NEIMME-Icorr Conference 2023: Integrity Engineering for a Sustainable Future

How do you take sustainability into account during design?

Birit Buhr, Chief Corrosion Engineer

EUROPEAN ENERGY

Takes from the presentation

Environmental impact

- Engineers know to which extent designs can be made more environmentally friendly, and still have the same functionality and required durability

- To get towards a more sustainable future, engineers, scientists, standardization bodies and regulators need to work together
- - to push limits
- - to speed up the process with increased value

- Stay sharp. When talking about environmental impact and sustainability. It is not as simple as it is sometimes communicated

- Reduction of quantity of materials will always make the environmental impact less

Agenda

- Takes from the presentation
- European Energy, who are we?
- Relevance of this conference
- Metal emission from offshore wind farms, example
- Danish requirements to upcoming bids
- Standardisation, engineering and regulators, how does it work?
- Responsible sourcing
- Takes from the presentation

Birit Buhr

B.Sc. Chemical engineer, 1987

AMPP certified cathodic protection specialist, CP4, 2010

Chair of S453, corrosion, cathodic protection

ISO TC219 WG10, CEN TC 219 WG3
PM on ISO 24656, cathodic protection of offshore wind
PM on ISO 9351, galvanic anodes for seawater and saline sediments

Chair of S305, coating

ISO TC 107 inorganic coating and metallization
ISO TC 35, organic coating
NWIP coming up on coating for offshore wind structures

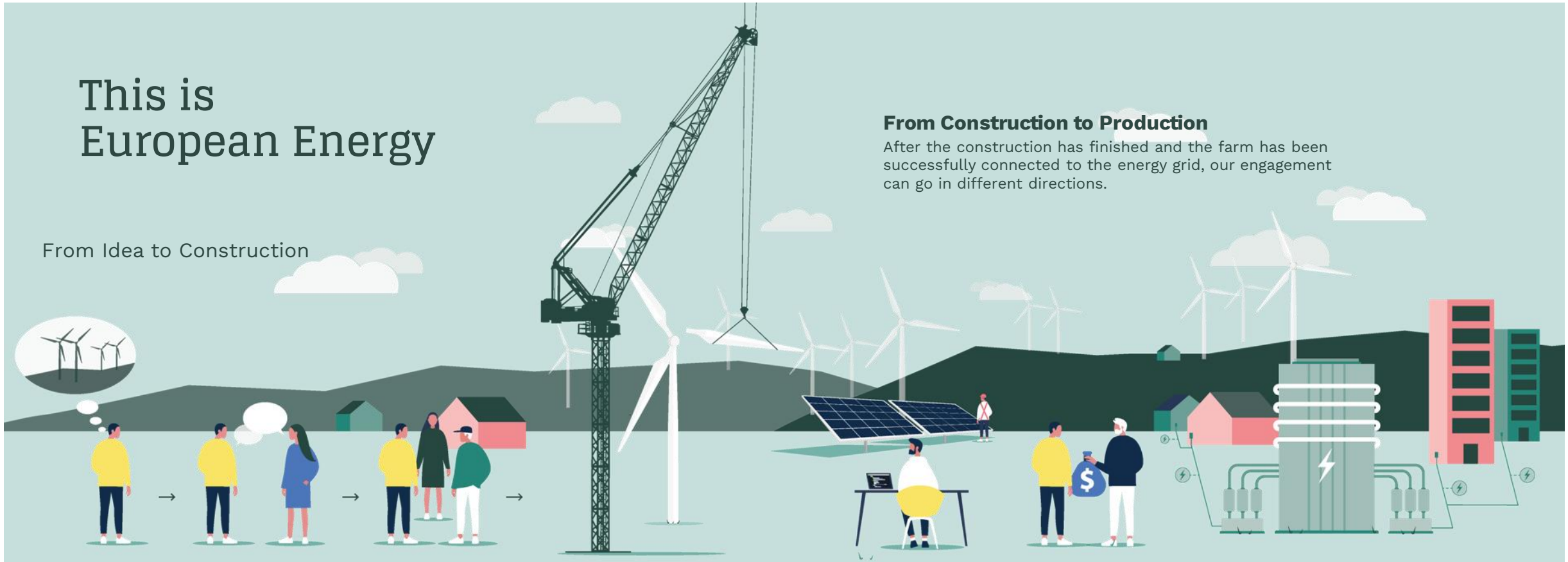
Work history

Chief corrosion engineer with European Energy, 2023-
Senior lead specialist with Ørsted, Offshore 2013-2022
Senior materials specialist with COWI, head of materials lab 1987-2013, including secondment to ministry of works in Bahrain/Oman 1995-96

Project manager for Bridge life cycle optimization including life cycle assessment for the Nordic road directorates in 2009-2012

This is European Energy

From Idea to Construction



From Construction to Production

After the construction has finished and the farm has been successfully connected to the energy grid, our engagement can go in different directions.

Location:

We secure the land rights in collaboration with the landowner and conduct environmental studies to minimize impact to the local environment.

Planning:

Once a location has been identified, a thorough analysis of the environmental impact, local grid capacities, both the political and the project economic framework conditions is needed. This includes but is not limited to all from navigating through national and local laws and permits to analyzing energy production estimates.

Involvement:

It is essential to involve local citizens and stakeholders as early as possible and strive to understand and address any concerns. At this stage we also invite investors to participate in the development of the project.

Construction:

When all the essential rights and permits have been acquired, the construction phase can be started. We manage the entire process from design of the energy plant, global sourcing of components, construction activities to grid connection as well as all many unforeseeable factors during this phase.

Managing the assets:

We consider managing the constructed assets as a part of our core business. This includes in-house competences in both technical, commercial and financial aspects of managing renewable energy plants.

Divestment

We assess each project individually and take the risk-and-reward profile into consideration. In some cases, we divest the energy farm to long-term investors at the optimal price. Often, we keep managing the plant for the investor to optimize production output and minimize operating costs.

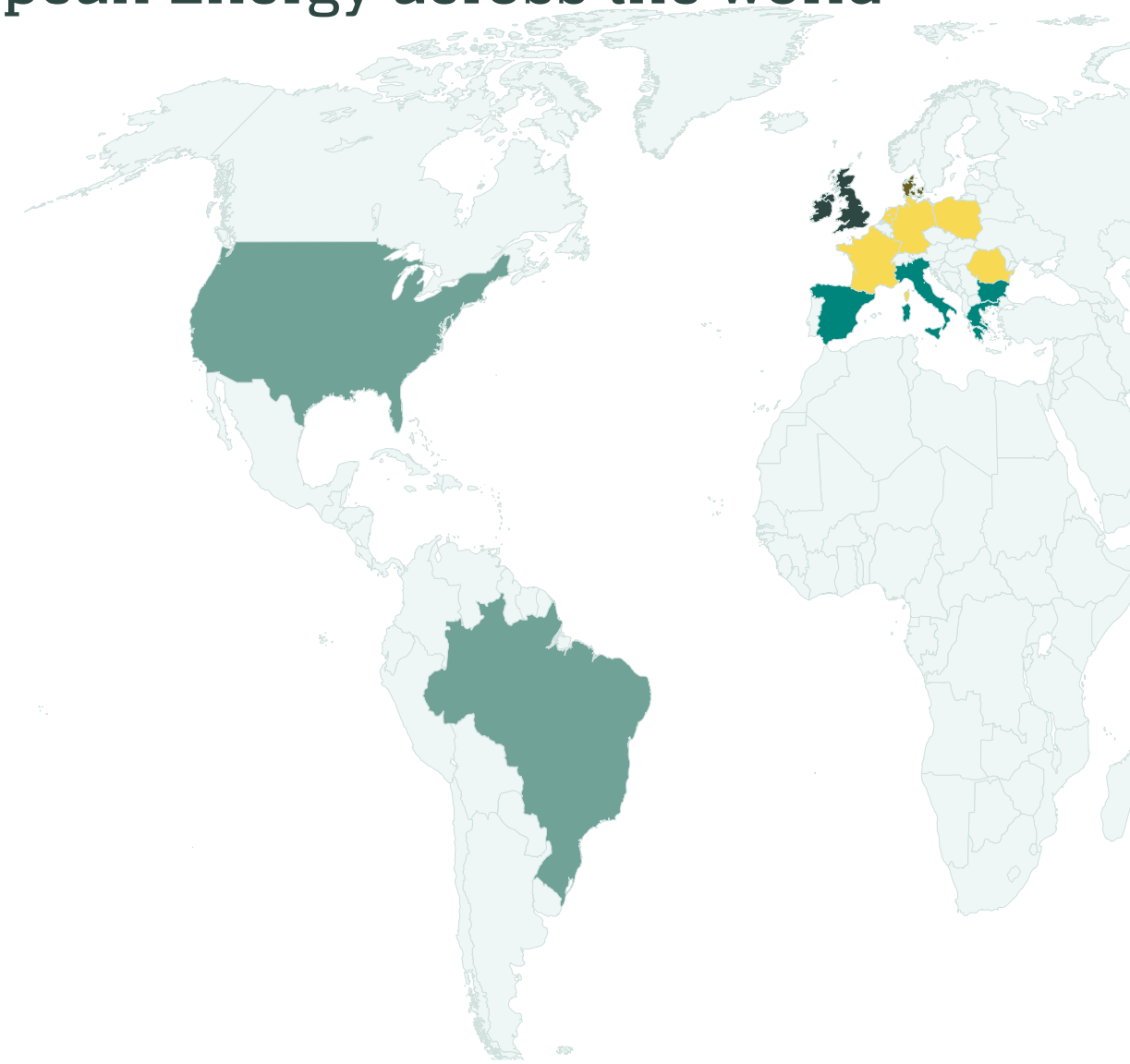
Independent power sale:

Other times we keep ownership of the energy farm and provide electricity as an independent power producer.

Power Purchase Agreements (PPA):

Many companies choose a PPA solution these days during the pre-construction and construction activities. These PPAs are long term supply contracts with a fixed price guaranteeing the delivery of renewable power from an energy farm to a business.

European Energy across the world



	Development solar/wind	Construction solar/wind	Operational wind activities	Operational solar activities	Offices
Home market					
Denmark	■	■	■	■	■
Northern Europe					
Finland	■				
Sweden	■	■	■		■
Latvia					■
Lithuania	■	■			■
UK	■		■	■	■
Central Europe					
Germany	■	■	■	■	■
Poland	■	■	■		■
Romania	■				■
France	■				
The Netherlands	■		■		
Southern Europe					
Italy	■		■	■	■
Spain	■			■	■
Greece	■				
Bulgaria	■		■		■
Rest of the world					
Brazil	■	■		■	■
Australia	■				
US	■				


304 MW
Kassø,
Denmark
75,000 house holds

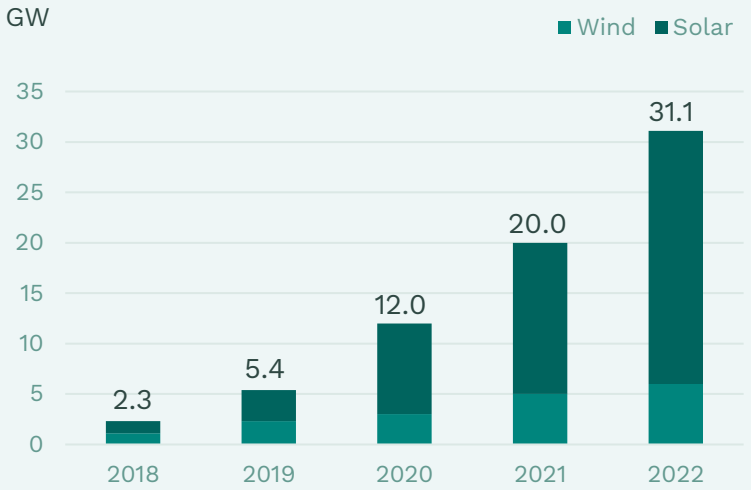
Project development

During 2022, European Energy continued its efforts to grow its project development activities, including greenfield development, partnering and acquisitions of ready-to-build assets. We are predominantly active in OECD countries, with a core focus on low-risk markets in Europe, but we are also present in Brazil, the US and Australia.

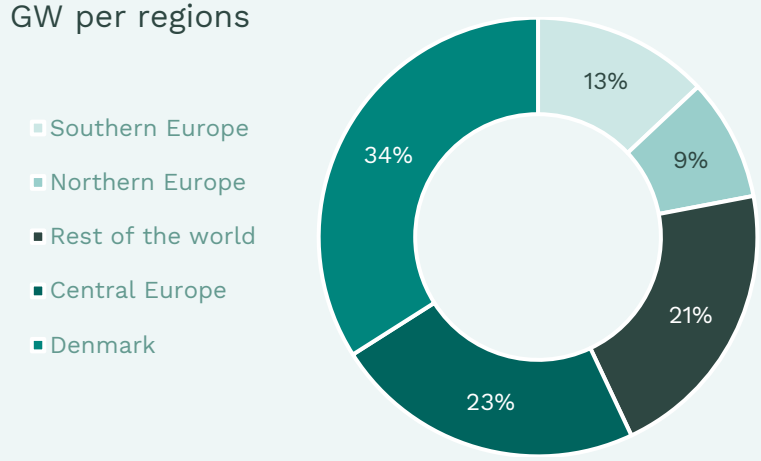
Project development activities are ongoing in 19 countries and we have established local offices in 18 countries (up from 12 at end-2021), as a broad geographical reach and a local presence are key enablers for securing new projects and to diversify country-specific risk.

Since 2018, a key focus has been to grow and mature our project pipeline, as this is considered to be a key value driver to ensure continued stable earnings growth.

Development pipeline



GW per regions



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Imagine a world powered by renewable energy

At European Energy, we imagine a world powered by renewable energy and we pledge to be a creative enabler of the green transformation of our society by supplying households and businesses with 100% clean and environmentally friendly solar power, wind power and Power-to-X.

We imagine a world where economic growth and social welfare do not come at the expense of increasing global temperatures which pose a threat to the health and safety of planet Earth and its inhabitants.

Since 2004, when European Energy was founded, we have installed renewable energy across the world, to replace existing fossil fuel consumption and contribute to the fight to prevent climate change.

At the same time, however, we have witnessed an escalating level of global greenhouse gas emissions and the world is currently on track to a 2.5 oC warmer planet by the end of the century[1].

Our four ESG focus areas

Climate and environment
- Greenhouse gas emissions
- Environmental management
- Biodiversity

Social Engagement
- People
- Local job creation
- Community involvement

Health and Safety
- Preventive measures, monitoring and reactive actions

Business Accountability
- Business ethics
- Responsible procurement
- Tax contributions

1) United Nations Framework Convention on Climate Change (UNFCC). Page 4 of our ESG report.

Power-to-X

ee_power2x_electriccity2021_final (Original).mp4

MAADE PTX FINAL (3).mp4

What is Power-to-X

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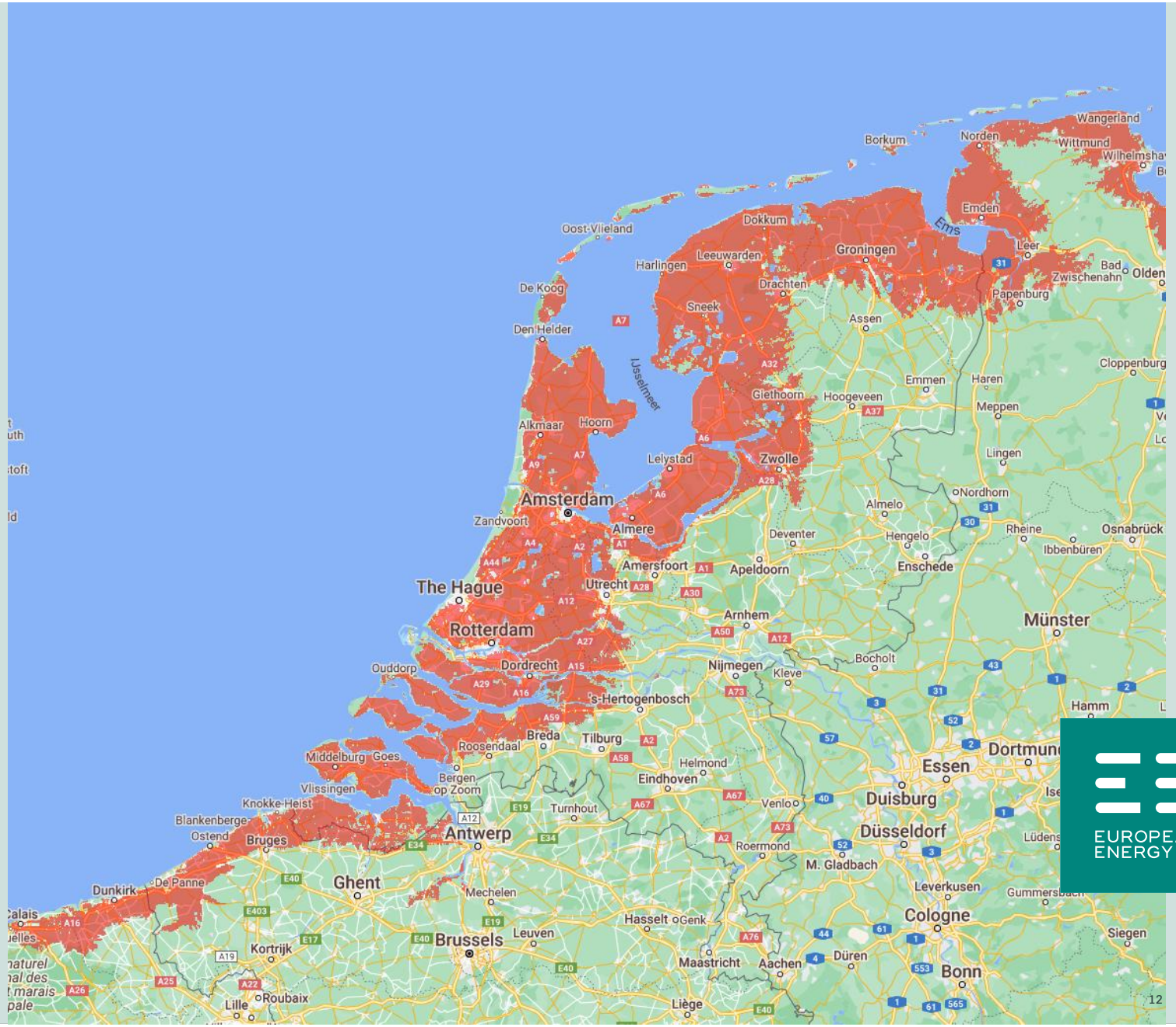
PtX

- Electrolysis - locally pumped water
- Owner of biogas plants – use e-CO_2
- No transport

- In Denmark currently a gas infrastructure is being built
- E-methanol
- PtX efficiency today approx. 30%

2.8 degrees

- A bomb was dropped before last year's COP27 in Egypt though.
- UN estimates that current national pledges in CO2-reductions will lead to a 2.8 degrees in temperature increase.
- With 2.8 rise in mean temperature around the globe – The policymakers will need to adapt policies faster – or the Netherlands will be gone in 2100.



Consequences

The Central European temperature forecast on average 4 degree above the normal (+21%)June 9. 2023

Extreme heat and drought

Rising sea levels and flooding

Biodiversity loss

The 2021 built out and 2030 ambition

	EEZ*	Built out 2021**	2030 ambition	2021	2030
	km^2	GW		% kw/km^2	
United Kingdom	731309	10.42		1.4	
China	963556	7.89		0.8	
Germany	56763	7.7	30	13.6	53
The Netherlands	64328	2.63		4.1	
Denmark	105021	2.34	13	2.2	12
Japan	4066513	0.09		0.002	

*Exclusive economic zones

**Maritime spatial planning and offshore wind energy, Anemoi workshop, Nico Nolte, Hamburg, 31 May., 2023

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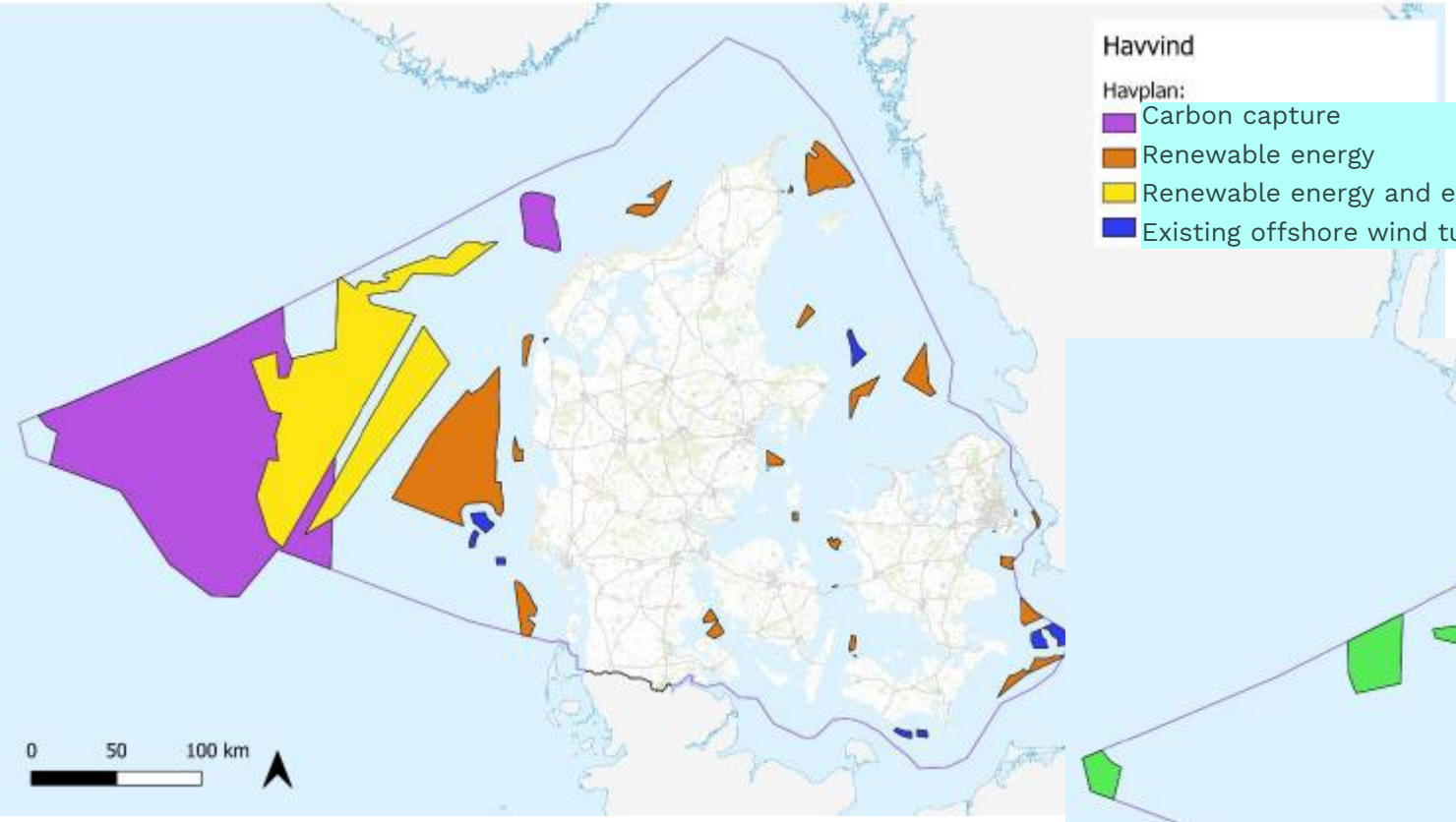
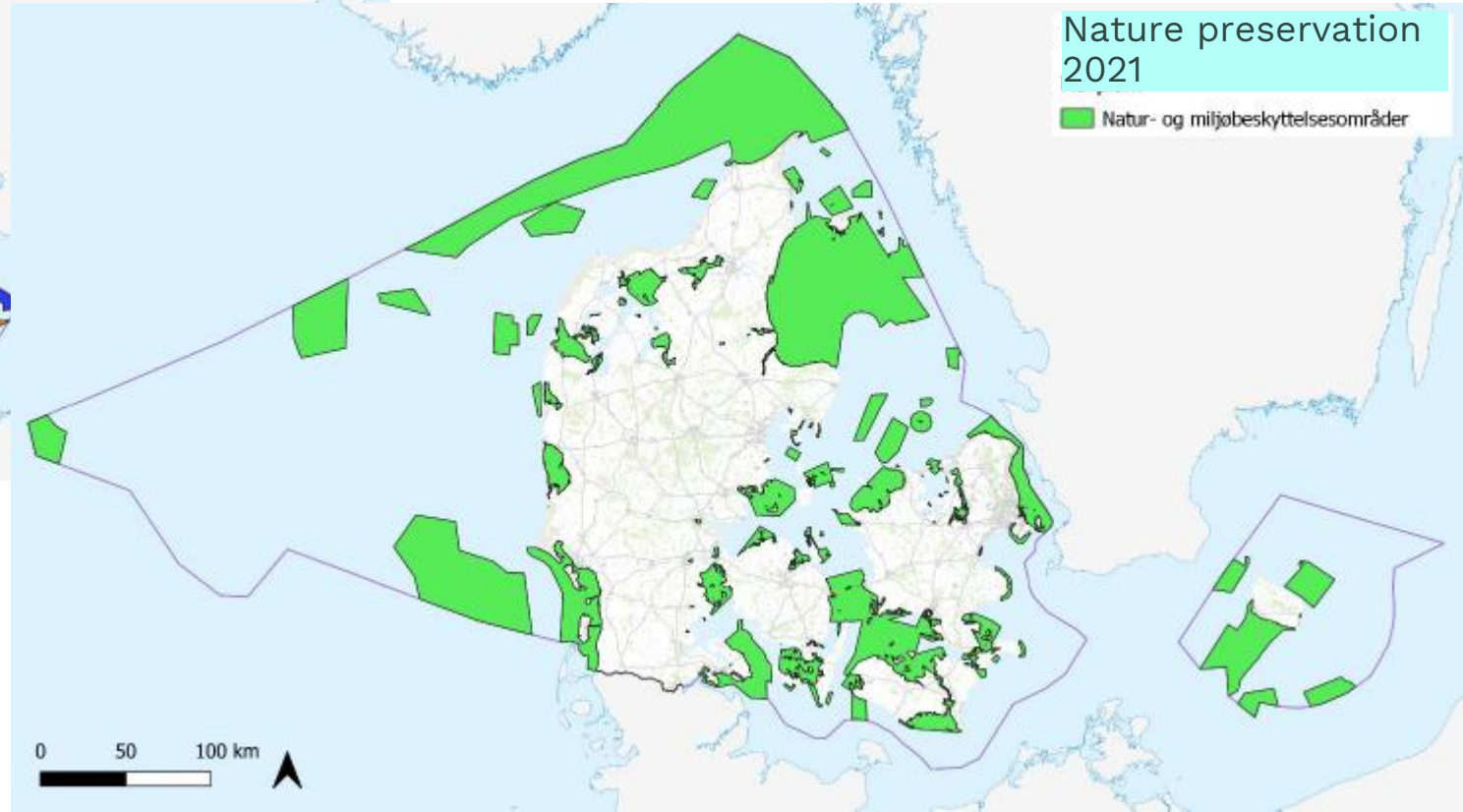
Use of exclusive economic zone (EEZ) Denmark - planning





Source: Arealbehov til havvindmølleparker og vurdering i forhold til naturbeskyttede havområder, analyse maj, 2023, From Tænketanken Hav

Offshore wind - Design example on metal emission

Offshore wind park – 25 years
- 100 foundations, 8MW each turbine
- 55 meters of water
- 8-meter diameter
- coated using >350 micron of epoxy coating
- 1.7 m of tide
- galvanic anodes

Scenarios

1. Design using DNV-RP-B401
2. Design using ISO 24656, Alloy using DNV-RP-B401, table 8.5
3. Design using ISO 24656, Alloy A5 from upcoming ISO 9351 (subject to successful DIS enquiry), v reduced Zn content
4. As. 3, but with regulation on current output

Table 8.5 from DNV-RP-B401

Alloying/impurity element	*Al-base*
Zn	2.5-5.75
Al	rem.
In	0.015-0.040
Cd	≤ 0.002
Si	≤ 0.12
Fe	≤ 0.09
Cu	≤ 0.003
Pb	na

Table C.1.1 from Draft ISO 9351

Elements	**Alloy A5**
Zn	0,3 – 0,8
In	0,018 – 0,040
Ga	0,04 – 0,10
Fe	0,08 max.
Si	0,10 max.
Cu	0,003 max.
Cd	0,002 max.
Other Impurities (each)	0,02 max.
Other Impurities (total)	0,05 max
Al	remainder

Offshore wind - Design example on metal emission

Anode optimized: insert diameter, length etc.

1. Design using DNV-RP-B401

   810 ton of metals, 33t Zn, 775t Al, 0.2t In plus traces of other

2. Design using ISO 24656, Alloy using DNV-RP-B401, table 8.5

   450 ton of metals, 19t Zn, 430t Al, 0.1t In plus traces of other

3. Design using ISO 24656, Alloy A5 from upcoming ISO 9351 (subject to successful DIS enquiry)), with reduced Zn content

   450 ton of metals, 2t Zn, 445t Al, 0.1t In plus traces of other

4. As. 3, but with regulation on current output

Ref. Using the new standard EN ISO 24656 “Cathodic protection for offshore wind structures”, Birit Buhr, Marine corrosion forum, July 6, 2022

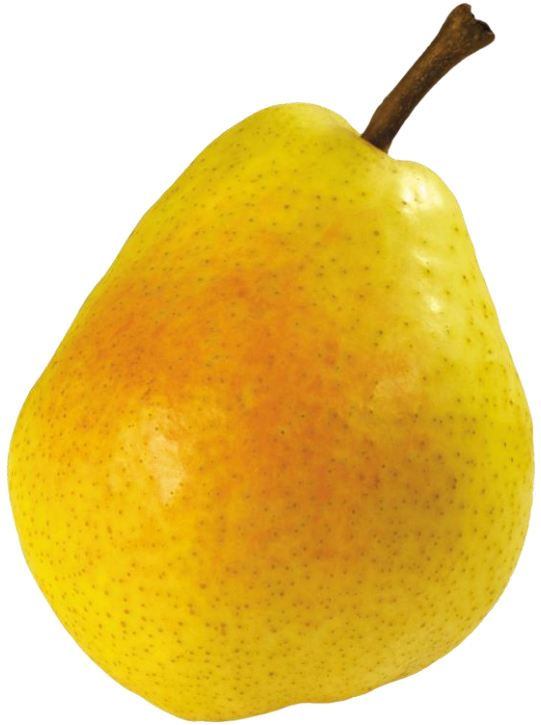
0.8 GW park – 100 turbines

Galvanic anode cathodic protection

- 450-810 ton of metals over 25 years (only external)

Impressed current cathodic protection

- 1 kg material for 80 turbines* release from the impressed current anodes



* Source Corrosion.nl, who says that 80 turbines over 25 years would dissolve about 1.5 million kg of aluminium alloy

What is the impact?
- in the sea?
- globally?
In a wider perspective

- Concentration of metals in the sea
- Toxicity of metal in the alloy

- Combining local impact with holistic view – we live in the same world

- It is always a good idea to minimize quantity (provided function and durability fulfilled)
- …and to match design life with expected service life

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Comparing products

ISO 14025

- Type III environmental declaration present quantified environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function.

- are based on independently verified life cycle assessment (LCA) data, life cycle inventory analysis (LCI) data or information modules in accordance with the ISO 14040 series of standards

Designers – in my view – have an obligation

- to optimize, this is what engineering is about, optimize and minimize material usage
- Substitute to minimize impact

Going forward

- Compare delivery from different suppliers, how do they optimize energy consumption, water usage, waste, etc.
- Request information on sourcing, be responsible
- Which impact categories are looked at?

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Impressed current systems

- MMO coated titanium
- Copper cables with insulation HVPE/PVC
- Electronics

- Small amounts of metal emitted
- Chlorine and (more?) hydrogen gas evolved. What is the consequence?
- Power consumption during operation
- Protection when connected to grid
- Risk with power failure

How do you compare sustainability impact of different solutions

- energy used to produce products and operate systems
- Impact on nature, felling of rainforest for instance (biodiversity). Copper, iron ore and aluminum is mined in the rain forest
- Impact categories should be looked at

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Danish government agreement

Requirements:

- ✓ Third party verified **environmental declarations** for all main components (i.e., foundations, cables, tower, blades, nacelle etc.) based on life cycle assessment
- ✓ Third party verified **life cycle assessment** (LCA) on project level, including installation, operation and decommissioning of the offshore wind turbine asset
- ✓ **Blades shall be re-useable**, unless marked analysis from Danish energy agency shows that erection of some of the 6GW assets will be prevented at end of 2030- alternatively re-used for other purposes when decommissioned
- ✓ **Monitoring** of nature and environmental impact of own offshore wind turbine asset
- ✓ Developers shall include **nature inclusive design**
- ✓ Developer shall fulfil **social clauses**, a.m.o. social dumping, human rights and international conventions – also for sup-suppliers

Tillægsaftale om udbudsrammer for 6 GW havvind og Energiø Bornholm

Tillægsaftale til Klimaaftale for energi og industri mv. 2020, Tillægsaftale til Klimaaftale om grøn strøm og varme 2022 og Tillægsaftale om Energiø Bornholm 2022

(30. maj 2023)

Very ambitious – needs implementation and dialogue

We (S305, S453) have been invited into this dialogue

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Standardisation – ISO as worldwide

In the ISO 2030 strategy ISO has the following mission:

"…ISO standards support global trade, drive inclusive and equitable economic growth, advance innovation and promote health and safety to achieve a sustainable future".

ISO keep track on how the standards developed are linked to the UN sustainability goals. The vast majority of standards are linked to UN goal 9 "Industry, innovation and infrastructure"

- For upcoming new work item proposals define which of the UN goals the standard will address:
- For *ISO 9351 – galvanic anodes for seawater and marine sediments*, the following was defined:
  - Goal 7: Affordable and Clean energy
  - Goal 12: Responsible Consumption and Production
  - Goal 13: Climate Action
  - Goal 14: Life Below Water

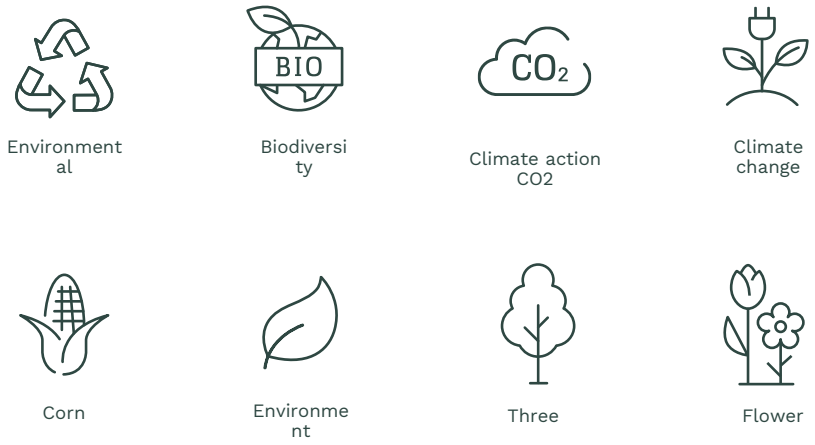
NWIP

Coating for offshore wind structures

Source: ISO Strategy 2030

Draft ISO 9351, galvanic anodes for cathodic protection in seawater and saline sediment

Functional requirements



Environment

- Chapter on environmental impact and Annex on environmental impact considerations
- Recommendation
  - environmental product declaration (EPD), from ore to anode
  - Optimise design, to reduce metal emission
  - Choose alloys with less environmental impact
  - Responsible sourcing

The sustainability expert within Danish Standard have suggested other technical committees to be inspired by our work

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Takes from the presentation

Environmental impact

- Engineers know to which extent designs can be made more environmentally friendly, and still have the same functionality and required durability

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Thank you

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PV solar parks