Deepening cost analysis for Onshore Wind Technology

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ETSAP Workshop, Stuttgart, GERMANY | Nov 9th 2018

Scope

To develop a more relevant method to investigate costs of energy technologies

- What is missing, and which needs improvements?
- To what extent can each costs component be analysed?
- The lesson learned can be applied for different energy technologies?

Costs drivers investigated in current methods

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HIGH LEVEL DRIVERS → MACRO-SYSTEM DYNAMICS

- LEARNING DUE TO DEPLOYMENT
- KNOWLEDGE SPILLOVERS BETWEEN ACTORS
- POLICY SUPPORT
- ECONOMIES OF SCALE (SIZE – PLANT, INDUSTRY)
- RESEARCH ACHIVEMENTS
- LOCAL INDUSTRY DEVELOPMENT
- INPUTS COSTS

LOW LEVEL DRIVERS → OBSERVABLE TECHNICAL PARAMETERS

- ECONOMIES OF SCALE (SIZE – DEVICE)
- TECHNICAL QUALITY (PERFORMANCE, MATERIAL USE)
- SITE CHARACTERISTICS (DISTANCE)
- INSTALLATION EFFICIENCY (TIME)

Methods to investigate cost reductions

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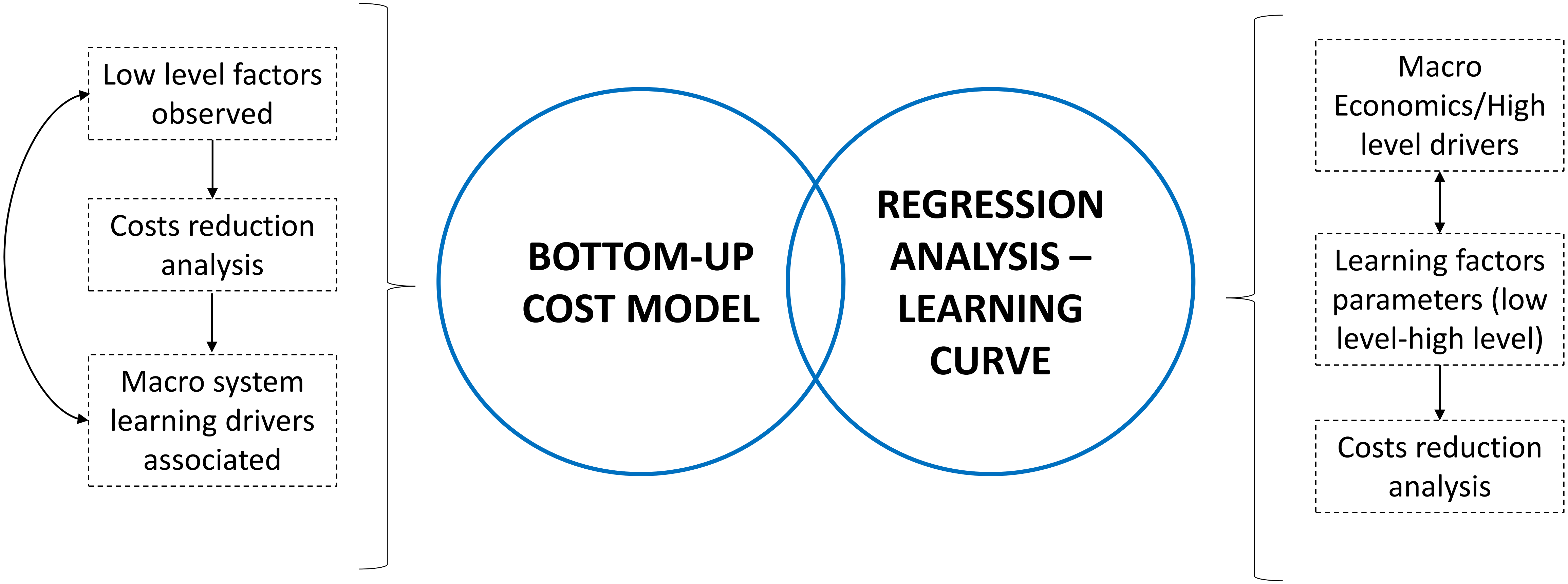
	COST-BREAKDOWN STRUCTURE	BOTTOM-UP COST MODEL	LEARNING CURVES
System boundaries level of analysis	PROJECT LEVEL	INDUSTRY/NATIONAL LEVEL	INDUSTRY/NATIONAL/GLOBAL LEVEL
Data gathering and Drivers of costs reduction	ENGINEERING ASSESSMENT (TECHNICAL AND SPECIFICS) OBSERVABLE TECHNICAL PARAMETERS/LOW LEVEL DRIVERS	DATABASE ANALYSIS (TECHNICAL BUT GENERAL) OBSERVABLE TECHNICAL PARAMETERS/LOW LEVEL DRIVERS	DATABASE ANALYSIS (TECHNICAL BUT GENERAL, MACRO-SECTOR TRENDS) MACRO ECONOMICS DRIVERS/ HIGH LEVEL DRIVERS
Extent range (Scope)	CASE SPECIFIC (limited)	GENERAL CASE	GENERAL CASE
Reduction costs approach by drivers	SENSITIVITY ANALYSIS (STATIC)	1. SENSITIVITY ANALYSIS (STATIC) 2. TIME VARIATION OF TECHNO-ECONOMIC DRIVERS (DYNAMIC)	REGRESSION ANALYSIS IN TIME (ECONOMETRIC MODEL-DYNAMIC)

Methods characteristics



ISSUES

1. LOW LEVEL FACTORS ARE NOT ALL DIRECTLY LINKED TO ALL MACRO SYSTEM LEARNING DRIVERS (later costs analysis)

ISSUES

1. LIMITS TO ADDRESS REALITY -DRIVER/FACTOR (before costs analysis)

LCOE cost components

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Energy generation costs (LCOE)

Investment costs – CAPEX plant | OPEX plant | FUEL costs | FINANCIAL | PERFORMANCE

Technology costs

Technology components (e.g. blades, transformers, PV module)

Main costs components of technology costs:

- Capital costs
- Input material
- Labor costs
- Energy costs
- Overhead

Balance of the system (BoS costs)

Hard/Soft deployment costs:

- Planning and project design costs
- Transport costs
- Installation/assembly
- Grid connection costs

Main costs components of technology costs:

- Equipment costs
- Labor costs
- Financial costs
- Customers acquisition/administration
- Technical feasibility
- Overhead

O&M Plant

- Land site lease cost
- Legal-administrative costs (tax, rates, insurances)
- Operation
- Maintenance, replacement

Fuel costs

- Primary energy resource
- Transportation costs
- Transformation costs

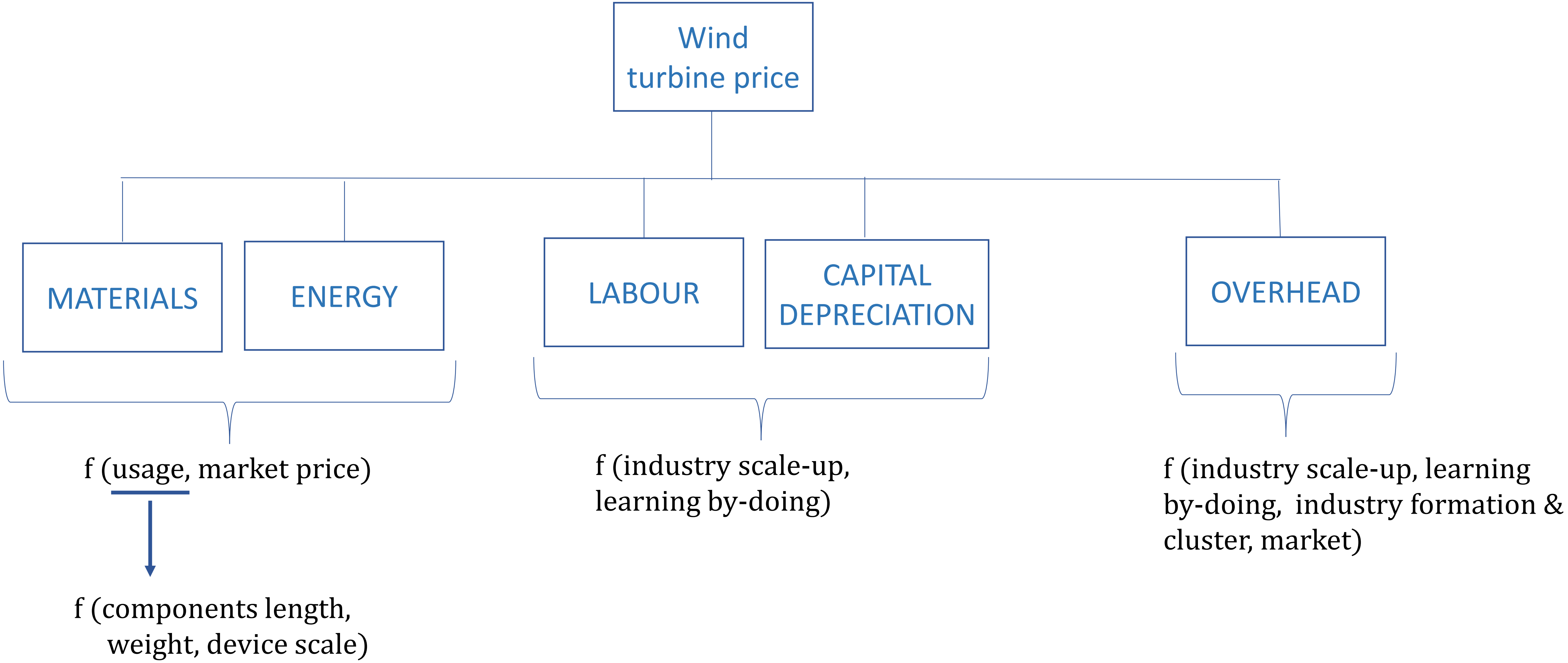
Cost of capital

- Discount rate (financial risk)

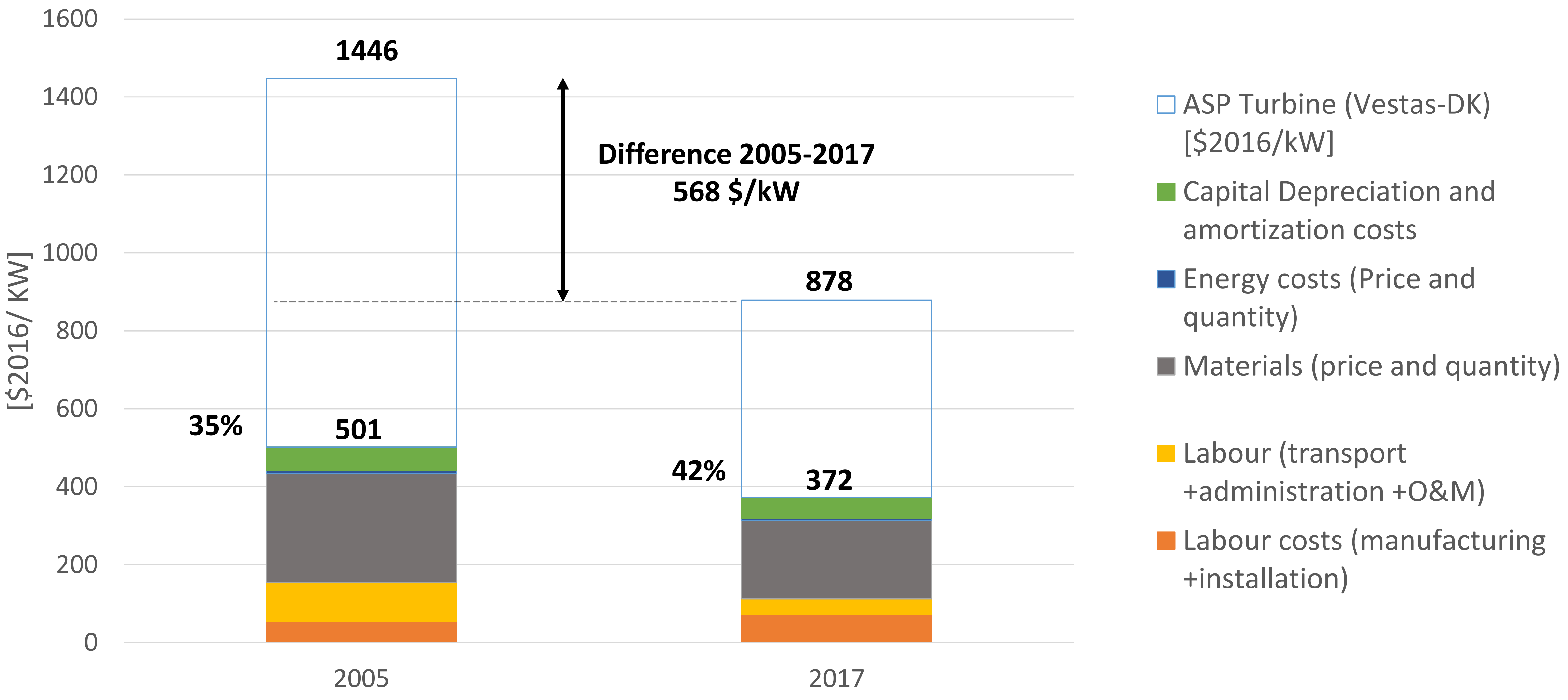
Performance drivers

- Capacity Factor (Resource quality)
- Technology life
- Technology choice
- Degradation

Turbine technology price



Technology price – Input costs drivers (Vestas)



Input drivers changes 2005-2017

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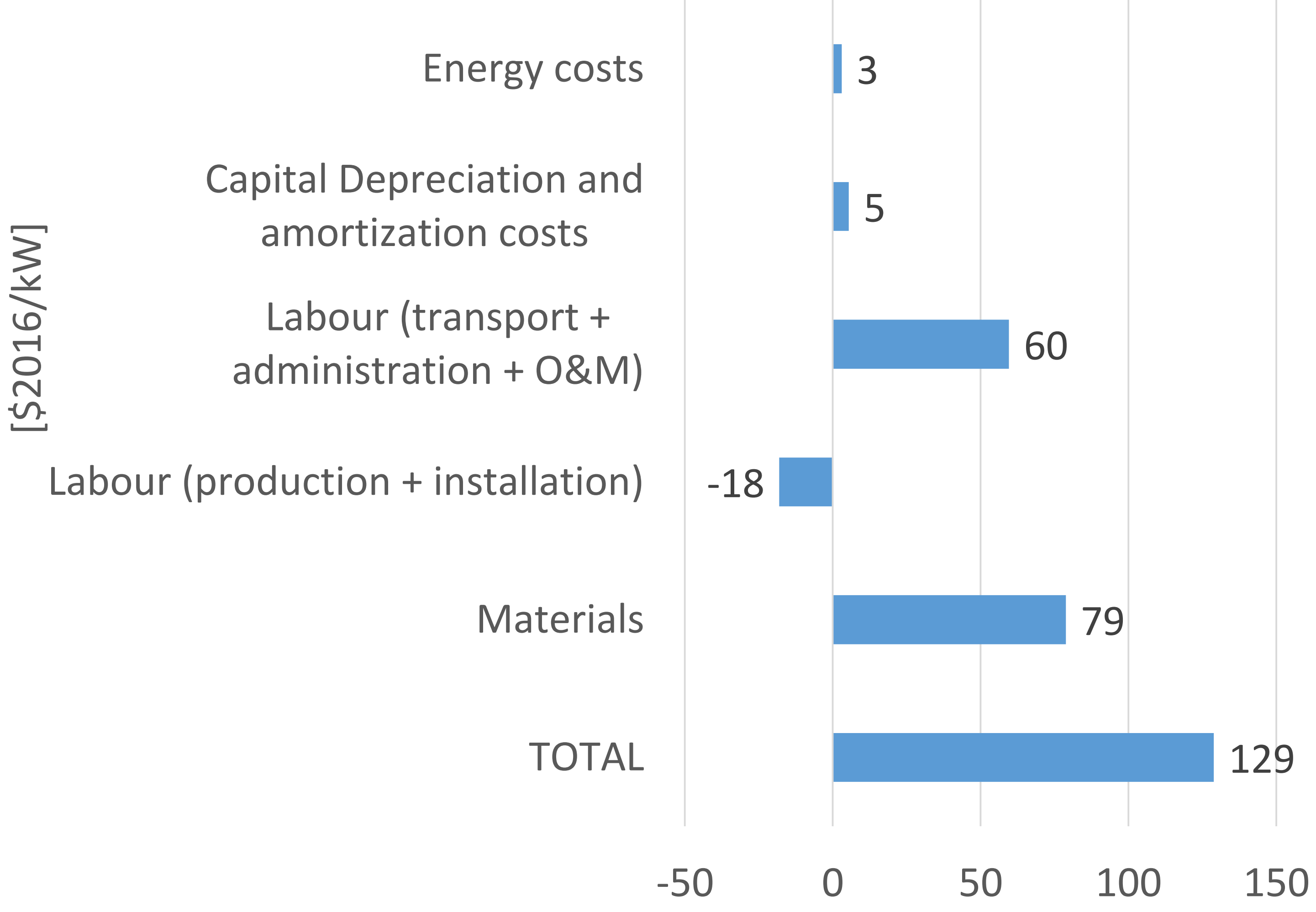
Total cost reduction → 568 $/kW

[$2016/kW]	Reduction	%
Contributions of input costs drivers	**129**	**23%**
Other costs (overhead)	**439**	**77%**



Material costs variation (Vestas)

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1st case: NO CHANGE IN COMMODITY PRICES

	2005	2017		
[$2016/kW]	v80 -2MW	v100-2 MW	v110-2 MW	v126-3.45 MW
STEEL	94	79	96	106
CAST IRON	14	9	9	15
ALUMINUM	34	14	13	8
COPPER	16	9	9	7
POLYMER TURBINE	3	3	4	3
POLYMER (CABLES)	11	4	4	2
CONCRETE	78	57	65	56
CERAMIC/GLASS +CARBON	29	33	23	22
TOTAL COSTS OF MATERIALS	280	208	223	220
CONTRIBUTION ON MATERIAL EFFICIENCY		72	57	59

2nd case: NO CHANGES IN TURBINE TECHNOLOGY

DIFFERENCES 2005-2017 [$2016/kW] (V90 – 2MW)	
STEEL	14.96
CAST IRON	-8.47
ALUMINUM	6.06
COPPER	-5.44
POLYMER TURBINE	-0.27
POLYMER (CABLES)	-0.94
CONCRETE	7.35
CERAMIC/GLASS + CARBON	1.40
TOTAL COSTS OF MATERIALS	15

17-21% MARKET CHANGES
79-83% TECHNICAL IMPROVEMENTS

Overhead (still unexplained)

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439 $2016/kW → ~77% Wind Turbine Technology price

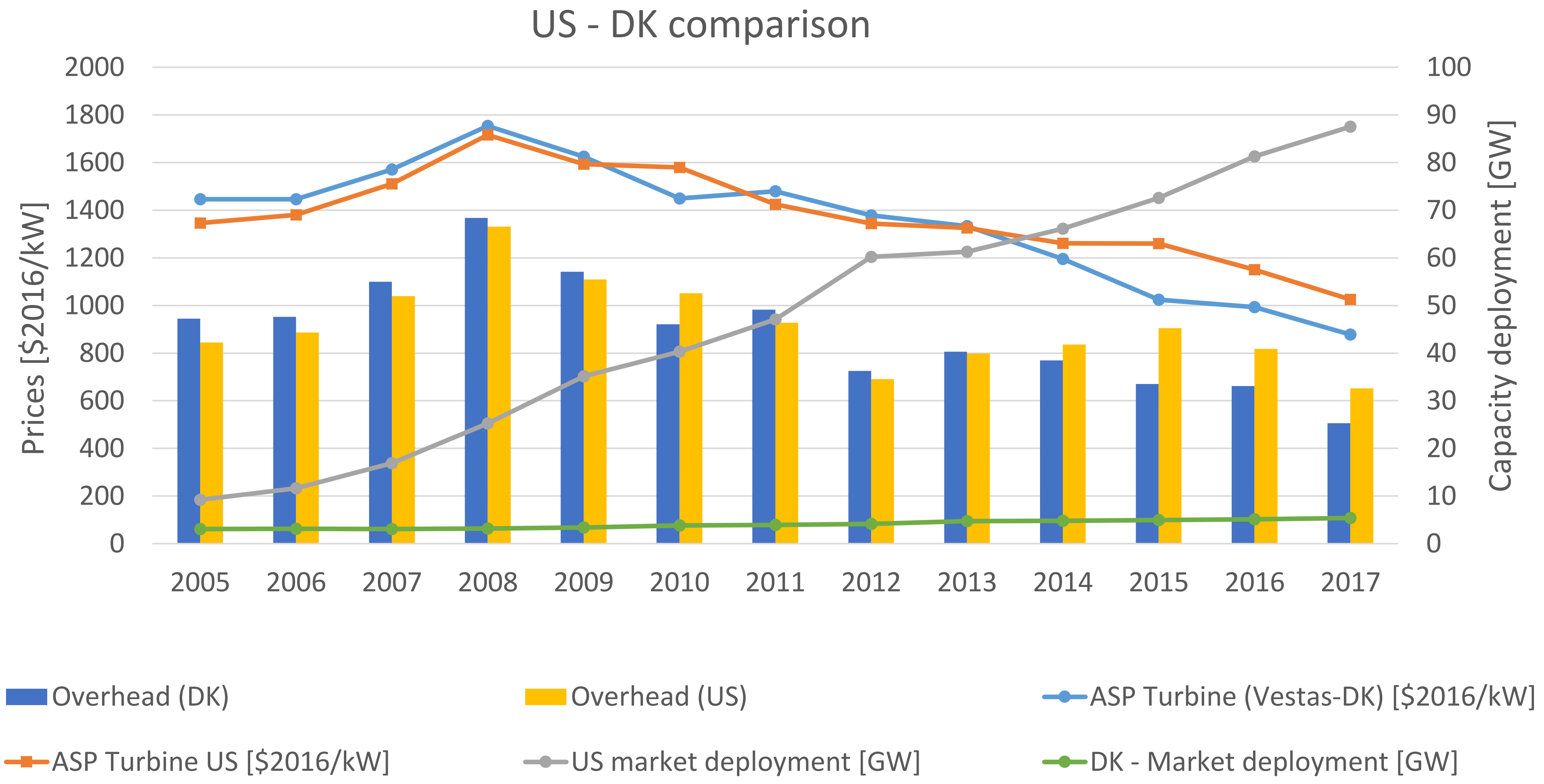
How can we cover the gap for overhead costs?

COMPANY PROFIT	Average of main manufactures in the world
TRANSPORTATION / INSTALLATION COSTS	Local behavior – Country specific analysis
SUPPLIER - COMPETITORS COSTS	Local behavior - Industry formation and market dynamics
FINANCIAL and OTHERS	Market, policy, manufacture learning, industry scale-up

1FLC – market deployment

15% - US
58% - Denmark

Global market deployment : 21%



Conclusion and Follow-up

- Most of technology costs components are still not explained
- Focus on understanding cost reduction dynamics of overhead costs is needed

  Are they dependent on local or global conditions?
  Project level data could provide more insights?
  More specific data needs: Low drivers or global drivers? Which is the best approach?

- FUTURE ANALYSES

  1) Balance of the system of wind farm at project level analysis
  2) Consideration stage where still deployment is not achieved