GOVERNMENT OF CURAÇAO

Presentation to:

Prof. dr. K. Putters

Voorzitter SER Nederland

Title:

The Dev't of a Hydrogen Value Chain in Curaçao

Ramon Chong MURP, MPIA

Chairman Program Organization Floating Offshore Wind

7th March 2025

A Sustainable and Energy Efficient Island for the *Economic Development* of Future Generations

Content:

1. Introduction
2. Mega Project-Organization
3. Netwerk in Nederland
4. Energy Transition Policy of Curaçao
5. Hydrogen Value Chain Development
6. Current Status of- and Future Works
7. Perspectieven

1. Introduction

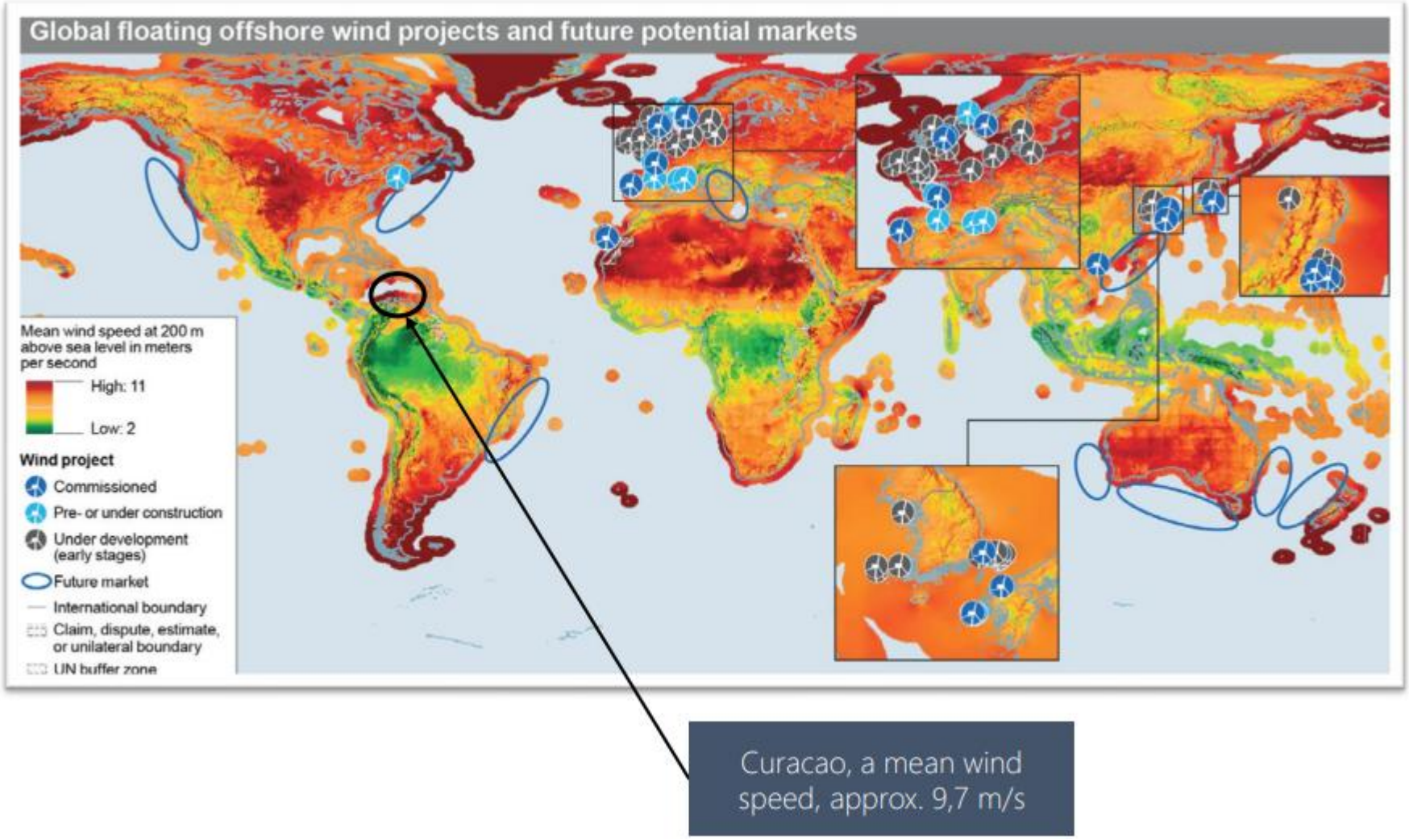
1.1 Conclusions of Floating Off-shore Wind *Study WP 2.3 ("Verkennen Kansen voor Wind op Zee") Conducted by TNO in 2022*

The hydrogen production based on the off-shore wind farm and the electrolyzes plant confirms the positive impact of the improved capacity factor of the wind farm on the downstream supply chain. The further downstream the supply chain is considered, the higher the impact.

Conclusively, Curaçao territorial waters are in potential perfectly equipped for large-scale deployment of floating off-shore wind farms.

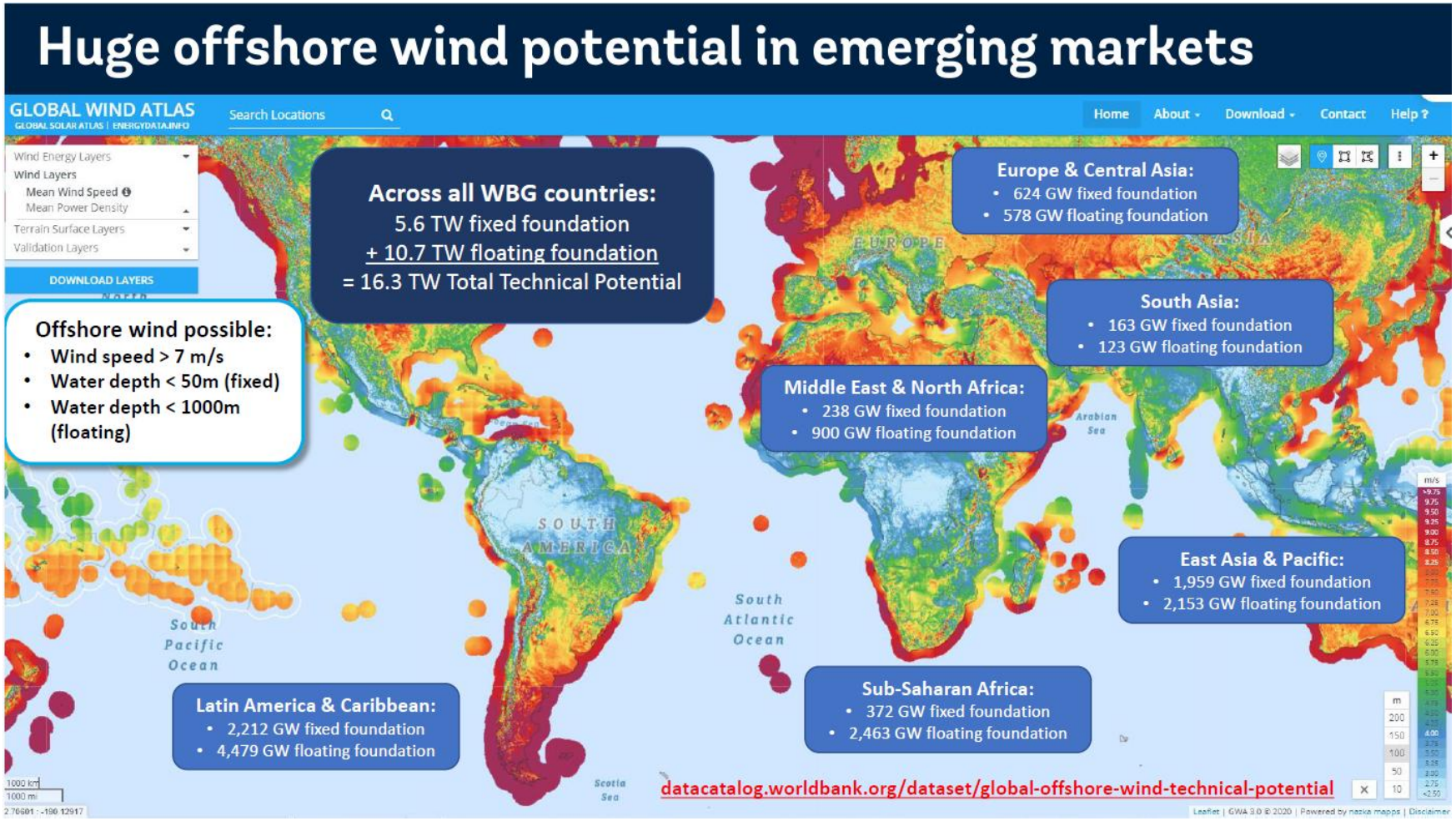
1. Introduction

1.2.1 Global Wind Atlas with the Identified Floating Wind Projects



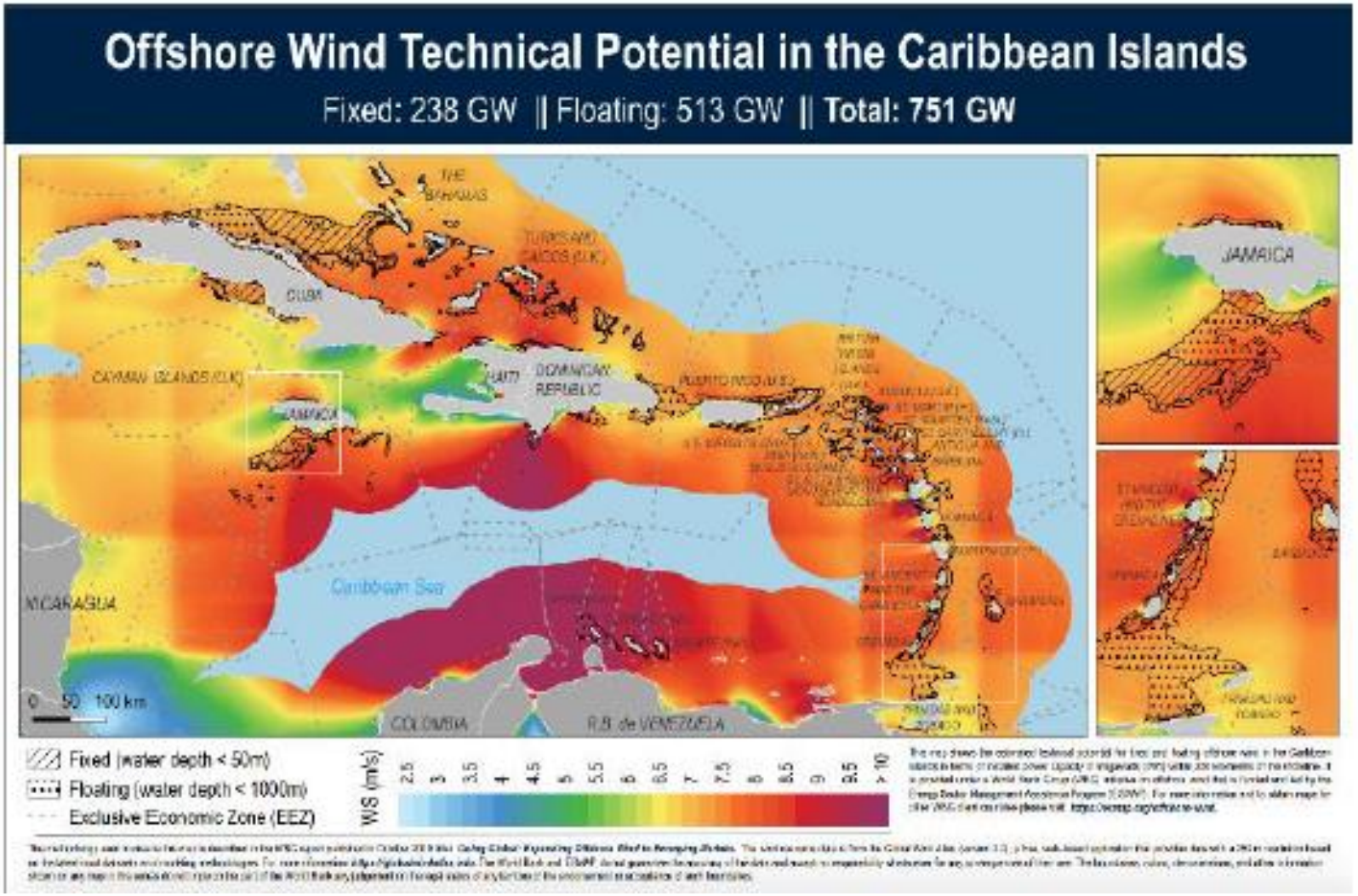
1. Introduction

1.2.2 Global Off-shore Wind Potential



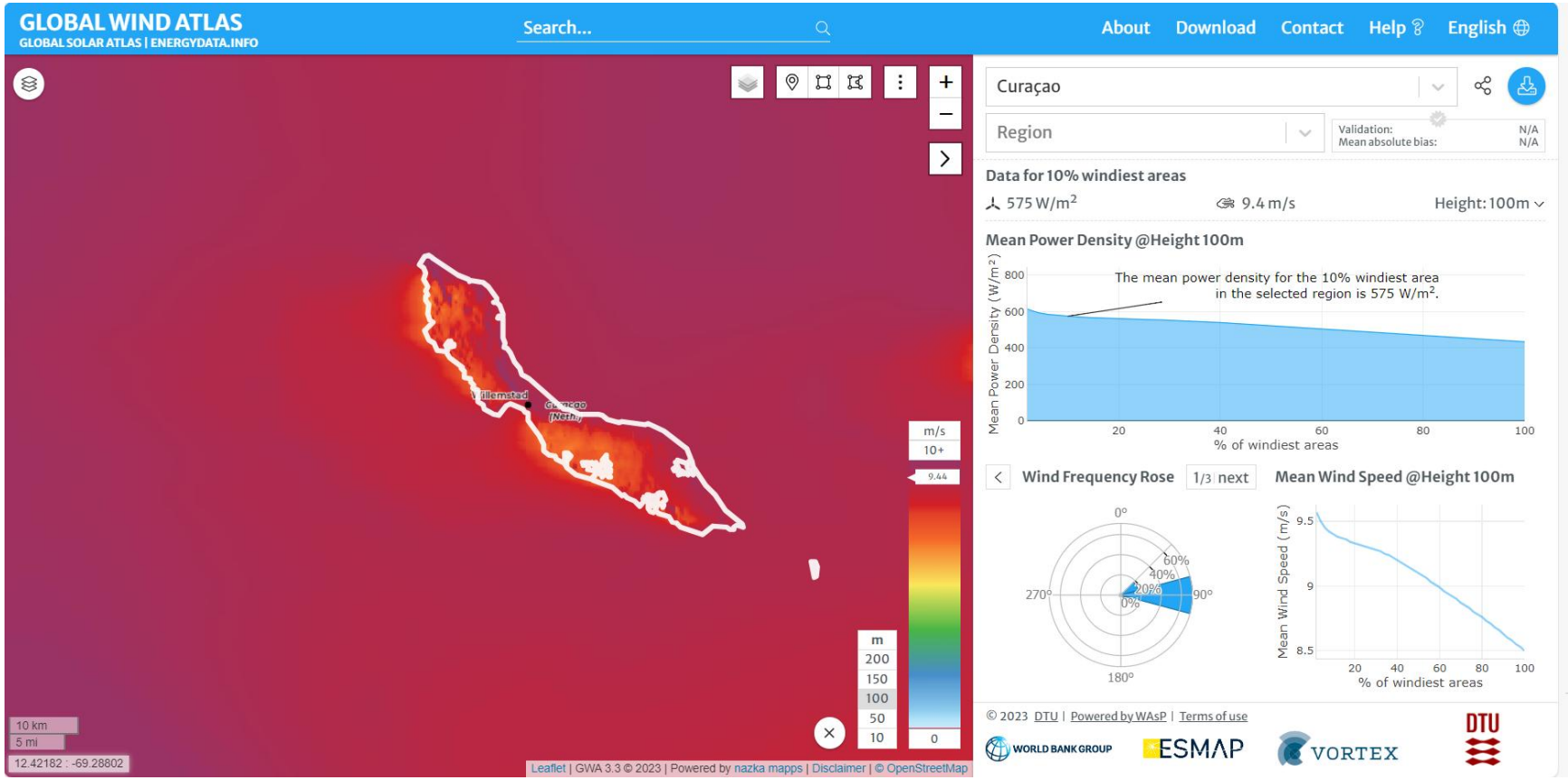
1. Introduction

1.2.3 Caribbean Wind Atlas Potential



1. Introduction

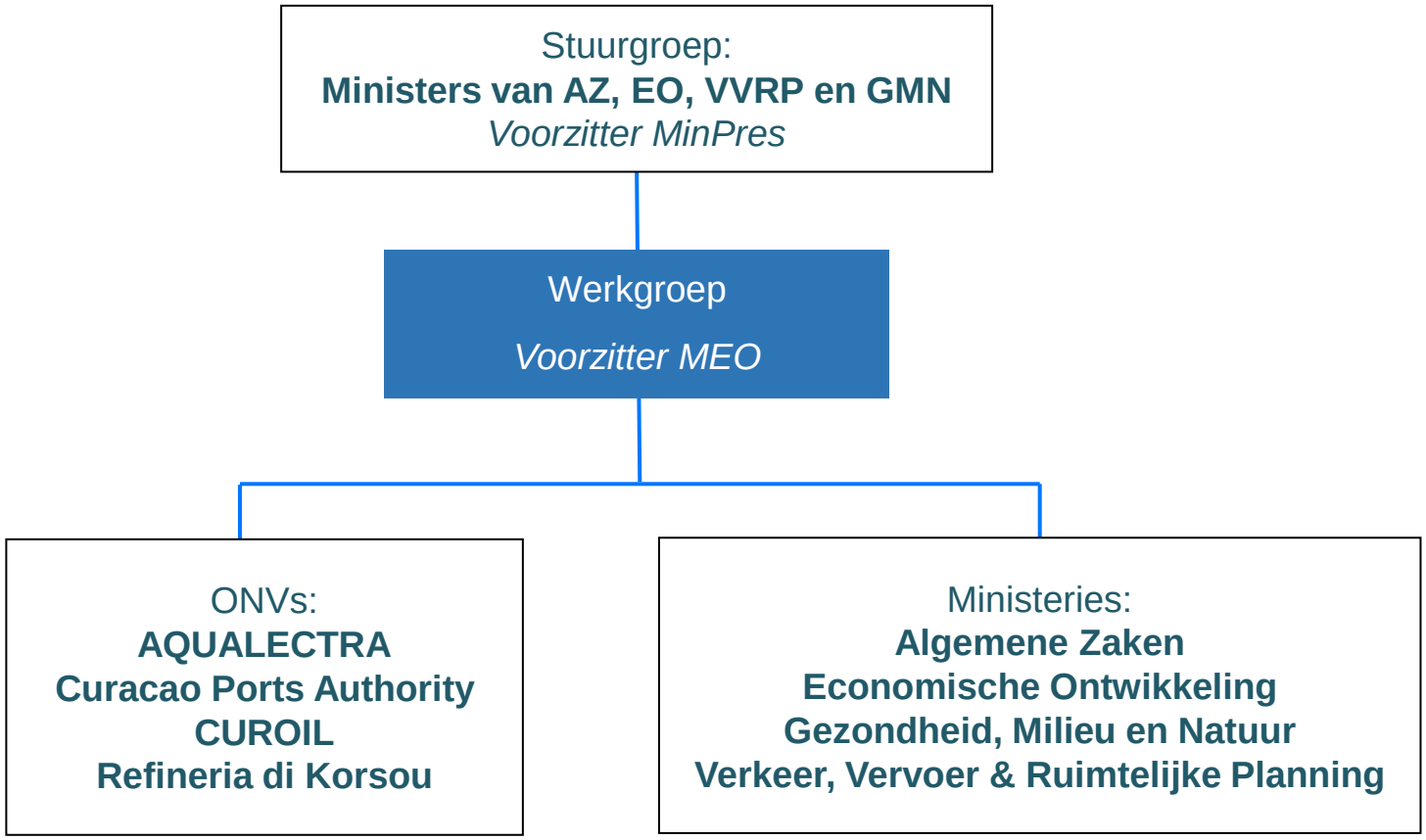
1.2.4 Curacao Wind Atlas Potential



Curacao Off-shore Wind Potential: 10+ GW

2. Mega-Project Organization

2.1 Project Embedding: CURAÇAO



2. Mega-Project Organization

2.2 Project Embedding: Curaçao-The Netherlands

Ministers:
Economische Ontwikkeling
Algemene Zaken
Vervoer, Verkeer & Ruimt. Plann.
Gezondheid, Milieu & Natuur

Minister(s) en Staatssecretaris:
Binnenlandse Zaken (BZK)
Economische Zaken (EZ)
[Klimaat & Groene Groei]

Stuurgroep

CUR: EO & AZ
NL: EZK & BZK

Driehoeksoverleg:
CUR: MEO, VVRP, Curoil, 2Bays
NL: EZK, BZK, RVO
TNO en Branche Organisaties:
NedZero, IRO en NL Hydrogen

Ambtelijk Werkgroep:
CUR: MEO, AZ
NL: EZK, BZK, RVO

Adviesraad:
Stuurgroep
VNO/NCW, Branche Org.
SER-NL, SER-CUR
Kennis-NL, Kennis-CUR

3. Netwerk in Nederland

5.3 Mission with NL Public- and Private Sector

4. Energy Transition Policy Framework

4.1 Approach by Curacao

Under guidance of the same Working Group

- The Kingdom Roadmap for Energy Transition lead by Minister R. Jetten to make use of the SDE++ Fund
- *The Production of Large Amount of Renewable Energy and Large Scale Export of Energy Carriers*
- The Roadmap for Energy Transition on Curacao in depth (most likely to carried out by IRENA & TNO), whereby the Working Group will be expanded with Ministry of SOAW

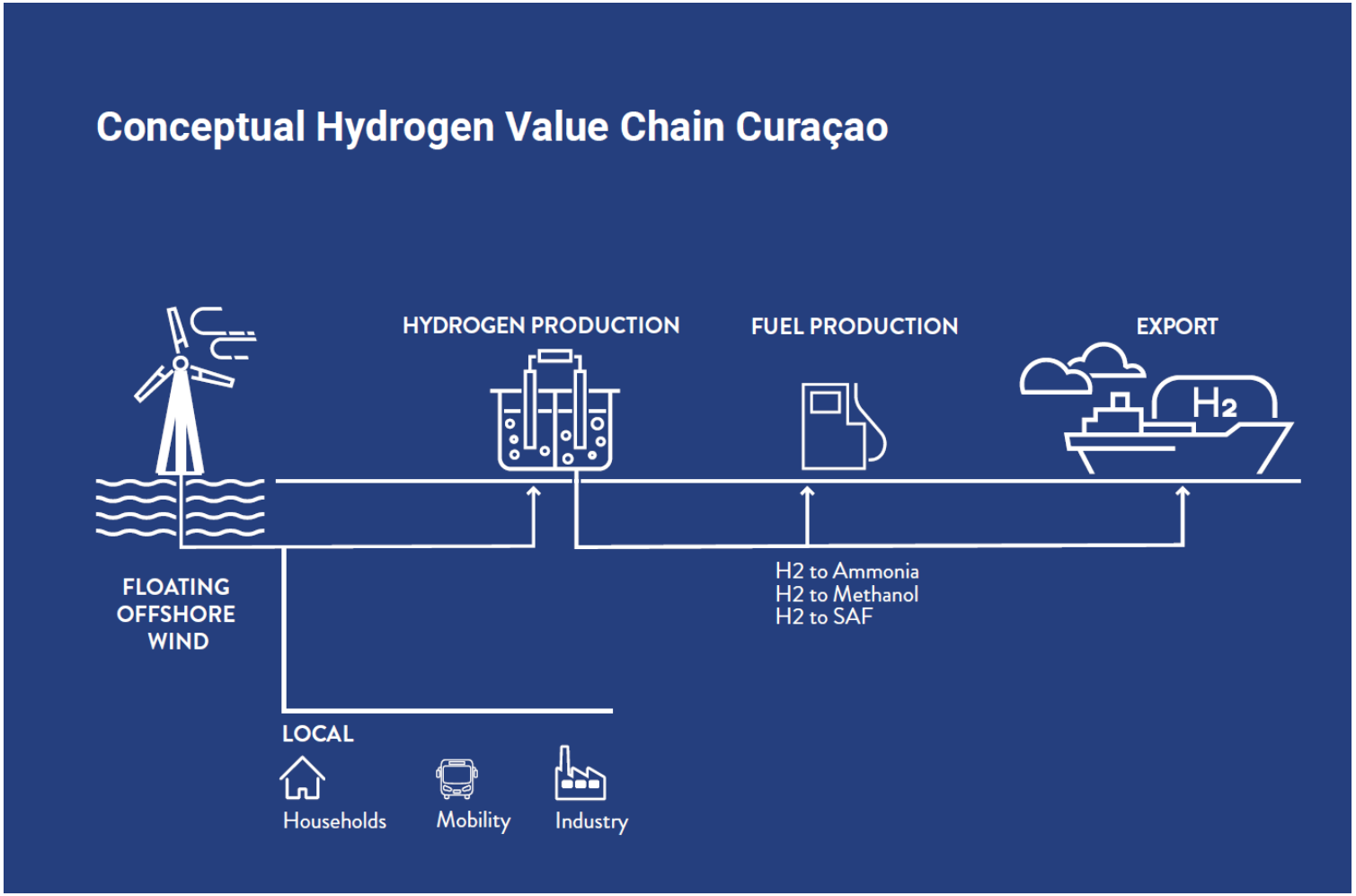
4. Energy Transistion Policy

4.2 Initial Overview of Projects

Project	Concreetheid	Impact (CO_2 reductie)	Kosten	Opmerkingen
4e windpark	Concreet	Groot (+20% RE penetratie)	22 M ANG (Aqualectra) + 95 M ANG (NuCapital). Rendabel project	Loopt al, urgent. Subsidie zal vooral kosten verlagen
Batterijopslag	Concreet	Indirect als enabler voor windenergie	Binnenkort meer details (eigen inschatting USD 20-25 mln)	Ongeveer 25 MW/25 MWh
E-bussen pilot	Concreet	Kleine CO_2 reductie (1 MWp PV) met grote bredere impact	~15 M€ voor het totaal	Project al grotendeels uitgewerkt. Financiering nu belangrijk
Investeringen elektriciteitsnet	Deels concreet, deels minder	Indirect grote impact (enabler)	Niet bekend (meer details volgen)	Studies lopen. Urgentie hoog
Repowering windpark 1 + 2	Semi-concreet	Groot (+20% RE penetratie)	Rendabel	Vervroegen kan energietransitie versnellen. Net moet het wel aankunnen
Grootschalige zon PV	Semi-concreet	Nog niet ingeschat	Niet bekend	1 project bij rechter. Bij RDK ruimte voor meer PV
Biodiesel productie	Semi-concreet	Klein (focus op export)	Niet bekend. Rendabel voor export? Onrendabele top voor lokaal verbruik	2 projecten: Curaçaose Dokmaatschappij en Steamboat bij Bullenbaai
Efficiënter diesel gebruik elektriciteitsproductie	Niet concreet	Nog niet ingeschat	Niet bekend	Onzeker of het binnen de subsidie past. H_z-ready maken misschien?
Elektrificatie schepen (ferry's en tugboats)	Niet concreet	Beperkt	Kosten schepen kunnen mogelijk gedeeld worden	Randvoorwaarde geschikt elektriciteitsnet
Waste-to-energy	Niet concreet	Onduidelijk wat de impact precies is (afhankelijk van emissies landfill)	Niet bekend. Onrendabele top afhankelijk van referentieprijs	Er lopen feasibility studies. Projecten in eerste plaats afvalverwerking

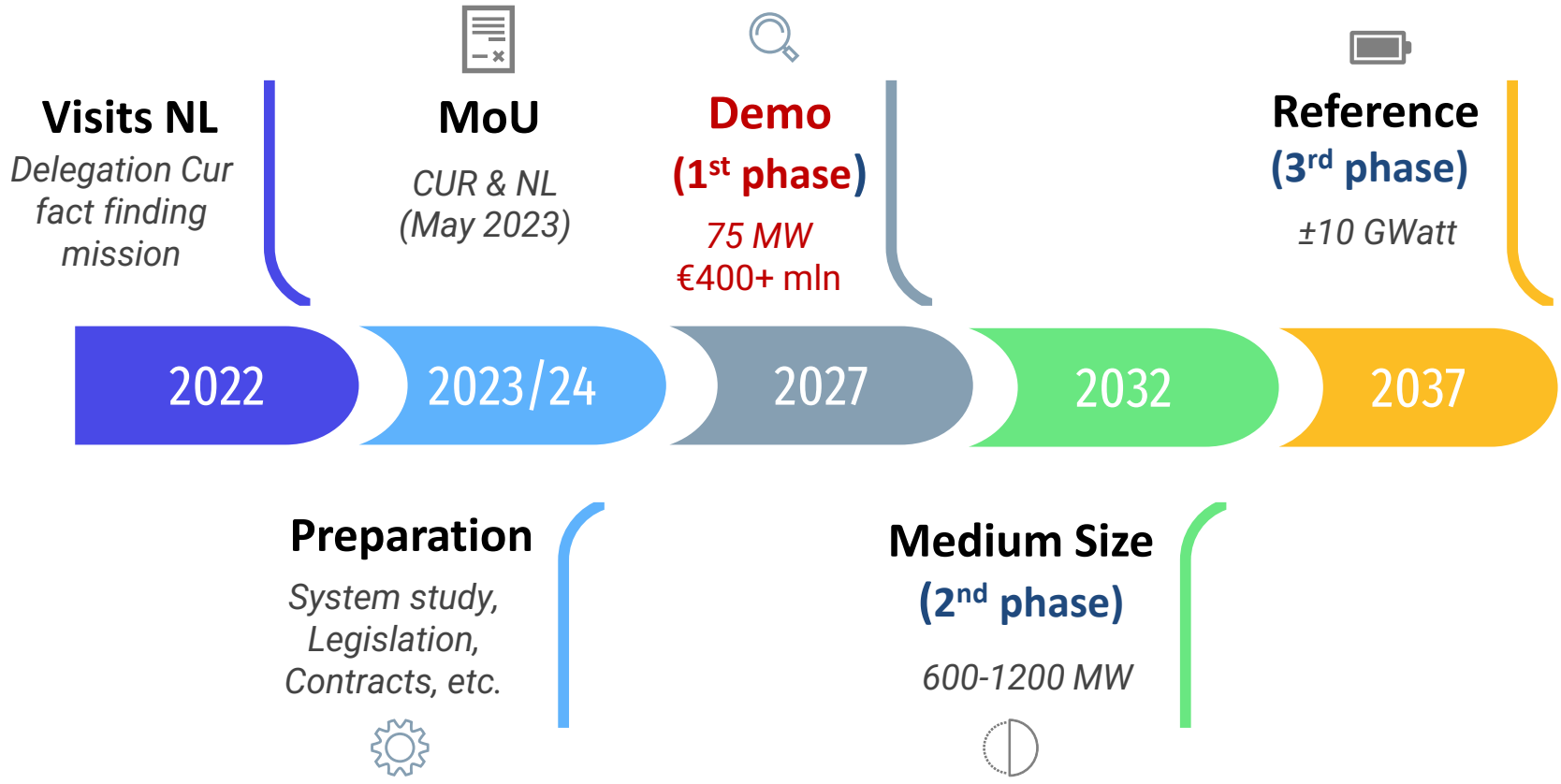
5. Hydrogen Value Chain Development

5.1 Sustainable Curaçao Hydrogen Chain



5. Hydrogen Value Chain Development

5.2 Initial Phasing of this Mega Project



5. Ambition

5.3 Vision

For Curaçao to be(come) the **(regional)** ***leader*** in the production and export of green energy

5.4 Mission

To optimally deploy the resources of Curaçao in partnership with ***strategic alliances*** to gain and maintain a ***competitive edge*** in and through the production, and export of hydrogen and other green carriers

6. Current Status of- and Future Works

6.1 Works Completed

1. Mega-project through several meetings in the Netherlands and Curacao has been conceptualized and delineated among the different interest parties
2. An MoU has been signed between the governments of The Netherlands and Curaçao in May 2023
3. An NDA for the 1st phase has been presented to the developers of the windmills, and operators of the hydrogen plants and based on their remarks has been reviewed and is ready to be to be signed
4. Desk research by Fugro for the seabed soil conditions has been completed
5. The System Study carried out by TNO has recently been completed
6. The Bathymetry Reconnaissance Survey of the selected zones has been completed by Fugro; the report has been presented per end of November
7. Agreement on Headlines has been signed in May 2024 between the governments of The Netherlands and Curaçao

6. Current Status of- and Future Works

6.1 Conclusions

TNO

System Study

- No Show Stopper!

Fugro

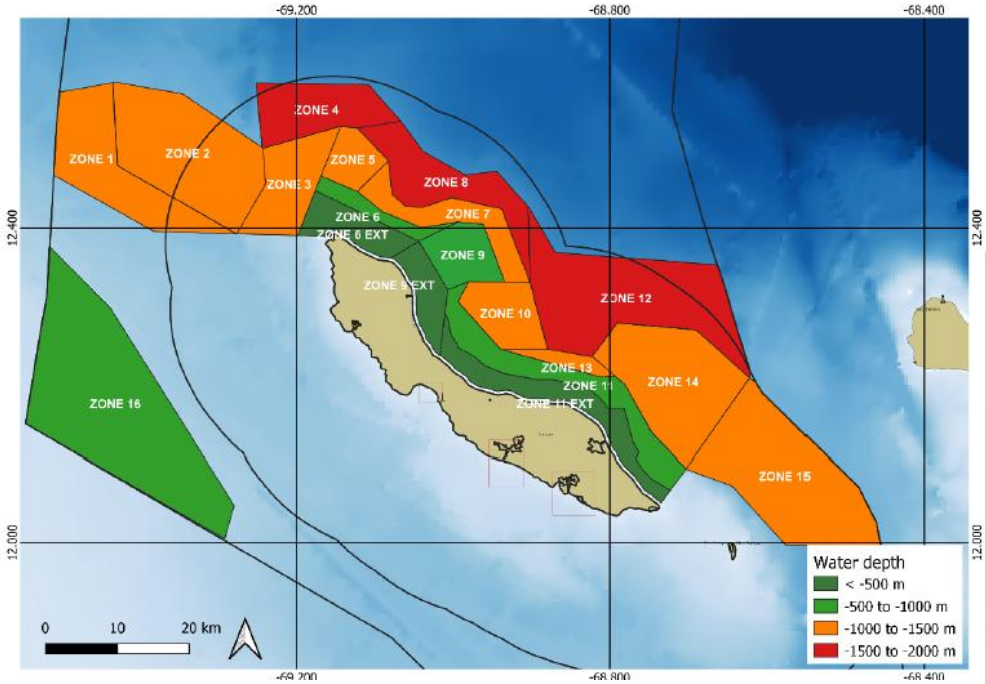
Bathymetry Reconnaissance Survey

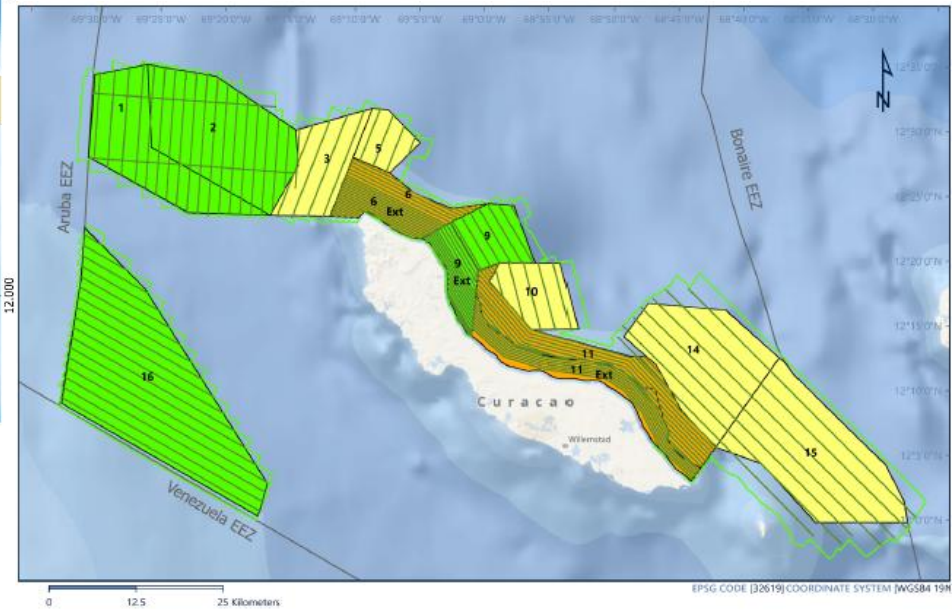
- No Show Stopper!

6. Current Status of- and Future Works

6.2 Fugro Bathymetry Reconnaissance Survey

6.2.1 Selected Zones surveyed by Fugro





6. Current Status of- and Future Works

6.3 System Study

6.3.1 Annual Estimated Production Capacity

Input / Output	Minimum case	Reference case	Maximum case
number of turbines [-]	77	324	627
planned capacity [MW]	1,155	4,860	9,405
overall capacity factor wind farm* [-]	0.62	0.62	0.62
AEP [GWh/yrs]	6,288	26,460	51,205

Based on a **wind capacity factor of 82% and 10D-6D spacing.*

*In the North Sea the **wind capacity factor** is 60%*

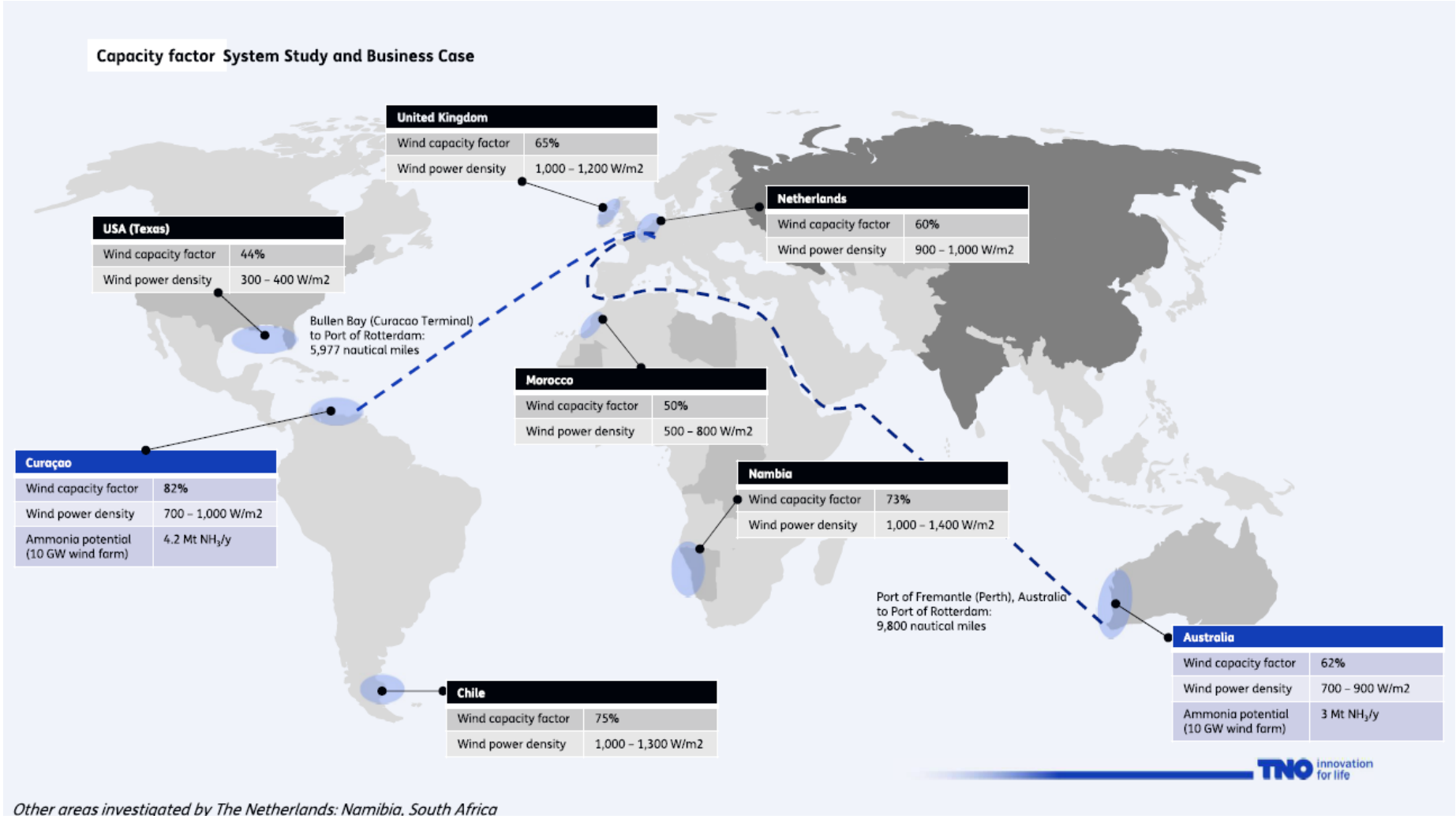
6. Current Status of- and Future Works

Table 5.10: production overview for all three evaluated cases

Description	Unit	Min Case	Ref Case	Max Case
Power generation				
Installed power	MW	1,155	4,860	9,405
Generation OWF	GWh/yr	6,293	26,481	51,245
Power consumption				
Domestic use	GWh/yr	131	876	876
Hydrogen production and storage	GWh/yr	5,690	23,956	46,315
Methanol production	GWh/yr	27	25	80
SAF production	GWh/yr	0	6	490
Ammonia production	GWh/yr	312	1,414	2,292
Export terminal	GWh/yr	66	79	79
		6,226	26,356	50,132
Production				
Hydrogen	kt/yr	114	482	927
Methanol	kt/yr	103	93	425
SAF	kt/yr	0	80	80
Ammonia	kt/yr	567	2,572	4,168
Resulting export product in NL				
Ammonia	kt/yr	545	2,475	4,011

6. Current Status of- and Future Works

6.5 Capacity Factor: System Study & Business Case



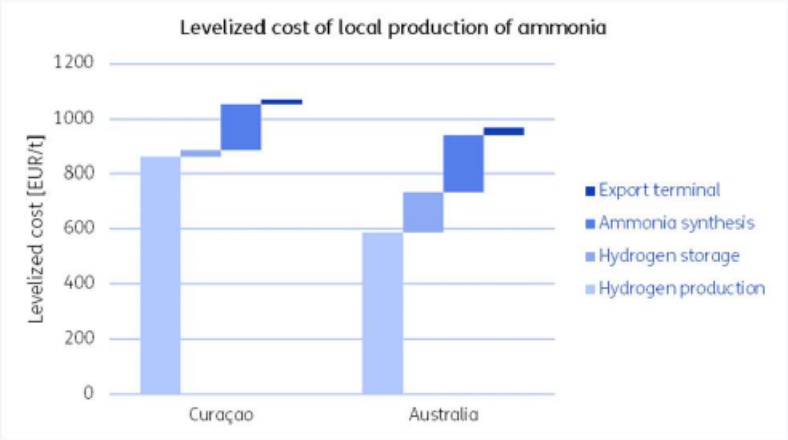
Other areas investigated by The Netherlands: Namibia, South Africa

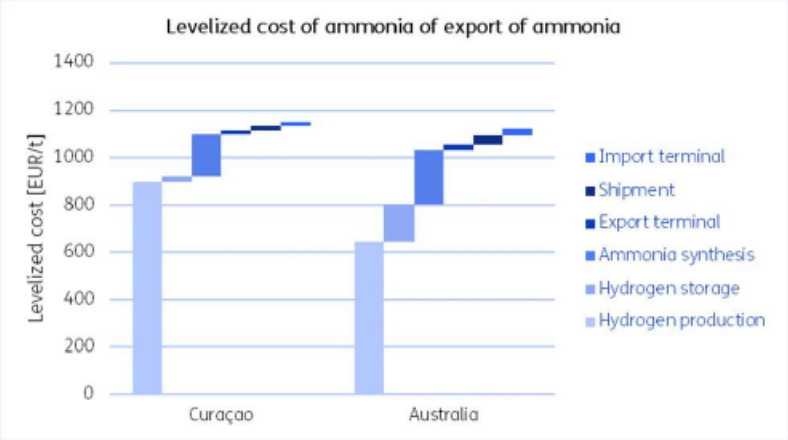
6. Current Status of- and Future Works

6.6 Levelized Cost of Energy

Export Comparison

- Onshore production of hydrogen in Australia cheaper than offshore production in Curaçao
- Value chain until Europe result in comparable results
- Curaçao is closer to Europe, so less shipping costs and consumption of hydrogen
- Less storage required due to more suitable wind conditions in Curaçao
- The same installed power can generate more hydrogen in Curaçao





6. Current Status of- and Future Works

6.7 Projected Capital Investment

- Two scenarios used for Dutch hydrogen demand in 2050
  - High: 14 Mt/year (Topsector Energie, 2018)
  - Low: 8 Mt/year (TNO, 2020)

Production Curaçao	Unit	Min Case	Ref Case	Max Case
Hydrogen	kt/yr	114	482	927
Methanol	kt/yr	103	93	425
SAF	kt/yr	0	80	80
Ammonia	kt/yr	567	2,572	4,168
Ammonia (for export*)	kt/yr	545	2,475	4,011
Hydrogen (for export)	kt/yr	97	442	716

**Ammonia consumption for shipping already deducted*

High demand scenario	Unit	Min Case	Ref Case	Max Case
Hydrogen exported by Curaçao	kt/yr	97	442	716
Hydrogen demand The Netherlands	kt/yr	14,000	14,000	14,000
Potential contribution Curaçao	kt/yr	0.7%	3.2%	5.1%

Low demand scenario	Unit	Min Case	Ref Case	Max Case
Hydrogen exported by Curaçao	kt/yr	97	442	716
Hydrogen demand The Netherlands	kt/yr	8,000	8,000	8,000
Potential contribution Curaçao	kt/yr	1.2%	5.5%	9.0%

6. Current Status of- and Future Works

6.8 Projected Capital Investment

CAPEX: Total 5.1 - 5.6 Meuro/MW

- *25.5 - 28 Billion Euro total*

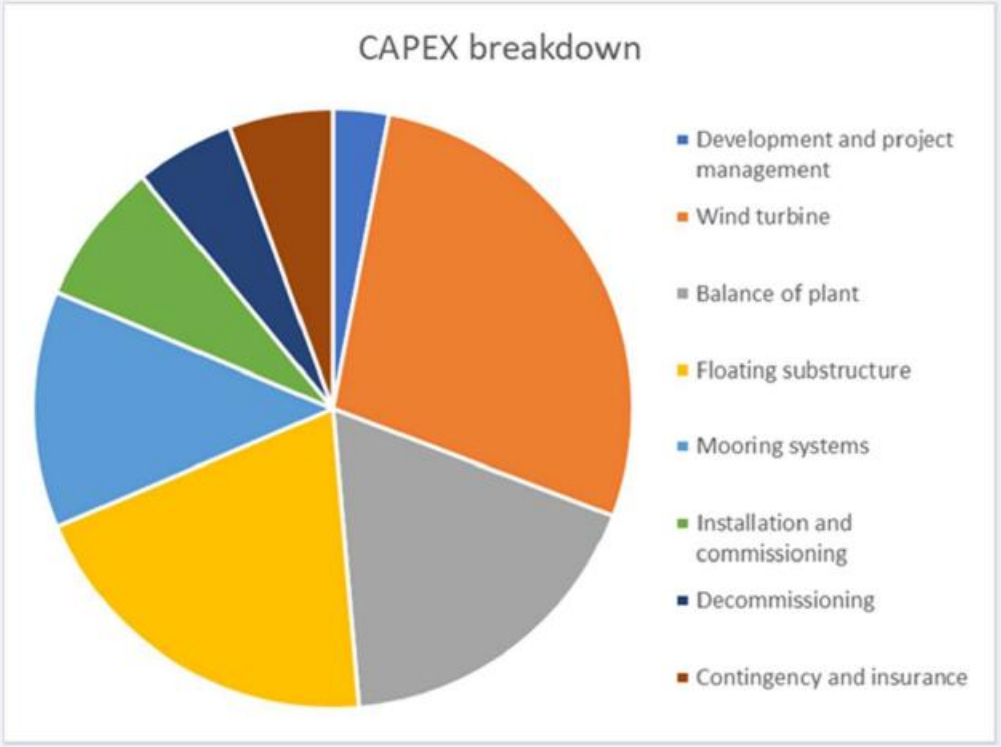
OPEX: 72-80 keuro/MW/yrs

\WACC*: 4% - 6%

LCoE: 80 euro/MWh

- Sensitivity: +/- 10 euro/MWh

- Port costs not taken into account **
- Learning curve not taken into account
  - Floating offshore in its infancy
  - Additional cost saving opps: shared services in region



**WACC = Weighted Average Cost of Capital*

*** Port location to be allocated*

6. Current Status of- and Future Works

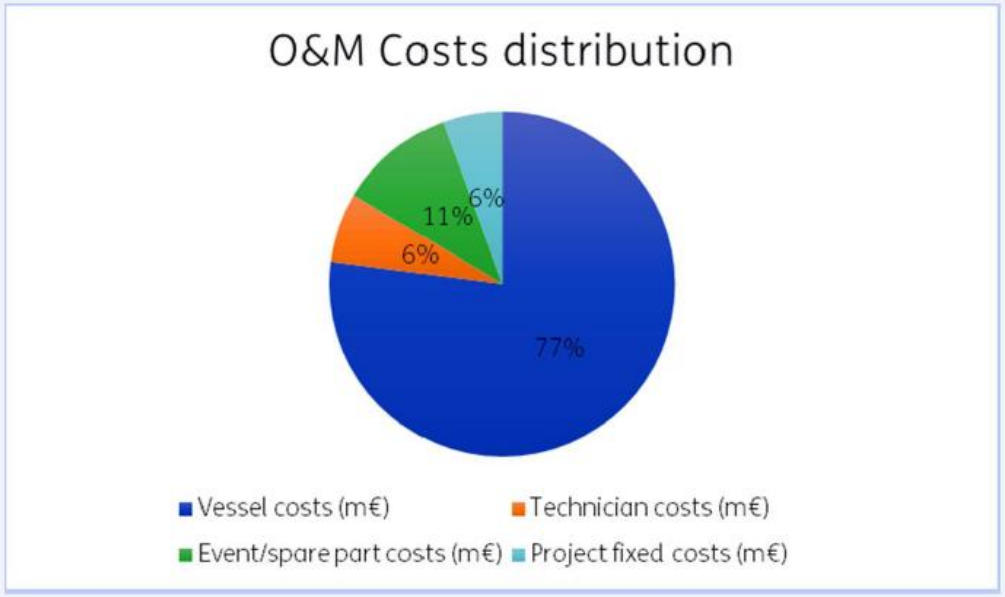
6.9 Operation and Maintenance Costs

Evaluation (600 MW, 40 turbines, 3-year period)

Results	**Value**
• Total O&M costs	128.7
• Vessel costs	99.2
• Technician costs	8.4
• Event and spare part costs	13.9
• Project fixed costs	7.2
• *Revenue losses*	*33.0*

Extrapolation

- To 5 GW
- To 30 year lifespan
- **Total: 10,7 billion euro**



6. Current Status of- and Future Works

6.10a Werkpakket Offshore

2	Offshore	Opdracht	Opdracht nemer	Beoogde deadline (maand)
2.1.1	Update input data	2.1.1	TNO	M1/M2
2.1.2	Update offshore zonering	2.1.2	TNO	M1/M2
2.2.3.1	Initieel ontwerp lay-out windparken	2.2E	TNO	M3
2.2.3.2	Initieel ontwerp elektrisch netwerk windparken (incl. aanlandingen)	2.2F	TNO	M3
2.3	Definitie ontwikkelingsopties Offshore	2.3	TNO	M3

* Metocean studie is recentelijk door Aktis opgeleverd

6. Current Status of- and Future Works

6.10b Werkpakket Onshore

3	Onshore	Opdracht	Opdracht nemer	Beoogde deadline (maand)
3.2.1	Marktonderzoek naar mogelijkheden van energie en waterstof(derivaten)	3.2.1	FEV Consultancy	M3
3.2.2	Bepaling schaalgrootte van waterstofproductie	3.2.2	HyCC	M3
3.3	Definitie ontwikkelingsopties Onshore	3.3	TNO	M3
3.5	Feedstock studie (carbon-feedstock, water)	3.5	FEV Consultancy	M3
3.6.1	Initiële inventarisatie onshore ruimtebehoefte voor offshore activiteiten	3.6.1	VVRP	M3
3.7.1	Initiële inventarisatie onshore ruimtebehoefte voor aanlanding, productie- en exportketen	3.7.1	Efuelution	M3

6. Current Status of- and Future Works

6.10c Wat is er nog te Besteden

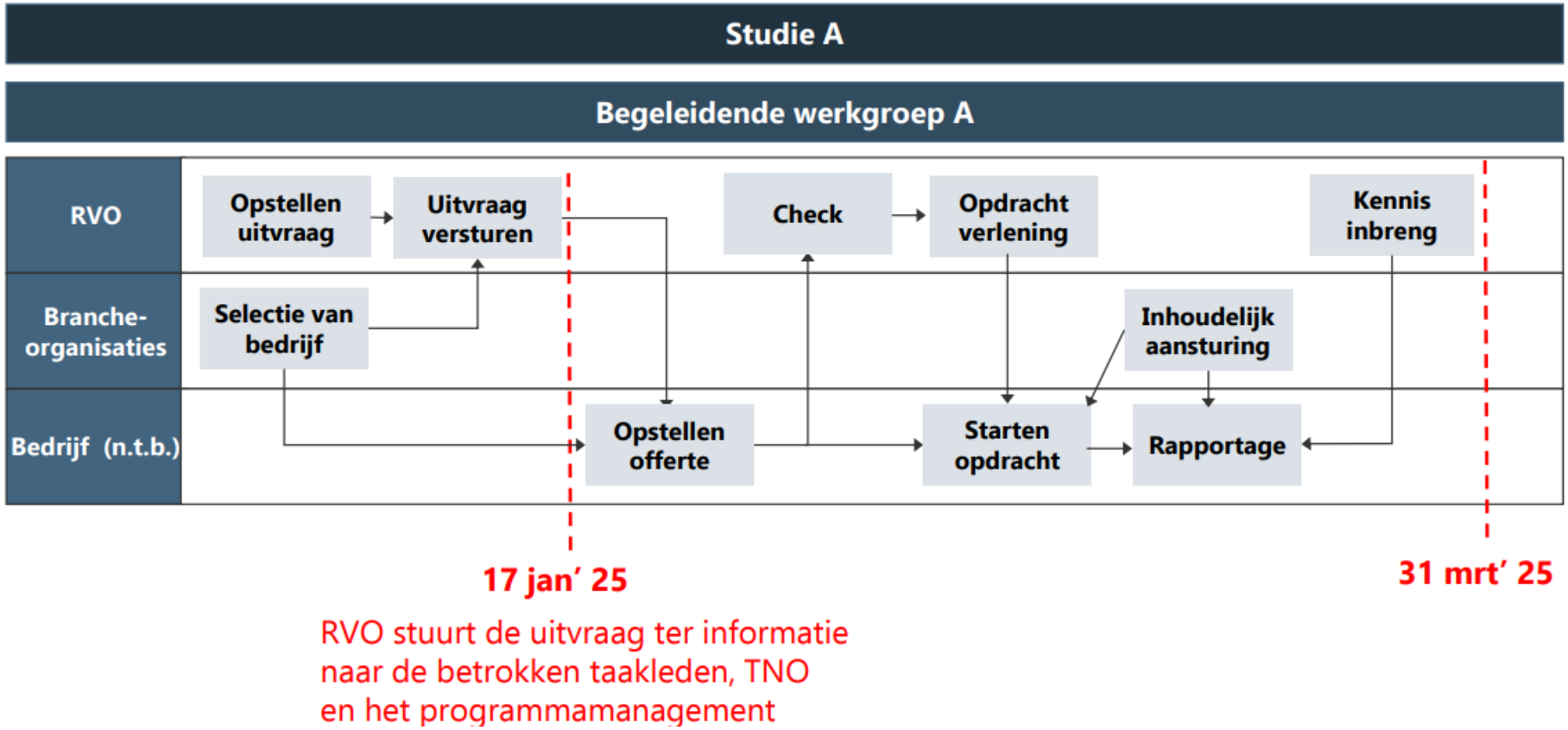
- Studies: 657K
- Officieel te besteden budget: 1000K
- Overige kosten BTW/RVO/Inhuur/Metaocean: +/- 280K
- Onbenut: 62K **of meer?**

NB 1: *de stuurgroep heeft besloten over de bestedingen van de studies (657), niet inzake de post 'Overige kosten'. Dit punt wordt voorgelegd aan de stuurgroep.*

NB 2: Nie*t bestede kosten vallen terug naar Economische Zaken.*

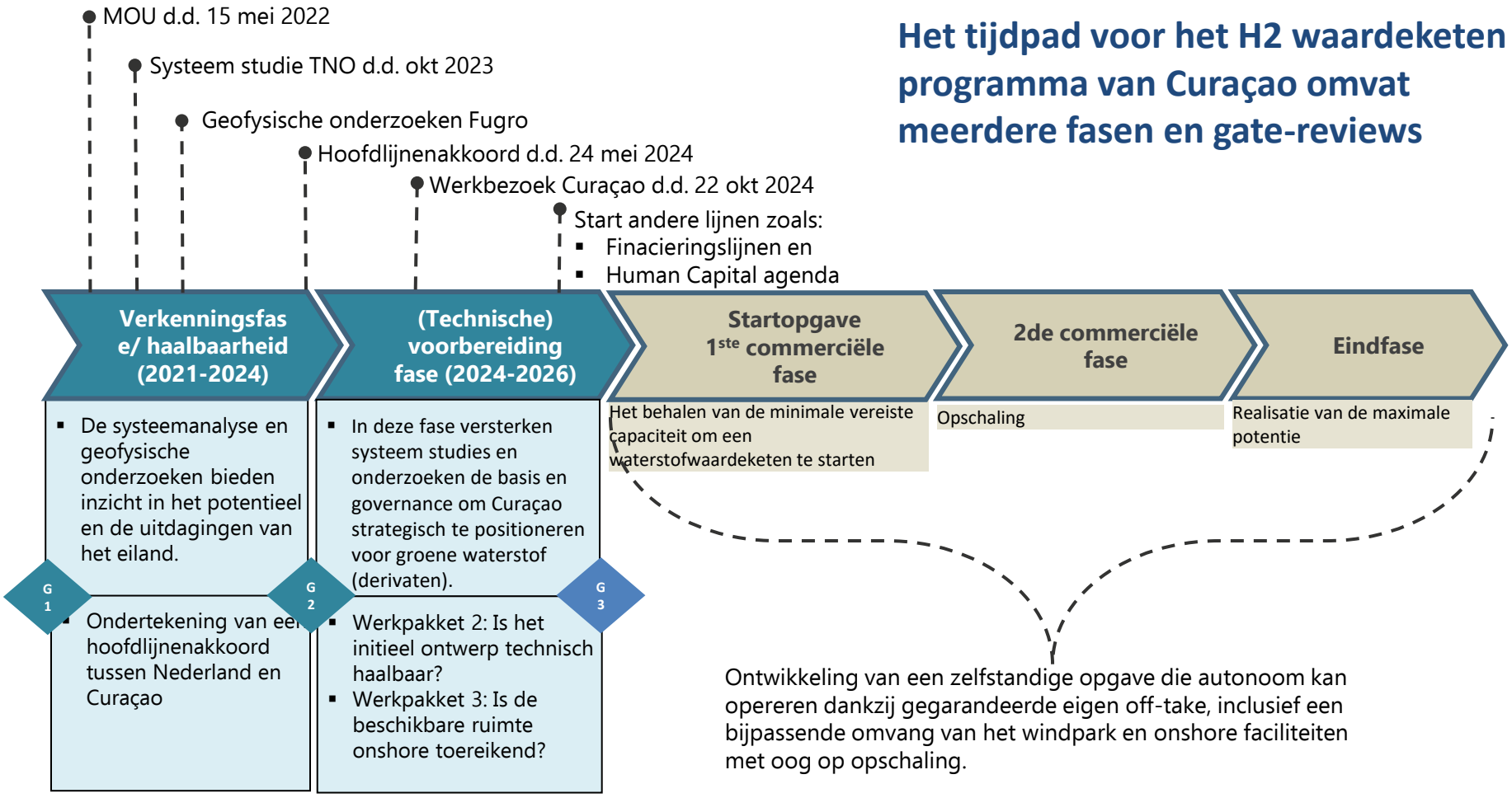
6. Current Status of- and Future Works

6.10d Proces van Uitvoering



6. Current Status of- and Future Works

6.10e Fasering



Het tijdpad voor het H2 waardeketen programma van Curaçao omvat meerdere fasen en gate-reviews

6. Current Status of- and Future Works

6.10f Fasering in Tijd

Technisch- economische haalbaarheid H2 waardenketen Curaçao

Verkenningsfase/ haalbaarheid (2021-2024) → **(Technische) voorbereiding fase (2024-2026)** → **Startopgave 1ste commerciële fase** → **2de commerciële fase** → **Eind fase**

Gate review:
- Werkpakket 2: bijvoorbeeld, is het initieel ontwerp technisch haalbaar?
- Werkpakket 3: bijvoorbeeld, is de beschikbare ruimtebeslag onshore toereikend?

G 3

Theoretische onderbouwing startopgave: werkpakket 2 offshore & werkpakket 3 onshore

Overige goedgekeurde studies door de stuurgroep d.d. 20 sep 2024:

- **Governance studie**
- **Meteorologische en metaocean studie**
- **Uitwerking van de bevindingen van het reconnaissance bathymetrieonderzoek**

Werkpakket 2 offshore

Taak	Naam	Kosten in euro's	Maanden 1	2	3	4	5	6	7	8	9	10	11	12
2.1	Update input data	40K	D2.1											
2.2	Update offshore zonering	40K		D2.2										
2.3	Initieel ontwerp	450K			D2.3									
2.4	Haalbaarheidsstudies van kritieke ontwerpaspecten	100K						D2.4						
2.5	Definitie ontwikkelingsopties	100K										D2.5		
2.6	Conceptontwerpen voor gekozen ontwikkelingsopties	100K												
2.7	Evaluatie van gekozen ontwikkelingsopties													
2.8	Risico-analyse van gekozen ontwikkelingsopties	40K												
	Prioritair	**870K**												

2026

Werkpakket 3 onshore

Taak	Naam	Kosten in euro's	Maanden 1	2	3	4	5	6	7	8	9	10	11	12
3.1	Studie maximale E-inpassing onshore	120K			D3.1									
3.2	Initieel ontwerp (Waterstof en infrastructuur)	80K				D3.2								
3.3	Definitie ontwikkelingsopties					D3.3								
3.4	Conceptueel ontwerp onshore infrastructuur	120K										D3.4		

= goedgekeurde studies stuurgroep

6. Current Status of- and Future Works

6.10g Financiering CUR - NL

Overzicht bekosting H2 waardeketen programma

Curacao			Nederland		
Budget	**Toelichting**	**Bron**	**Budget**	**Toelichting**	**Bron**
Besteed	EUR 2.4 milj	Hoofdlijnenakkoord	Besteed	EUR 149K	BZK
Restant	EUR 2.6 milj	Hoofdlijnenakkoord	Restant	EUR 1 milj (RVO)	Hoofdlijnenakkoord
Gereserveerd	EUR 12.5 milj	Begroting 2025	Gealloceerd	EUR 4 milj	Voorjaarsnota 2025 (op basis van Hoofdlijnen akkoord)
			In de pijplijn	Deel van EUR 60 milj budget	Sectoragenda Maritieme maakindustrie
Totaal budget	**EUR 17.5 milj**		**Totaal budget**	**EUR 5.149 milj**	

Questions?