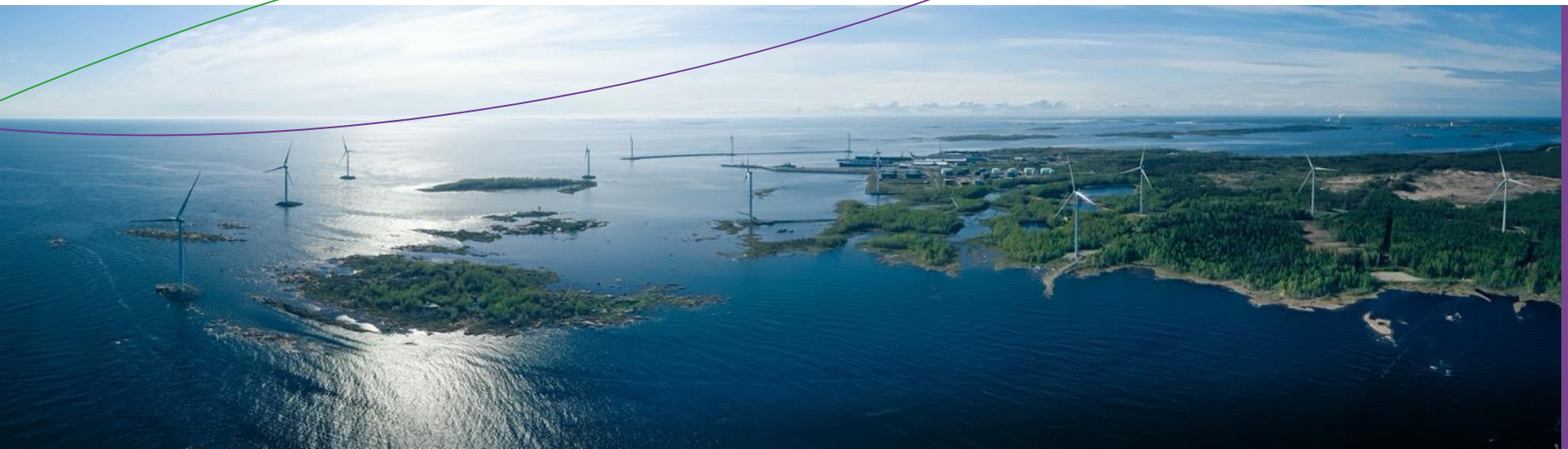
Solutions for a clean Nordic energy system 2024 - 2030

Strategies to meet the climate and security challenge



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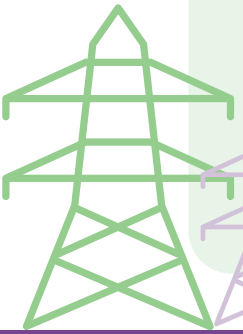
FEBRUARY 2024

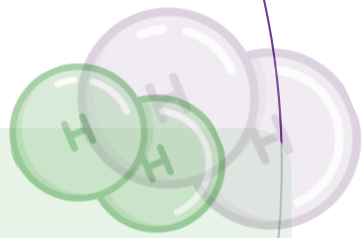
A changed outlook called for strategic reflection

In 2022 the Nordic TSOs launched a 2030-strategy as a response to new climate goals with the purpose of enabling green industries and increased electrification. The strategic outlook and challenges facing the Nordic TSOs remain a product of the circumstances in the Nordics and Europe. As these changes, the **strategic compass must align** to constitute an answer and objective to said circumstances.

The war in Ukraine further stressed the necessity of **security** against cyberattacks and sabotage and pushed **security of supply** even higher on the political agenda intensifying the need of energy security by speeding up the energy transition from an already intensified pace and navigating wisely in **pressured European supply chains**. Both pressured supply chains and the accelerated green transition drive **cost increases** for components, reserves and human resources compelling the Nordic TSOs to react in due time. Achieving accelerated ambitions for transitioning the Nordic energy system can only happen through **close Nordic cooperation** on system development focusing on **four strategic themes.** These will pose responses to both the climate and security challenge.

The strategy aims to **direct and prioritize efforts** through concrete goals and answers to the most present challenges, but also maps the **behavior** that will enable and move us to deliver on the strategic themes.





ADEQUATE SYSTEM INFRASTRUCTURE

SECURE AND OPTIMIZED ENERGY SYSTEM

ENERGY MARKETS THAT ENABLE

THE DIGITAL FOUNDATION

Nordic strategic terms

*Massive increase in power of **wind, solar etc.** poses **high technical complexity** bringing challenges with balancing and system security in the Nordic system*

*The role of **customers** is changing and requires closer **dialogue** in the TSO/customer interrelationship and **mutuality** between grid connection and making flexibility available.*

*Shorter decision windows, increasing technical complexity and advancing cyber threats push for an advanced **digital foundation***

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*Pressured **supply chains** increase costs and reduce availability of goods and services risking delays in green transition and timely infrastructure*

***The speed of development** is accelerating **requiring cooperation capabilities** in terms of decision making, implementation and European liaison*

*Rapid development in **hydrogen** requires timely responses to system management and development on Nordic level with high focus on **flexibility***

*Push for **energy independence** and **security of supply** follows from geopolitical developments*

New or increasing challenges for the Nordic energy system

INCREASING **OFFSHORE WIND** AND OTHER RENEWABLES IN NORTH AND BALTIC SEAS

The outlook towards immense increases of offshore wind moves closer and along with other generation technologies, our **connection and transmission capacity** is challenged.

It will require comprehensive and holistic **system planning,** new **IT system support** and **operational tools** as we face larger adequacy gaps, flow changes, reduced inertia and risk of internal bottlenecks. The increased offshore capacity and larger units will affect reserve **dimensioning** and balancing needs as well as **security management** increases in urgency.

Hence, the Nordic TSOs commit to provide solutions to connecting the increasing amounts of offshore wind as well as to the system consequences the increase entails. The Nordic Region Coordination Center (NRCC) plays a critical role in this.

THE ROLE OF **HYDROGEN** IN THE FUTURE ENERGY SYSTEM

Power-to-X plants are emerging, and the development of H_2 requires a solid grid infrastructure to release its **sector integration** potential. H_2 can compliment the electricity system by offering both **flexibility** and **production surplus utilization**, however it can also **challenge system stability**, and without timely design principles and technical requirements, flexibility may not be available in the extent desired.

The Nordic TSOs navigate in **heterogenic national offsets** where detailed planning must be decentralized, but in an overarching and **aligned Nordic big picture**.

Hence, the Nordic TSOs cooperate internally and with stakeholders to ensure the right investment climate and governing frameworks for H_2 development without counterproductive incentives across borders and barriers for flexibility.

EUROPEAN **SUPPLY CHAINS** UNDER PRESSURE

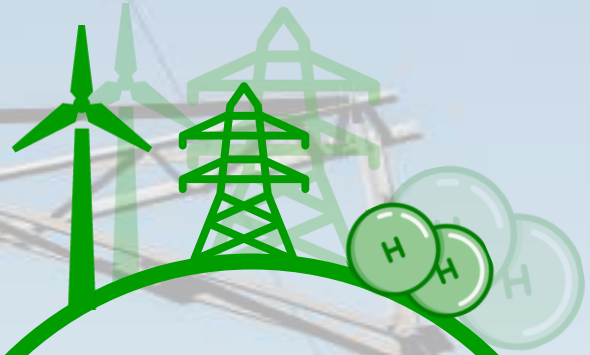
Competition on green investments between the US, Asia and Europe along with **surging costs and prices** is making the green transition more challenging for all – both in terms of lead times and grid expansion and development costs. Potential **investment delays** is risking security of supply as the grid ages.

Though pressured supply chains cannot be fully mitigated, **cooperation is key** to mitigating the situation by **proactive insight building** among the Nordics, neighboring TSOs and vendors.

Hence, the Nordic TSOs strive to unleash time and cost potentials through transparency on grid development plans and working together to identify sourcing optimums and upsides from increasing standardization on components and technical requirements.

Nordic challenges 2016	Nordic solutions 2018, 2020, 2022	Nordic TSO strategy 2022	Nordic TSO strategy 2024
Arising from climate changes, technical development and the European framework for markets	Reports looking towards 2025: What is our response to the challenges?	Towards 2030: Response to climate goals. Enabling green industries and increased electrification.	Towards 2030: An updated strategy to also reflect challenges with hydrogen, offshore and supply chains in a changed Europe.

We have identified the challenges and the solutions that enable us to reach our vision



Vision

Clean and competitive energy that enables a climate-neutral, secure and integrated energy system.

DRIVERS

- Security of supply
- Climate change
- Green growth
- Energy independence

ENABLERS *and* SOLUTIONS

- Energy infrastructure
- Technology, AI and data
- Cross border cooperation
- Sector integration
- Flexibility and grid utilization
- Electrification
- Clean generation
- Customers
- Automated operation
- Linking market and physics

VISION

Clean and competitive energy that enables a climate-neutral, secure and integrated energy system

NORDIC 2030 VISION

Clean and competitive energy that enables a climate-neutral, secure and integrated energy system

Adequate system infrastructure

Enabling increases in production and consumption through a strong and efficiently utilized grid.

Secure and optimized energy system

Ensuring a resilient, reliable and clean sector integrated energy system while balancing system and stakeholder needs.

Markets that enable

Paving the way with market designs that support flexibility and a level playing field for all technologies.

The digital foundation

Reaching our vision by thinking digital capabilities, innovative technologies and advanced cyber security.

Trustworthy and transparent basis for clean energy with socio-economic focus and cost awareness

Nordic roadmap

Adequate system infrastructure

Enabling increases in production and consumption of clean energy through a strong and efficiently utilized grid.

Towards a…

Clean and competitive energy that enables a climate-neutral, secure and integrated energy system

… through common Nordic projects or in parallel efforts with cooperation, learnings and knowledge building.

How will the Nordic TSOs provide adequate infrastructure?

1. Coordinated modeling and timely planning for a reliable converter dominated and sector integrated energy system
2. Knowledge sharing to speed up connection to grid and to fully utilize grid capacity
3. Common Nordic positions on technical solutions and requirements

Nordic roadmap

Secure and optimized energy system

Ensuring a resilient and reliable energy system with climate neutrality and sector integration and balancing system and stakeholder needs.

Towards a…

Clean and competitive energy that enables a climate-neutral, secure and integrated energy system

… through common Nordic projects or in parallel efforts with cooperation, learnings and knowledge building.

How will the Nordic TSOs provide a secure and optimized energy system?

1. Ensure system security with timely technical requirements and tools for robustness and resilience
2. Dynamic system support and automated processes
3. State of the art crisis preparedness for system security

Nordic roadmap

Towards a…

Clean and competitive energy that enables a climate-neutral, secure and integrated energy system

… through common Nordic projects or in parallel efforts with cooperation, learnings and knowledge building.

Markets that enable

Paving the way with market designs that support flexibility and a level playing field for all technologies.

How will the Nordic TSOs ensure markets that enable?

1. Create a framework for flexibility across all technologies
2. Introduce offshore bidding zones and integrate offshore solutions into the electricity markets
3. Ensure market mechanisms to ensure adequacy and optimal grid utilization

Nordic roadmap

The digital foundation

Reaching our vision by thinking digital capabilities, innovative technologies and advanced cyber security.

Towards a…

Clean and competitive energy that enables a climate-neutral, secure and integrated energy system

… through common Nordic projects or in parallel efforts with cooperation, learnings and knowledge building.

How will the Nordic TSOs ensure the digital foundation?

1. Ensuring Nordic synergies on information-, data- and system architecture
2. Ensuring strong Nordic and European cooperation within cyber security
3. Establish Nordic common services and IT platforms for the balancing and electricity markets

Higher pace and emerging risks call for cooperative and behavioral responses

STRUCTURES

- Dedicated **resources** in prioritized projects
- Cooperation structures that support **efficiency** and **execution**
- Clear **roles**, responsibilities and mandates

CAPABILITIES

- **Innovation** and **development** as enablers
- **Transverse** cooperation
- Excellent **project management**

INVOLVEMENT

- From cooperation to **co-creation**
- Engage with **stakeholders**, build knowledge and remove barriers
- Seek and utilize **learnings** from other industries

EXECUTION

- Utilize existing and innovative **technologies** incl. AI
- Visibility on **inter-dependencies**
- Narrower project **scopes** for higher **commitment**

The key messages

Strategic drivers

The Nordic TSOs **work together to provide solutions** for a rapid and urgent green transition, increasing consumption and electrification, sector integration and high security of supply in a changed Europe. They do so through a strategy that enables joint direction and prioritization.

Strategic themes

Four strategic themes constitute the structure for the Nordic responses to the strategic drivers

Adequate system infrastructure
Secure and optimized energy system
Markets that enable
The digital foundation

Implementation plan

Concrete and prioritized efforts and projects are summarized in an implementation plan structured according to roadmaps for the strategic themes. Some efforts are common Nordic projects whereas others are joint ambitions that are nationally rooted. The implementation plan **commits the Nordic TSOs to progress and deliverables** and undergoes yearly updates.

Behavioral responses

Higher pace and emerging risks call for ambitious behavioral and cooperative responses to advance and succeed. The Nordic TSOs will deliver on the strategic themes through

Right structures
Strong capabilities
Swift execution and
Deeper involvement

Nordic TSO groups in different areas

- Nordic Planning Group (NPG)
- Regional Group Nordic (RGN); system operation
- Nordic Market Steering Group (MSG)
- Nordic IT Group (NIT)
- Nordic R&D Group (NRD)

For more information, please visit

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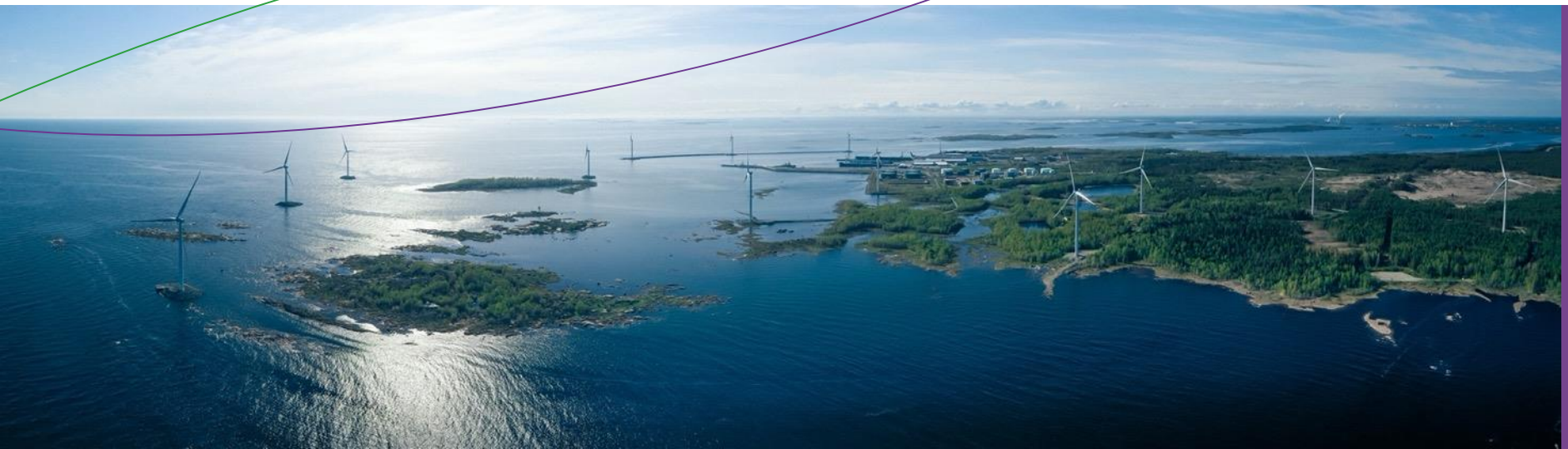
Implementation Plan

Nordic TSO strategy

June 2024



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Background for the Implementation Plan

The Nordic TSOs are working on projects that are prerequisites for enabling the growing amount of clean and variable generation in the electricity system and creating economic signals and incentives for flexibility and energy sector integration.

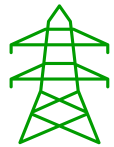
Especially the Nordic Balancing Program will be key to enabling such developments. Additionally, the increased coordination of operational planning among the Nordic TSOs through the Nordic Regional Coordination Centre and the new coordinated capacity calculation will benefit the region through improved utilization of the Nordic transmission network.

The Implementation Plan of the Nordic TSO strategy presents the prioritized measures under the selected strategic themes that the Nordic TSOs plan to initiate working on to start paving the way for offshore development and sector integration.

The Implementation Plan – like the strategy itself – contains measures that the Nordic electricity TSOs jointly need to work on: what is there for the TSOs and what is there for their Nordic cooperation.

The progress of the Implementation Plan will be monitored and updated at least on an annual basis. Therefore, it is possible to take into account the developments in the sector as well as newly identified tasks.

Adequate system infrastructure

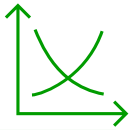


	Strategic subtheme	Description of the measure	Key deliverable(s)	Deadline	Responsible
1	**Coordinated modeling and timely planning for a reliable converter dominated and sector integrated energy system**	Profound and common understanding of joint Nordic system challenges and solutions	Nordic Grid Development Perspective	Q4-2025	NPG
			Common Nordic alignment on input to ENTSO-E Ten Year Network Development Plan (TYNDP) for 2026	Q4-2025	NPG
		Establish, update and develop joint Nordic grid model for system analysis	Nordic planning model exchange process implemented, and first model released for TSO use	Q1-2025	NPG
2	**Knowledge sharing to speed up connection to grid and to fully utilize grid capacity**	Harmonize technical requirements towards customers	Common technical requirements for converters; batteries, HVDC, STATCOM, wind and solar plants	2026-2027	NPG (through ConDoN project)
		Coordination of connection and dimensioning principles	Mapping of best practices and competences	2025	NPG
			Ensured interoperability of converters in cross-border regions	Q4-2026	NPG (through ConDoN project)
3	**Common Nordic positions on technical solutions and requirements**	The most efficient technical solutions to support system stability	Management of converter response and stability developed	Q4-2025	NPG (through ConDoN project)
			Update of common planning guideline to include the impact of converter connected generation	Q4-2026	NPG (through ConDoN project)

Secure and optimized energy system

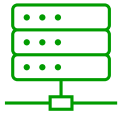
	Strategic subtheme	Description of the measure	Key deliverable(s)	Deadline	Responsible
1	**Ensure system security with timely technical requirements and tools for robustness and resilience**	Maximize the joint value of mFRR energy activation market, Flowbased capacity calculation and 15-minute markets in operational systems	Initial hurdles and deployment challenges in the wake of launching mFRR energy activation market, Flowbased and 15-minute markets in operational systems are mitigated	Q4-2025	RGN
		Continuous development of reserve principles and tools to match the green transition and introduction of new markets	FCR (Frequency Containment Reserve) requirements implemented	2025	RGN
			Future technical requirements for ancillary services mapped	2025	RGN
2	**Dynamic system support and automated processes**	Ensuring FRR needs as to meet requirements from Nordic Balancing Model	Dynamic Dimensioning implemented	2024	RGN
		DSA/WAMS (Dynamic Stability Assessment/Wide Area Monitoring System)	DSA/WAMS implemented in control centres and best practice identified	2027	RGN in coordination with ConDoN
3	**State of the art crisis preparedness for system security**	Identify impacts of extreme events and provide for training and simulation purposes	Best practice for simulation facilities in control centres implemented in Nordic training procedures	2025	RGN
		Development of Nordic training programmes and governances to prepare for extreme operational situations	Update of Nordic SOA (System Operation Agreement)	2026	RGN

Energy markets that enable



	Strategic subtheme	Description of the measure	Key deliverable(s)	Deadline	Responsible
1	**Create a framework for flexibility across all technologies**	Knowledge sharing on regulatory framework and market barriers across technologies	Experience and recommendation report on market setup for batteries and other storage technologies	Q1-2025	MSG
		Explore opportunities for common Nordic FCR market	Roadmap for common Nordic FCR market	Q4-2025	MSG
		Remove market barriers for smaller actors to have a larger, more diverse actor landscape	Pre-study on harmonization on aggregators, BRPs/BSPs, market actor support and technical requirements including pre-qualification	2028	MSG
2	**Introduce offshore bidding zones and integrate offshore solutions into the electricity markets**	Market framework for offshore development	Pre-study on common Nordic position on balancing and reserve dimensioning in an offshore development context	2025	MSG
3	**Ensure market mechanisms to ensure adequacy and reduce grid expansions**	Increased grid utilization from Flowbased and related projects	Flowbased market coupling implemented	2024	Flowbased project
		MARI and PICASSO	Nordic accession to MARI and PICASSO	2026	MARI/PICASSO project group
		Local flexibility and coordination with DSOs and other market actors	Coordinated implementation of grid code on Demand Side Response (DSR)	2026	MSG
		Adequacy and capacity mechanisms	Pre-study on feasibility of common Nordic position on adequacy and capacity mechanisms	TBD	MSG
			Knowledge sharing of capacity mechanisms in the Nordics and yearly consequence analysis on Nordic adequacy and impact on markets	Annually	MSG
		Analyze and monitor imbalances and undesirable market behavior + explore incidents and malfunctions	Present development and causes of imbalances in the Nordics incl. monitoring and reporting from eSett	Ad hoc	MSG

The digital foundation



	Strategic subtheme	Description of the measure	Key deliverable(s)	Deadline	Responsible
1	**Ensuring Nordic synergies on information-, data- and system architecture**	Establish Nordic downstream market Business Requirement Specifications (BRS)	Common Information Model (CIM) model/communication standard implemented	2027	NIT
		Outlining new requirements for ECP (Energy Communication Platform) incl. new secure Nordic communication platform	ECCO SP Energy Communication Platform as deliverable to NBM	2024	NIT
		Establish overview of Nordic IT services, applications and platforms	Capability mapping of Nordic systems and develop a Nordic IT systems roadmap	2025	NIT
		Establish harmonized guidelines for our Nordic IT system development	Architectural guidelines for common Nordic IT systems	2026/2027	NIT
2	**Ensuring strong Nordic and European cooperation within cyber security**	Nordic system security requirements	Common security standards implemented in MVS (Minimum Viable Solution) security plan	2025	NIT
		Nordic push for higher cyber security	European network code for cyber security implemented	2024-2026	NIT
3	**Establish Nordic common services and IT platforms for the balancing and electricity markets**	Efficient and secure IT deliverables for Nordic Balancing Model (NBM)	Platforms for Nordic Balancing Model delivered	2024	NBM project
		Efficient and secure IT deliverables for Flowbased capacity calculation	Platform for Flowbased delivered	2024	Flowbased project

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