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Development Fund



HELLENIC REPUBLIC
Ministry of Economy
and Finance

Special Secretariat for
ERDF & CF Programmes
Managing Authority of "Competitiveness" Programme



GENERAL SECRETARIAT FOR
RESEARCH AND INNOVATION

ΕΡΑνεΚ 2014-2020
OPERATIONAL PROGRAMME
COMPETITIVENESS
ENTREPRENEURSHIP
INNOVATION



Co-financed by Greece and the European Union

NAMED

Development of:

Nanotechnology-enabled “next-generation”

Membranes and their applications

in Low-Energy, zero liquid discharge

Desalination membrane systems.

Consortium and Dates

- Eastern Macedonia & Thrace Institute of Technology
 - ECOTECH
 - Helmholtz Association of German Research Centres
 - FutureCarbon GmbH
-
- 1 March 2018 (German Partners)
 - 29 May 2018 (Greek Partners)
 - 24 May 2021 (End of Project)
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AIM

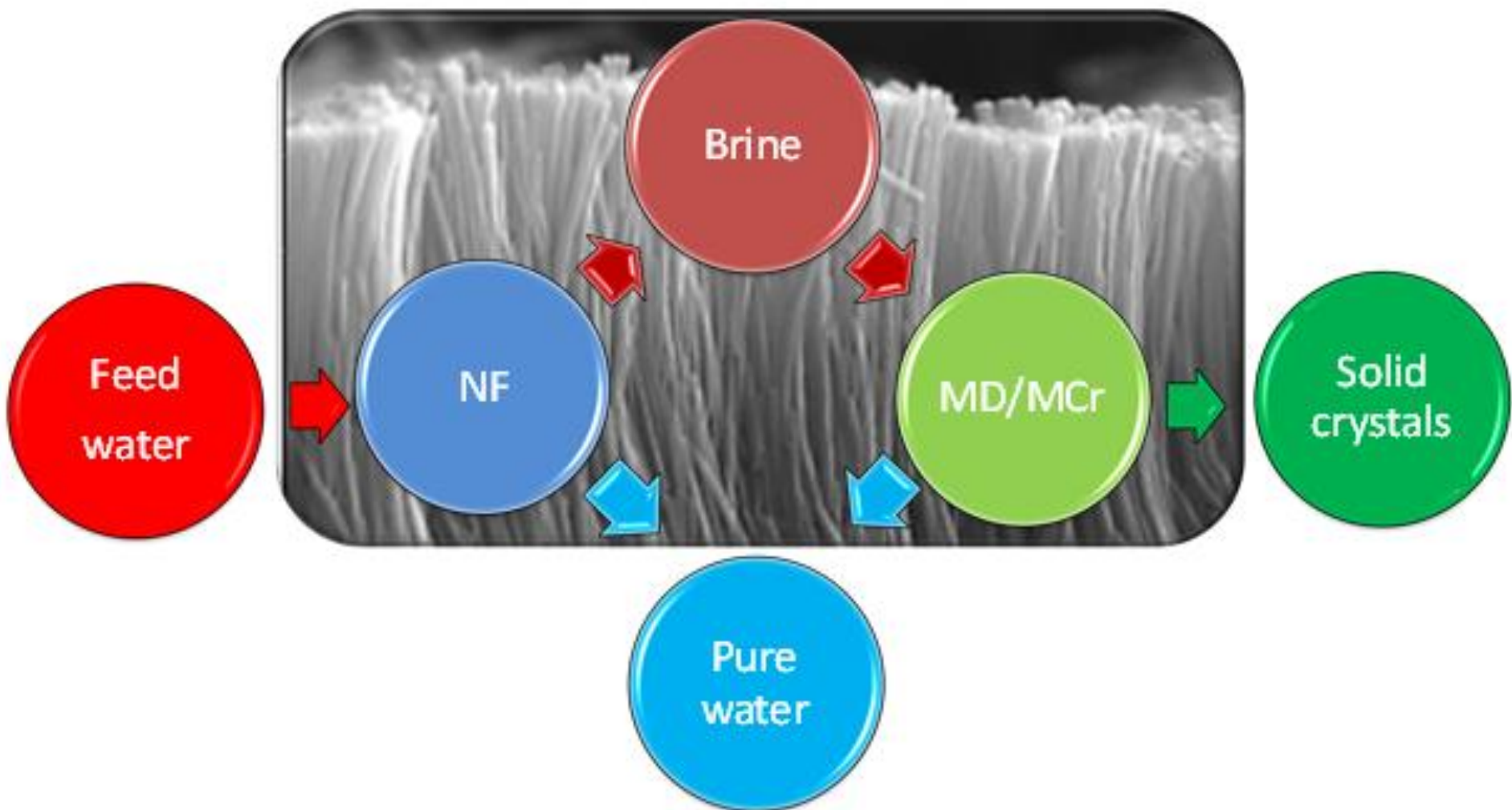
The aim of the project is to develop the “next-generation” of desalination systems by combining innovative membranes to:

membrane-distillation

membrane-crystallization (MD/MCr) unit

with nanofiltration and/or ultrafiltration (NF/UF)

that overall exhibit low energy consumption and minimum fouling problems to a friendly environmental process of low cost.



INDUSTRIAL PROBLEM

The currently used technologies are quite energy consuming.

The management of the generated by-product (brine) is inefficient.

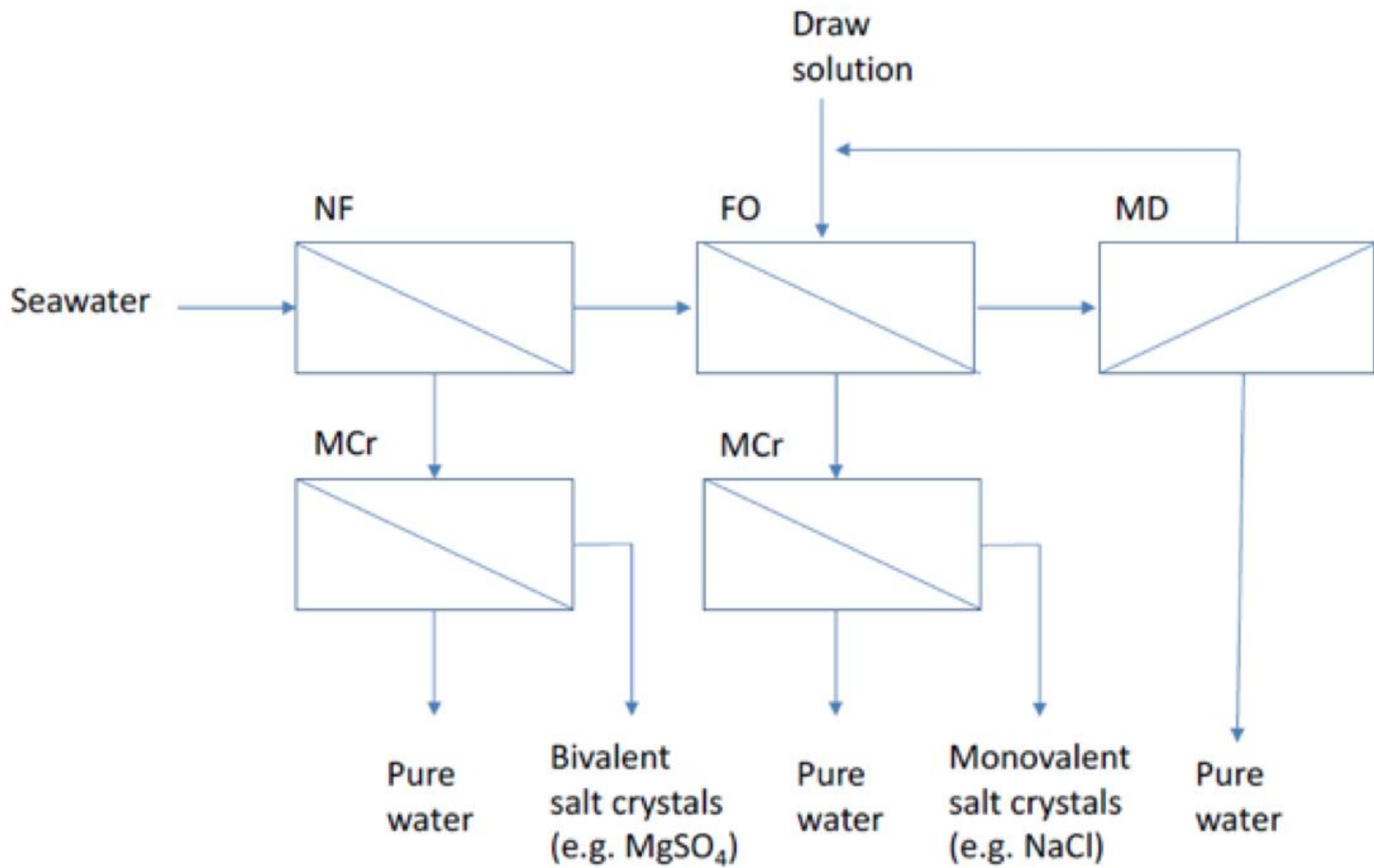
There is a need to replace fossil fuels with renewable energy

PROPOSED SOLUTION

NAMED will address the aforementioned problems by developing a novel solar powered desalination system with low energy consumption, which combines different novel membranes and technologies with minimum environmental impact, low cost, re-utilization of waste and high efficiency. In more details the system is combining an innovative unit of:

- ❑ Forward-osmosis (FO)
- ❑ Membrane-distillation (MD)
- ❑ Membrane-crystallization (MCr)
- ❑ Nanofiltration (NF).

Recently developed nanotechnology techniques will be applied to develop this “next generation” membranes which will be evaluated and one NF, one FO and one MD/MCr membrane will be selected, up-scaled and integrated in the NF/FO/MD/MCr hybrid desalination lab-pilot unit, which can be utilized for recovery of the brine water, valuable crystalline products (e.g. NaCl, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) avoiding/reducing the liquid discharge.



Work package number	1	Start date or starting event:			1
Work package title	Synthesis the “next-generation” NAMED membranes				
Activity Type	RTD				
Participant number	1	2	3	4	
Participant short name	TEMT	ECO	HZG	FCAR	
Person months	0	0	26	20	

Objectives
The preparation of the “next-generation” NAMED membranes

Description of work

Task 1.1 Synthesis of Aligned Carbon Nanotube Membrane: With uniform length 60 nm and internal diameters ranging from 4 nm to 10 nm.

Task 1.2 Synthesis of microporous hollow fiber membranes: Carbon hollow fiber membranes will be prepared via controlled carbonization of P84 polyimide hollow fiber precursors. The effect of spinning conditions, such as air gap, polymer concentration in extruded solution, take up velocity etc in structural and permeation properties of polymeric hollow fiber membranes will be studied. In addition, the effect of pyrolysis environment (heat flow rate, inert gases or vacuum, final pyrolysis temperature) on the microporous structure will be also evaluated.

Task 1.3 Synthesis of integral asymmetric membranes with branched polyolefins. The right conditions must be determined for a phase inversion process. Functionalization of carbon nanomaterials (CNT, graphene) to make them dispersible in the membrane casting solutions (**HZG**).

Task 1.4. Synthesis of Graphene Membranes : Oxidative treatment of the nanocarbon particles, preferably by plasma, wet chemical treatment in HNO₃ could be an option. Optimization towards defined amount of O-groups. Moreover, transfer the nanocarbon particles into dispersion, pasty form with highest concentration possible. If necessary dilute towards a defined concentration in a solvent compatible with the solvents used for casting the membranes.

Task 1.5. Synthesis of Hydrophobic and dense thin film composite membranes: Within the scope of this project, new monomers with tailor-made properties are to be synthesized. For desalination applications polar groups are necessary to be introduced in the membrane. For mechanical stability cross-linkable groups will be introduced. Another approach will be the synthesis of PIMs with hydrophilic polymer blocks such as poly (ethylene oxide). Regarding the thermal properties of PIM; it is known that they do not exhibit any glass transition temperature and that they are highly thermal stable polymers with decomposition temperatures above 400°C.

Task 1.6. Synthesis of Carbon nanotube (CNT) and graphene oxide composite membranes: First the functionalization of the CNTs and GOs will be at the forefront for a better dispersion. The objective will be the increase of hydrophobicity and mechanical stability. The increase of the surface roughness by protrude CNTs and GOs will be another advantage for the decrease of fouling behavior.

Task 1.7. Selection of most appropriate membranes: The most appropriate membranes for MD/NF/UF/MC_r will be selected for upscaling.

Deliverables

D1.1 Report on Aligned Carbon Nanotube Membrane

D1.2 Report on microporous hollow fiber membranes

D1.3. Report on integral asymmetric membranes with branched polyolefins

D1.4. Report on Graphene Membranes

D1.5 Report on Hydrophobic and dense thin film composite membranes

D1.6. Report on Carbon nanotube (CNT) composite membranes

D1.7. Report on an up scaled membranes

Work package number	2	Start date or starting event:			3
Work package title	Characterisation of the NAMED membranes				
Activity Type	RTD				
Participant number	1	2	3	4	
Participant short name	TEMT	ECO	HZG	FCAR	
Person months	20.25	0	4	2	

Objectives
The prepared membranes from WP1 will be evaluated comparatively and the most promising ones will be optimized and up scaled for the lab scale NAMED pilot unit.

Description of work
Task 2.1 Advanced techniques: Such as simple and mixture gas permeability, relative permeability, scanning electron microscopy (SEM), x-ray diffraction (XRD), small angle x-ray and neutron scattering (SAXS/SANS) nitrogen porosimetry, high pressure gas adsorption will be used in order to estimate properties such as pore size, the surface properties and the tortuosity
Task 2.2 The effect of spinning conditions: such as air gap, polymer concentration in extruded solution, take up velocity, etc. in structural and permeation properties of polymeric hollow fiber membranes will be studied. In addition, the effect of pyrolysis environment (heat flow rate, inert gases or vacuum, final pyrolysis temperature) on the microporous structure will be also evaluated.
Task 2.3. In-situ rotational SAXS: Simulation and characterization of liquid flow within the porous media will be undertaken.

Deliverables
D2.1 Report on the advanced characterization
D2.2. Report on the effect of synthesis conditions
D2.3. Report on simulation of liquid flow

Work package number	3	Start date or starting event:			12
Work package title	Hybrid lab pilot unit				
Activity Type	RTD				
Participant number	1	2	3	4	
Participant short name	TEMT	ECO	HZG		FCAR
Person months	21.15	16	4	0	

Objectives
The major goal of this WP is the development of a hybrid lab pilot unit integrated with TEIEMT's reviewable energy infrastructure. Existing MD and NF/UF membranes will be evaluated and further developed in WP2, thereafter two different types one NF/UF and one MD membrane will be selected, up-scaled and integrated in the NF/MD hybrid desalination lab-pilot unit. Moreover, development of a testing-facility for water vapor permeability and characterization of the membranes for their MD application performance.

Description of work
Task 3.1 Design of a hybrid desalination lab-pilot unit
Task 3.2 Development of a hybrid desalination lab-pilot unit
Task 3.3 Integration with TEI-EMT's renewable-energy infrastructure
Task 3.4 Testing of the hybrid desalination lab-pilot unit

Deliverables
D3.1 Report on the Lab pilot unit designs
D3.2 Lab pilot unit
D3.3. Report on the integration of the lab pilot unit with TEIEMT's renewable infrastructure
D3.4. Report on the results of the lab unit

Work package number	4	Start date or starting event:			28
Work package title	Feasibility Study				
Activity Type	RTD				
Participant number	1	2	3	4	
Participant short name	TEMT	ECO	HZG		FCAR
Person months	5	14	2	0	

Objectives
Development of models and simulation for upscaling the developed technologies.

Description of work

Task 4.1 Market research; market research will be undertaken to illustrate the characteristics unique to the water market to help make decisions for your business.

Task 4.2 Cost-benefit analysis; a systematic approach will be used to determine the strengths and weaknesses of the developed technologies, and map its position in the current state-of-the-art. The benefits and costs will be expressed in monetary terms, and adjusted for time, so that all flows of benefits over time are expressed on a common basis in terms of their net present value.

Task 4.3 Development of models; A dynamic lumped-parameter model will be derived using first-principles, computing parameters from experimental data to minimize the error between model predictions and the developed lab pilot desalination system.

Task 4.4 Development of simulation; a real-world simulation will be developed, that uses the model in the Previous deliverable to determine the right upscaling parameters and mechanisms for the potential development of An industrial desalination unit.

Deliverables

D4.1 Market research report

D4.2 Cost-benefit analysis

D4.3 Report on models

D4.4 Report on developed simulations

Work package number	5	Start date or starting event:			1
Work package title	Dissemination, Communication and Exploitation				
Activity Type	MGT				
Participant number	1	2	3	4	
Participant short name	TEMT	ECO	HZG		FCAR
Person months	36	36	36	36	
<p>Objectives concerned with a targeted set of activities to boost overall outreaching and dissemination as well as exploitation of NAMED project results, namely with the Effective exploitation of the project results and outcomes with respect to both technological results and intellectual property rights, the development of a series of outreaching and dissemination activities and the promotion of the project’s visibility.</p>					
<p>Description of work Task 5.1 Development of Public Relation Materials and project related communication materials. Task 5.2 Development of the <i>NAMED</i> web site Task 5.3 Participating in events, scientific meetings, brokerage events and exhibitions. Task 5.4 Organizing outreach actions with industry Task 5.5 IPR issues, development of patent applications and cooperation/licensing agreements. Task 5.6 Development of the Exploitation strategy</p>					
<p>Deliverables D5.1 <i>NAMED</i> Web site for inter-consortium communications and exchange of information and dissemination of project related activities. (M3) D5.2 Finalised plan of dissemination activities and science communication events (M6) D5.3 Exploitation Plan and Dissemination activities overview (M18) D5.4 Summary of project results pertaining to know how development, publications and patent field month</p>					

Work package number	6	Start date or starting event:			1
Work package title	Project Coordination				
Activity Type	MGT				
Participant number	1	2	3	4	
Participant short name	TEMT	ECO	HZG	FCAR	
Person months	36	36	36	36	

Objectives
 WP6 aims at effective and comprehensive management and timely implementation of project activities. This is done through project administration, financial coordination and quality, risks and innovation management. This WP is also in charge of the management and coordination of, the NAMED Steering Committee (SC) that will provide strategic guidance and promote the uptake of the results among the relevant stakeholders. Specific objectives are:

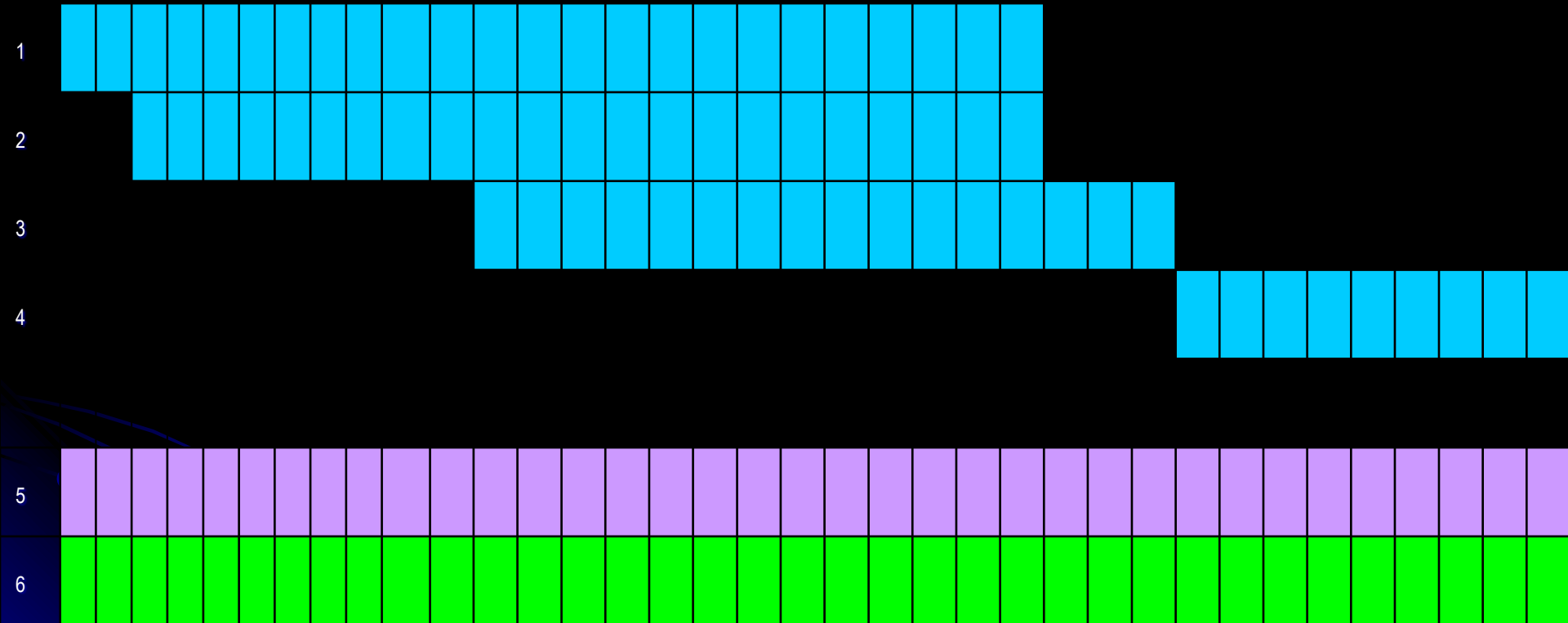
- Effective management and steering of the whole project
- Monitoring and reporting resource and financial expenditures and fulfilment of contractual obligations.
- Carrying out periodic communications and high-quality technical and financial reporting.
- Ensuring quality, risks and innovation management are addressed.
- Management and coordination of the NAMED Steering Committee (SC).

Description of work
Task 6.1. Project Administrative and Financial Coordination [M1-36] Project administrative coordination ensures and monitors the project planning and progress, it also ensures partners are fully informed about the status of the different activities that are underway and communication is regular
Task 6.2 Quality, Risks & Innovation management [M1-M36] Quality assurance and risk management is intended to ensure the production of concrete and high-quality results in line with the project work plan. To achieve this goal, a Quality Plan will be defined at the beginning of the project addressing the following topics: Quality requirements and quality control of the project & its deliverables; Organisational structure and planning and control; Files and archives management; Risk Management and contingency plans.
Task 6.3 Steering Committee (SC). Engagement [M1-M36] This committee will be established to offer advise on relevant issues.

Deliverables
D6.1 Quality assurance & Risk Management Plan (M2) Interrelate the project objectives' achievement with the quality requirements; enumerating tools and resources, including risk management procedures and the quality assurance plan.
D6.2 Steering Committee (SC). First Meetings (M12). The first meeting will be held to examine the current situation in the project, and provide strategic advice to support NAMED's objectives.
D6.3 Annual Activity and Financial Report (M12, M24, M36) summarises activities performed and planned in reporting period, including details financial expenditure, issues and deviations. The final report will also include a publishable summary.
M1 NAMED kick-off (M1); first meeting.

GR-TIMETABLE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36



Thank you for your attention.

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