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75 years

LTM API & LTM for Linux

Presented by he LTM API teams at SINTEF and Lyse

Plan

1) Intro [Bernt Garten Galtrud]
2) Status [BGG]
3) Design and technical solutions - [Kent Fagerjord]
4) How to use it? - [Harald Wilhelmsen]
5) Development process - [HW]
6) LTM API as seen and used by Lyse [Øivind Høivik and Ådne Øvrebø]
7) Questions?

1) Intro

a) What is it?

b) Why do we do it?

c) How is it organized?

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1a) What is the LTM API?

- New product/project/supported-OS
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➢ All the old LTM stuff is still there, but only as a hidden sub-component

➢ You do not need to care about all the details any more

1b) Why do we do it?

- If you:
  - Remember how it was to get started using LTM?
  - Ever tried to change an LTM dataset?
  - Ever been lost in the “brukerveiledning” (doc)?

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➢ Then you already know why …

1b) Why do we do it?

- Complex & hard task, but we do it such that you do not have to
- “Harmonisation” with the other SINTEF models
- Makes it easier to integrate LTM into other tools / workflows
- Facilitate use/transition to ngLTM + testing of both old and new

1c) How is it organized?

- SINTEF-project started up after last user meeting (November 2023)
- Lyse reached out for close cooperation:
  - Dedicated inhouse resources for extensive and continuous beta-testing
  - Pays for one of the developers in the project
- Funding: Sub-project of the “maintenance project” + devel from Lyse

1c) How is it organized?

- Current team: 3.5 developers + project leader (BGG)
  - Kent Fagerjord
  - Harald Wilhelmsen
  - Ole Martin Hansen
  - Emil Lysholm (50%)

2) Status

a) Current features

b) “Work-in-progress”

c) Roadmap(s)

2a) Current features

- Remodelled objects, not one-to-one file-API

- EMPS parallel sim
  - Detailed hydro
  - Aggregated hydro
  - Wind & solar
  - Batteries
  - Exogenous prices
  - Up to hourly resolution
  - …

2a) Current features

- EOPS series sim

- Linux
  - All API functionality => works on both OS
  - “Manual port” of a full CLI dataset from a customer

2b) “Work-in-progress”

- EMPS
  - MPI
  - FBMC
  - Series simulations

- CLI to API dataset converter tools

2c) Roadmap(s)

- Baseline – Current funding
  - 2025: EMPS & EOPS – parallel and series simulations (most LTM functionalities)
  - 2026 – 2027: “Advanced LTM functionalities ” (EMPS, EOPS, EMPS seasonal model)
  - 2028 - 2029: Samnett – detailed grid

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- Project proposal: Fast track Samnett API
  - Q2 2026: Full detailed grid modelling

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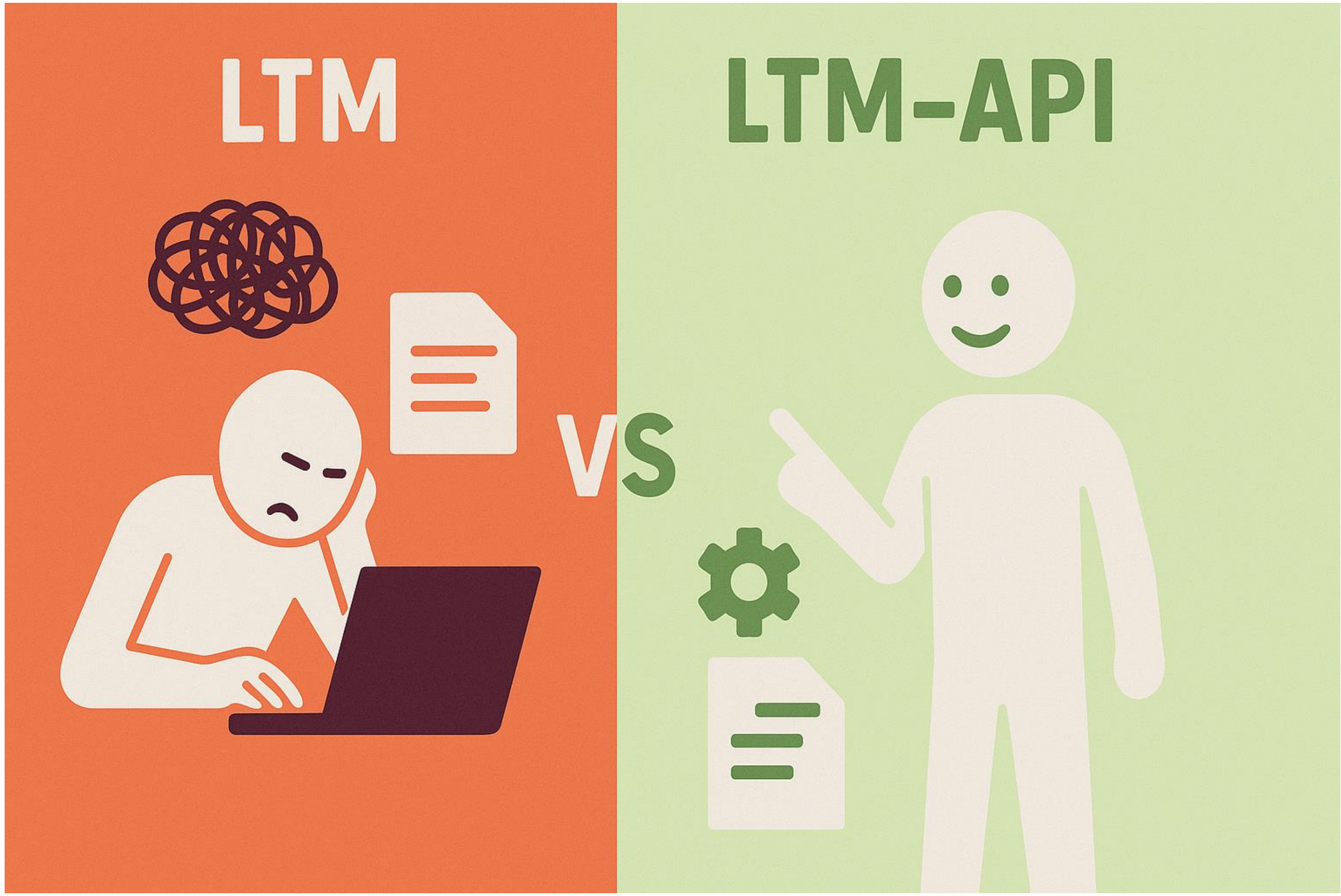
- Project proposal(s): Fast track advanced LTM functionalities
  - TBD …

Summary



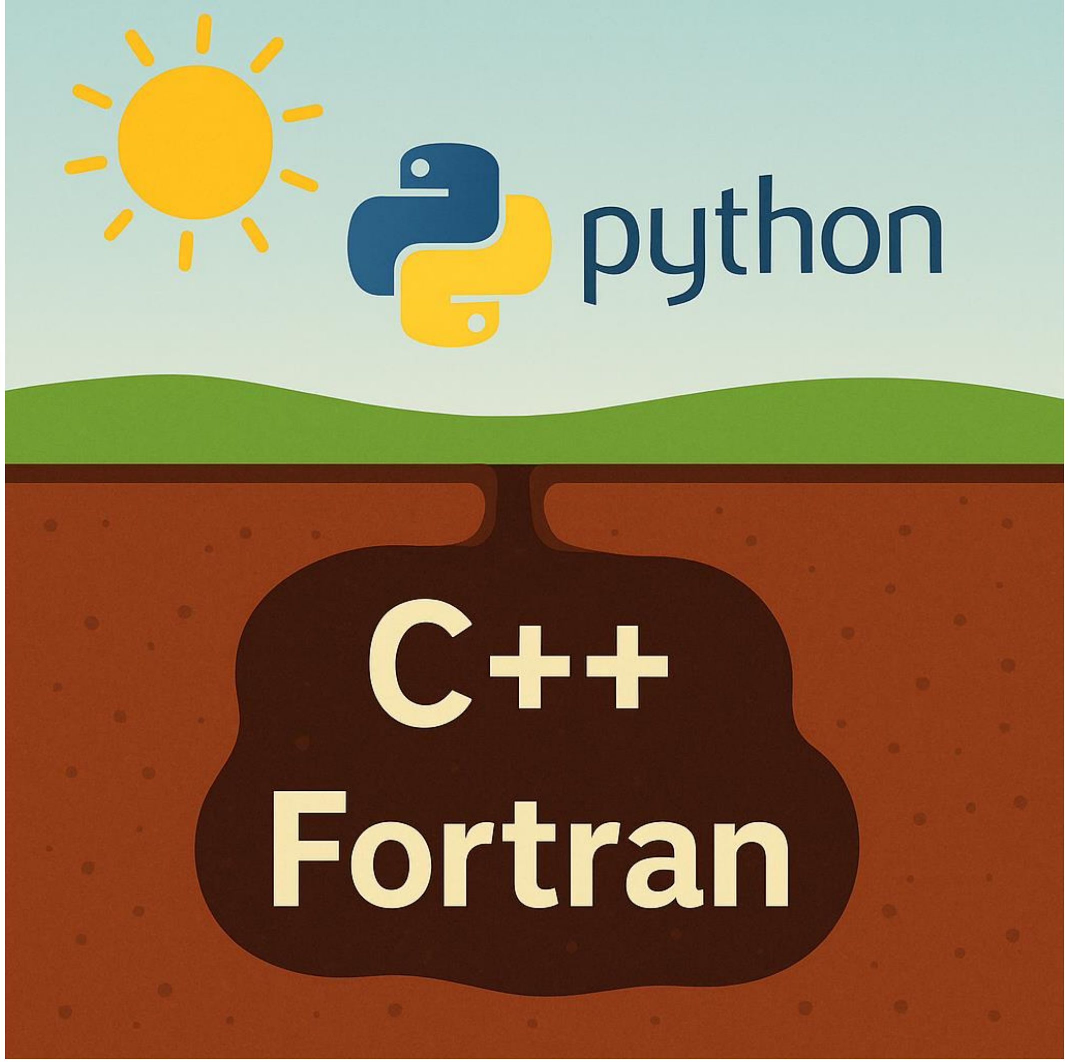
KISS – Keep it Simple & Stunning

- Driven by structured data

- Ensures internal data consistency for all LTM input files

- Common components with ngLTM
  - ltmio (Input / Output)
  - Timeseries library

Technology stack



Future interface:

- C++

Sub-surface:

- Safe and modern C++
- Unit test coverage >85%
- Python – C++ bridge with pybind11

ltmio

- Shared with ngLTM.
- Standalone readers and writers.

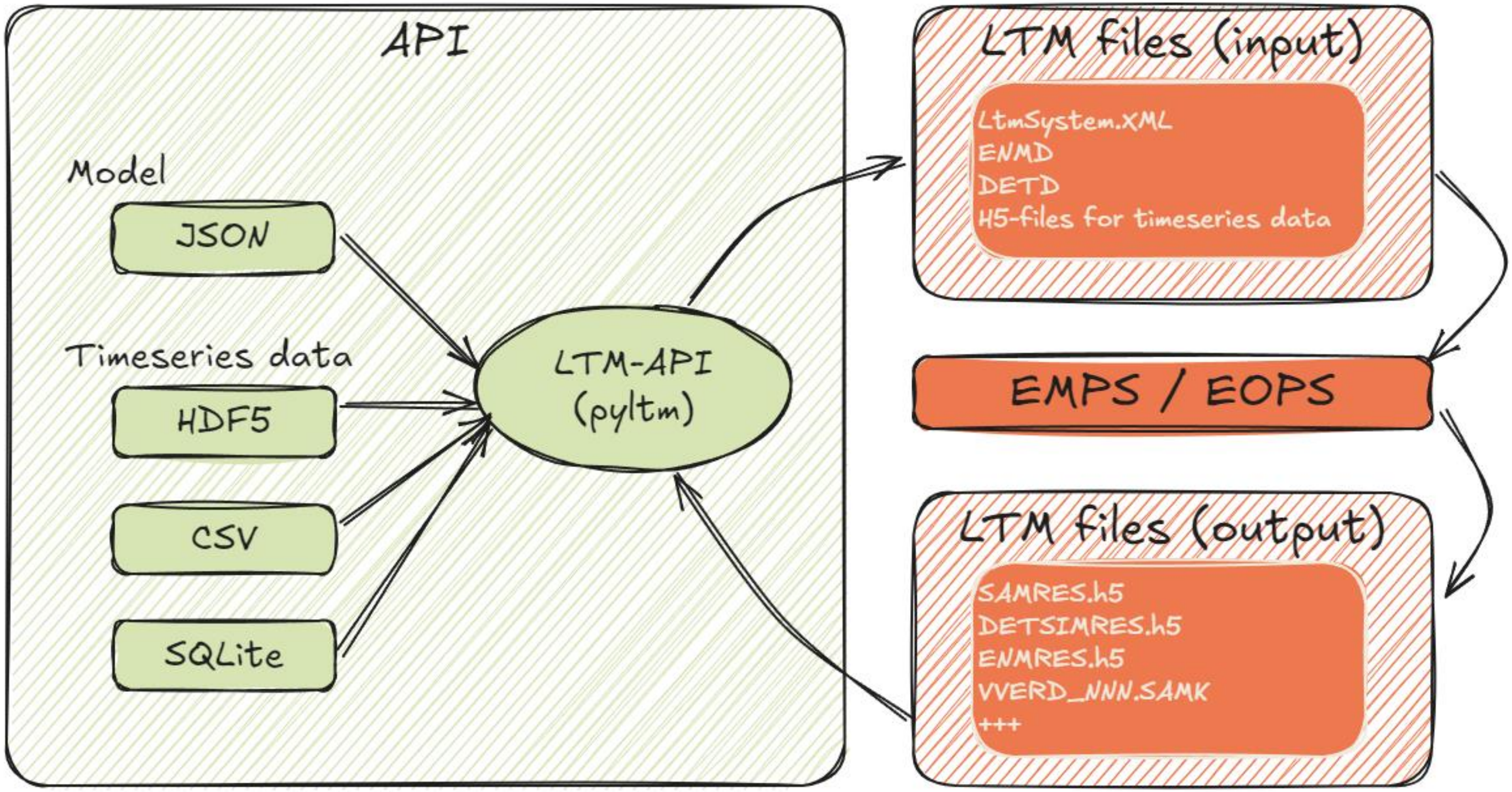
ltmapi

- Transforms the model into EMPS / EOPS compatible files
- Runs the model
- Results have a uniform shape

pyltm

- Bridge between Python and native C++ libraries

Very high-level data flow



4) How to use it?

Example JSON input file:

```
{
"model": {
    "global_settings": { ... },
    "busbars": [ ... ],
    "dclines": [ ... ],
    "loads": [ ... ],
    "inflow_series": [ ... ],
    "reservoirs": [ ... ],
    "plants": [ ... ],
    "detailed_hydro_modules": [ ... ],
    "aggregated_hydro_modules": [ ... ],
    "connections": [ ... ],
    "wind": [ ... ]
}
```

Example Python code:

```
from pyltmapi import LtmSession

ltm_core_path = <path to ltm-core>
license_file = <path to license_file>

with LtmSession("demo") as session:
    session.load(filename="model.json") # Convert json to c++ objects
    validation = session.validate_model() # Optional validation
    write_model = session.write_model() # Writes files to folder
    last_rc, results = session.execute_model() # Run ltm from folder
```

5) Workflow

a) Development and testing of new features

b) Packaged and distributed:

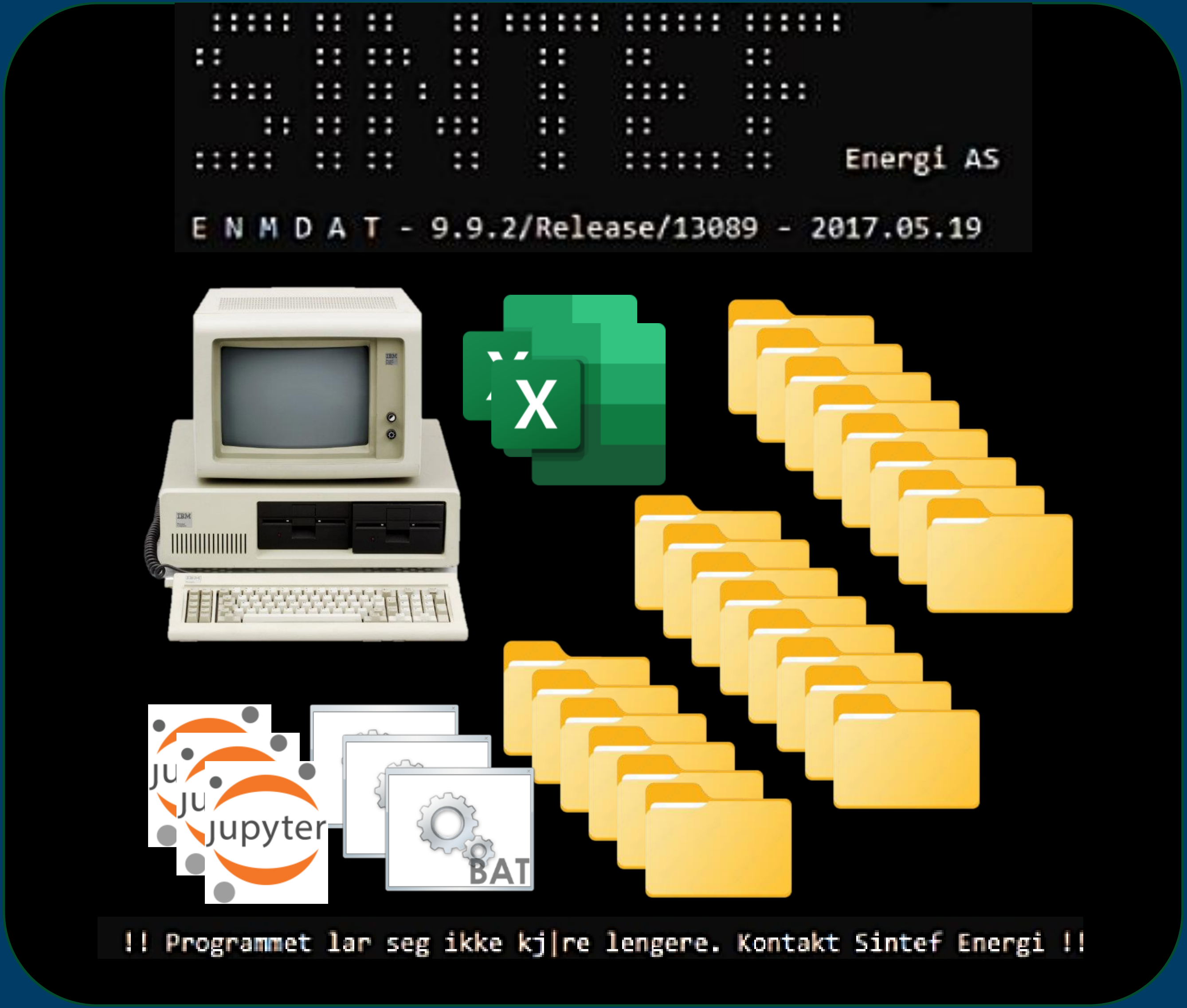
  - Release candidate (RC)
  - Stable releases uploaded to the LTM Portal

c) Test and feedback from Lyse on each RC

LTM API at Lyse

Hydropower Scheduling User meeting 2025

Lyse

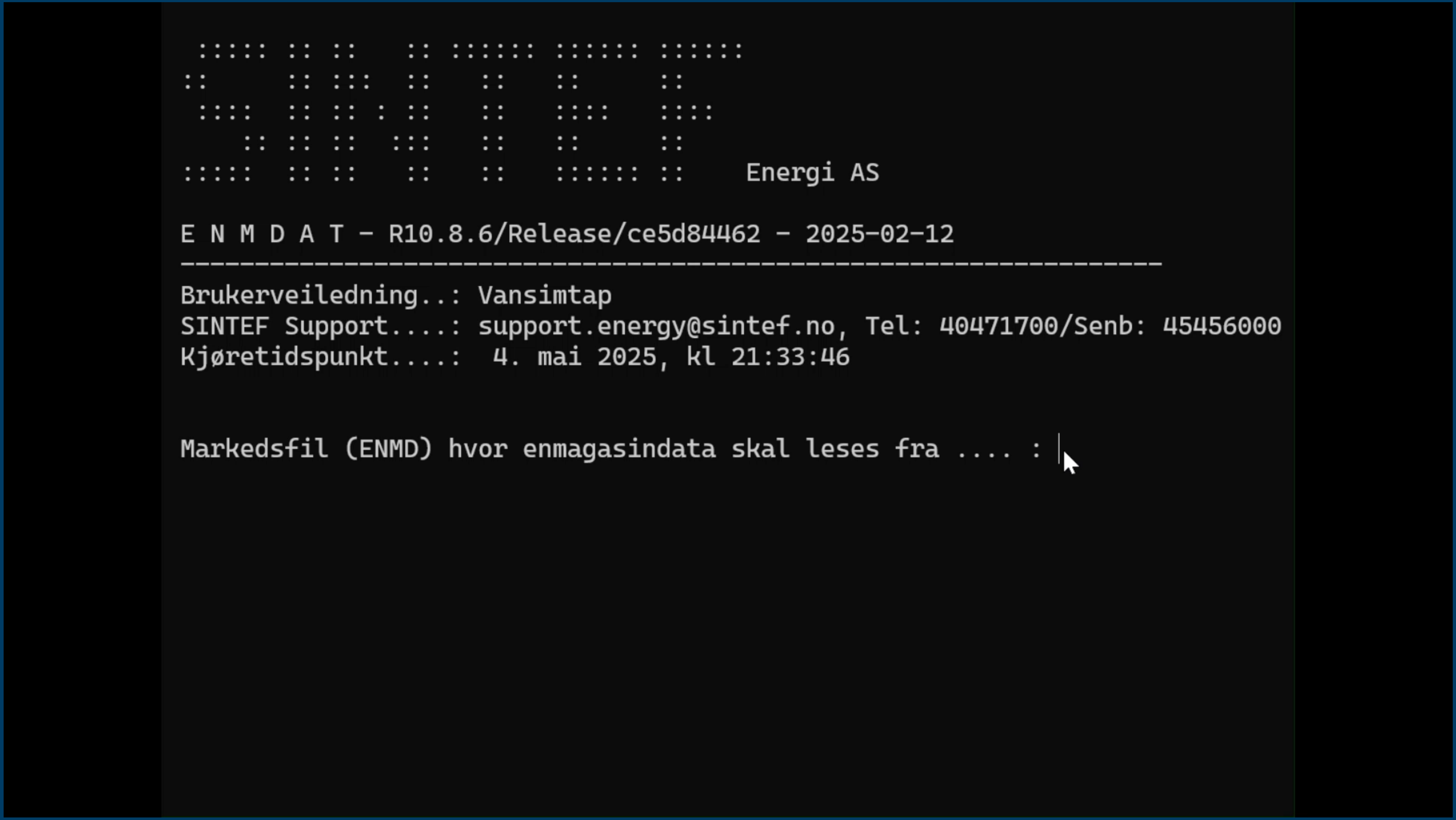


```
Energi AS
E N M D A T - 9.9.2/Release/13089 - 2017.05.19
```

```
!! Programmet lar seg ikke kj|re lengere. Kontakt Sintef Energi !!
```

Current operational EMPS setup

Example – Add load



```
   ::::: :: ::   :: :::::: :::::: ::::::
  ::     :: :::  ::   ::   ::     ::
   ::::  :: :: : ::   ::   ::::   ::::
      :: :: ::  :::   ::   ::     ::
  :::::  :: ::   ::   ::   :::::: ::    Energi AS

E N M D A T - R10.8.6/Release/ce5d84462 - 2025-02-12
------------------------------------------------------------------
Brukerveiledning..: Vansimtap
SINTEF Support....: support.energy@sintef.no, Tel: 40471700/Senb: 45456000
Kjøretidspunkt....:  4. mai 2025, kl 21:33:46


Markedsfil (ENMD) hvor enmagasindata skal leses fra .... :
```

Lyse

End goal

One model representation

One runtime environment

LTM|EMPS

LTM|EOPS

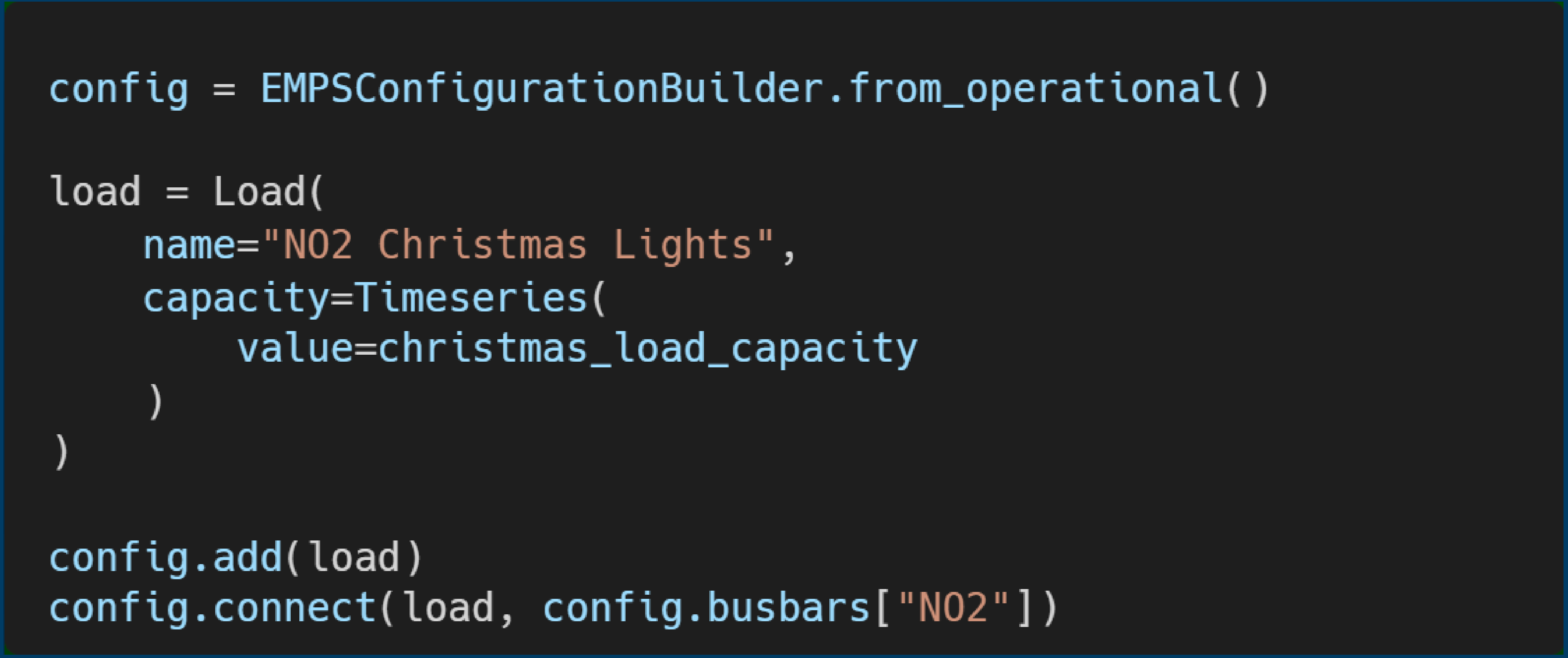
Prodrisk

SHOP

++

One common way of handling results

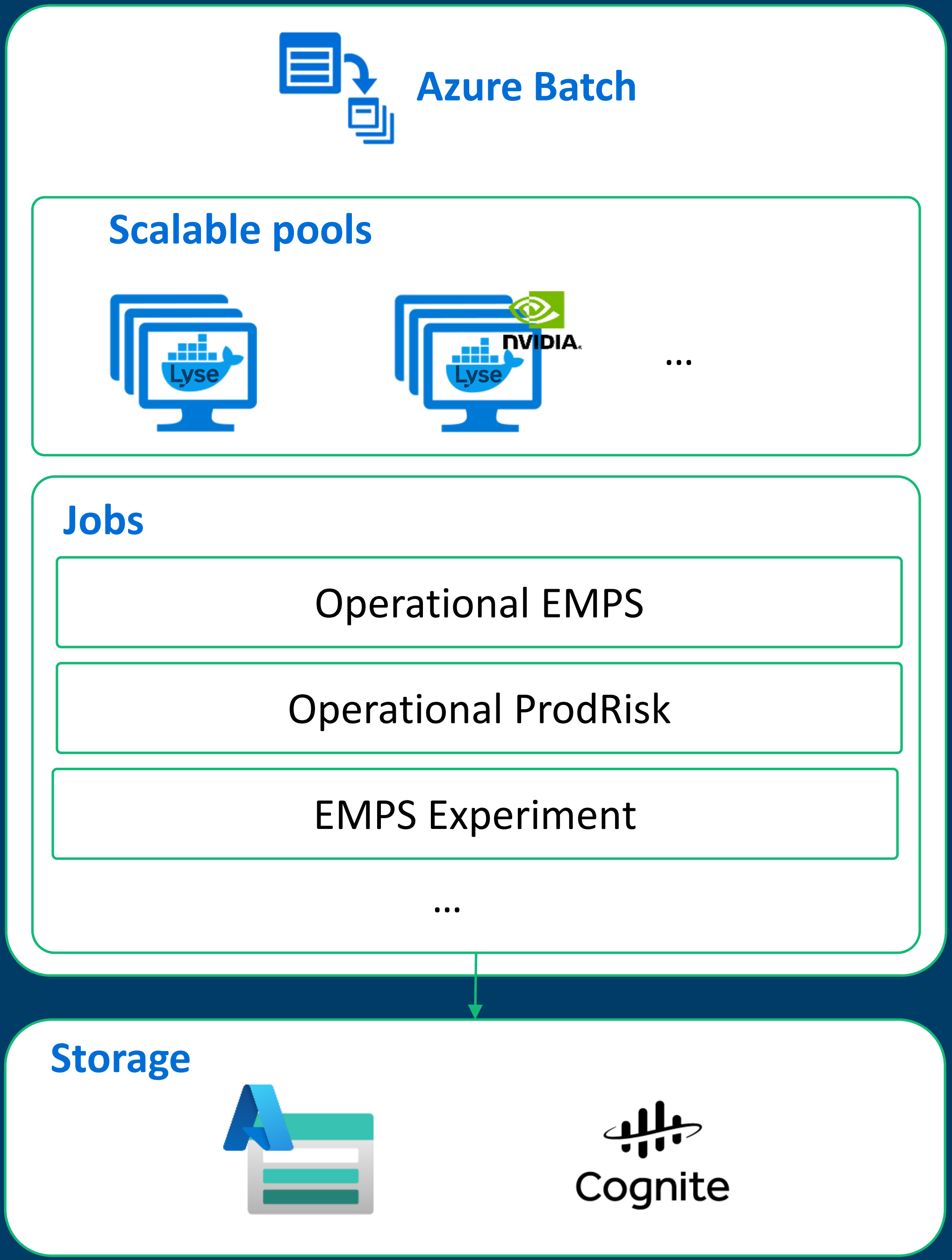
Example – Add load



```
config = EMPSConfigurationBuilder.from_operational()

load = Load(
    name="NO2 Christmas Lights",
    capacity=Timeseries(
        value=christmas_load_capacity
    )
)

config.add(load)
config.connect(load, config.busbars["NO2"])
```



Azure Batch

Scalable pools

…

Jobs

Operational EMPS

Operational ProdRisk

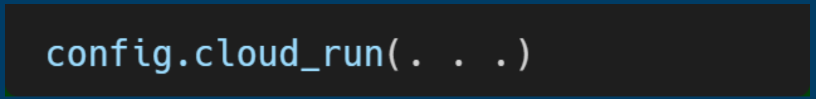
EMPS Experiment

…

Storage

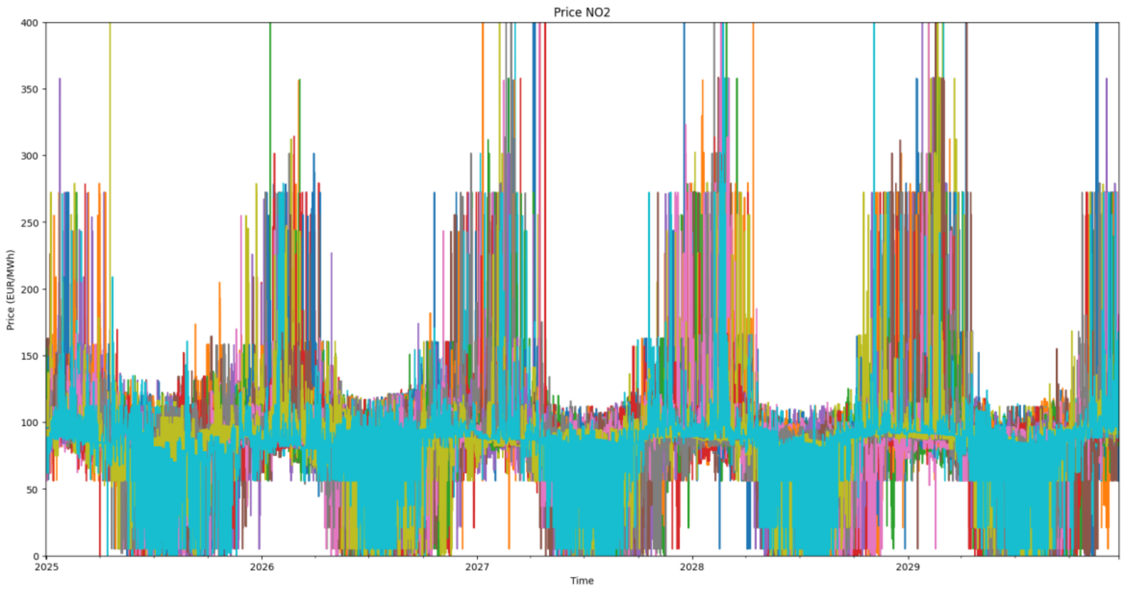
Infrastructure

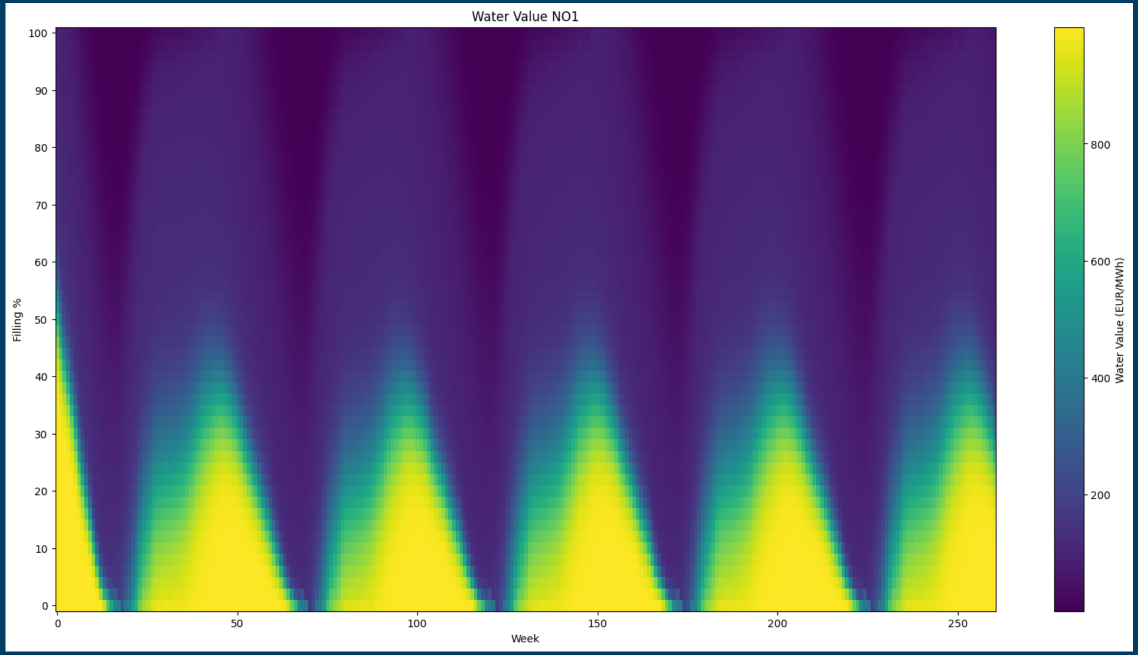
- Linux version
  - Containerization
    - Unified environment for all models
  - Full version control
  - Dev Containers
- Azure Batch
  - Near-infinite compute
  - Cost-efficiency
  - Parallelization
  - Resource Targeting



```
config.cloud_run(. . .)
```

Lyse





Current state

- Building LTM models using multiple sources
    - NVE, Volue, Nena, Volt, TheMA, inhouse data/models
- Close to operational EMPS model
- Able to run EOPS -> Prodrisk
- Converted watercourses

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7) Questions?

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1950 – 2025
Technology for a better society

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