

### A COMPUTER TOOL FOR OPTIMISATION OF MARINE OPERATIONS FOR OFFSHORE WIND FARM INSTALLATION EERA DEEPWIND'2021, 13-15 JANUARY 2021 Elin Espeland Halvorsen-Weare<sup>1</sup>, Eivind Fonn<sup>2</sup>, Kjetil Johannesen<sup>2</sup>, Yauheni Kisialiou<sup>1</sup>, Lars Magne Nonås<sup>1</sup>, Agathe Rialland<sup>1</sup>, Kristian Thun<sup>1</sup>

<sup>1</sup> Energy and Transport, SINTEF Ocean <sup>2</sup> Mathematics and Cybernetics, SINTEF Digital

### Application: early phase planning of wind farm installation

**Objective:** decision support with regards to installation/development strategy and planning for early phase offshore wind farm development

Input: number of wind farm components and number and type of resources (vessel/port) available

**Output:** schedule of marine operations (transport and installations of offshore wind farm components) associated with lowest cost and time, given potential weather conditions





### INPUT

• Database

3

• Interface: Scenario set-up

#### Django administration WELCOME, ADMIN. VIEW SITE / CHANGE PASSWORD / LOG OUT

Basics administration

BASICS		
Components	+ Add	🖋 Change
Ports	+ Add	🖋 Change
User groups	+ Add	🥜 Change
Vessels	+ Add	🥜 Change
Wind farm locations	+ Add	🥜 Change



User: sintef Group: Default Scenario: Scenario 0.3 w0 o2

Co	omponents								
8	Component		#	To be installed after	Float [%]	Port-A			
	Blade-A	30		RNA-A	0	~			
	RNA-A	10		Tower-A	0	×			
	Tower-A	10		TransitionPiece-A	0	×			
	TransitionPiece-A	10		Monopile-A	0	×			
	Monopile-A	10			0	×			
	······ T				0				
					(	Add new Save			
			_						
Ve	Vessels								
Op	otimization settings [advanced]								

**()** SINTEF



## Optimisation algorithm

#### Version of a Genetic Algorithm:

- 1. Start by generating *standard schedules*
- 2. Evaluate each schedule by a simulation procedure
- 3. Education local search procedure
- 4. Generate *new generation* based on schedules in the current *population*
- 5. Evaluate by simulation procedure and educate
- 6. Add *immigrants* to population generated by *construction heuristics*
- 7. Evaluate by simulation procedure and educate
- 8. Continue from 4. until stopping criterium is met



# OUTPUT

- Schedule solutions (time/cost Pareto front)
- 2. Schedule Gantt-diagrams
- 3. Main performance indicators
- 4. Weather simulation

Contact: Elin Espeland Halvorsen-Weare <u>Elin.Halvorsen-Weare@sintef.no</u> Phone: +47 975 32 092

							U	pdate jobs	Nev	scenar	io Com	are sch	edule
	Name	Wind Farm	Planning start	Status	Last run	5	•	ñ	80	۰			
	Scenario 0.3 w0 o1 (C2)	Windfarm1	January	Finished	2019-11-06 14:42	10	0	1	70	10	C. D	0	C
	Scenario 0.3 w0 o1 (B2)	Windfarm1	January	Finished	2019-11-06 14:41	10	0	1	70	10	20	0	C
	Scenario 0.3 w0 o1 (A2)	Windfarm1	January	Finished	2019-11-06 14:40	10	0	1	70	10	C.G	ø	e
3	Scenario 0.10 (copy)	Windfarm1	January	Finished	2019-11-06 14:02	10	0	1	70	2	C.G.	0	e
	Scenario 0.3 w0 o1 (D)	Windfarm1	January	Finished	2019-11-06 12:00	10	0	1	70	10	C 🖗	0	e
1	Scenario 0.3 w0 o1 (C)	Windfarm1	January	Finished	2019-11-06 11:59	10	0	1	70	10	<b>B</b> , <b>B</b>	0	•
ı.	Scenario 0.3 w0 o1 (B)	Windfarm1	January	Finished	2019-11-06 11:59	10	0	1	70	10	<b>B</b> , <b>B</b>	0	
	Scenario 0.3 w0 o1 (A)	Windfarm1	January	Finished	2019-11-06 11:59	10	0	1	70	10	<b>B</b> , <b>B</b>	0	(
	Scenario 1.1 w0 o1 (b)	Windfarm1	January	Finished	2019-11-06 09:09	5	1	1	43	3	C.Q.	0	(
i	Scenario 1.1 w0 o2 (a)	Windfarm1	January	Finished	2019-11-06 09:09	5	1	1	43	3	C.G	0	
	Scenario 0.3 w0 o1 (2)	Windfarm1	January	Finished	2019-11-05 22:50	10	0	1	70	10	C.G	ø	
ľ	Scenario 0.3 w0 o1 (1)	Windfarm1	January	Finished	2019-11-05 12:55	10	0	1	70	10	8.	0	•
	Files: stder; zml; weather 0: Schedule: 3 zip: vessels; compon 0: Schedule: 4 zip: vessels; compon 0: Schedule: 3 zip: vessels; compon 0: Schedule: 2 zip: vessels; compon 0: Schedule: 1 zip: vessels; compon	ents, vessels (net), co ents, vessels (net), co ents, vessels (net), co ents, vessels (net), co ents, vessels (net), co	omponents (net), ri omponents (net), ri omponents (net), ri omponents (net), ri omponents (net), ri	sk sk sk sk sk		000 0000000000000000000000000000000000	5 2 <b>7</b> 5 0 5 0 5 0 5 0 5 0 5 0 5 0 5 0 5 0 5 0	25	)0 Time (C	35 alendar d	40 4 2ys]	5 5	2
	Scenario 0.3 w0 o2	Windfarm1	January	Finished	2019-11-05 09:05	10	0	1	Time (C	alendar d 10	ays)	0	
				AL 2 4 1					-		100.00	-	



hare	0 5221 0						01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18			
) HUV-cheep	2820-67-01 00:00	2020-07-17 08:40	392.7 hrs			189.0 hrs				
CABLE-charp	2020-07-04 00:00	2020-07-17 19:40	328.7 hrs		151.7 hrs	63.0 hrs				
- Lording	2020-07-04 00:00 🗎	2020-07-04 06:00 🗎	6.0 hrs	6.0 hrs	0.0 hrs	0.0 hm				
Cable transport 1 X InterArrayCable-A X 1	2320-07-04 06:00 🚞	2020-07-04 16:00 🛗	10.0 hrs	10.0 hrs	0.0 hrs	0.0 hrs	4			
Positioning for installation	2020-07-04 16:00 🛗	2020-07-05 08:00 📋	15.0 hrs	16.0 hrs	0.0 hrs	0.0 hrs				
Cable Installation: 1 X InterArrayCable-A	2320-07-05 08:00 🚞	2020-07-06 14:00	30.0 hrs	12.0 hrs	0.0 hrs	18.0 hrs	-			
- Prepare to leave	2020-07-06 14:00 🛗	2020-07-07 01:00 🛗	11.0 hrs	8.0 hrs	0.0 hrs	3.0 hrs	4			
Transit to port Port-A	2020-07-07 01:00 🚞	2020-07-07 11:00 🗎	10.0 hrs	10.0 hrs	0.0 hrs	0.0 hm	4			
- Loading	2020-07-07 11:00 🚞	2020-07-07 17:00	8.0 hrs	6.0 hrs	0.0 hrs	0.0 hrs				
Cable transport 1 X ExportCable-4 X 1	2020-07-07 17:00 📋	2020-07-08 15:00 📋	22.0 hrs	10.0 hrs	0.0 hrs	12.0 hrs	•			
Positioning for installation	2020-07-08 15:00 🗎	2020-07-10 13:00 🗎	46.0 hrs	16.0 hrs	0.0 hrs	30.0 hrs	-			
Cable installation: 1 X ExportCable-A	2020-07-10 13:00 👹	2020-07-17 08:40 🛗	163.7 hrs	12.0 hrs	151.7 hrs	0.0 hrs				
Prepare to leave	2020-07-17 08:40 🛗	2020-07-17 16:40 📋	8.0 hrs	8.0 hrs	0.0 hrs	0.0 hrs	4			
JRDNP-cheep	2020-07-01 00:00	2020-07-23 20:20	548.3 hrs	310.0 hrs	10.3 hrs	228.0 hrs	-			
- Loading	2020-07-01 00:00 🗎	2020-07-01 06:00 🛗	60hrs	6.0 hrs	0.0 hrs	0.0 hrs	i .			
- Transport 1 X Transition Piece-A X 1	2020-07-01 06:00 🚞	2020-07-02 10:00 🗎	28.0 hrs	10.0 hrs	0.0 hrs	18.0 hrs	-			
Positioning for installation	2020-07-02 10:00 🚞	2020-07-03 10:00	24.0 hrs	24.0 hrs	0.0 hrs	0.0 hrs				
Installation: 1 X TransitionPlace-A	2020-07-03 10:00 🗎	2020-07-04 08:20 🛗	22.3 hrs	12.0 hrs	10.3 hrs	0.0 hrs	•			
Prepare to leave	2020-07-04 08:20 🚞	2020-07-04 20:20 🗎	12.0 hrs	12.0 hrs	0.0 hrs	0.0 hrs	4			
- Transit to port Port-A	2020-07-04 20:20	2020-07-05 06:20 📋	10.0 hrs	10.0 hrs	0.0 hrs	0.0 hrs	i i			
- Loading	2020-07-05 06:20 🚞	2000-07-05 12:20 🗎	8.0 hrs	6.0 hrs	0.0 hrs	0.0 hrs	4			
- Transport: 1 X Tower-A X 1	2020-07-05 12:20	2020-07-06 07:20	19.0 hrs	10.0 hrs	0.0 hrs	9.0 hrs	•			
Positioning for installation	2020-07-06 07:20	2020-07-13 01:20		24.0 hrs	0.Dhrs	138.0 hrs				



