The international technology Catalogue experiences

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Recap of first session

The most important things from session 1…

- *The technology catalogue is used for many purposes and by many stakeholders*

- *The value of the technology catalogue is local conditions*

- *It takes time to develop a technology catalogue setup, which should be repeated often*

Objective

The objective of this session is:

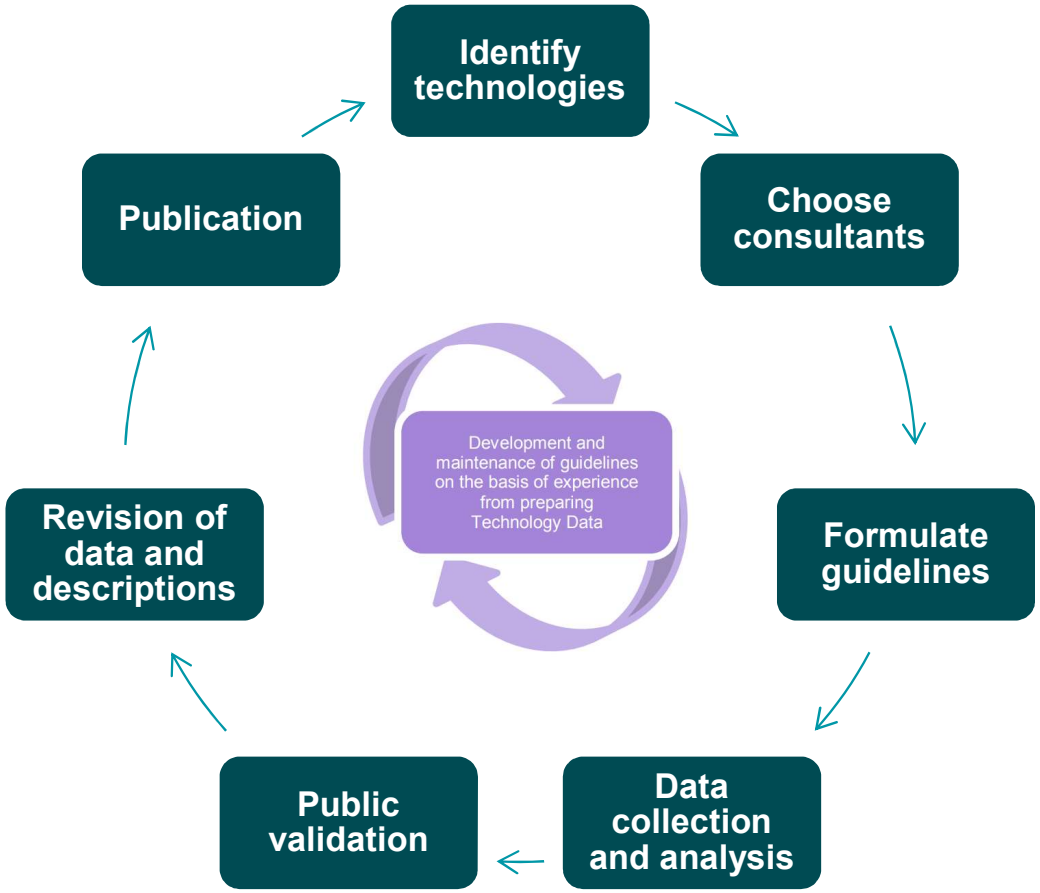
- To provide details about managing the technology catalogue process
- To suggest possible methods and tools to use
- To initiate reflections on moving the Danish experiences to an Indian context

Agenda

The process of the technology catalogue

- Developing guidelines
- Data collection
- Stakeholder involvement
- Timelines
- Projections into the future
- Updating the process

Process

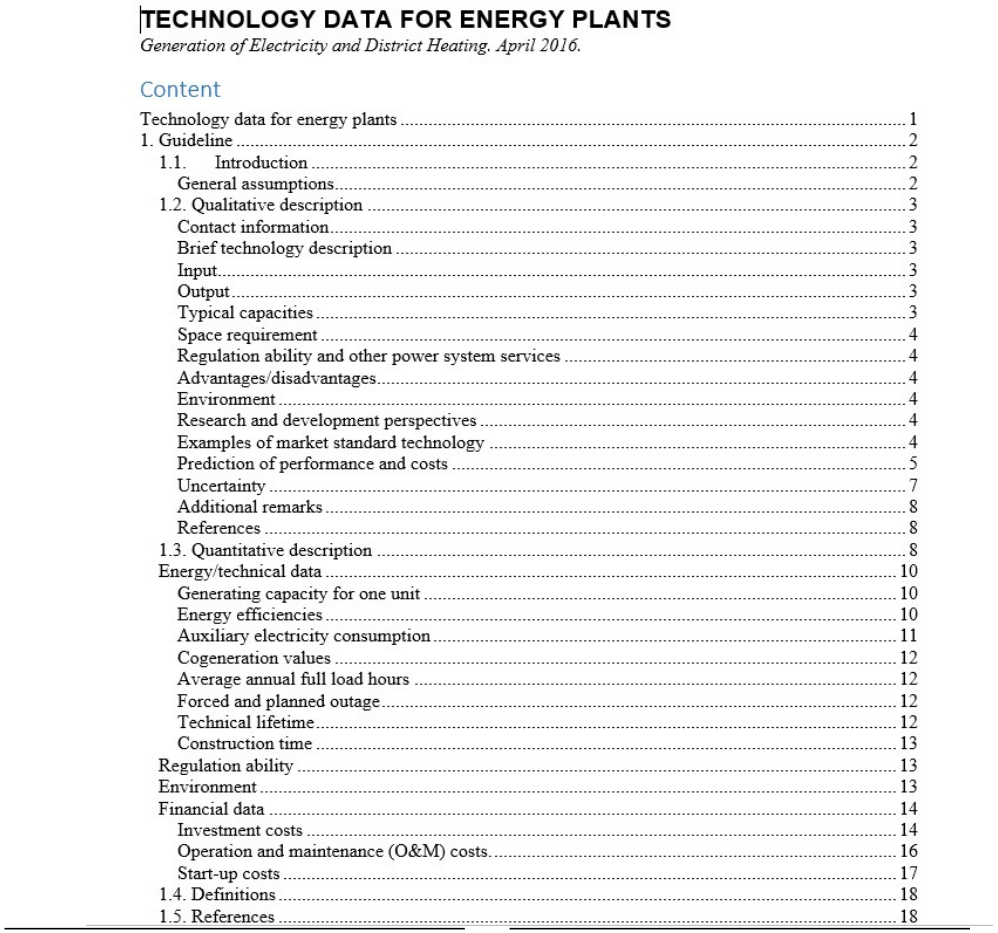

Identify technologies
Choose consultants
Formulate guidelines
Data collection and analysis
Public validation
Revision of data and descriptions
Publication
Development and maintenance of guidelines on the basis of experience from preparing Technology Data

Guidelines

- What is a guideline for a technology catalogue?
- Why developing guidelines?
- How to update the guideline?

What is a technology catalogue guideline?

- The guideline specifies the content and definitions of the technology catalogue
- It is a useful tool for the project manager
- Should be adjusted according to the technology analysed and technology development



TECHNOLOGY DATA FOR ENERGY PLANTS

Generation of Electricity and District Heating. April 2016.

Content

Why develop guidelines?

- The guidelines should be developed to achieve a consistent understanding of the categories and definitions, e.g.:
    - Technical terminology
    - Units
    - Which type of categories
    - Previous examples

- Useful when outsourcing/sharing tasks with others (e.g. consultants)

To ensure:

- Consistency
- Comparability
- Transparency

Examples of definitions

Construction time

Time from final investment decision (FID) until commissioning completed (start of commercial operation), expressed in years.

Energy efficiencies

Efficiencies for all thermal plants (both electric, heat and combined heat and power) are expressed in percent at lower calorific heat value (lower heating value) at ambient conditions in Denmark, considering an average air temperature of approximately 8 °C.

Space requirement

Space requirement is expressed in 1000 m^2 per MW. The value presented only refers to the area occupied by the facilities needed to produce energy.

In case the area refers to the overall land use necessary to install a certain capacity, or a certain minimum distance from dwellings is required, for instance in case of a wind farm, this is specified in the notes. The space requirements may for example be used to calculate the rent of land, which is not included in the financial cost, since this cost item depends on the specific location of the plant.

Examples of definitions

The investment cost is reported on a normalized basis, i.e. cost per MW. The specific investment cost is the total investment cost divided by the capacity stated in the table, i.e. the capacity as seen from the grid, whether electricity or district heat. For electricity generating technologies, incl. combined heat and power generation, the denominator is the electric capacity.

The investment cost of extraction steam turbines, which can be operated in condensation mode, is stated as cost per MW-condensation mode capacity.

Where possible, the investment cost is divided on equipment cost and installation cost. Equipment cost covers the components and machinery including environmental facilities, whereas installation cost covers engineering, civil works, buildings, grid connection, installation and commissioning of equipment.

The rent of land is not included but may be assessed based on the space requirements, if specified in the qualitative description.

The owners' predevelopment costs (administration, consultancy, project management, site preparation, approvals by authorities) and interest during construction are not included. The costs to dismantle decommissioned plants are also not included. Decommissioning costs may be offset by the residual value of the assets.

How to update guidelines?

- Agree across all parties involved before commencing on the work
    - Likely differences across countries
- Follow internationally acknowledged definitions (e.g. similar definitions to international organisations such as IEA, UN or World Bank)
- Update the guidelines when new technologies are included
    - See examples in the list of the most recent technology catalogue

Data collection

- Types of data
- How to collect it?
- What if data does not exist ?
- How to manage many data inputs?

Types of data

Data types across the technologies are adjusted according to the specific technology

- Qualitative
- Quantitative
  - Energy/Technical data
  - Regulation
  - Environmental
  - Financial
  - (Technology specific)

Technology	20 Large wind turbines on land									
Year of final investment decision	2015	2020	2030	2050	Uncertainty (2020)		Uncertainty (2050)		Note	Ref
Energy/technical data					Lower	Upper	Lower	Upper		
Generating capacity for one unit (MW)	3,5	3,5	4	5	2,0	6,0	1,5	8,0	A1	3
Average annual full-load hours	3100	3150	3200	3300	2000	4000	2000	4500	A, L	3
Forced outage (%)	3,0%	2,5%	2,0%	1,5%	1,0%	5,0%	1,0%	5,0%	B	4
Planned outage (%)	0,3%	0,3%	0,3%	0,3%	0,1%	0,5%	0,1%	0,5%	C	4
Technical lifetime (years)	25	27	30	30	25	35	25	40	D	14
Construction time (years)	1,5	1,5	1,5	1,5	1	3	1	3	E	4
Space requirement (1000m2/MW)	---	---	---	---	---	---	---	---	F	
Regulation ability										
Primary regulation (% per 30 seconds)									G	
Secondary regulation (% per minute)									G	
Financial data (in 2015€)										
Nominal investment (M€/MW) incl grid connection	1,07	0,99	0,91	0,83	0,9	1,1	0,7	1,0	H	16, 2, 4
Nominal investment (M€/MW) excl. grid connection (5% of nom. Investment)	1,02	0,94	0,86	0,79	0,8	1,0	0,6	0,9	I, M	16, 2, 4
- of which equipment	75%	75%	75%	75%	70%	80%	70%	80%		4
- of which installation	25%	25%	25%	25%	20%	30%	20%	30%		4
Fixed O&M (€/MW/year)	25.600	23.900	22.300	21.200	21.510	26.290	16.960	25.440	J,N	
Variable O&M (€/MWh)	2,8	2,5	2,3	2,1	2,3	2,8	1,7	2,5	J,N	4, 15, 18
Technology specific data										
Rotor diameter	120	120	130	150	90	130	100	150	K	4
Hub height	90	90	100	110	85	120	85	150		4
Specific power (W/m2)	309	309	301	283	270	350	250	350		
Average capacity factor	37%	37%	38%	39%	23%	46%	23%	51%		4
Average availability (%)	97%	97%	98%	98%	99%	95%	99%	95%		4

Methods for data collection

- Stakeholder consultation
  - Workshops
  - Direct consultation
  - Technology expert groups
- Literature study
  - International studies
  - National publications
- Project specific
  - Recently commisioned projects
  - Bids for tenders in the country
- National registers/statistics

Data issues

Data availability can be an issue for a number of reasons:

- Technology is immature
- Technologies developing in a new country (e.g. offshore wind)
- Stakeholders are not willing to share or do not have data

Ways of handling this:

- Use data from similar markets (e.g. neighbouring countries)
- Use international experiences and adjust to own country
- Convince why the technology catalogue is also important for the stakeholders

Data issues

Sometimes data does not align across data sources:

- Experiences have shown bias towards stakeholders own technologies (prices too low)
- Experiences have shown stakeholders providing data that will increase the governmental support to them (prices too high)
- Data from similar stakeholders might be rather different
- Data can be provided in different units and definitions
- The extent of data requested can be higher than the stakholders can manage

Data issues

Ways of managing data:

- Using averages
- Using what the majority of data sources propose
- What is deemed most likely by DEA/consultants – which stakeholder should have the best data insights
- Include public/experts to get their views on data issues

Stakeholder involvement

- Why is stakeholder involvement crucial?
- Which methods can be used to involve stakeholders?
- How to decide which stakeholder should be included?

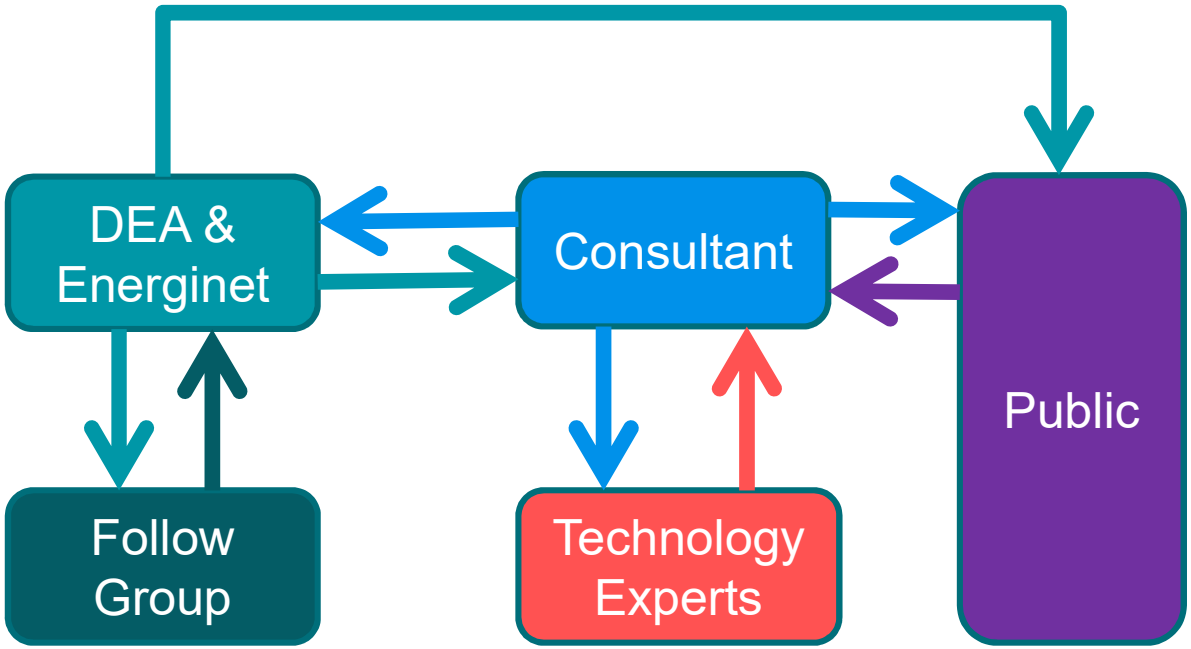
Why is stakeholder involvement crucial?

- Stakeholders in many cases have unique knowledge and data
- Stakeholder involvement creates ownership to the products – they will also be users afterwards
- Common assumptions across energy sector
- Involvement of stakeholders reduces the critique afterwards as they were part of the process and had the opportunity to contribute
- Stakeholder involvement is a matter of trust building. This has taken many years in Denmark to build relations with the stakeholders.

Recap of process

Various stakeholders involved in different processes

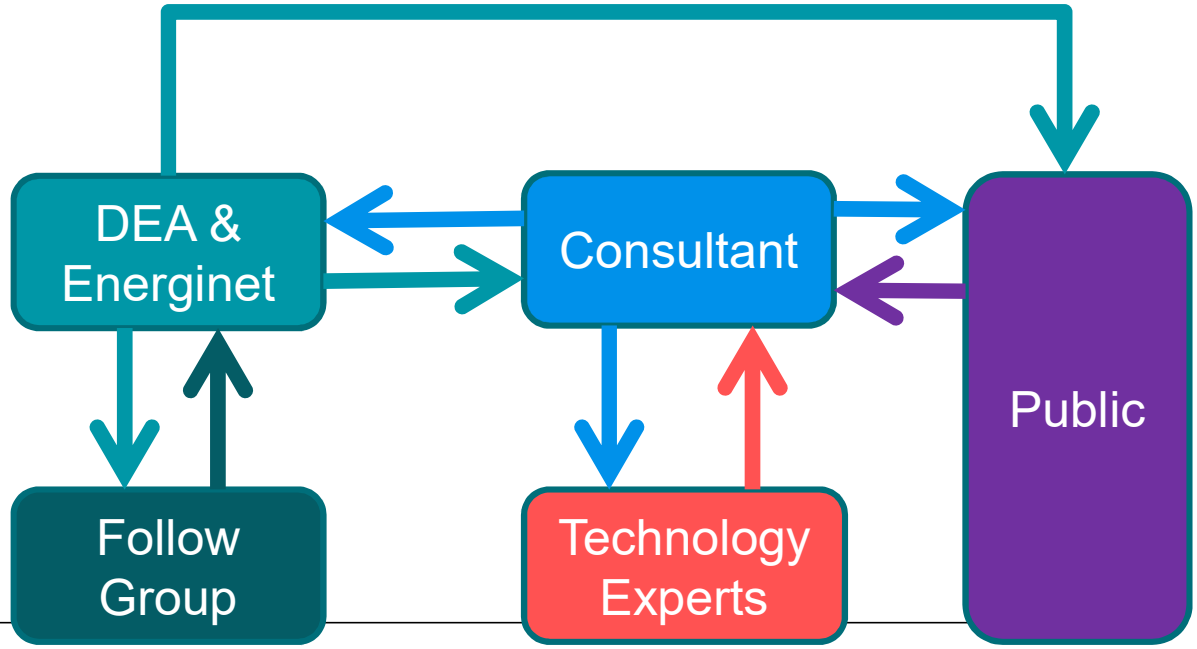
1. Follow Group suggests updates of the catalogue
2. DEA/ENDK decide on updates and hire a consultant for the task
3. Consultant writes a draft update and presents it to the technology experts at a deep dive workshop
4. Consultant writes an updated draft and receives written feedback from the technology experts and all other interested stakeholders
5. Consultant writes final version
6. DEA/Energinet publish final version



Which methods can be used to involve stakeholders?

- A typical technology catalogue process lasts ½-1 year depending on the urgency and the scope of technologies

- Typically three workshops:



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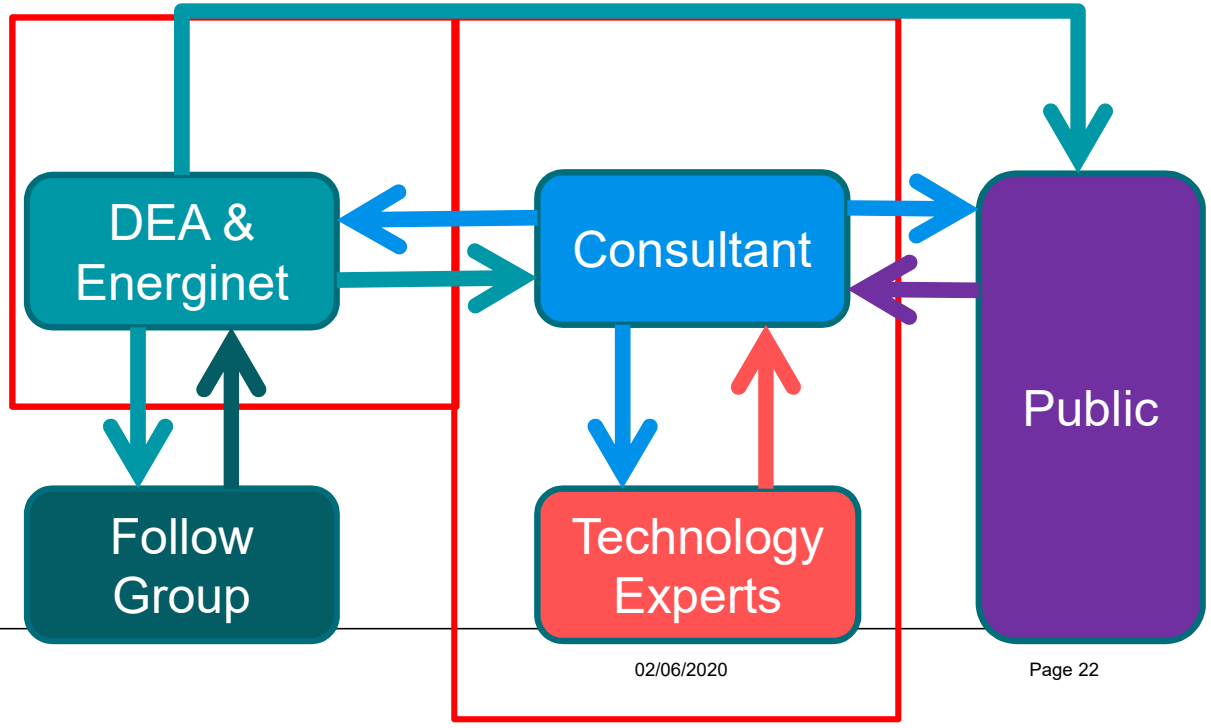
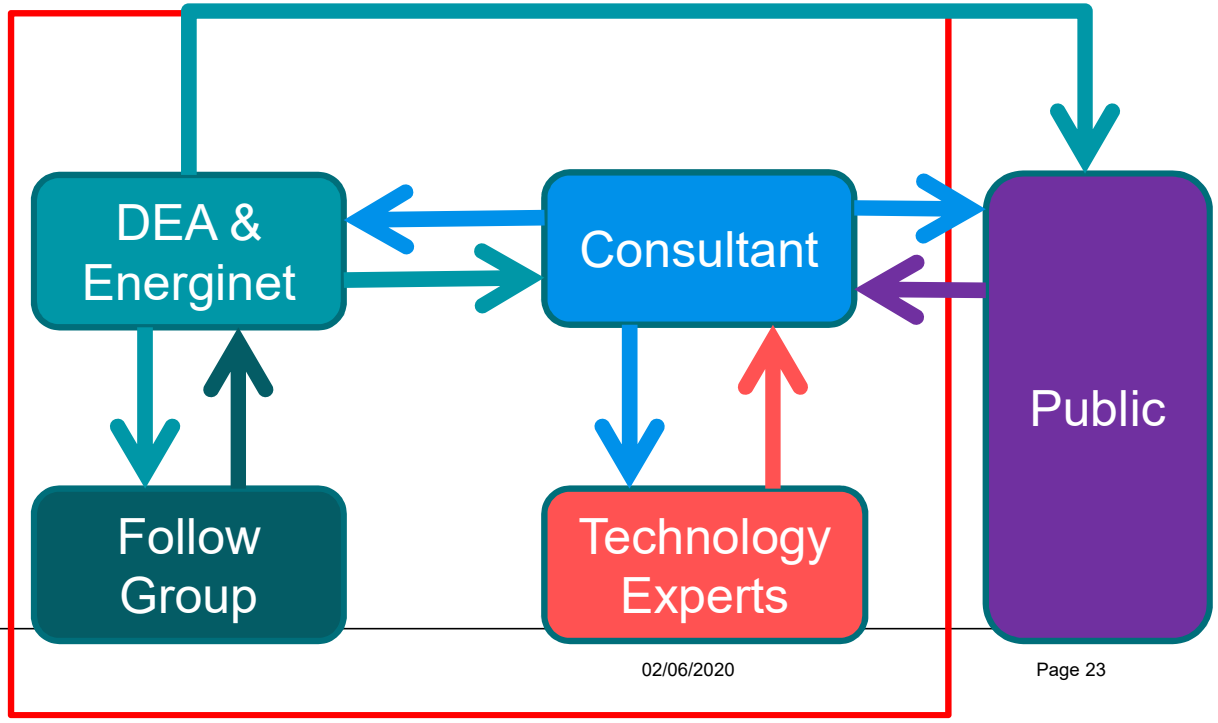
- Typically three workshops:
  - Kick-off workshop



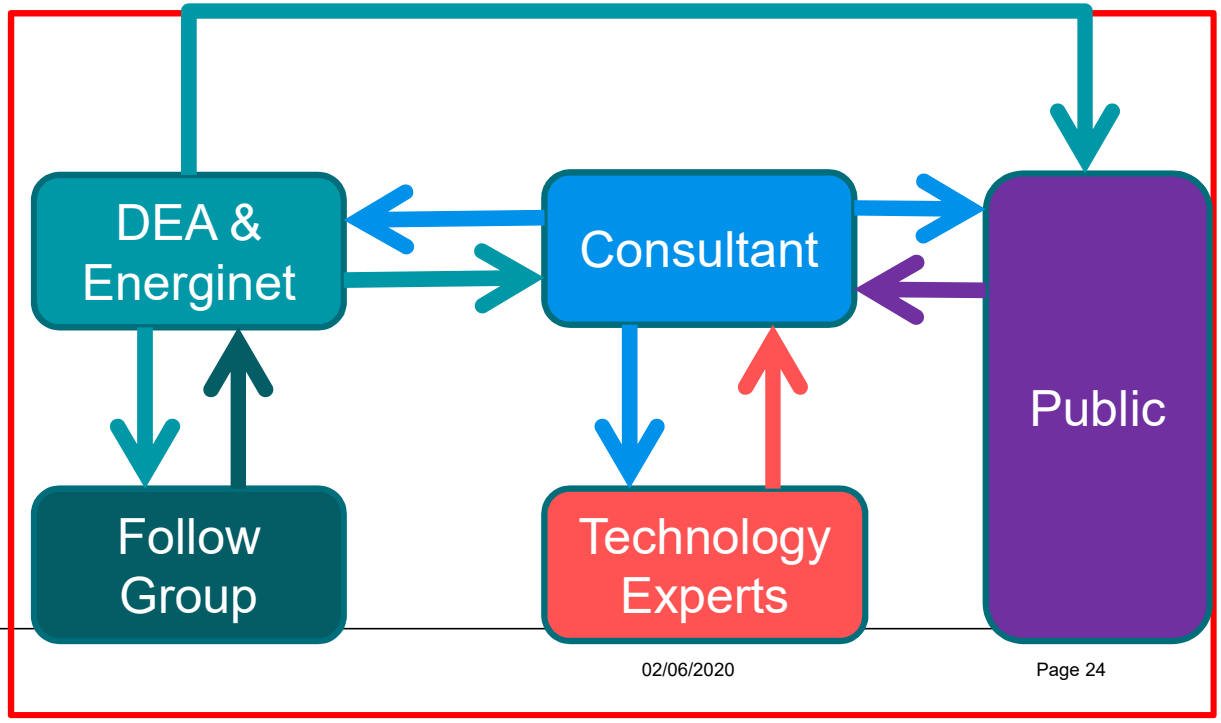
Which methods can be used to involve stakeholders?

- Typically three workshops:
  - Kick-off workshop
  - Midway workshop



Which methods can be used to involve stakeholders?

- Typically three workshops:
  - Kick-off workshop
  - Midway workshop
  - Final workshop

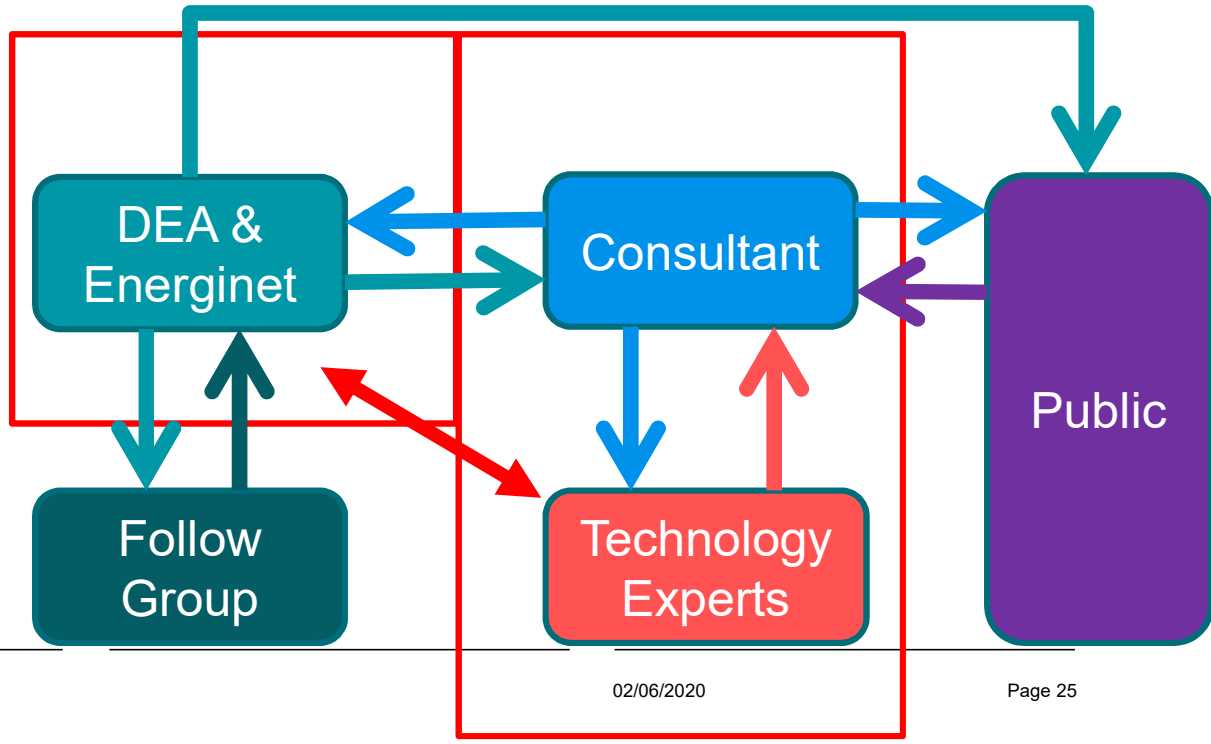


Consultation with Technology experts/Expert groups

Consultation between consultant and experts or DEA and experts

- Direct 1:1 consultations and interviews

- Email communication for stakeholder database



Technology experts/Expert groups

- Typical experts are e.g. private companies, governement research institutions, universities, authorities, NGOs

- Different experts can contribute with different inputs/feedback

- Some data can be confidential and key to their business, hence they will not share their data.
    - Instead they will in general terms comment on the data estimates.
    - Anonymizing their inputs could lead to more data.

Consultation with Technology experts/Expert groups

- Stakeholder database with all organisations that are interested – everyone is welcome

Fra: Thøger Kiørboe
Sendt: 2. april 2019 12:50
Emne: Invitation til at kommentere Energistyrelsens og Energinets forslag til opdatering af teknologidata for land-, og havvindmøller

Kære Teknologikatalog interessent

Energinet og Energistyrelsen udsender hermed forslag til nye kapitler i Teknologikataloget for land-, og havvindmøller, som vi meget gerne vil have dine kommentarer til.

Hvis du ikke ønsker at modtage nye kapitler og data til kommentering fremover, eller hvis vi skal tilføje nye navne, vil vi bede dig melde dette tilbage til os.

Energistyrelsen og Energinet har vurderet, at der er behov for at opdatere kapitlerne i Teknologikataloget om land-, og havvindmøller, og vi ønsker at inddrage jer, da vi mener at I kan bidrage med at højne kvaliteten af det foreliggende materiale. Vi sætter stor pris på at modtage alle jeres kommentarer. Arbejdet med det nye kapitel er udarbejdet af EMD.

Materialet, som er vedhæftet mailen, indeholder følgende ændringer:

1. Landvindmøller:
    a. Delvist opdaterede beskrivelser (kapiteltekst), som er skrevet sammen med den eksisterende beskrivelse
    b. Opdaterede dataark (udgifter til landleje, nedtagning af gamle møller og nabokompensation er desuden tilføjet)
2. Havvindmøller:
    a. Delvist opdaterede beskrivelser (kapiteltekst), som er skrevet sammen med den eksisterende beskrivelse
    b. Opdaterede dataark

Vi har brug for din viden
For at forbedre kvaliteten af kataloget ønsker Energistyrelsen og Energinet at indhente kommentarer fra eksperter, mulige brugere, brancheforeninger m.v. som ligger inde med viden på området.
Vi sætter stor pris på at modtage kommentarer og vil bede dig om at inkludere referencer, hvis du indsender estimater for parametre.

Consultation with Technology experts/Expert groups

Material that is shared:

- Entire technology catalogue

- Excel datasheets

21 Wind Turbines, Offshore

Contact information:

Danish Energy Agency: Thøger Kiørboe, TKI@ens.dk

Author: Mads V. Sørensen / Henrik Sundgård Petersen / Per Nielsen (EMD)

Publication date

August 2016

Amendments after publication date

Date	Ref.	Description
June 17	21 Wind turbines, offshore	Financial data (Investment cost and O&M) updated
Apr 19		Financial and technical data updated in data sheets
		Description of Floating foundations
		Environment chapter extended

Note to Amendment April 2019:

The trend seen in the 2017 amendment were seen to continue. The reasons are as described in 2017 amendment. The costs have decreased further illustrated by the bid winning prices:

	øre/kWh	MW	MW/WTG
HR3 - installed 2018	77	406,7	8,3
VH (Vesterhav)	47,5	344,4	8,4
KF (Krigers Flak)	37,2	604,8	8,4

The large decrease is mainly based on increased competition, but also by sizing. The WTGs purchased for the two new projects has been negotiated as one delivery, which make the purchase order more than twice as large as for HR3.

The updated costs for offshore wind farms are mainly based on costs informed by Vattenfall, partly on their home page, partly supported by interviews. Also OPEX cost has been updated based on

Updated April 2019 (Financial data (Investment cost and O&M)) + 2040 added AND cost for land, old WTG and neighbor comp. Added in costs

Technology	20 Large wind turbines on land										
Year of final investment decision	2015	2020	2030	2040	2050	Uncertainty (2020)		Uncertainty (2050)		Note	Ref
Energy/technical data						Lower	Upper	Lower	Upper		
Generating capacity for one unit (MW)	3,1	4,2	5	5,5	6	2,0	6,0	1,5	8,0	A1	3
Average annual full-load hours	3100	3400	3600	3700	3800	2000	4000	2000	4500	A, L	3
Forced outage (%)	3,0%	2,5%	2,0%	1,8%	1,5%	1,0%	5,0%	1,0%	5,0%	B	4
Planned outage (%)	0,3%	0,3%	0,3%	0,3%	0,3%	0,1%	0,5%	0,1%	0,5%	C	4
Technical lifetime (years)	25	27	30	30	30	25	35	25	40	D	14
Construction time (years)	1,5	1,5	1,5	1,5	1,5	1	3	1	3	E	4
Space requirement (1000m2/MW)	---	---	---	---	---	---	---	---	---	F	
Regulation ability											
Primary regulation (% per 30 seconds)										G	
Secondary regulation (% per minute)										G	
Financial data (in 2015€)											
Nominal investment (M€/MW) incl grid connection, land, compensations etc.	1,33	1,17	1,11	1,05	0,99	1,05	1,29	0,80	1,19	I, M	16, 2, 4
Nominal investment (M€/MW) excl. grid connection (5% of nom. Investment)	1,26	1,11	1,06	1,00	0,94	1,00	1,22	0,76	1,13	H, M	16, 2, 4, 26
- of which equipment	74%	67%	67%	67%	67%	61%	74%	54%	81%		25
- of which installation/development	5%	9%	9%	9%	9%	8%	10%	7%	11%		25
- of which is related to rent of land	12%	10%	10%	10%	10%	9%	11%	8%	12%		25
- of which is related to decommissioning of existing turbines	5%	3%	3%	3%	3%	3%	3%	3%	4%		25
- of which is related to other costs (i.e. compensation of neighbours, etc.)	5%	10%	10%	10%	10%	9%	11%	8%	12%		25
Fixed O&M (€/MW/year)	25600	14000	13300	12600	11900	12600	15400	9520	14280	J,N	25,26
Variable O&M (€/MWh)	2,80	1,50	1,43	1,35	1,28	1,35	1,65	1,02	1,53	J,N	25,26
Technology specific data											
Rotor diameter	106	130	145	155	165	90	130	100	150	K	4, 26
Hub height	85	85	100	105	110	85	120	85	150		4, 26
Specific power (W/m2)	351	316	303	291	281	314	452	191	453		
Average capacity factor	35%	39%	41%	42%	43%	23%	46%	23%	51%		4, 26
Average availability (%)	97%	97%	98%	98%	98%	99%	95%	99%	95%		4, 26

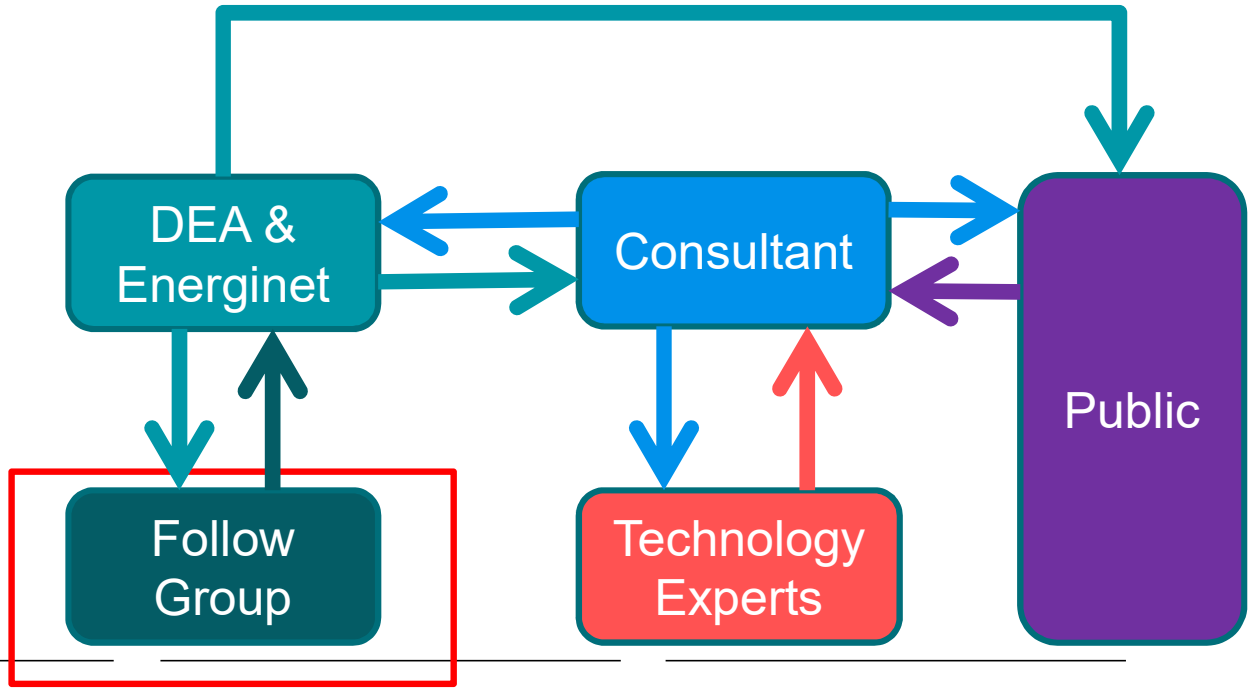
20 Onshore turbines NEW | 21 Offshore turbines NEW | 21 Near shore turbines NEW | ⊕

Follow group

- The members are experts across the entire energy sector and represent some of the key users of the technology catalogues

13 members in Denmark:

- Public authority (1)
- Universities (2)
- Large interest organisations (3)
- Consultant (2)
- Research institution (1)



Follow group

- The role of the follow group is to
  - Propose technologies that should be updated
  - Provide feedback on methods
  - Sparring for relevant issues
  - Participate as technology experts

The use of consultants

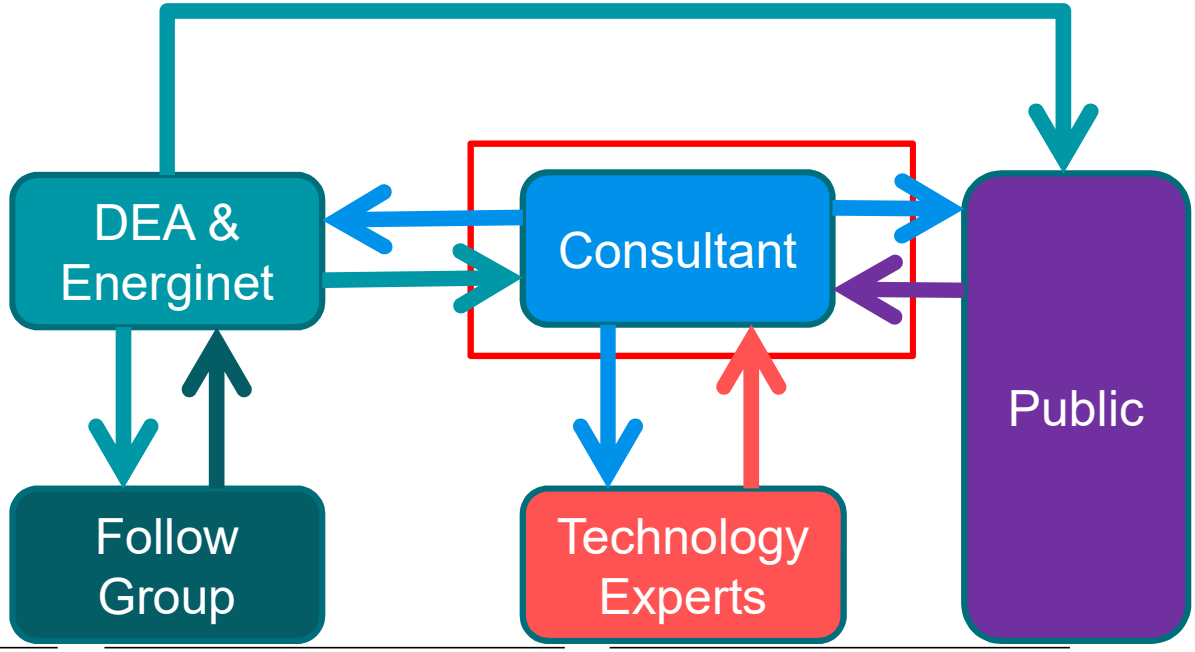
Consultants are typically used for various tasks such as data collection, data management and drafting first versions of the products

Benefits:

- Resource issue
- Technology experts
- Commitment outside DEA

Disadvantages

- Requires management
- Less in-house experience



Timelines

- What is a typical timeline?

Timeline

- Timelines are different according to factors such as:
  - The number of technologies to be updated
  - The maturity of the technology
  - The resources available
  - The urgency
  - The development of the technology catalogue setup in the country
- Typical timeline is ½-1 year for an update

Timeline

Week number	Activity	Time consumption of activity *Primary*	*Secondary*
-2	Task description & selection of consultants	0	0
1	Conclusion of agreement and contract	15	2
2	Start-up meeting on possible joint training session	6	
3-6	Consultant working	3	
	- dialogue with the consultant about external participants for a deep dive workshop (DD WS)	10	1
	- send invitations to external participants for the deep dive workshop (DD WS)		
7-8	Internal review incl. collecting input from colleagues within the organization & midway meeting with the consultant to assure the right direction of the process	30	15
9-11	Consultant incorporates internal adjustments	3	
11	Material will be sent to participants of the DD WS	5	
13	External deep dive workshop (DD WS) is held	15	7
13	Opportunity for workshop participants to make comments	7	3
14	Consultant makes adjustments to reflect the comments	3	
15	Quality check of the draft chapter	4	
15	Sending material into external consultation	10	
16-18	External consultation and classifying the comments	5	
19-20	Internal review of comments, dialogue between consultant and internally. Agreement made on which changes are included and how.	10	5
21-22	Consultant adjusts the draft chapter as agreed	2	
23	Last quality check and publication	8	2
24	Publishing on www.ens.dk/teknologikatalog	5	5
25	Published version is sent to focus group, the participants of the DD WS and other commenters	1	1
25-26	Data is incorporated in the LCoE model	3	3
25-26	Data is sent to the modelling team incl. quality check	2	2
	Total per technology for individual technology updates	**147**	**46**

← Consultant begins work

← Internal review

← External deep dive

← External consultation

← Publication

Future projections

- Why project the data into the future
- Which methods can be used for this
- Uncertainties

Projecting costs

Why projecting costs into the future:

- Decisions we make today will have an influence for decades
- Inputs for analysis and energy modelling

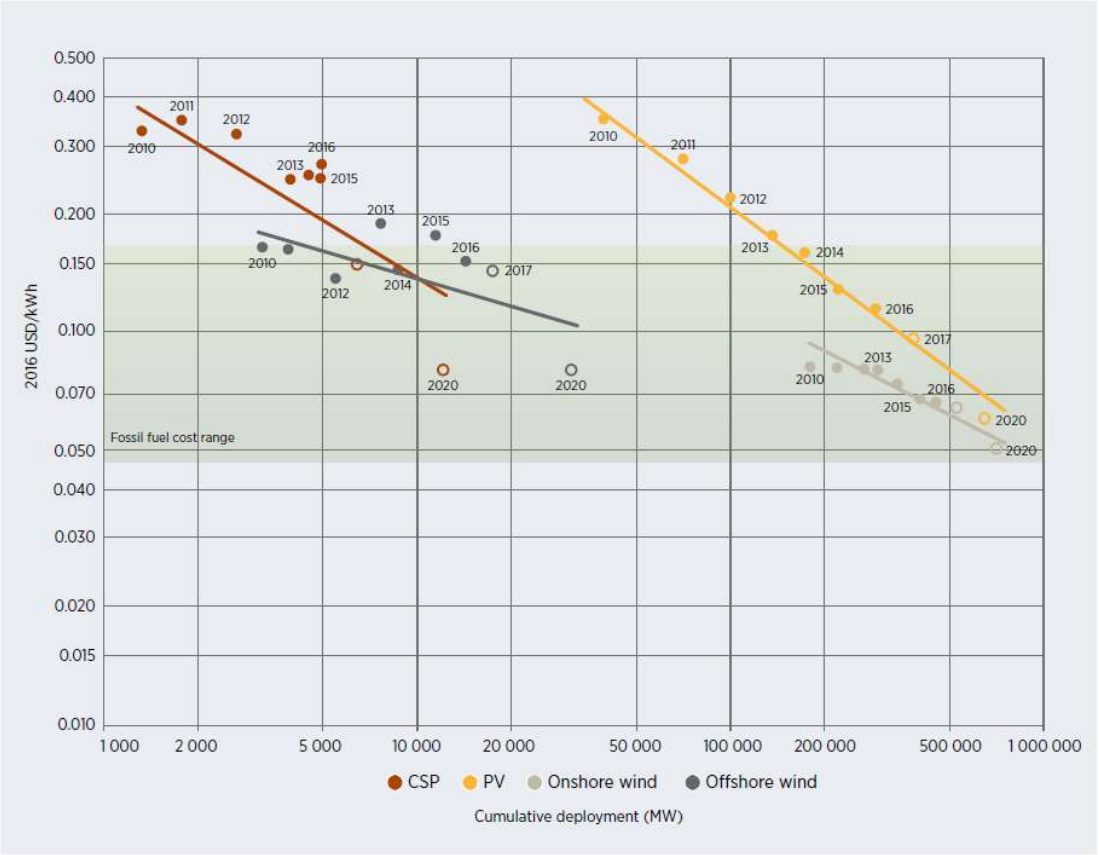
In Denmark, current data is projected towards 2050, which corresponds with national policies

These estimations for future years inherently will be uncertain and most times not reflecting the actual costs in these years

Projecting costs

Methods for projecting into the future:

- Experience curves / learning curves
  Cost reduced X% every time the installed capacity doubles
- Fixed yearly improvement
  for mature technologies
- Bottom-up approaches
  what is the cost development for each component
- Expert judgements



Based on IRENA Renewable Cost Database and Auctions Database; GWEC, 2017; WindEurope, 2017; MAKE Consulting, 2017a; and SolarPower Europe, 2017a.

Next session

Upcoming in session 3:

The international experiences

- ***Examples of international technology catalogues***
- ***The offshore wind technology catalogue in India***
- ***The power sector technology catalogue in India***

Q&A Session on Monday, June 8

Live online Q&A session discussing:

- Possible questions from presentations and the project
- The exercises
- Brief evaluation

If you have any questions or points that are worth discussing, please send the questions in advance to keha@ens.dk

They will be aggregated and answered by the DEA!

Exercise

Question 1:

What are the most important processes as a technology catalogue project manager?

Provide 3 examples and a description of why these are important.

Question 2:

Which of these activities/processes are most likely to be different between how things are usually done in Denmark and India?

Provide 3 examples.

Danish Energy Agency

Thank you for listening!

Kenneth Hansen (keha@ens.dk)
Danish Energy Agency