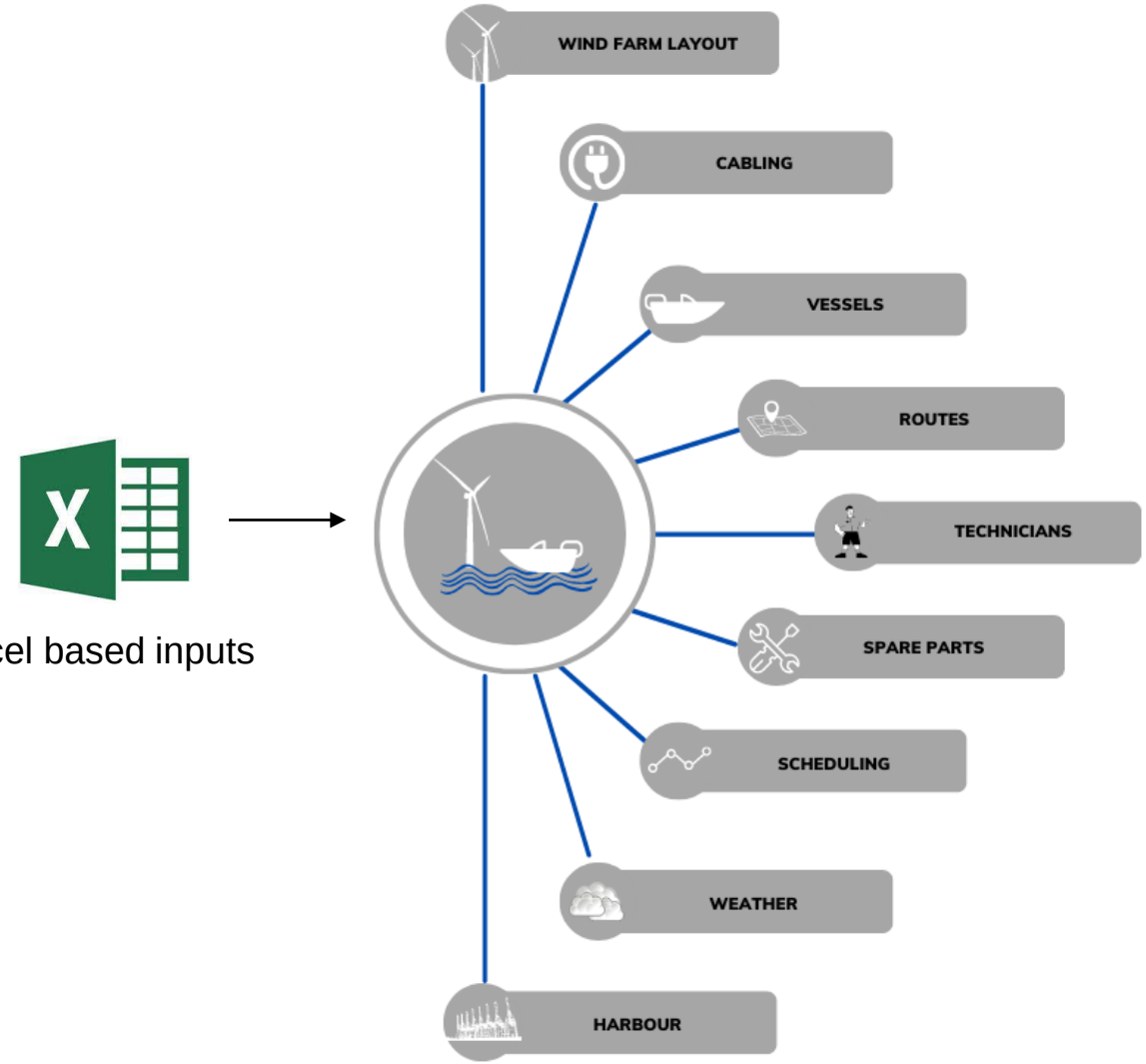
AIRTuB business cases using TNO's O&M planner tool

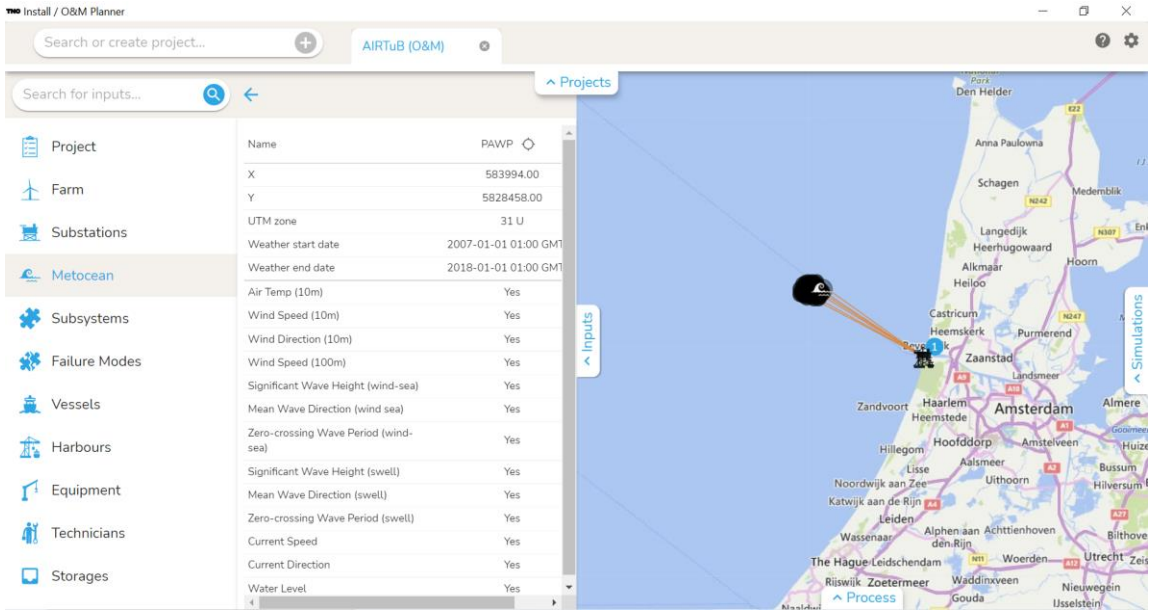
DR. VINIT .V. DIGHE

TNO O&M PLANNER



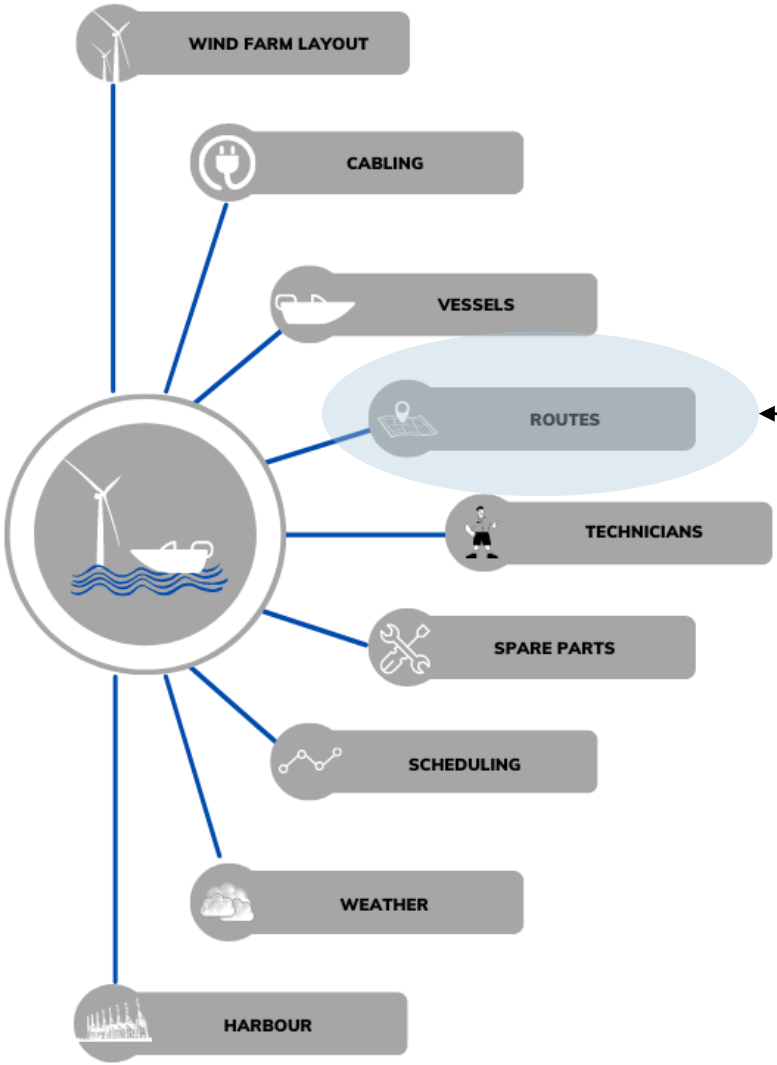
Excel based inputs

User inputs



TNO O&M Planner UI

TNO O&M PLANNER



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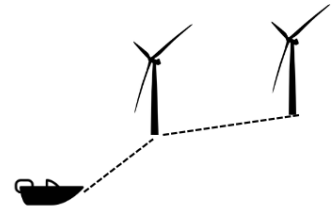
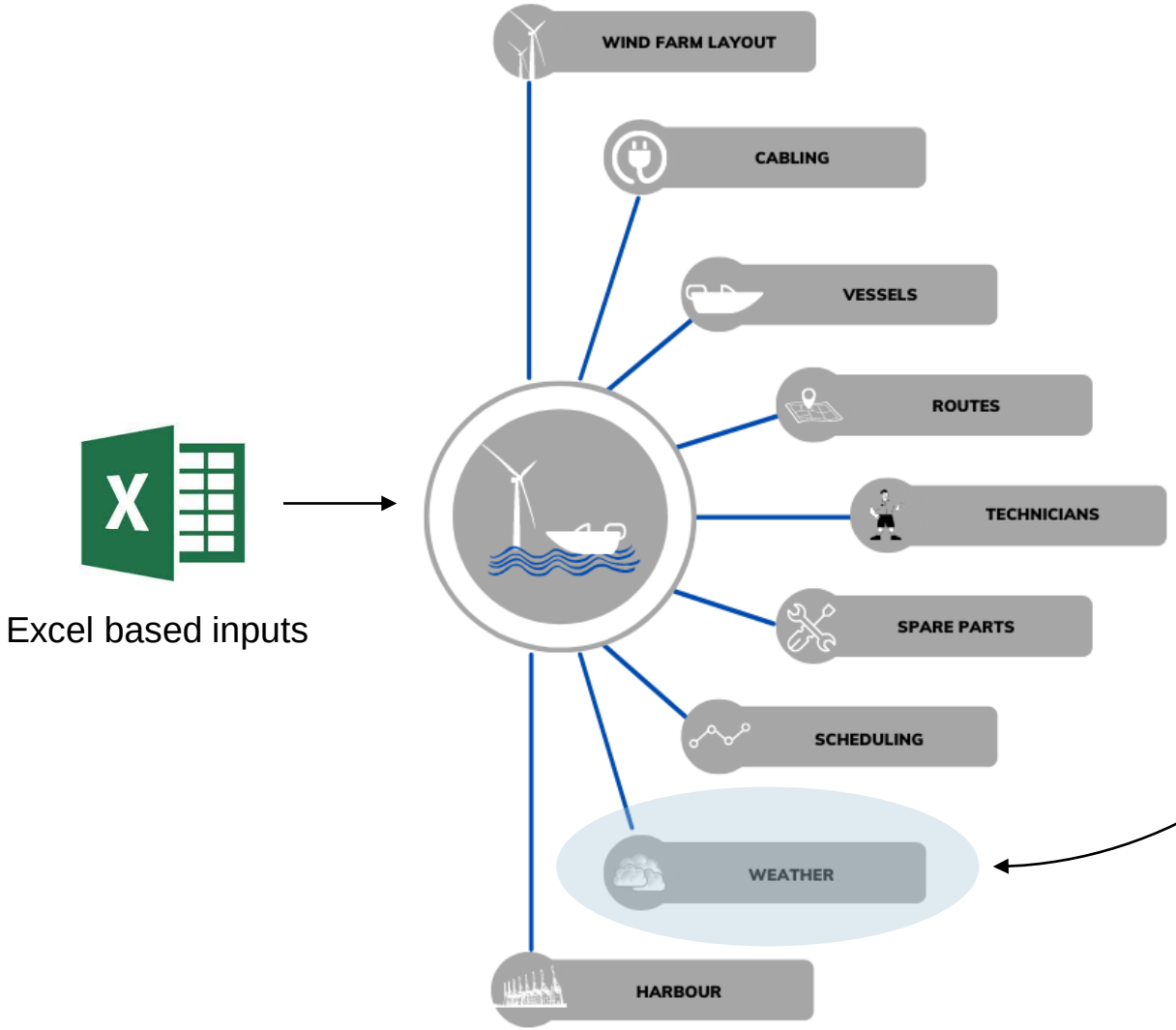


Transit time between turbines

TNO O&M PLANNER



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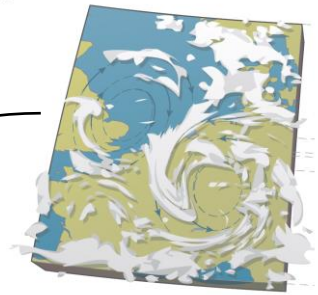


Metocean hindcast weather data

User inputs

KEY PERFORMANCE INDICATORS

Project duration

Calendar days

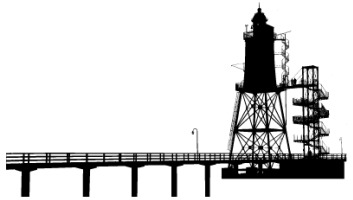
Project costs

Technician costs

+

Vessel costs

+



Harbour costs

=

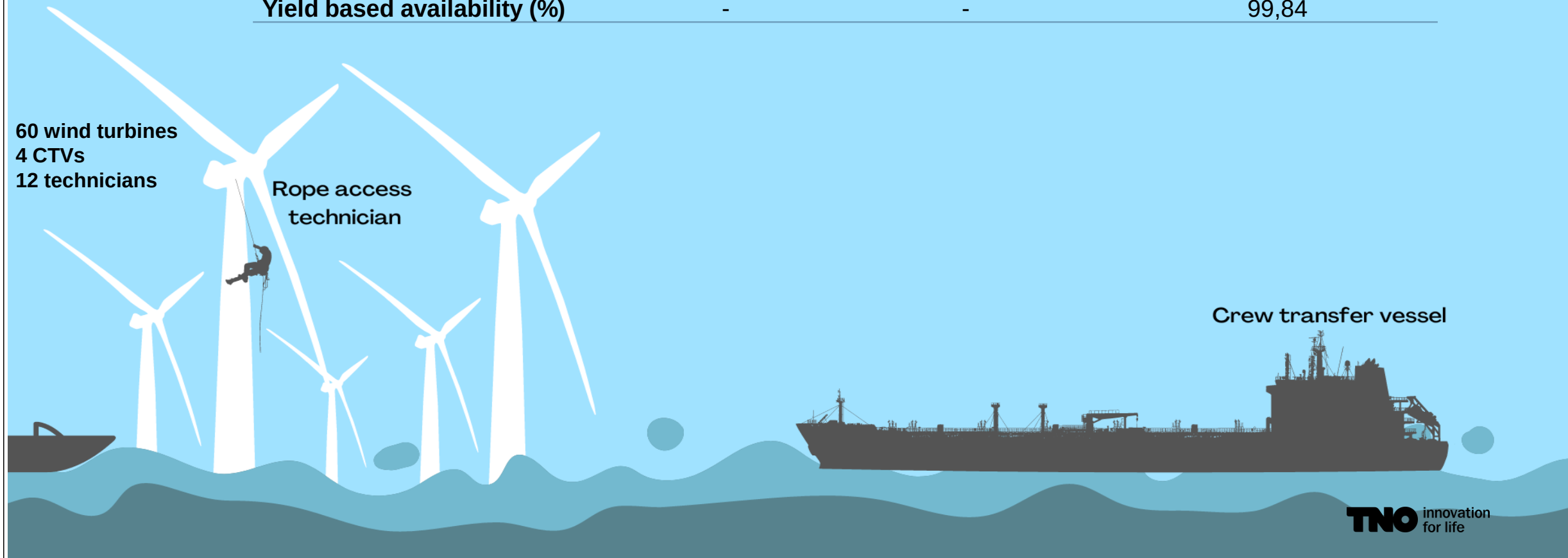
Total costs

Wind farm availability

Period (%) that a wind turbines are available for operation

SCENARIO: ROPE ACCESS

SCENARIO: Rope access	Calculation	TNO O&M Planner (PW)	TNO O&M Planner(3yrs)
Duration (days)	15	15	19
Personnel costs inspection (k€)	216	216	237,60
Vessel costs (k€)	240	240	264
Total O&M costs (k€)	456	456	501,6
Harbour costs (k€)	-	10,75	10,90
Yield based availability (%)	-	-	99,84



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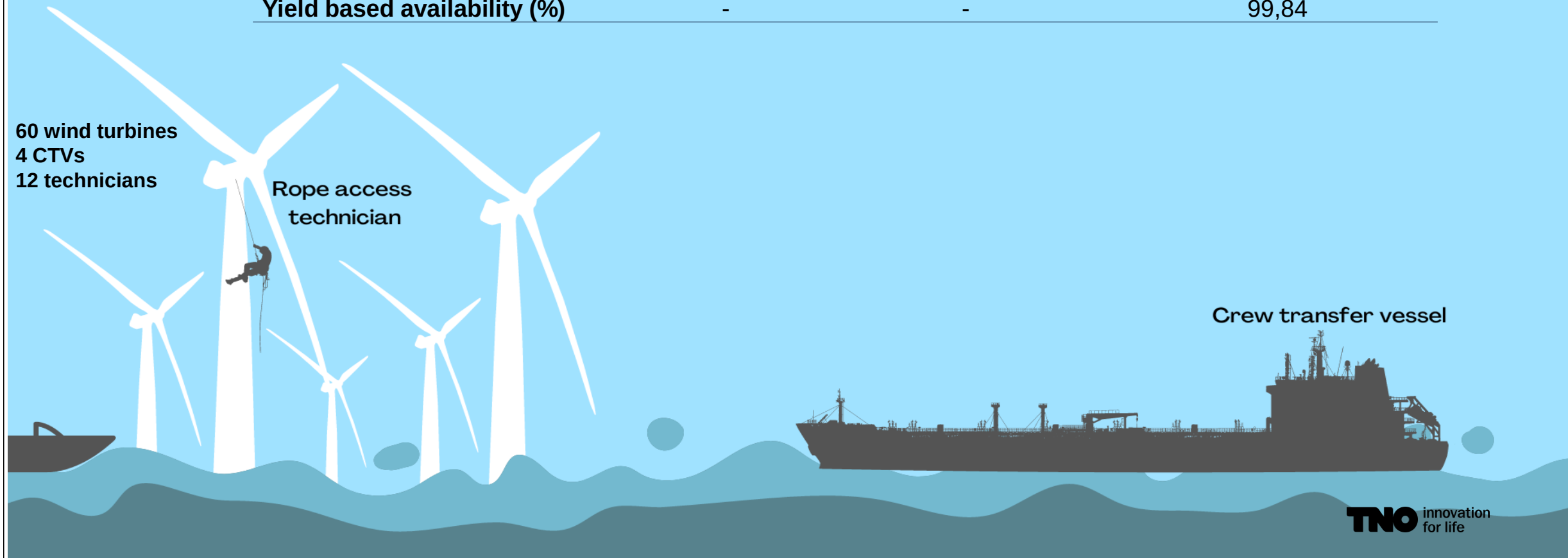
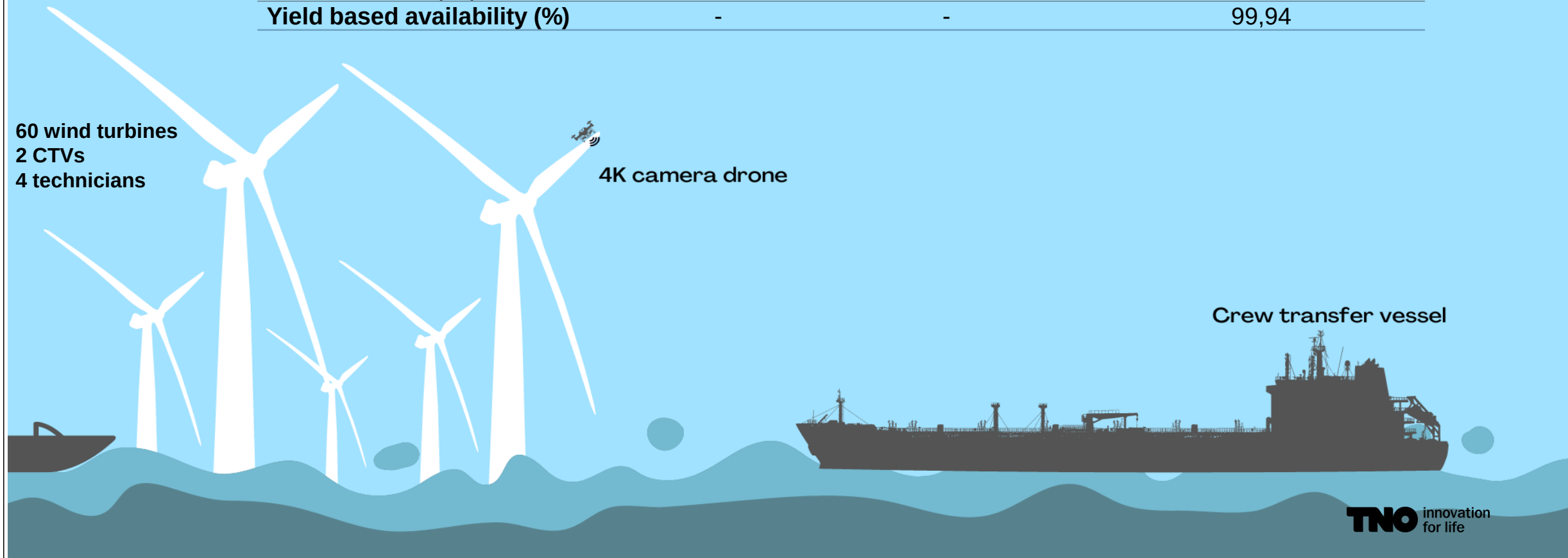


SCENARIO: 4K CAMERA DRONE

SCENARIO: 4K camera drone	Calculation	TNO O&M Planner (PW)	TNO O&M Planner (3yrs)
Duration (days)	6	6	9
Personnel costs inspection (k€)	22,50	22,50	28,75
Vessel costs (k€)	48	48	61,33
Total O&M costs (k€)	70,5	70,5	90,08
Harbour costs (k€)	-	10,30	10,38
Yield based availability (%)	-	-	99,94



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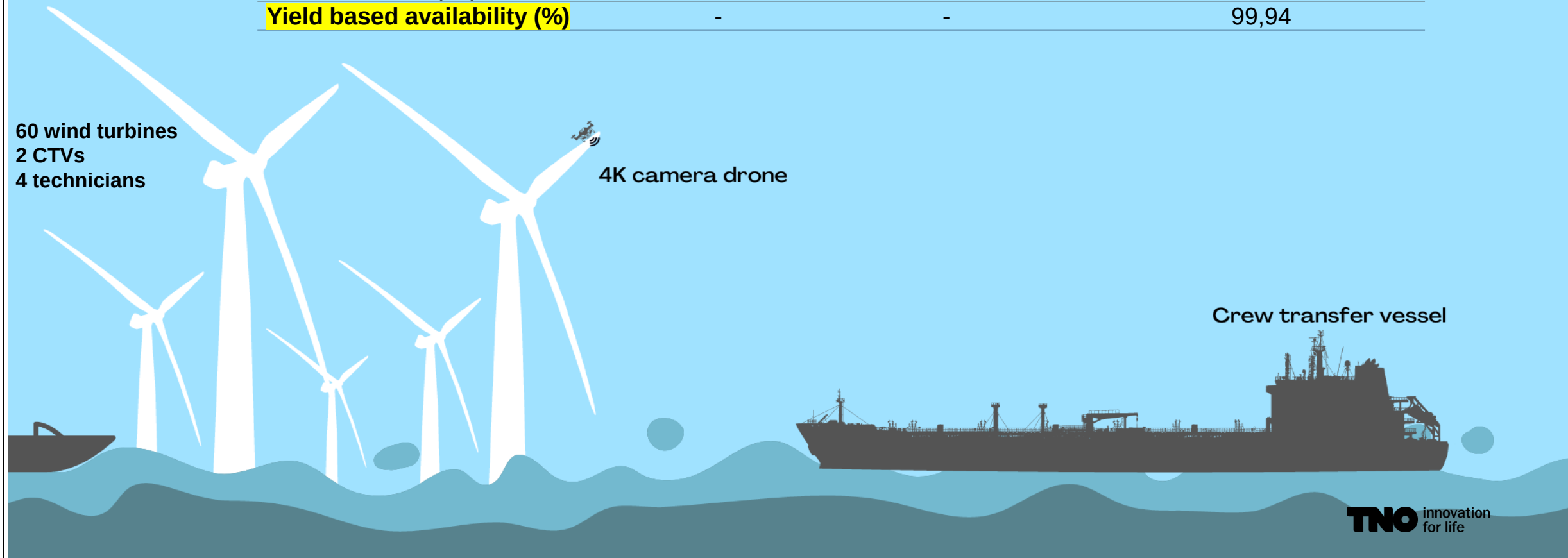
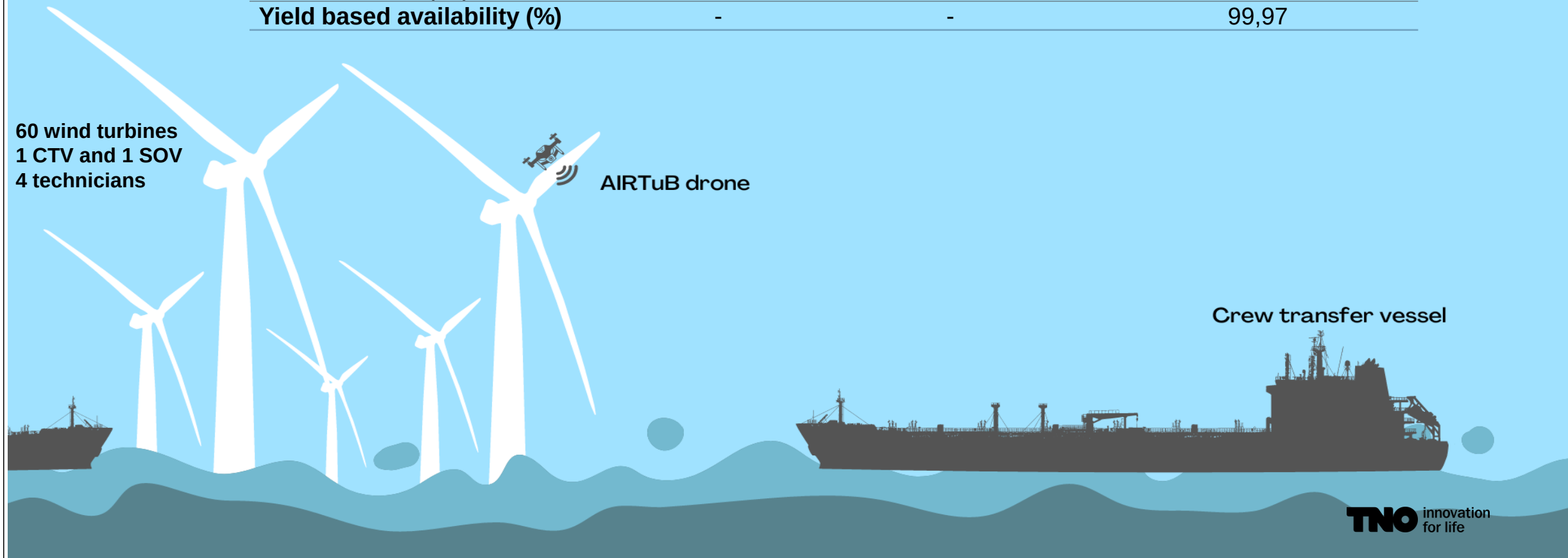


SCENARIO: AIRTUB DRONE

SCENARIO: AIRTuB drone	Calculation	TNO O&M planner(PW)[1]	TNO O&M Planner(3yrs)
Duration (days)	6	6	9
Personnel costs inspection (k€)	27	27	33
Vessel costs (k€)	72	72	88
Total O&M costs (k€)	99	99	121
Harbour costs (k€)	-	10,30	10,37
Yield based availability (%)	-	-	99,97



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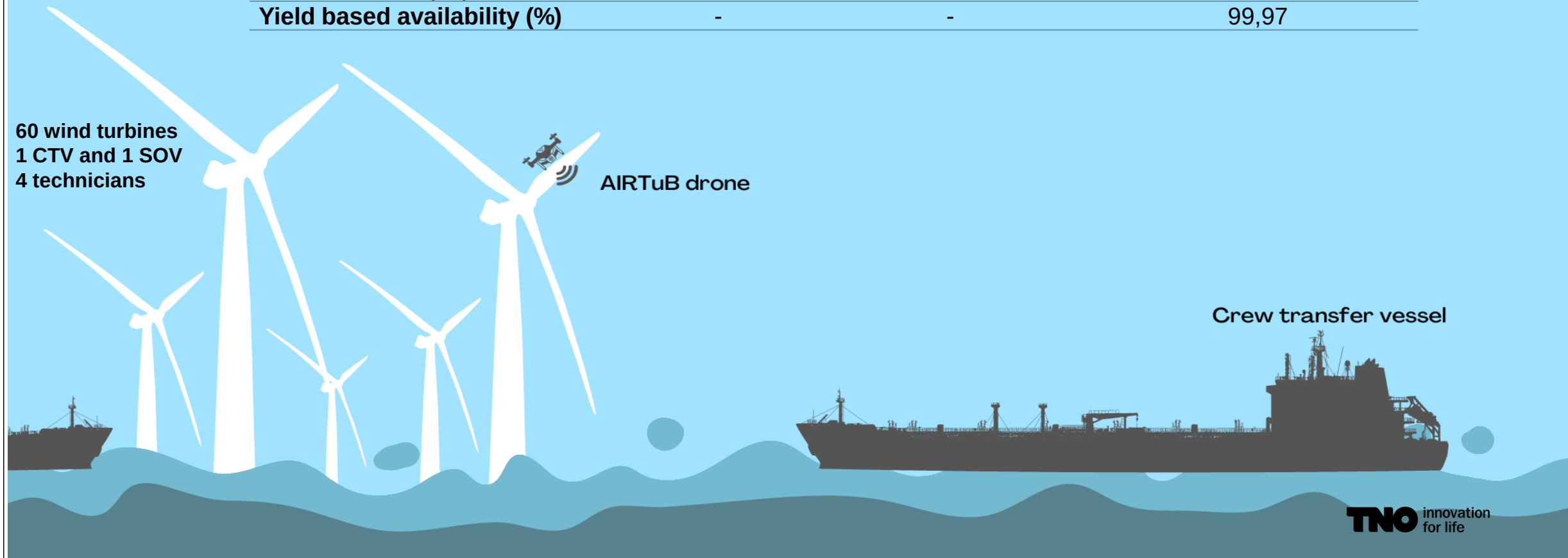
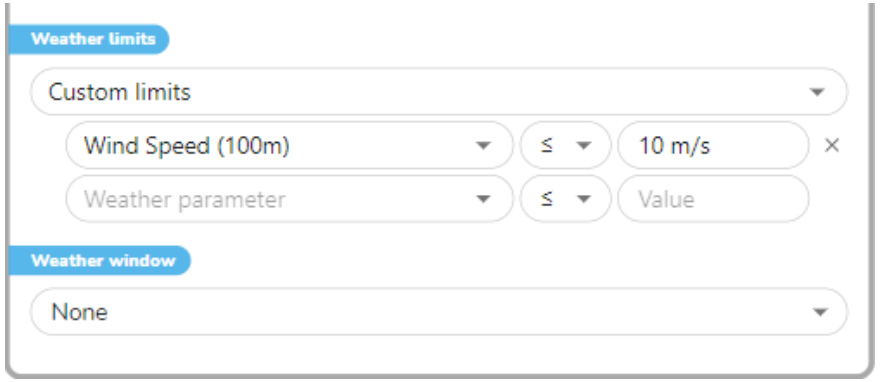
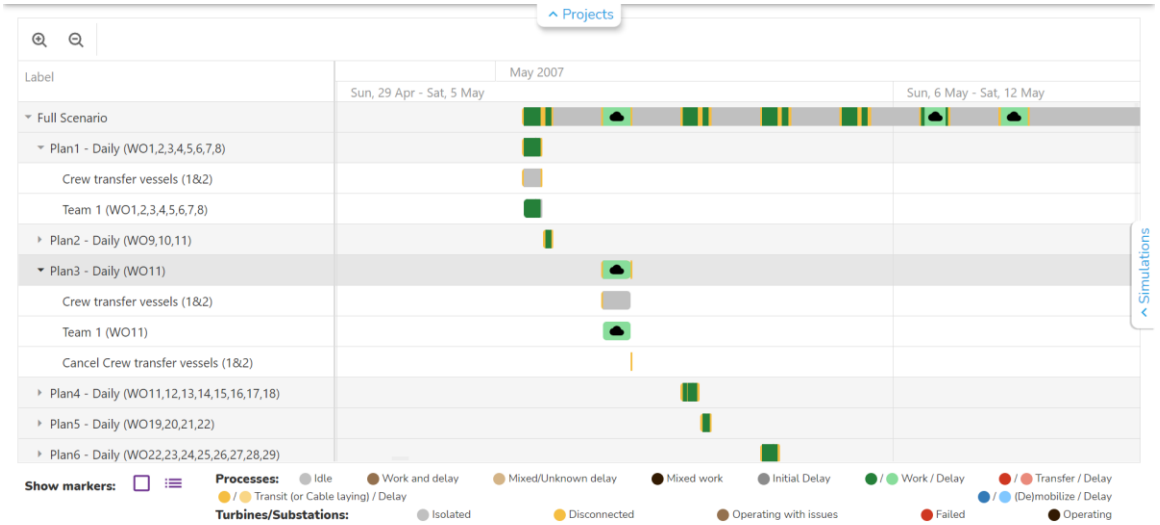


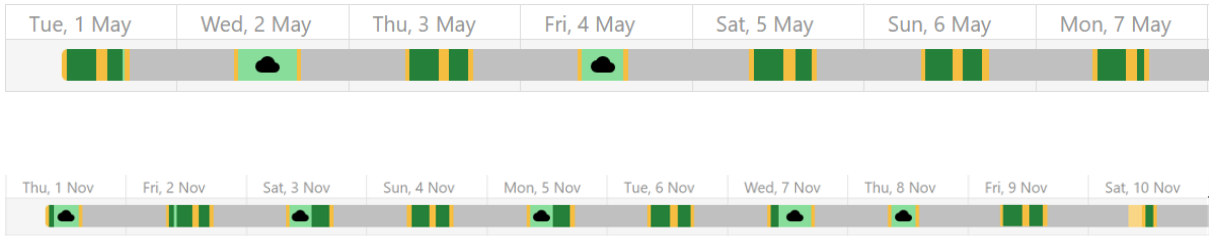
TNO O&M PLANNER FEATURES



Custom weather limit based on the expert inputs



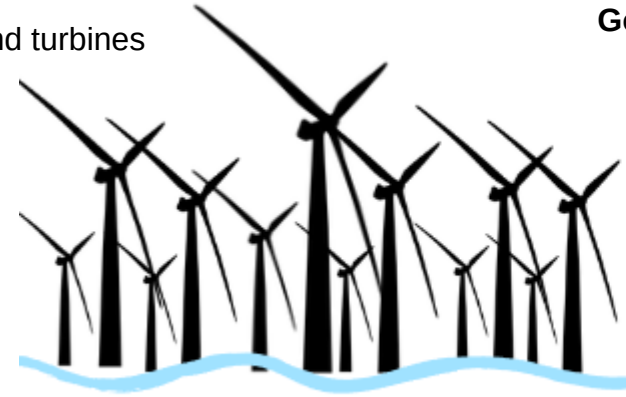
Work order distribution using Gantt charts



Monthly accessibility comparison

LEARNING CURVE

12 wind turbines



Goal: Visual inspection and repair using AIRTuB drone with laser scanner.

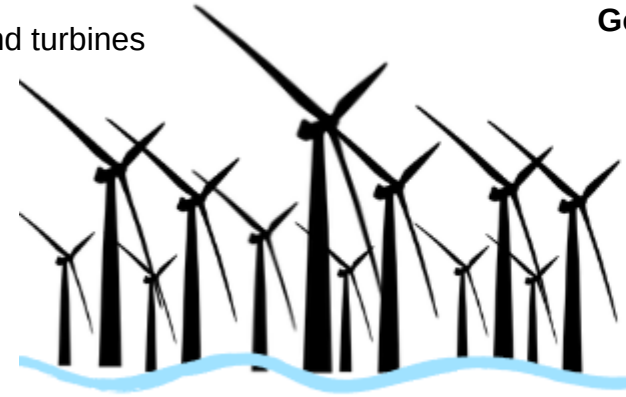
4 teams (CTVs) each with 3 technicians.

Block Name	Iteration	Actions Executed	Start Time [date]	Total Duration [h]	Core Duration [h]	Permits Delay [h]	Weather Delay [h]	Resource Delay [h]	Idle Time [h]	End Time [date]
Crawford model	1		2021-01-01T00:00:00	93,05	68,46	0,00	24,59	0,00	0,00	2021-01-04T21:03:04
Loop 1 (1).Loop 2 (1).Do work	1	Work	2021-01-01T00:00:00	6,00	6,00	0,00	0,00	0,00	0,00	2021-01-01T06:00:00
Loop 1 (1).Loop 2 (2).Do work	2	Work	2021-01-01T06:00:00	6,00	6,00	0,00	0,00	0,00	0,00	2021-01-01T12:00:00
Loop 1 (1).Loop 2 (3).Do work	3	Work	2021-01-01T12:00:00	6,00	6,00	0,00	0,00	0,00	0,00	2021-01-01T18:00:00
Loop 1 (1).Loop 2 (4).Do work	4	Work	2021-01-01T18:00:00	24,35	6,00	0,00	18,35	0,00	0,00	2021-01-02T18:21:07
Loop 1 (2).Loop 2 (1).Do work	5	Work	2021-01-02T18:21:07	5,70	5,70	0,00	0,00	0,00	0,00	2021-01-03T00:03:07
Loop 1 (2).Loop 2 (2).Do work	6	Work	2021-01-03T00:03:07	5,70	5,70	0,00	0,00	0,00	0,00	2021-01-03T05:45:07
Loop 1 (2).Loop 2 (3).Do work	7	Work	2021-01-03T05:45:07	5,70	5,70	0,00	0,00	0,00	0,00	2021-01-03T11:27:07
Loop 1 (2).Loop 2 (4).Do work	8	Work	2021-01-03T11:27:07	5,70	5,70	0,00	0,00	0,00	0,00	2021-01-03T17:09:07
Loop 1 (3).Loop 2 (1).Do work	9	Work	2021-01-03T17:09:07	5,42	5,42	0,00	0,00	0,00	0,00	2021-01-03T22:34:01
Loop 1 (3).Loop 2 (2).Do work	10	Work	2021-01-03T22:34:01	5,42	5,42	0,00	0,00	0,00	0,00	2021-01-04T03:58:55
Loop 1 (3).Loop 2 (3).Do work	11	Work	2021-01-04T03:58:55	5,42	5,42	0,00	0,00	0,00	0,00	2021-01-04T09:23:49
Loop 1 (3).Loop 2 (4).Do work	12	Work	2021-01-04T09:23:49	11,65	5,42	0,00	6,24	0,00	0,00	2021-01-04T21:03:04

Leaning curve: The trend that measures the progress of a specific metric based on the acquired learning dataset.

LEARNING CURVE

12 wind turbines



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Loop 1 (1).Loop 2 (1).Do work	1	Work	2021-01-01T00:00:00	6,00	6,00	0,00	0,00	0,00	0,00	2021-01-01T06:00:00
Loop 1 (1).Loop 2 (2).Do work	2	Work	2021-01-01T06:00:00	6,00	6,00	0,00	0,00	0,00	0,00	2021-01-01T12:00:00
Loop 1 (1).Loop 2 (3).Do work	3	Work	2021-01-01T12:00:00	6,00	6,00	0,00	0,00	0,00	0,00	2021-01-01T18:00:00
Loop 1 (1).Loop 2 (4).Do work	4	Work	2021-01-01T18:00:00	24,35	6,00	0,00	18,35	0,00	0,00	2021-01-02T18:21:07
Loop 1 (2).Loop 2 (1).Do work	5	Work	2021-01-02T18:21:07	5,70	5,70	0,00	0,00	0,00	0,00	2021-01-03T00:03:07
Loop 1 (2).Loop 2 (2).Do work	6	Work	2021-01-03T00:03:07	5,70	5,70	0,00	0,00	0,00	0,00	2021-01-03T05:45:07
Loop 1 (2).Loop 2 (3).Do work	7	Work	2021-01-03T05:45:07	5,70	5,70	0,00	0,00	0,00	0,00	2021-01-03T11:27:07
Loop 1 (2).Loop 2 (4).Do work	8	Work	2021-01-03T11:27:07	5,70	5,70	0,00	0,00	0,00	0,00	2021-01-03T17:09:07
Loop 1 (3).Loop 2 (1).Do work	9	Work	2021-01-03T17:09:07	5,42	5,42	0,00	0,00	0,00	0,00	2021-01-03T22:34:01
Loop 1 (3).Loop 2 (2).Do work	10	Work	2021-01-03T22:34:01	5,42	5,42	0,00	0,00	0,00	0,00	2021-01-04T03:58:55
Loop 1 (3).Loop 2 (3).Do work	11	Work	2021-01-04T03:58:55	5,42	5,42	0,00	0,00	0,00	0,00	2021-01-04T09:23:49
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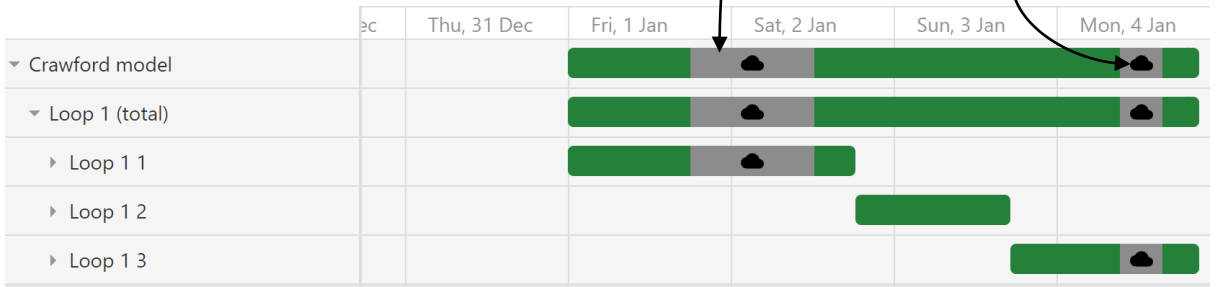

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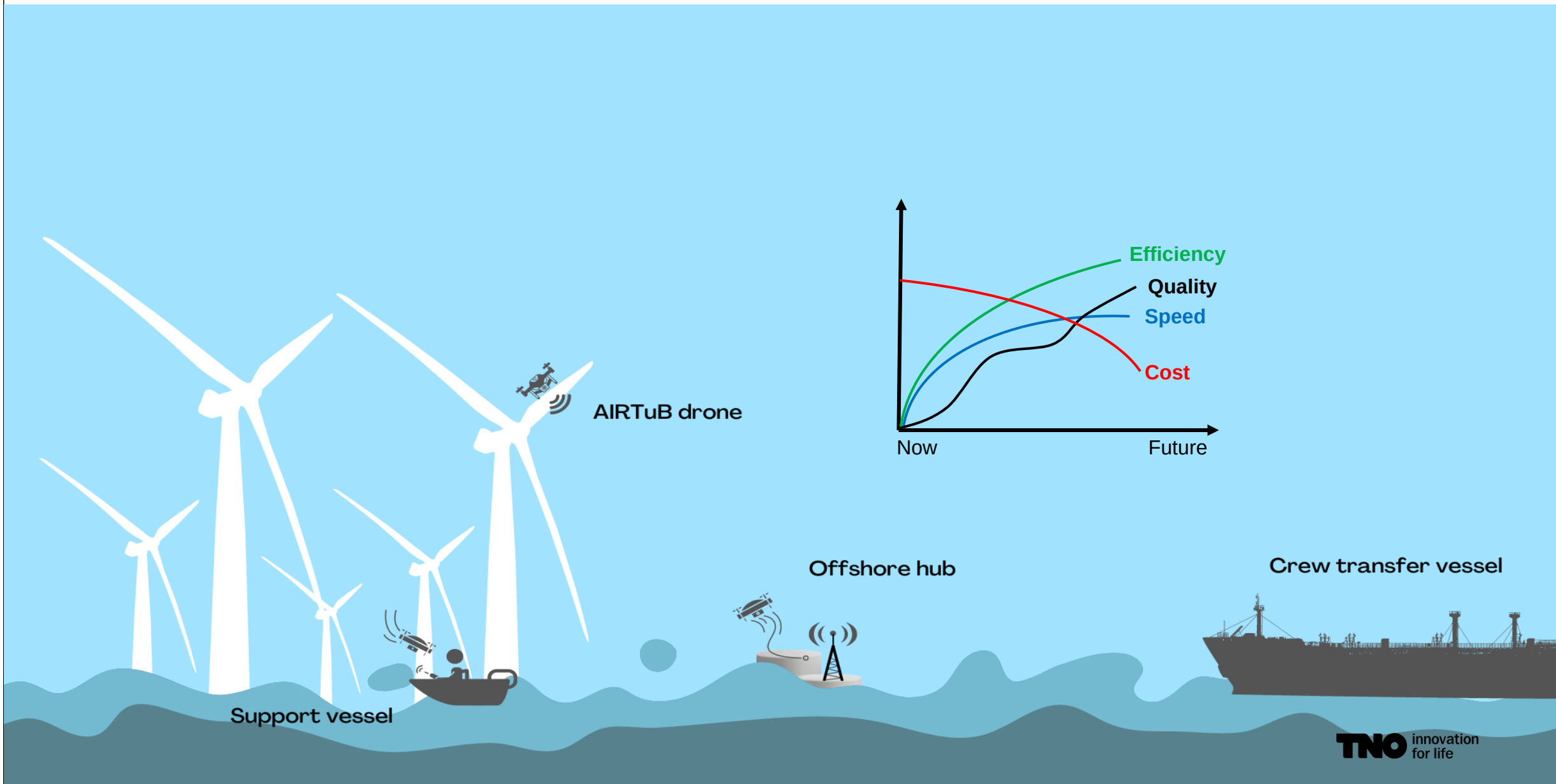
TNO innovation for life

FUTURE SCENARIO



THANK YOU

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