Expenditure	**m EUR**	**2'329**	**1'834**	**0**	**4'163**
Domestic output	**m EUR**	**1'982**	**1'834**	**1'246**	**5'062**
Direct employment	**EP**	**13'737**	**3'517**	**6'689**	**23'943**
Indirect employment	**EP**	**10'820**	**2'118**	**6'779**	**19'718**
Total employment	**EP**	**24'557**	**5'636**	**13'468**	**43'661**

Application of gross IO modelling approach to RETD countries: tentative results

Country	Direct employment	Indirect employment	Total RE related employment	Share of total employment in the country	
	Employed persons	Employed persons	Employed persons	direct employment	direct + indirect employment
Canada	32'000	21'700	53'700	0.2%	0.3%
Denmark	27'200	21'700	48'900	1.0%	1.7%
France	29'800	19'100	48'900	0.1%	0.2%
Germany	149'600	120'700	270'300	0.4%	0.7%
Ireland	2'600	700	3'300	0.1%	0.2%
Japan					
Netherlands	9'200	11'600	20'800	0.1%	0.2%
Norway	10'200	6'200	16'400	0.4%	0.6%
United Kingdom	16'200	11'000	27'200	0.1%	0.1%