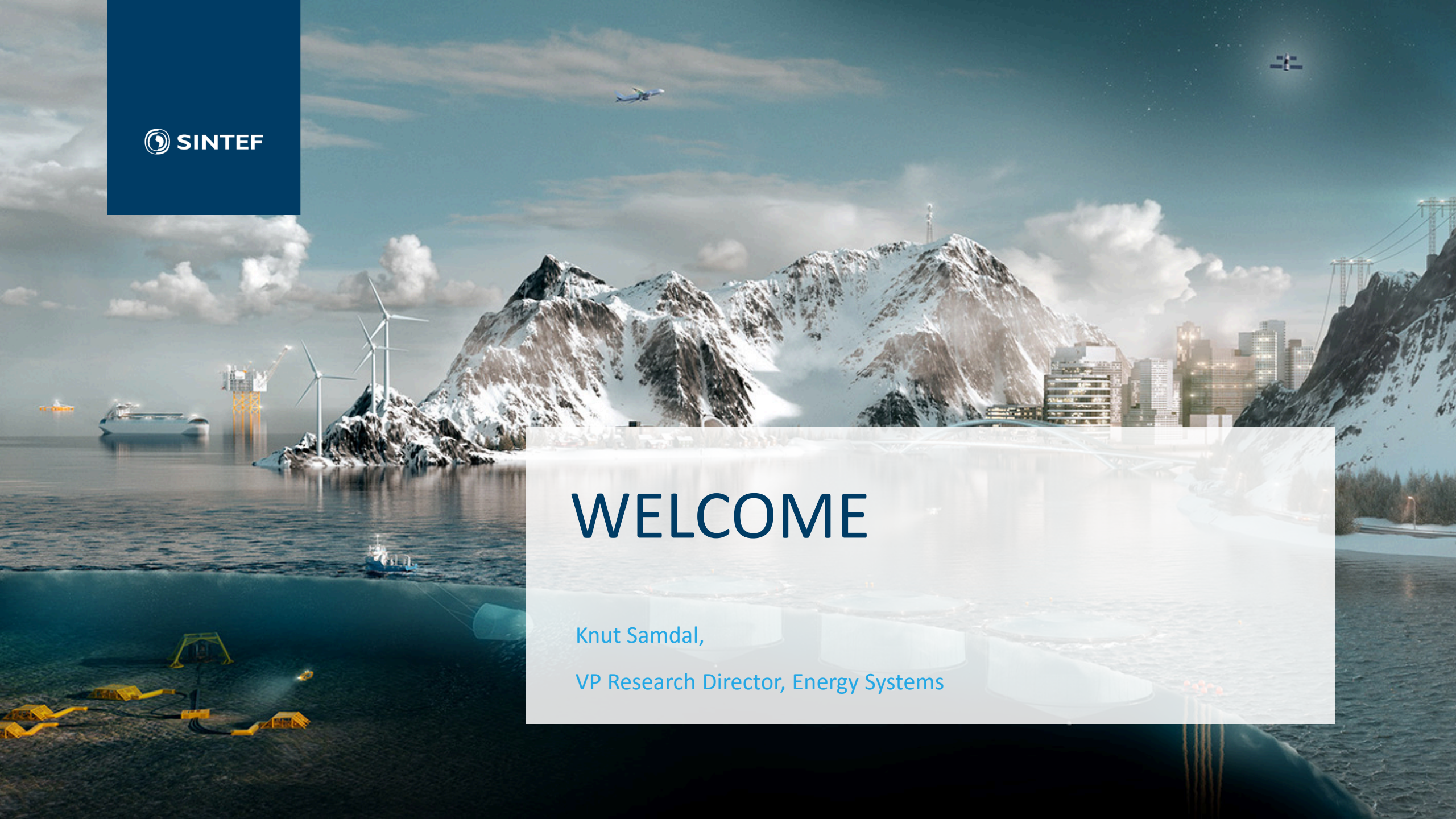


WELCOME

Knut Samdal,

VP Research Director, Energy Systems

One of Europe’s largest independent research organisations

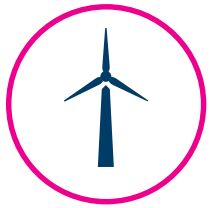
NOK 3.2 billion
Revenues

NOK 450 MILL
International sales

SINTEF

Applied research, technology and innovation

Expertise from ocean space to outer space:


Renewable energy


Ocean space


Industry


Buildings and infrastructure


Materials


Micro-, nano- and biotechnology


Climate and environment


Oil and gas


Health and welfare


Society


Digitalization


Transport

SINTEF

Our vision: **Technology for a better society**

SINTEF develops society through research and innovation

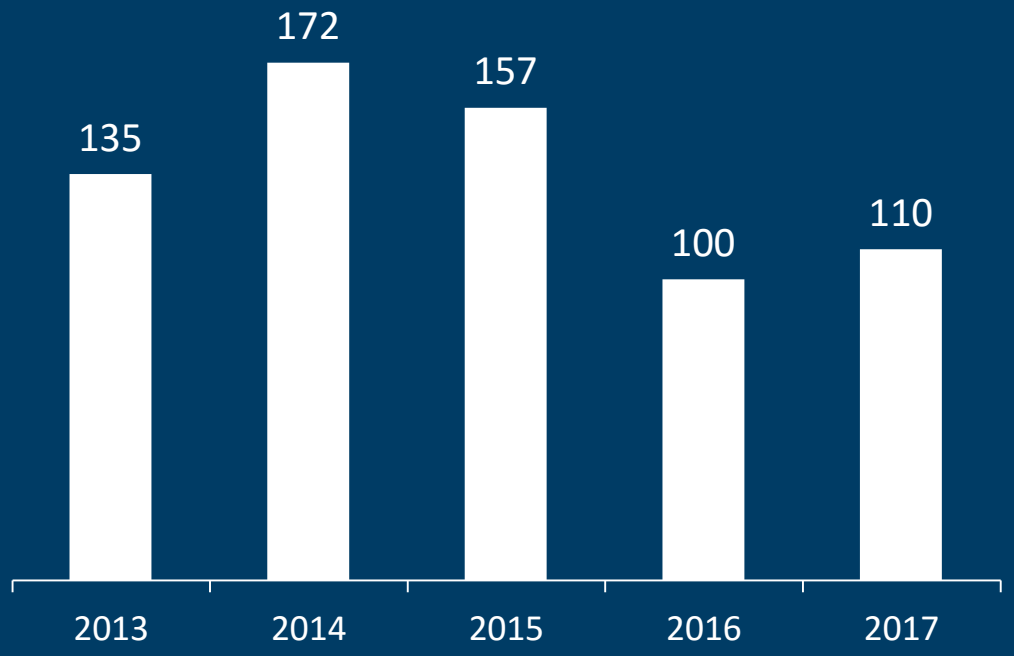
- We create value and develop solutions to challenges faced by society
- We actively and boldly communicate our knowledge, solutions and recommendations

SINTEF

AN INDEPENDENT, NOT-FOR-PROFIT RESEARCH INSTITUTE

SINTEF

We invest our profits in laboratories and knowledge generation



Investments in laboratories, scientific equipment and buildings (NOK mill)

SINTEF

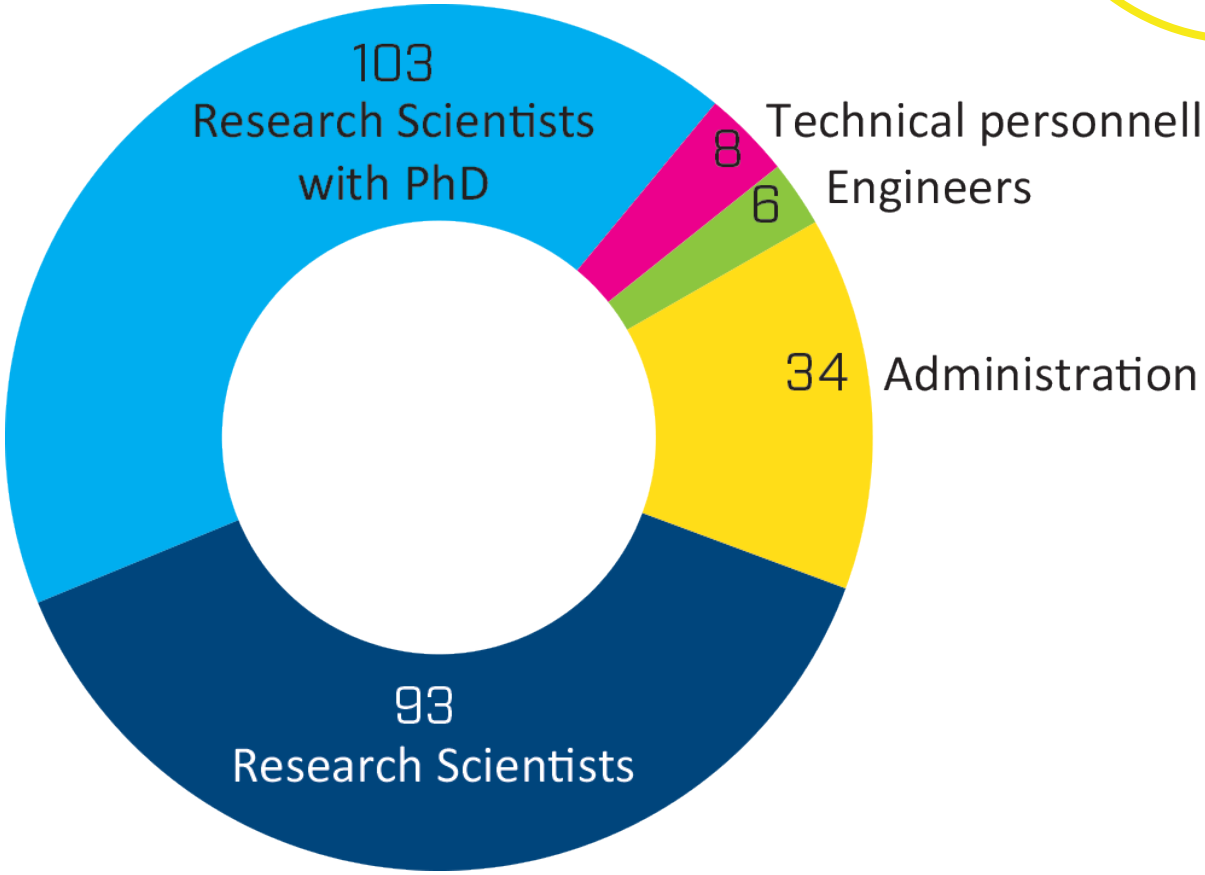
This is SINTEF Energy Research

- We shape energy solutions for the future
- SINTEF Energy Research is an institute for applied research dedicated to create innovative energy solutions.
- We offer cutting-edge knowledge based on research that provides our clients with added-value solutions and services.

SINTEF

Employees

244
employees



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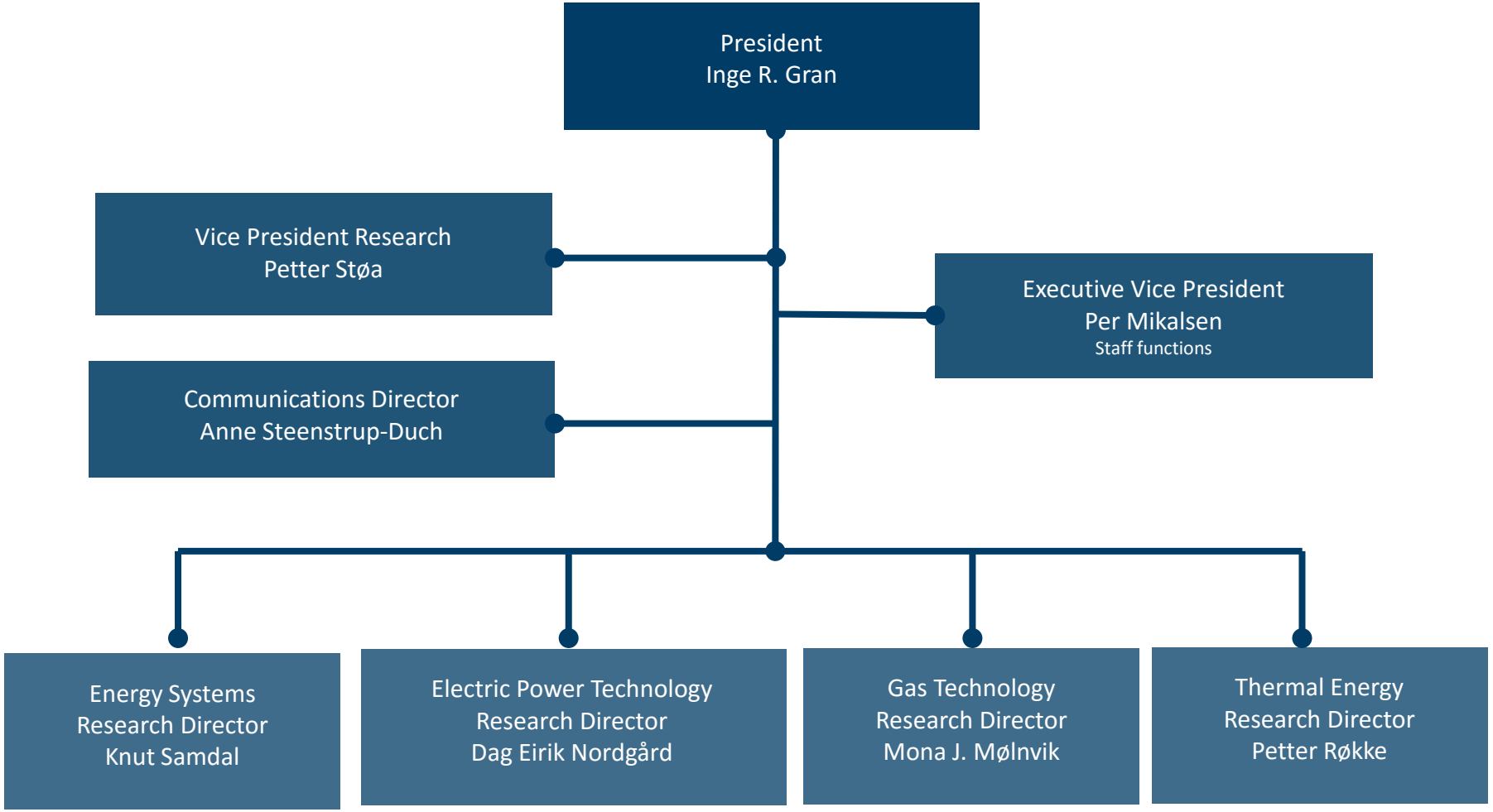
Organisation – SINTEF Energy Research



Energy Systems Department

Knut Samdal
VP, Research Director
Energy Systems

Oddbjørn Gjerde

Research Manager
Power System Asset Management

Julie Charmasson

Research Manager
Water resources

Henning Taxt

Research Manager
Active distribution grids

- Approx 80 full time researchers
- NTNU professors holds position as scientific advisors
- Extensive research facilities (SINTEF Energy Lab, Power Electronics lab, Smartgrid lab, Subsea Lab, Software models and more

Christian Andresen

Research Manager
Analytics

Ellen Krohn Aasgård

Research Manager
Operations

Arild Helseth

Research Manager
Markets

John Olav G. Tande

Research Manager
Power Conversion

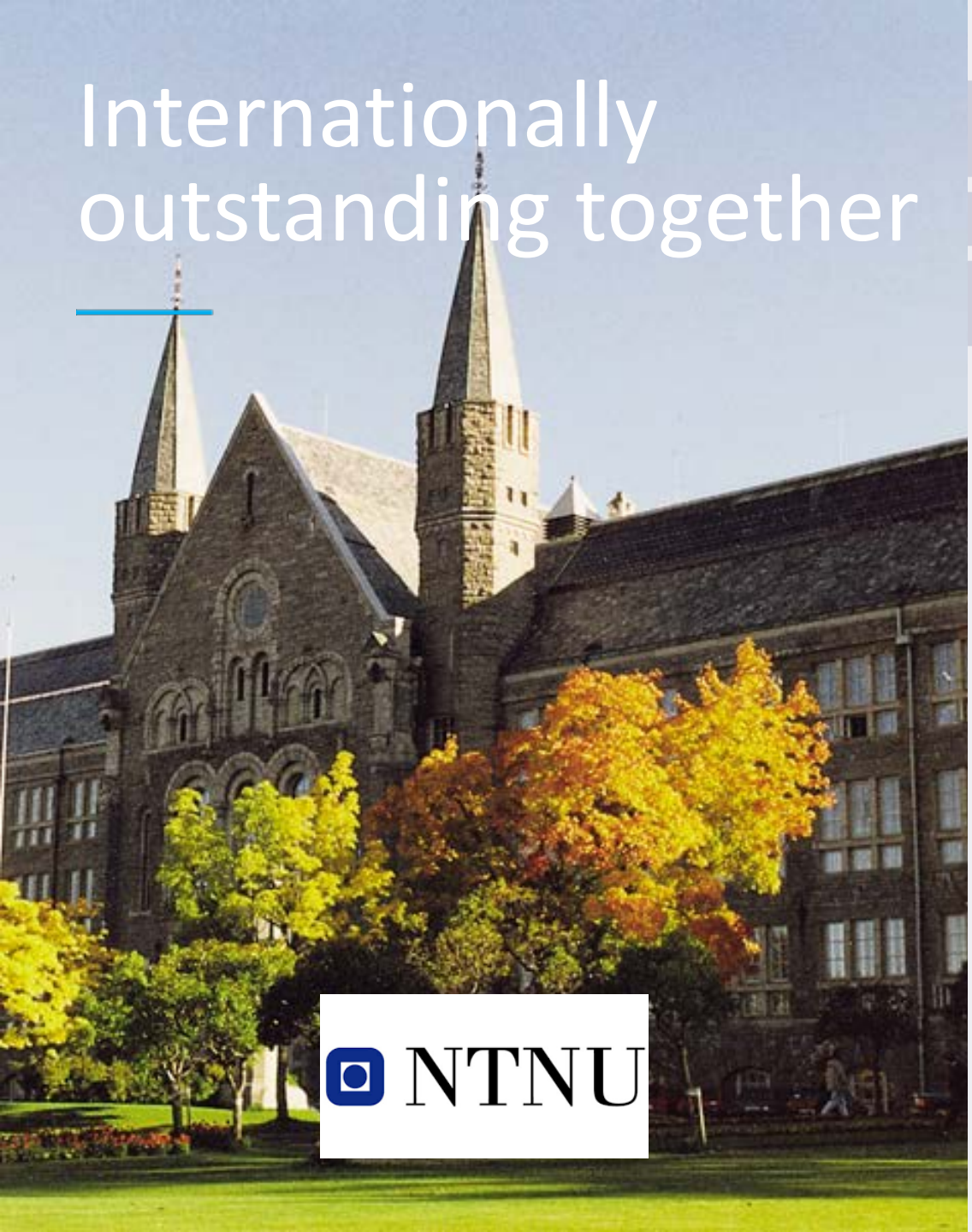
SINTEF

Partnership with NTNU

- Strategic and operational cooperation since 1950
- Joint use of laboratories and equipment
- Cooperation covers research projects, research centers and teaching

SINTEF

Internationally outstanding together



FILE EDIT VIEW PROJECT BUILD DEBUG TEAM TOOLS TEST ANALYZE WINDOW HELP

Sign in

Local Windows Debugger | Debug_v

shop_python_service.cs | shop_message_list.h | shop_message.cpp | shop_cut_desc.cpp

(Global Scope) | SHOP_select_end_desc(SHOP_SYS * pSys, int s)

```
if (rsv->schedule && schedule_flag == 1)
{
  vol_sched = SHOP_get_internal_txy_value(rsv->schedule, time_int->num_intervals, s); /* use enc
  if ( (vol_sched >= 0.|| rsv->upper_slack) && ( vol_sched <= maxvol || rsv->lower_slack) )
  {
    if ( rsv->lower_slack )
    {
      min_slack = SHOP_get_internal_txy_value(rsv->lower_slack, time_int->num_intervals, s); /*
      if (min_slack > minvol)
        minvol = min_slack;
    }
    if ( rsv->upper_slack )
    {
      max_slack = SHOP_get_internal_txy_value(rsv->upper_slack, time_int->num_intervals, s); /*
      if (max_slack < maxvol)
        maxvol = max_slack;
    }
    if (maxvol < minvol)
      maxvol = minvol;
  }
  else
    vol_sched = minvol;
}
else
  vol_sched = minvol;

/*mix cut and ind vv*/
if (rsv->cut_or_vv != 1)
{
  npkt = rsv->endpoint_desc->npkt;
  wsys = rsv->endpoint_desc->number - 1;

  x_values = rsv->endpoint_desc->x;
  water_value = rsv->endpoint_desc->y;

  if (rsv->endpoint_desc->x_unit == PERCENT)
  {
    for (k = 0; k < npkt; k++)
    {
      x_values[k] *= 0.01*rsv->maxvol;
    }

    rsv->endpoint_desc->x_unit = MM3;
  }
}
else
{
  npkt = rsv->endpoint_desc_cut->npkt;
  wsys = rsv->endpoint_desc_cut->number - 1;

  x_values = rsv->endpoint_desc_cut->x;
  water_value = rsv->endpoint_desc_cut->y;

  if (rsv->endpoint_desc_cut->x_unit == PERCENT)
```

Solution Explorer

Search Solution Explorer (Ct

shop_type_no.h
shop_type_xy_f
shop_update_re
shop_update_u
shop_vectors.h
shop_write_dat
shop_xy_polyn
shop_xy_table.h
Source Files
dogleg.c
dpmpar.c
enorm.c
hybrj.c
hybrj1.c
qform.c
qrfac.c
r1mpyq.c
r1updt.c
shop_access.cp
shop_best_prof
shop_bidding.c
shop_block_ge
shop_build_cor
shop_build_cor
shop_build_cor
shop_build_mo
shop_build_pla

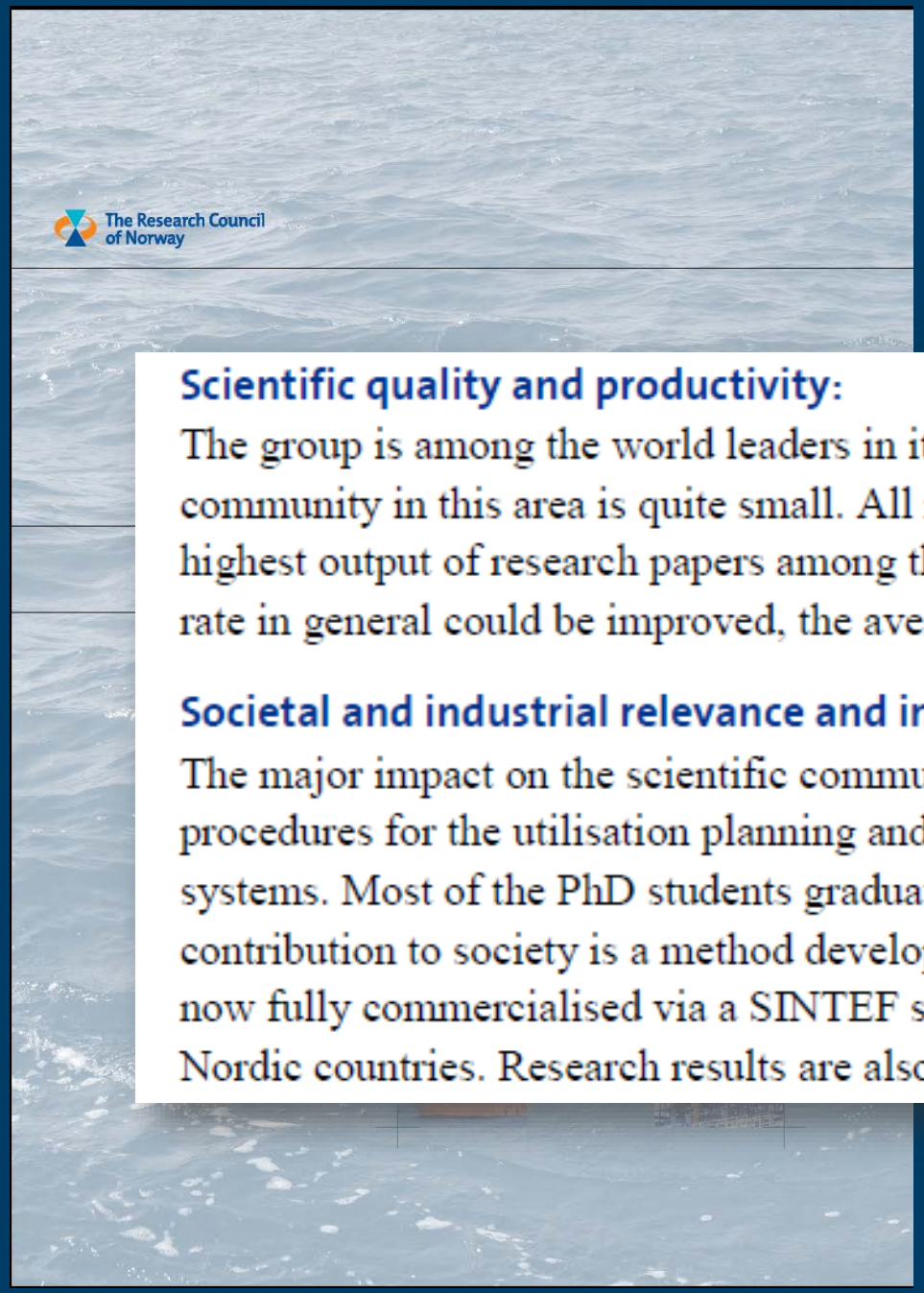
Solutio... | Team E... | Class Vi...

Properties

SHOP_select_end_desc VCCo

C++

(Name)	SHOP_select_end_c
File	c:\svn_shop\shop\s
FullName	SHOP_select_end_c
IsDefault	False
IsDelete	False
IsFinal	False
IsInjected	False
IsInline	False
IsOverloac	False
IsSealed	False
IsTemplat	False
TypeStrinc	SHOP_Severity_Co



4.2.1.3. ***Electric Power Systems***

Description of the research unit:

As of the end of 2013, the research group included 4 professors and 7 part-time/associate professors and 25 additional staff, with core expertise in electric power system engineering, economics and markets. Research activities cover Smart Grids, offshore grids, and hydropower and markets.

Scientific quality and productivity: **Grade: 4**

The group is among the world leaders in its field of activity, although the scientific community in this area is quite small. All results are publishable, with the group having the highest output of research papers among the groups in the department. While the publication rate in general could be improved, the average citation index in the field is high.

Societal and industrial relevance and impact: **Grade: B**

The major impact on the scientific community is the development of methodologies and procedures for the utilisation planning and operation of hydropower plants and transmission systems. Most of the PhD students graduating in the group work in these fields. The biggest contribution to society is a method developed for the distribution of hydropower, which is now fully commercialised via a SINTEF spin-out. These methods are used by operators in all Nordic countries. Research results are also used in teaching at advanced level.

- The group should be co-located to facilitate communication.
- More attention should be given to acquiring EU projects.
- The publication strategy should be improved in terms of overall publication rate and publication in peer reviewed journals.

Source: Research Council of Norway 2015

SINTEF

.no Forskningsnytt fra NTNU og SINTEF

Videoer Arkivet MER

Han er Shop-ansvarlig hos SINTEF og vil levere sin doktorgrad på Shop i vår.

Milliardgevinst

Norsk kraftproduksjon består av 96 prosent vannkraft og er en av våre viktigste naturressurser. En fersk rapport fra Impello Management og Menon Economics anslår at bruken av Shop øker verdien av vannet i norske kraftreservoar med to prosent. I penger utgjør den anslåtte gevinsten 6,8 milliarder kroner for siste tiårsperiode. Ifølge rapporten er den potensielle nåverdien 12 milliarder kroner, dersom alle nordiske kraftprodusenter tar i bruk Shop-systemet.

– Vi er stolte over det vi har fått til. Shop er et stjerneeksempel på godt samarbeid mellom SINTEF og NTNU – og hvilke verdier vi kan skape, sier Olav Bjarte Fosso. Han er professor ved Institutt for elkraftteknikk ved NTNU.

– Hva har vært den største utfordringen?

– Hovedutfordringen er at ingen av vassdragene er helt like. Det har utløst en enorm kreativitet i forhold til tekniske løsninger, for det er alltid noe spesielt som skal løses. Det gjøres små forbedringer hele tiden.

30 års forskning

Det hele startet i 1989, da Statkraftverkene (Statkraft) kontaktet Olav Bjarte Fosso som på

– Det tar omlag ti år å få forskningsresultater ut i drift for alvor. For å lykkes kreves iherdighet. Vi har greid å holde aktiviteten fra vi hadde en pilot – til vi fikk Shop ut i drift. Hvis ikke ville dette prosjektet kanskje ligget i en skuff i dag, sier NTNU-professoren.

Først ute til å bruke Shop var India og Egypt.

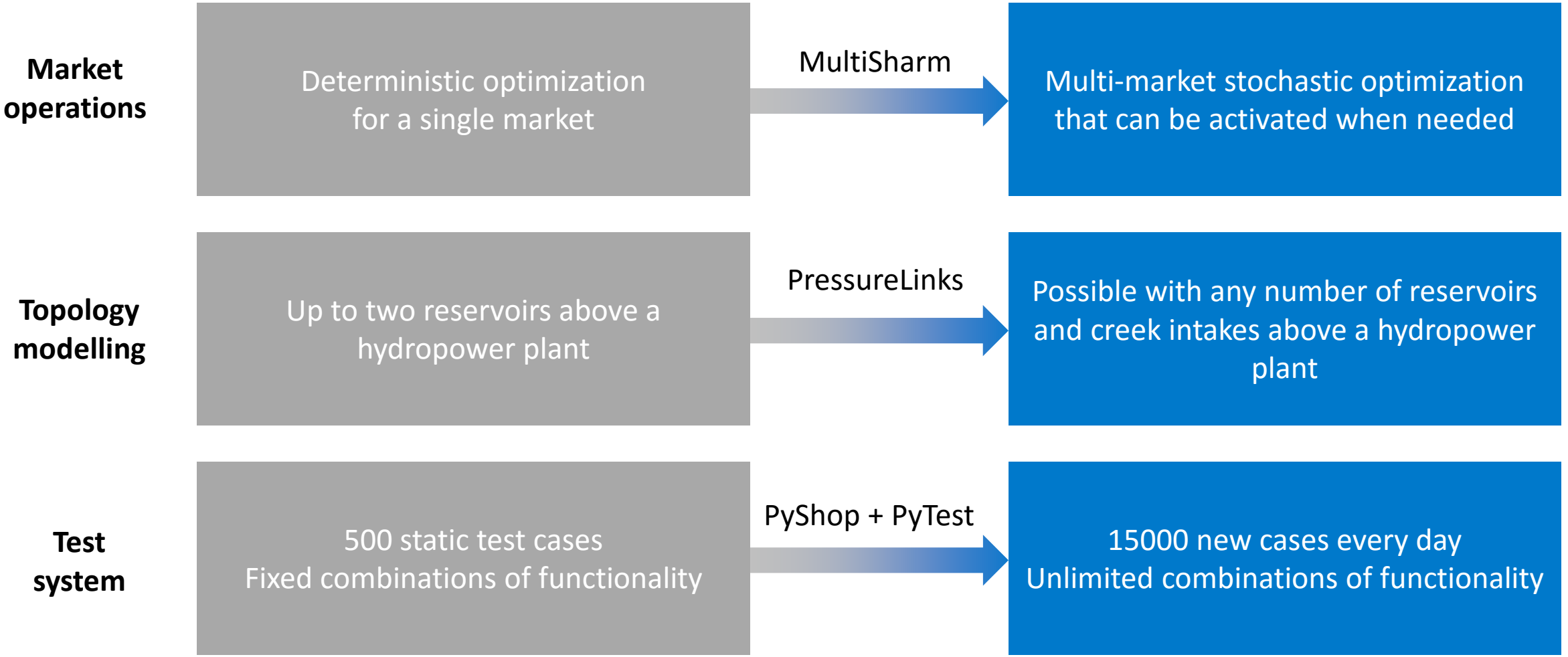
– Fra midten av 2005 tok utrullingen fart i kraftbransjen i Norge og Skandinavia, forteller Michael Belsnes i SINTEF. Han leverte sin doktorgrad på Shop i 2008 og hadde ansvar for utviklingen av SHOP frem til Skjelbred overtok stafettpinnen i 2013.

effektiv drift og samtidig ta hensyn til miljøet og livet i vassdragene, sier Ellen Krohn Aasgård, som nylig har tatt doktorgrad på Shop. Foto: Mona Sprenger

løses, sier professor Olav Bjarte Fosso ved NTNU. Foto: Mona Sprenger

– Vi er stolte over det vi har fått til. Shop er et stjerneeksempel på godt samarbeid mellom SINTEF og NTNU – og hvilke verdier vi kan skape, sier Olav Bjarte Fosso. Han er professor ved Institutt for elkraftteknikk ved NTNU.

SHOP – recent breakthroughs

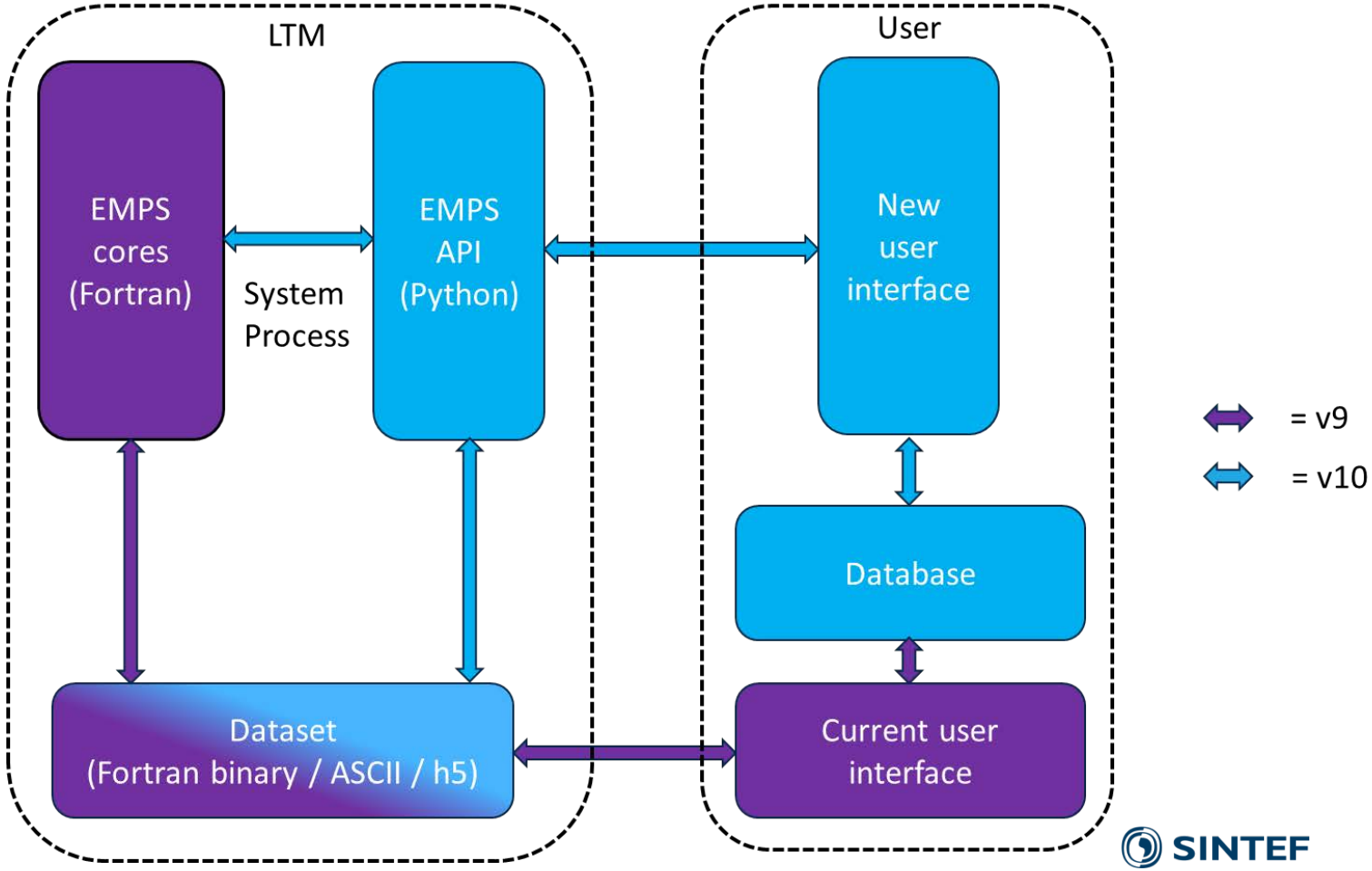


SINTEF

Models in Shape for The Digital Age

Example: version 10 of the EMPS model

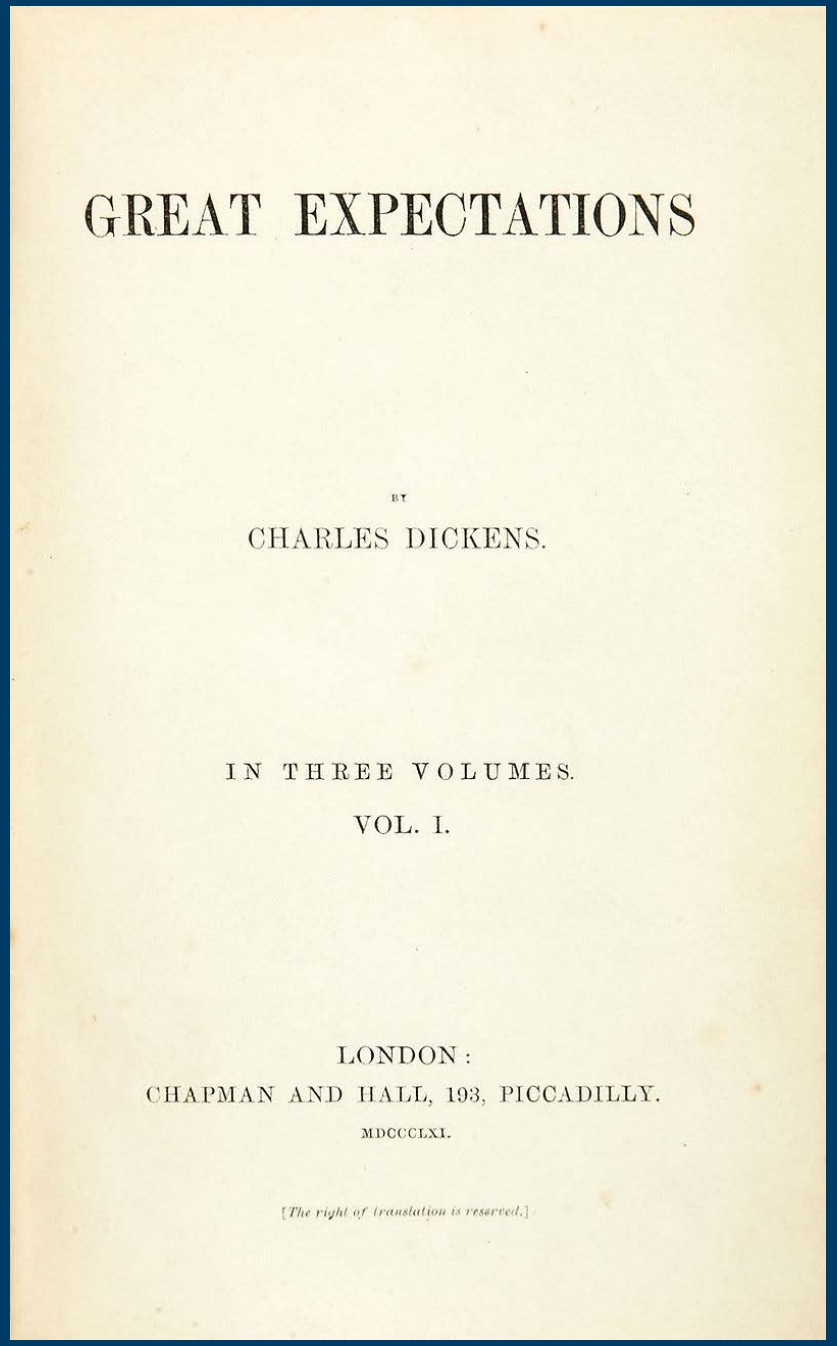
- Not painless
- But has lifted the model framework to a new level
  - Flexible system integration
  - Efficient/Automated use



SINTEF

User meeting 2019

- Be introduced to state-of-the- art and the seeds to be solutions for the future
- Learn from the experts in the industry – how can new knowledge harvest value creation in the industry?
- What are the drivers and trends influencing future market design and operation?
- My expectations to YOU: Be active. Be curious. Be social in building new relations.


GREAT EXPECTATIONS

BY

CHARLES DICKENS.

IN THREE VOLUMES.

VOL. I.

LONDON:

CHAPMAN AND HALL, 193, PICCADILLY.

MDCCCLXI.

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SINTEF

Teknologi for et bedre samfunn