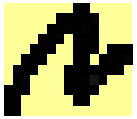
IPAC 11 in San Sebastián

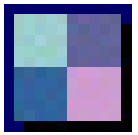
"When the Wind blows..."

Colin Carlile, ESS, Lund, Sweden

Neutrons are beautiful !

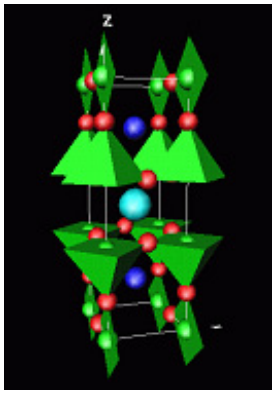
Wave Particle Magnetic moment Neutral



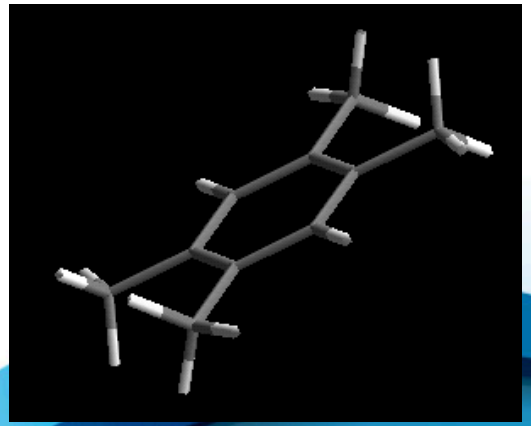
Diffractometers - Measure structures
– Where atoms and molecules are

1 - 10 Ångström



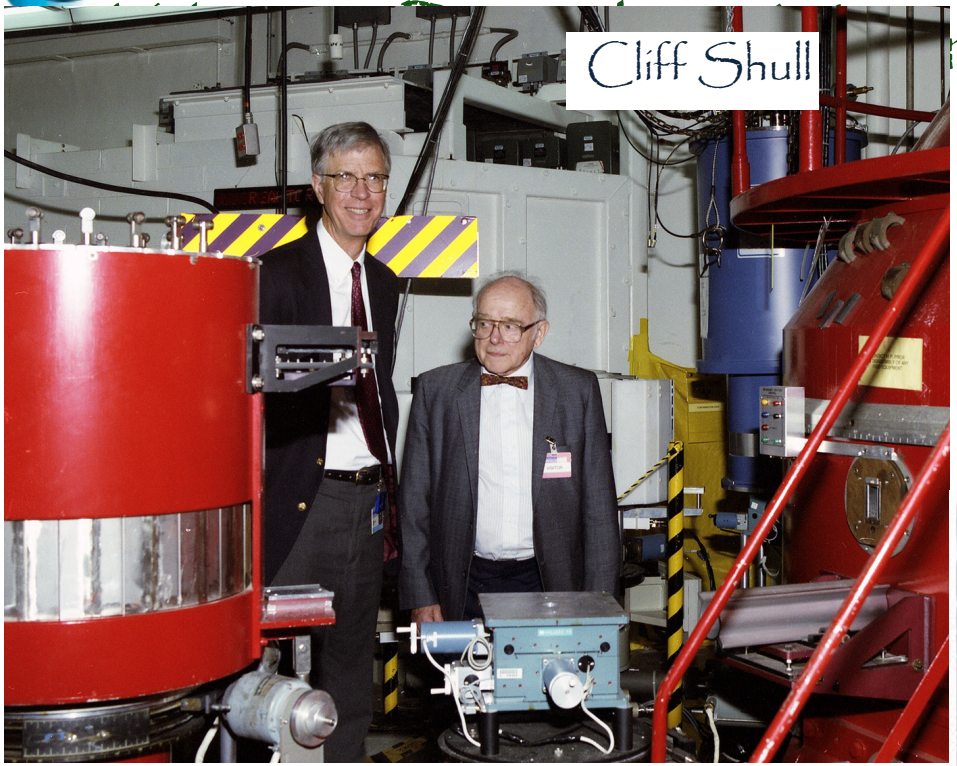
Spectrometers - Measure dynamics
– What atoms and molecules do

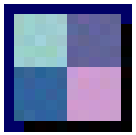
1 - 80 meV

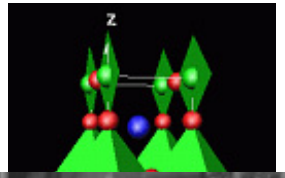


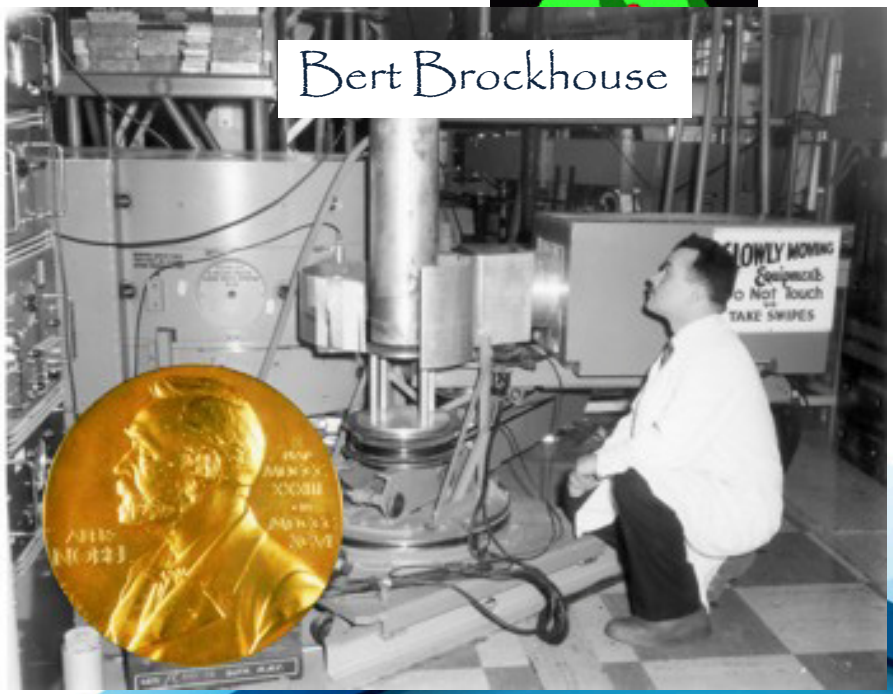
Neutrons are beautiful !

netic moment Neutral









Spectrometers - Measure dynamics
- What atoms and molecules do

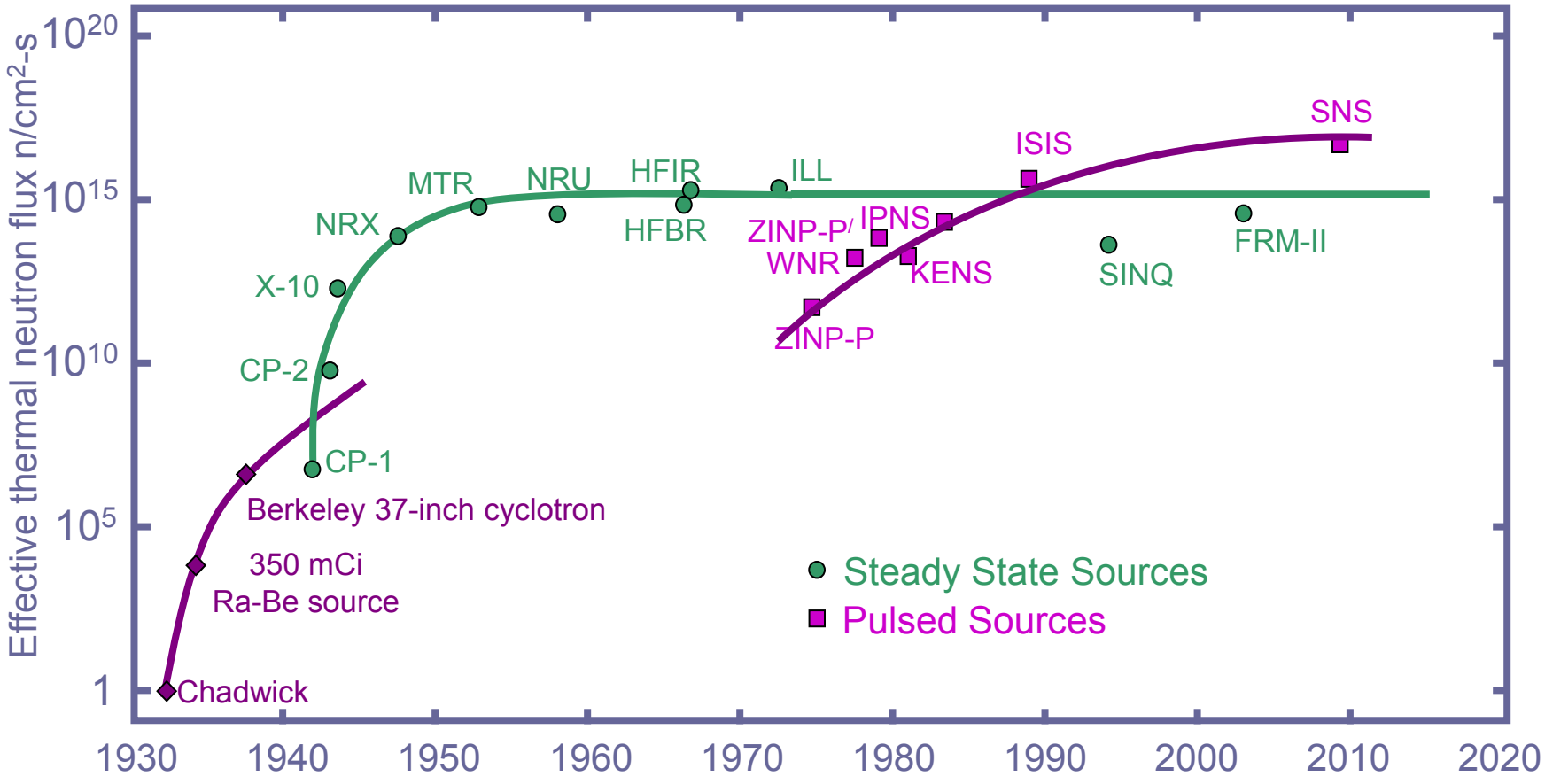
1 - 80 meV

Neutrons are the Swiss Army Knife of Analytic techniques

Thanks to Dimitri Argyriou

But neutrons, like diamonds, are still rather rare...

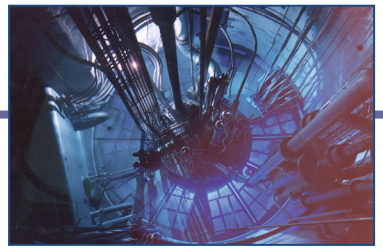
Evolution of the performance of neutron sources



(Updated from *Neutron Scattering*, K. Skold and D. L. Price, eds., Academic Press, 1986)

But neutrons, like diamonds, are still rather rare...

Evolution of the performance of neutron sources



ESS

Effective thermal neutron flux n/cm^2-s

10^{20}
10^{15}
10^{10}
10^{5}
1

1930 1970 1980 1990 2000 2010 2020

Ch
Berkeley 37-inch cyclotron
350 mCi
CP-1
CP-2
X-10
NRX
MTR
NRU
HFIR
HFBR
ILL
ZINP-P
ZINP-P/
WNR
IPNS
KENS
ISIS
SNS
SINQ
FRM-II

Steady State Sources
Pulsed Sources

utron Scattering, K. Skold and D. L. Price, eds., Academic Press, 198

EUROPEAN SPALLATION SOURCE

We have to build the best facilities
with the best instruments
if we are to develop, understand, and harness
New Materials

"The stone Age didn't end for lack of stone"

Ahmed Zaki Yamani

my phone, my email, my notebook, my calculator, my atlas, my weather,
my camera, my star map, my music, my calendar, my address book...
& my training routine for Lundaloppet !

Packed with new materials !

Driven by the User Experience

And, as Henry Ford correctly said

"If I had asked my customers what they wanted they would have said faster horses"

We must avoid
the "faster horses" syndrome

Planning Horizon Gap

Researchers	5 years
Facility builders	20 years

A little bit of ESS history

1991

European Spallation Source workshop

Authors: A. D. Taylor [a]; G. H. Lander
Affiliation: [a] Rutherford Appleton Laboratory,
Published in: Neutron News, Volume 3, Issue 2 1992 , page 4
Subjects: Atomic & Nuclear Physics; Particle & High Energy Physics

Abstract

A meeting of about 70 experts in condensed-matter science took place in late February at Abingdon, UK, to discuss the scientific opportunities and technological challenges of a new 3rd generation spallation source - the so-called European Spallation Source (ESS).

This Workshop was, in fact, the third in a series: the first, in September 1991 at Simonskall near Jiilich, considered the accelerator options; the second in February 1992, in PSI, Villigen, Switzerland, considered the problems of providing targets and monochromators. The meeting opened with talks from S. Martin (Jiilich), G. Bauer (PSI) and J. Carpenter (Argonne) on the accelerator, target, and moderator options, respectively. Although the problems are formidable in all areas, there don ot seem to be any insuperable obstacles for building a system with a 5 MW beam of protons with a short pulse length of ~1 μ delivered onto two (or more) stationary targets surrounded by a variety of moderators. The heat load on the target could approach 4 MWAitre, similar to that found in a high-flux reactor, but Bauer pronounced that “it can be done.” The neutron production of such a source would be spectacular, with a peak flux of ~ 10^{17} n/sec/cm^2 and an average flux close to that of the ILL.

2000

ELSEVIER
Physica B 276–278 (2000) 38–44
PHYSICA B
www.elsevier.com/locate/physb

The project “European Spallation Neutron Source (ESS)”: status of R&D programme

R. Wagner*, W. Bräutigam, D. Filges, H. Ullmaier

Forschungszentrum Jülich, D-52425 Jülich, Germany

Abstract

At present the ESS-Project is in its R&D phase (1997–2001) comprising activities in the areas of accelerator (linac and rings), target station (target, moderators, reflector) and instruments. The work is carried out by 14 laboratories and universities in the European Union and Switzerland and co-ordinated by the ESS R&D Council. Intense and fruitful collaborations with partners in the United States, Japan and Russia have been established. In this article, examples of typical results of R&D work on the ESS linac and target will be given.

Keywords: Neutron sources

1. Introduction

After delivering the ESS Technical Study [1] in November 1996, the project entered the R&D phase with a planned duration of 5 years.

The following 14 European institutions contributing to the ESS R&D activities have signed a Memorandum of Understanding (MoU):

Atominstitut der Österreichischen Universitäten (AIU), Austria, Centro de Investigaciones Energeticas (CIEMAT), Spain, Commissariat a l'Energie Atomique (CEA), France, Consiglio Nazionale delle Ricerche (CNR), Italy, Forschungszentrum Jülich (FZJ), Germany, Hahn-Meitner-Institut (HMI), Germany, Institut für Angewandte Physik der Universität Frankfurt (IAPUF), Germany, Interfaculty Reactor Institute (IRI), Netherlands, IRC Polymer Science and Technology (EPSRC), United Kingdom, Istituto Nazionale per la Fisica della Materia (INFM), Italy, Naturvetenskapliga forskningsradet (NFR), Sweden, Paul-Scherrer-Institut (PSI), Switzerland, Risø National Laboratory (RISØ), Denmark, Rutherford Appleton Laboratorys (RAL), United Kingdom.

The R&D work concentrates on problems which have been identified in the technical study as topics where additional results are needed for the engineering design of a pulsed 5 MW neutron source with optimum performance, efficiency, availability and cost/benefit ratio.

The *accelerator* development covers high-intensity ion sources, funnel design, RFQ's, superconducting cavities for the high-energy part of the linac, beam dynamics, beam losses and halo studies, diagnostic hardware and cost estimates.

The research in the *target* area includes materials development, fluid dynamics and structure mechanics, design optimization and engineering, advanced cold moderator research, new moderator concepts and radiation physics due to experimental verification of particle transport simulation and neutronic optimization of the target–moderator–reflector layout. Most of these topics are investigated in close collaborations with international partners which are listed in Table 1.

For the user *instruments* of ESS, new concepts will be developed and studied including e.g. thermal neutron detection systems, single crystal diffractometers, solid-state detectors and large crystal monochromators. These topics have been treated in several contributions to this conference. We therefore restrict the following sections to the areas of accelerator and target technology where we illustrate the status of the ESS R&D programme by presenting some typical results.

* Corresponding author.
E-mail address: ri.wagner@fz-juelich.de (R. Wagner)

0921-4526/00/$ - see front matter
PII: S0921-4526(99)01271-5

ESS was a grass roots project in Scandinavia from the outset: October 3rd 2000

"After a nice lunch in the pleasant surroundings at the first floor of Gamla Biskopshuset the discussion session started. Robert McGreevy expressed that as of today Kjeller seemed to have the longest perspective for neutron scattering in the Nordic countries. NFL at Studsvik is shaky and DR3 is shut down permanently. If we should do something we should do it now. We have nothing to lose, except maybe credibility. Kim Lefmann agreed, "Even if we do not succeed in getting ESS-Scandinavia we will have formed a body working towards ESS and that is already something". Martin Vigild felt that "that we have a window of opportunity on a Danish and Swedish leg, maybe in the end we could add more legs". Lars Börjesson remarked that "it was a golden opportunity with a slim chance" and Börje Johansson thought, "it might be possible to get funding".....After the discussion it was unanimously agreed to go ahead and the ESS Scandinavia was officially inaugurated. A set of preliminary statutes was distributed to the participants and thoroughly discussed. Several amendments were proposed and agreed upon. The amended version of the Statutes is enclosed. It was decided that ESS-Scandinavia is a Nordic initiative although the name is ESS Scandinavia. The argument for this is that we want ESS placed in the Öresund region, preferentially Skåne and Scandinavia is the classic Latin name for Skåne. The ESS-Scandinavia Inauguration meeting had participants from Sweden, Denmark and Norway who will all work for ESS-Scandinavia."

ESS was a grass roots project in Scandinavia from the outset: October 3rd 2000

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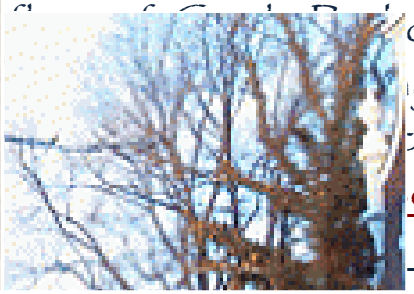

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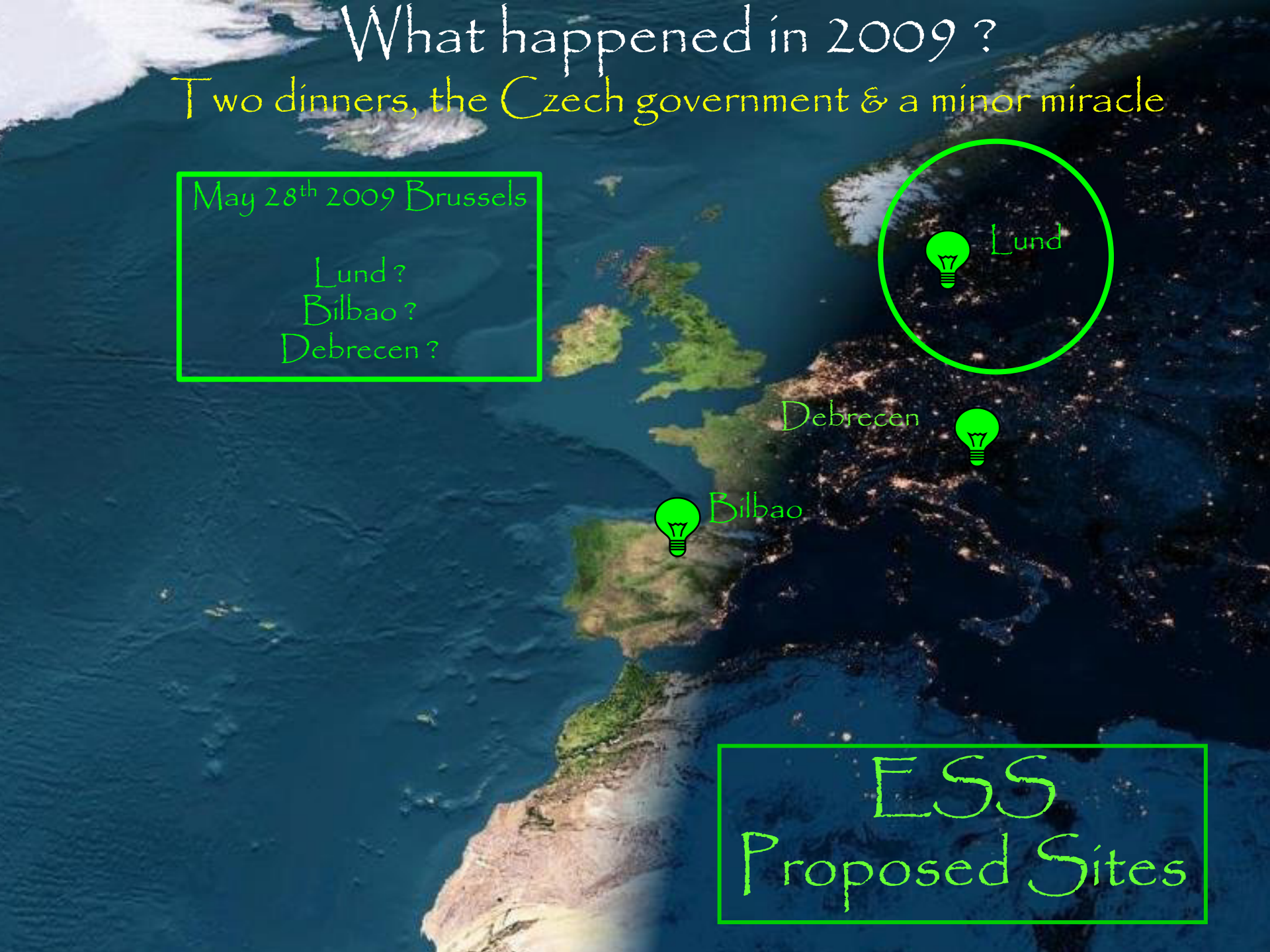
What happened in 2009 ?

Two dinners, the Czech government & a minor miracle

May 28th 2009 Brussels

Lund ?
Bilbao ?
Debrecen ?



ESS
Proposed Sites

What happened in 2009 ?

Two dinners, the Czech government & a minor miracle

May 28th 2009 Brussels

Lund

Bilbao

ESS Proposed Sites

Malmö

Öresund bridge

Copenhagen

Lund

MAX IV
&
ESS

Fast forward
to this in 2019

15th – 17th May 2002
ESS relaunch Bonn

Lisa Arleth &
Martin Vigild

Peter Fabi

15th – 17th May 2002
ESS relaunch Bonn

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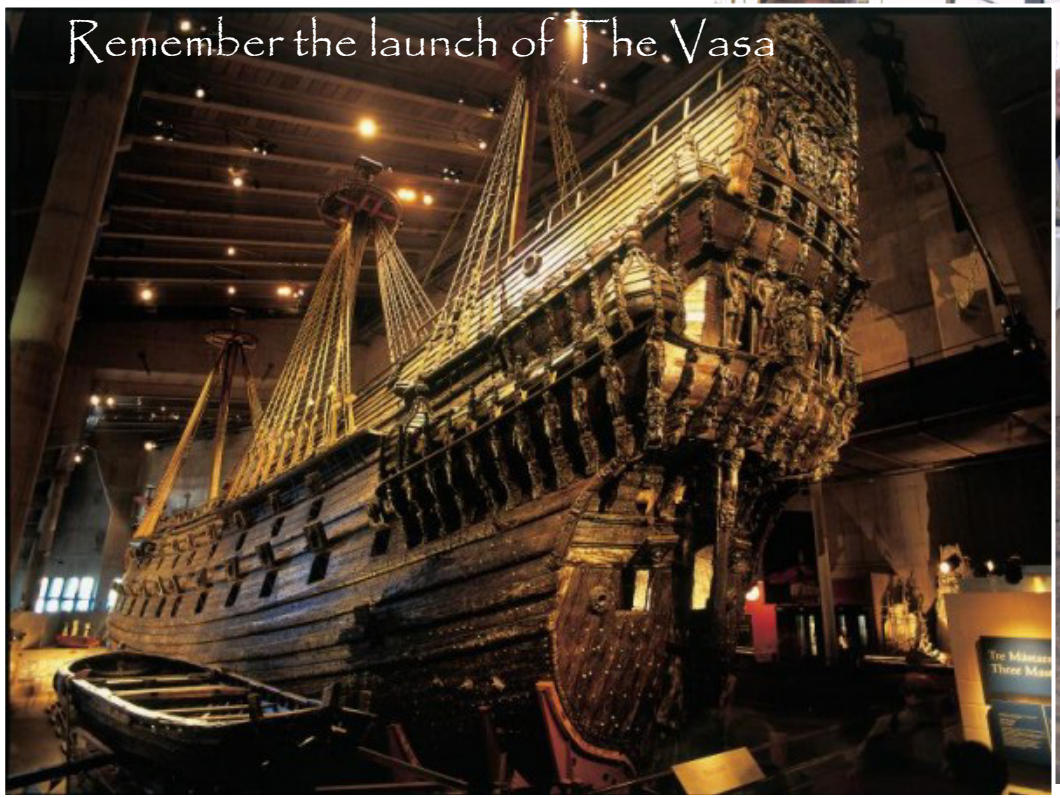
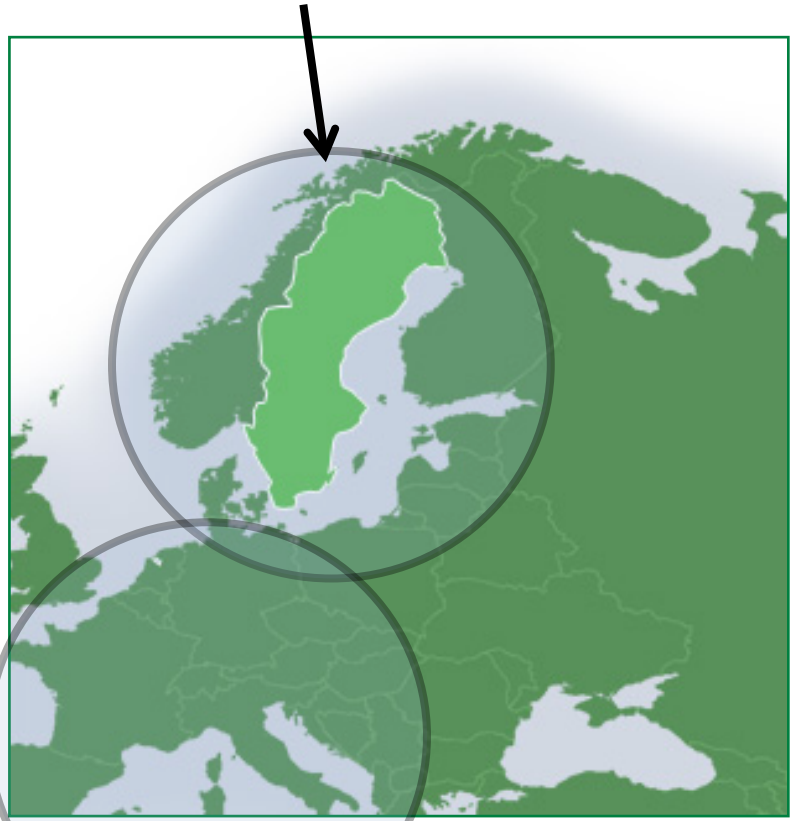
After 20 years the project is only now making its first hesitant steps



We have got the Partners

EUROPEAN SPALLATION SOURCE

Sweden, Denmark and Norway
50% of construction costs – 1479 M€



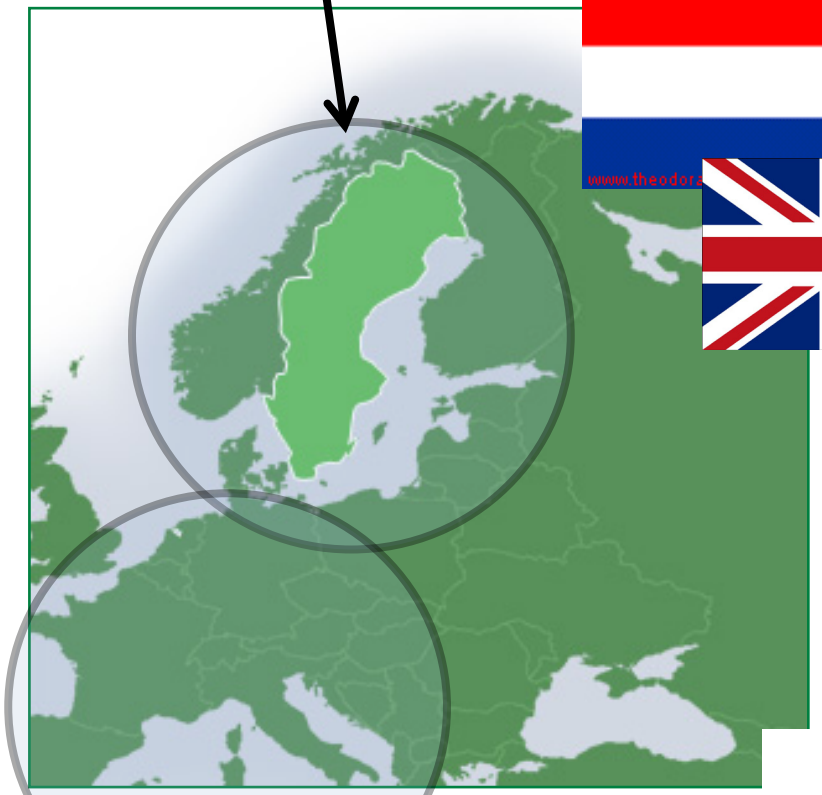
Spain, France, Germany, Italy, Switzerland, Hungary, Czech Republic, Poland, Netherlands, Estonia, Latvia, Lithuania, Iceland & UK
the remaining 50%

We have got the Partners

EUROPEAN SPALLATION SOURCE

Sweden, Denmark and Norway
50% of construction costs – 1479 M

17 Partners today



Spain, [illegible] Switze[illegible]zech Republic,
Poland[illegible]ania, Iceland & UK
th[illegible]g 50%

What can you get for 1.5B€ today ?

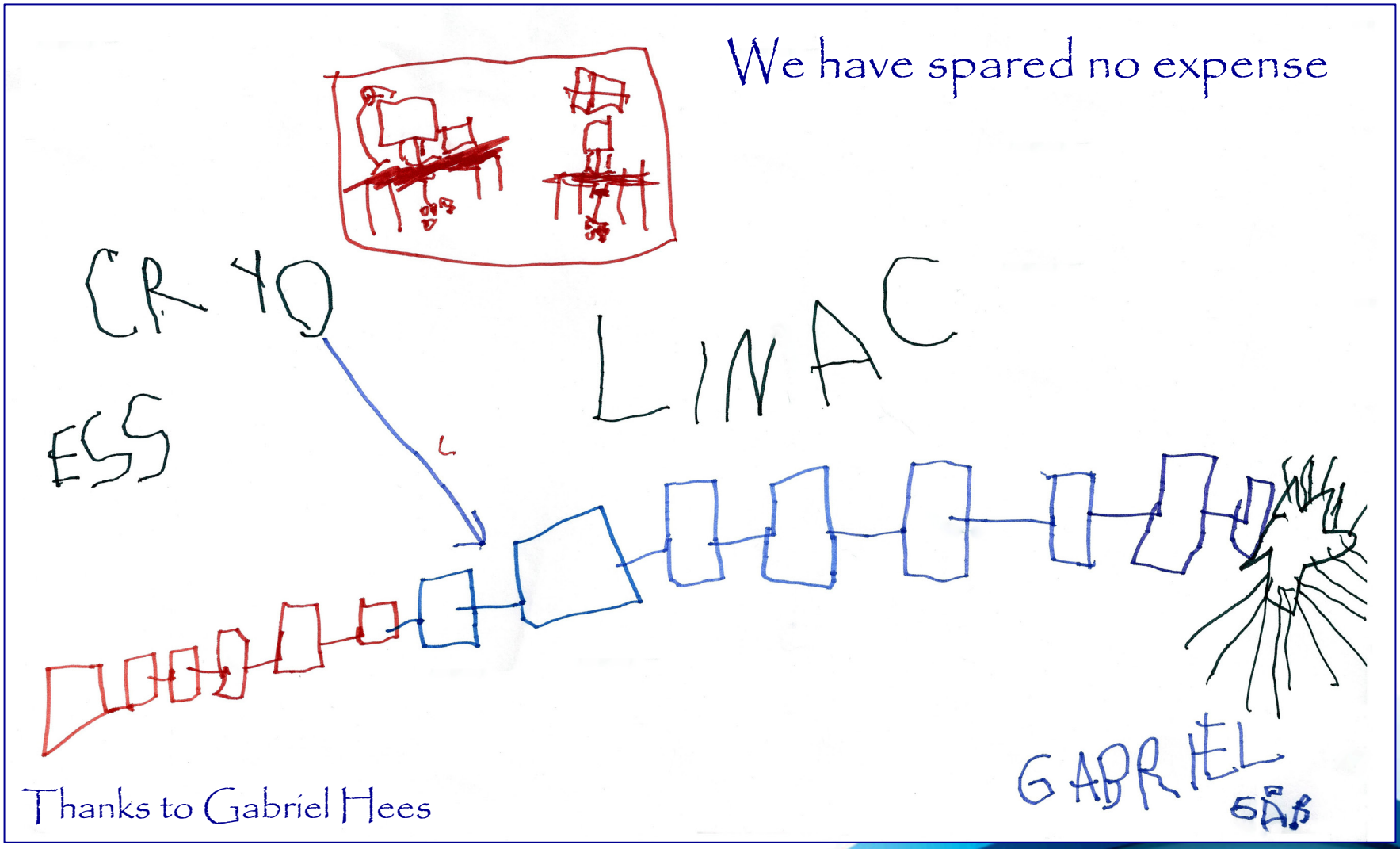
You could buy four A380 airbuses...

or, 28% of the Fehmarn Bridge

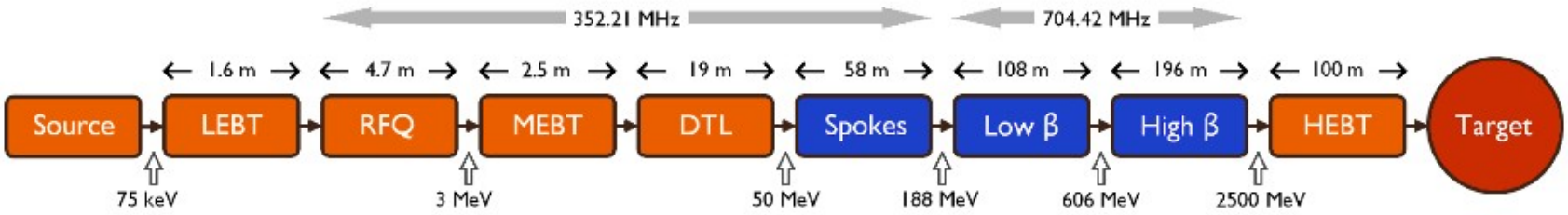
or, you could pay the bonuses of US bankers for...

24 days

The ESS Design Update Phase 2010 - 2012



Linear Accelerator layout



	Length (m)	Input Energy (MeV)	Frequency (MHz)	Geometric β	# of Sections	Temp (K)
RFQ	4.7	75×10^{-3}	352.2	--	1	≈ 300
DTL	19	3	352.2	--	3	≈ 300
Spoke	58	50	352.2	0.57	14 (2c)	≈ 2
Low Beta	108	188	704.4	0.70	16 (4c)	≈ 2
High Beta	196	606	704.4	0.90	15 (8c)	≈ 2
HEBT	100	2500	--	--	--	--

H. Danared, M. Eshraqi, A. Ponton, ESS

EUROPEAN SPALLATION SOURCE

The Sustainable Research Centre

ESS - A Different Kind of Neutron Source

Responsible – Recyclable – Renewable

To be carbon dioxide neutral,
over the lifetime of the facility,
including transport to and from the site.

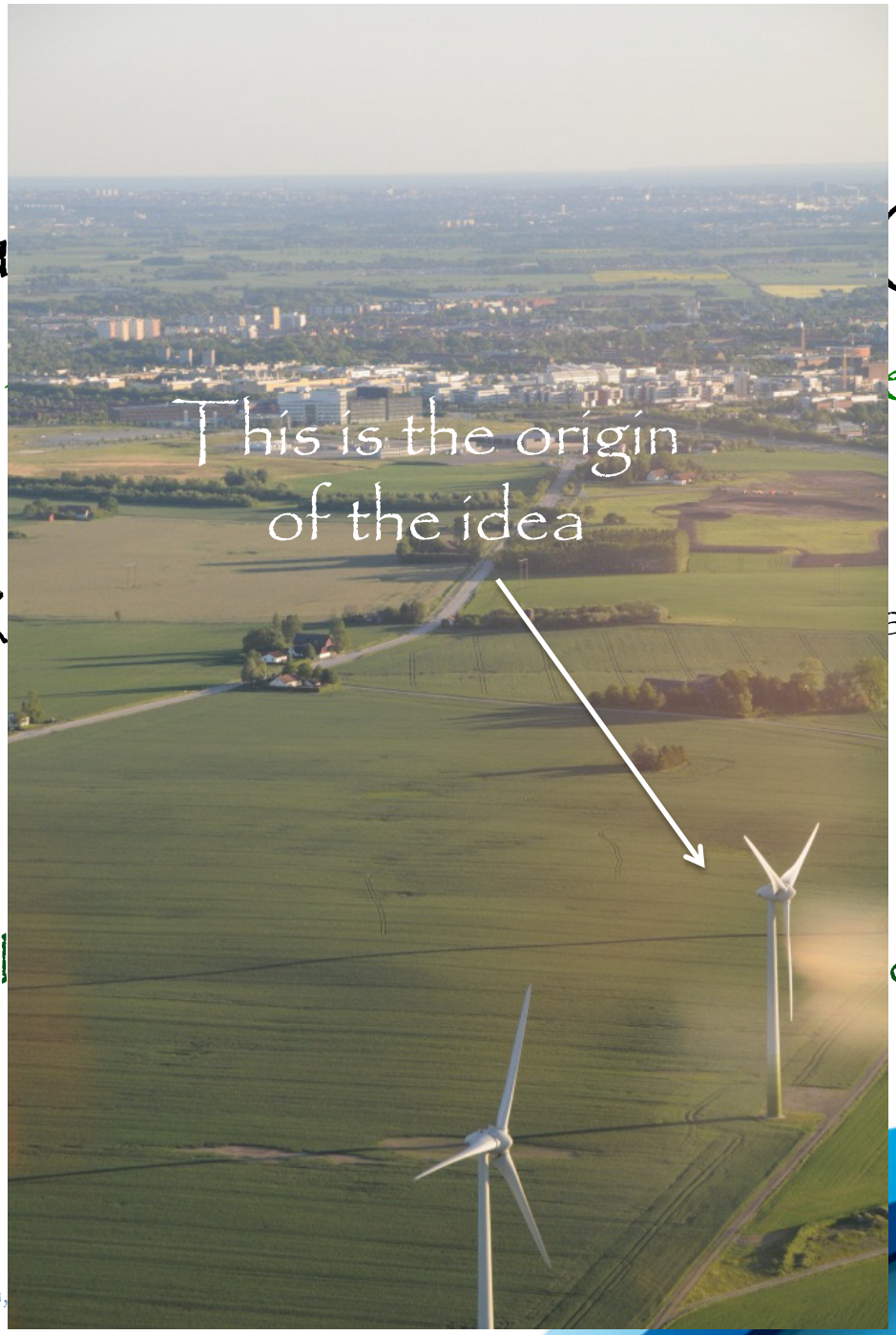
EUROPEAN SPALLATION SOURCE

The Su Centre

ESS eutron

R able

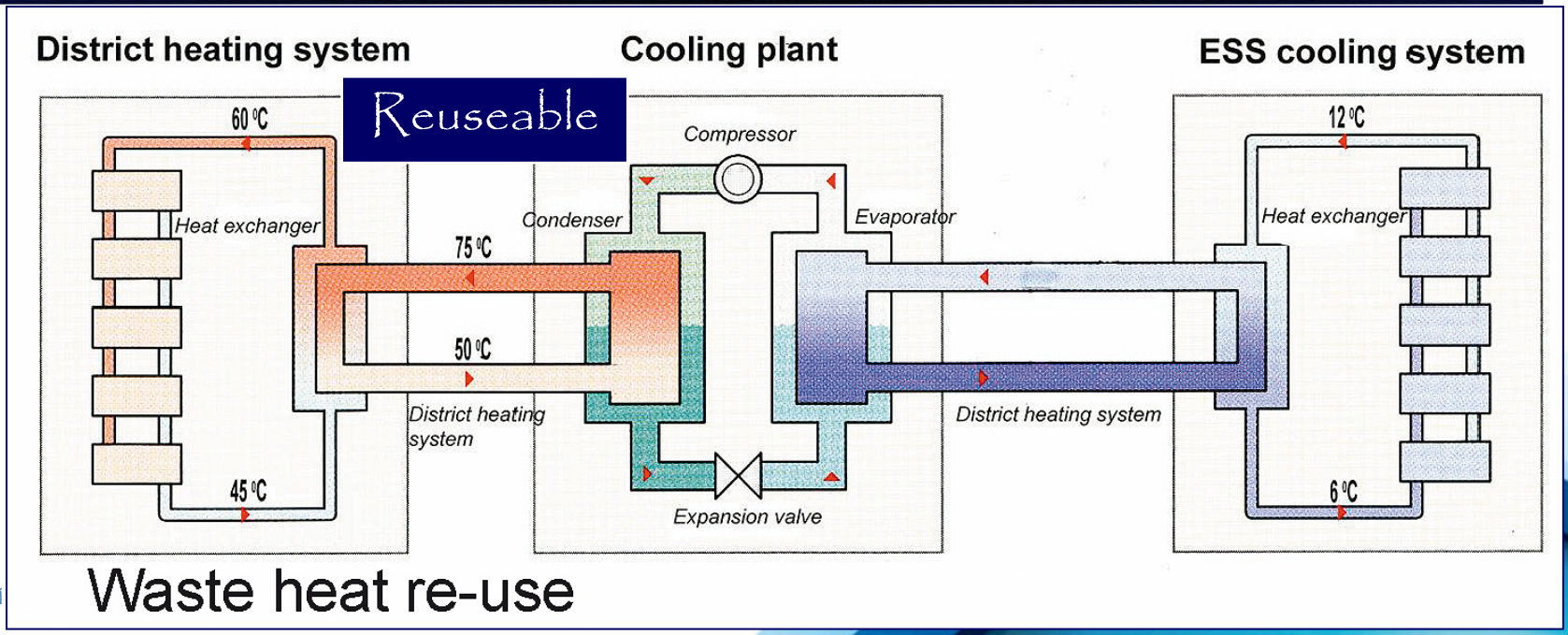
incl e.



Innovative Energy Policy

Innovative Energy Policy

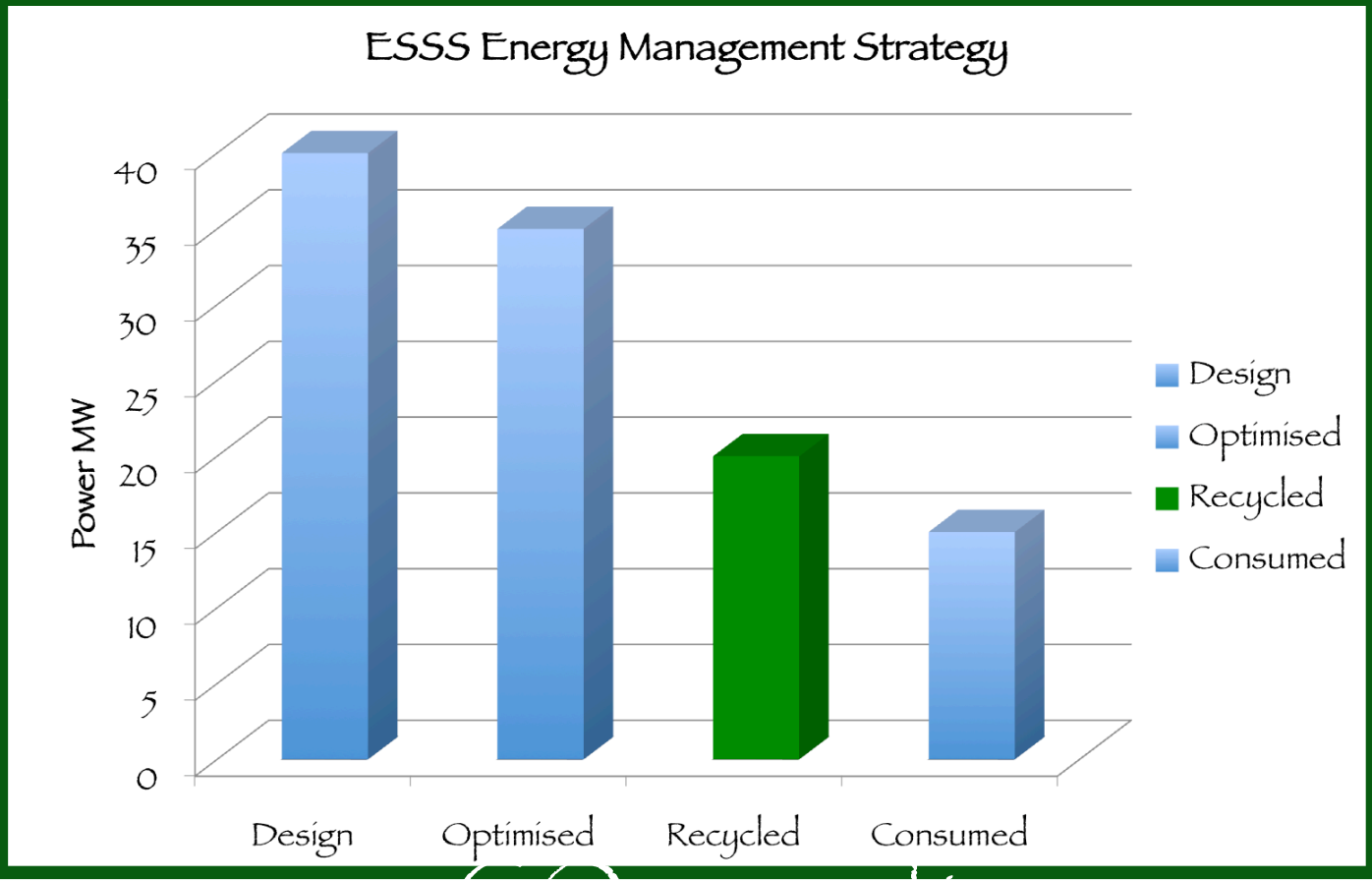
EUROPEAN SPALLATION SOURCE



Waste heat re-use

Innovative Energy Policy

ESS Energy Management Strategy



Aim to reduce operations costs by ~9 M€ p.a.

- Waste heat re-use

Let's get "back to our beetroot" – the environment

Let's get "back to our beetroot" – the environment

Let's get "back to our beetroot" – the environment

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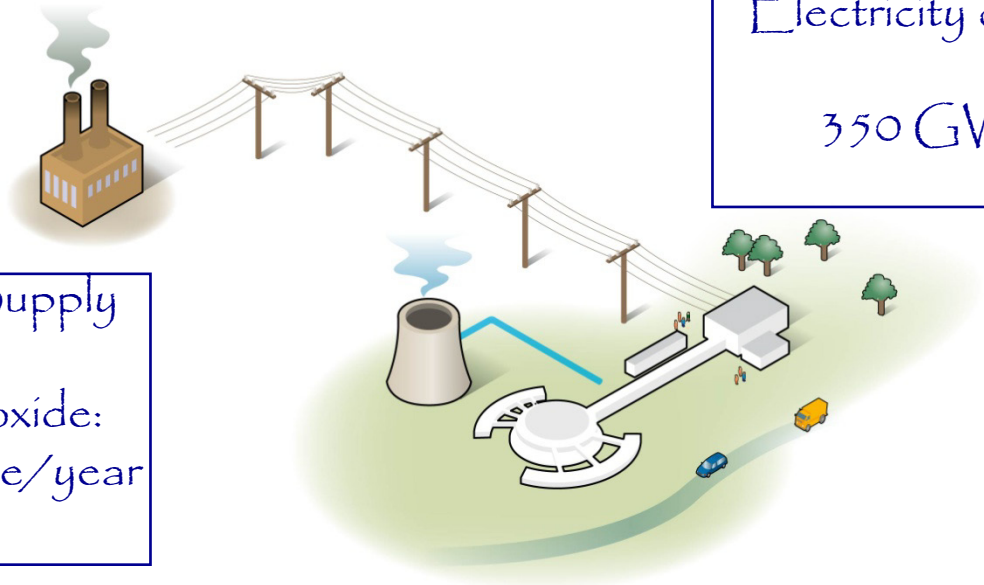
Let's get "back to our beetroot" – the environment

This is how it is usually done

Electricity consumption:

350 GWhr/year

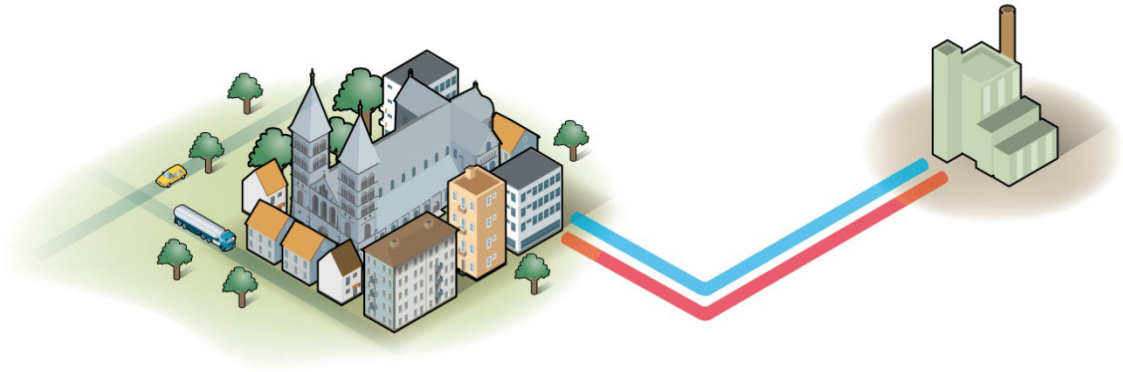


Electrical Supply

Carbon Dioxide:
150,000 tonne/year

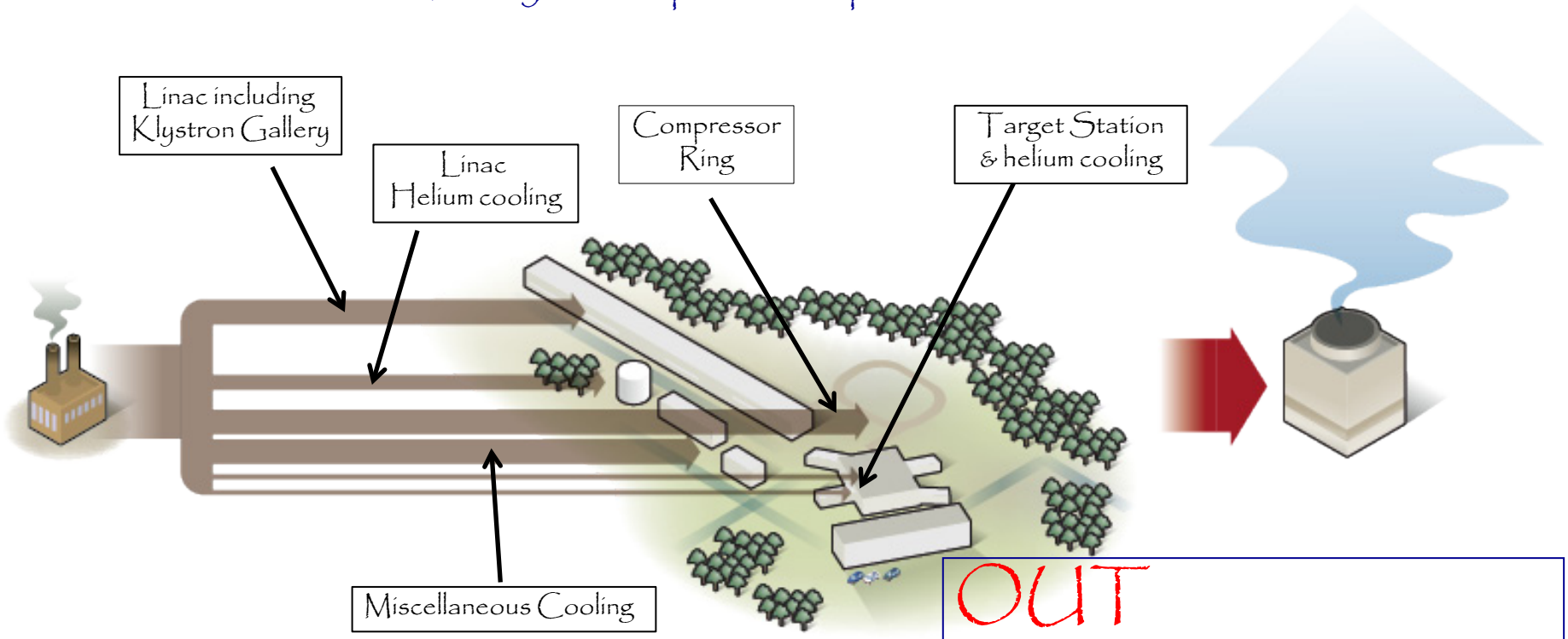
Heating Supply

Carbon Dioxide:
15,000 tonne/year



SNS Energy flow

Today's most powerful spallation source

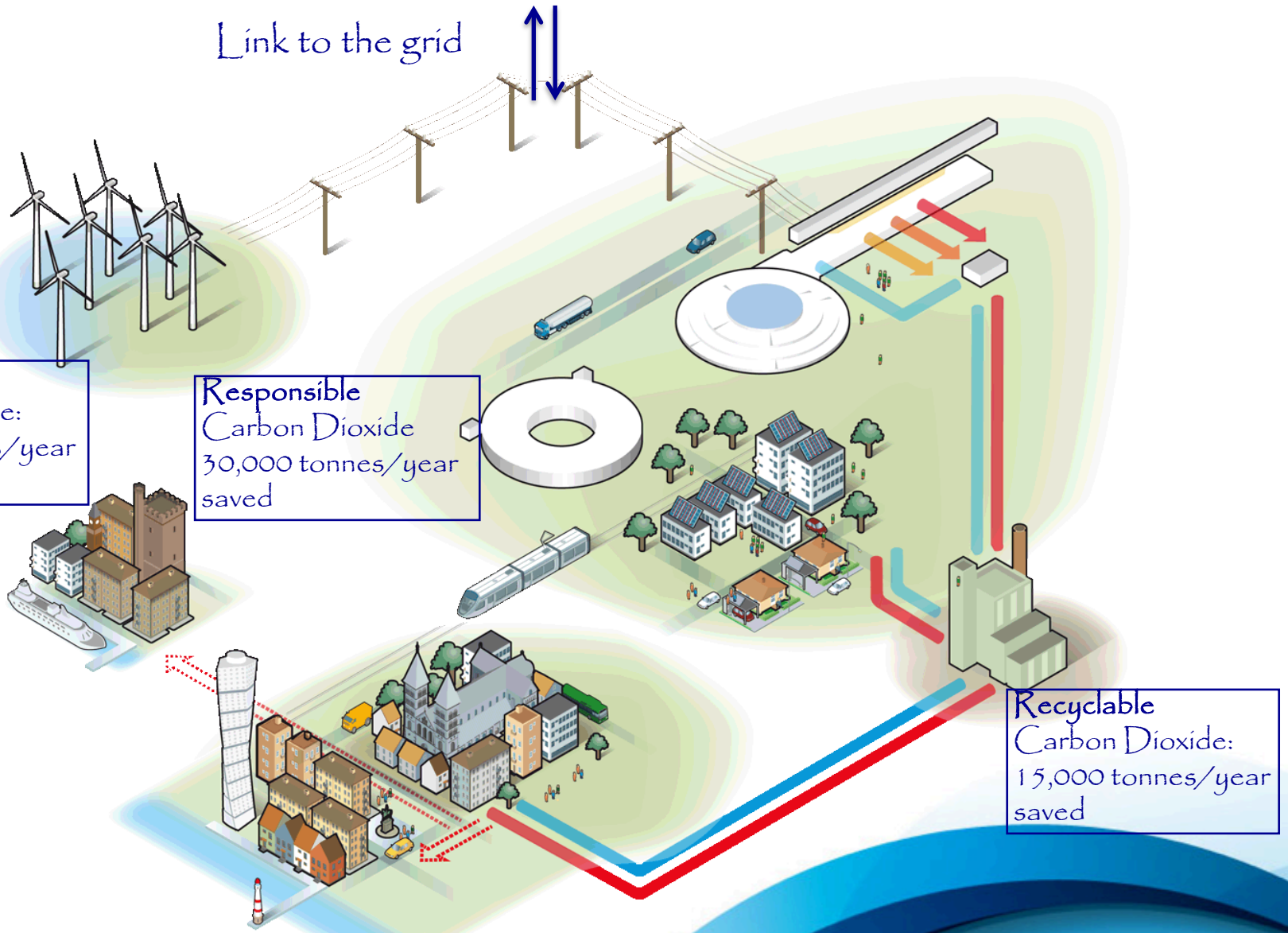


IN
150 GWhr electricity
Much of it HEP

OUT
140 GWhr waste heat
Cooling Towers

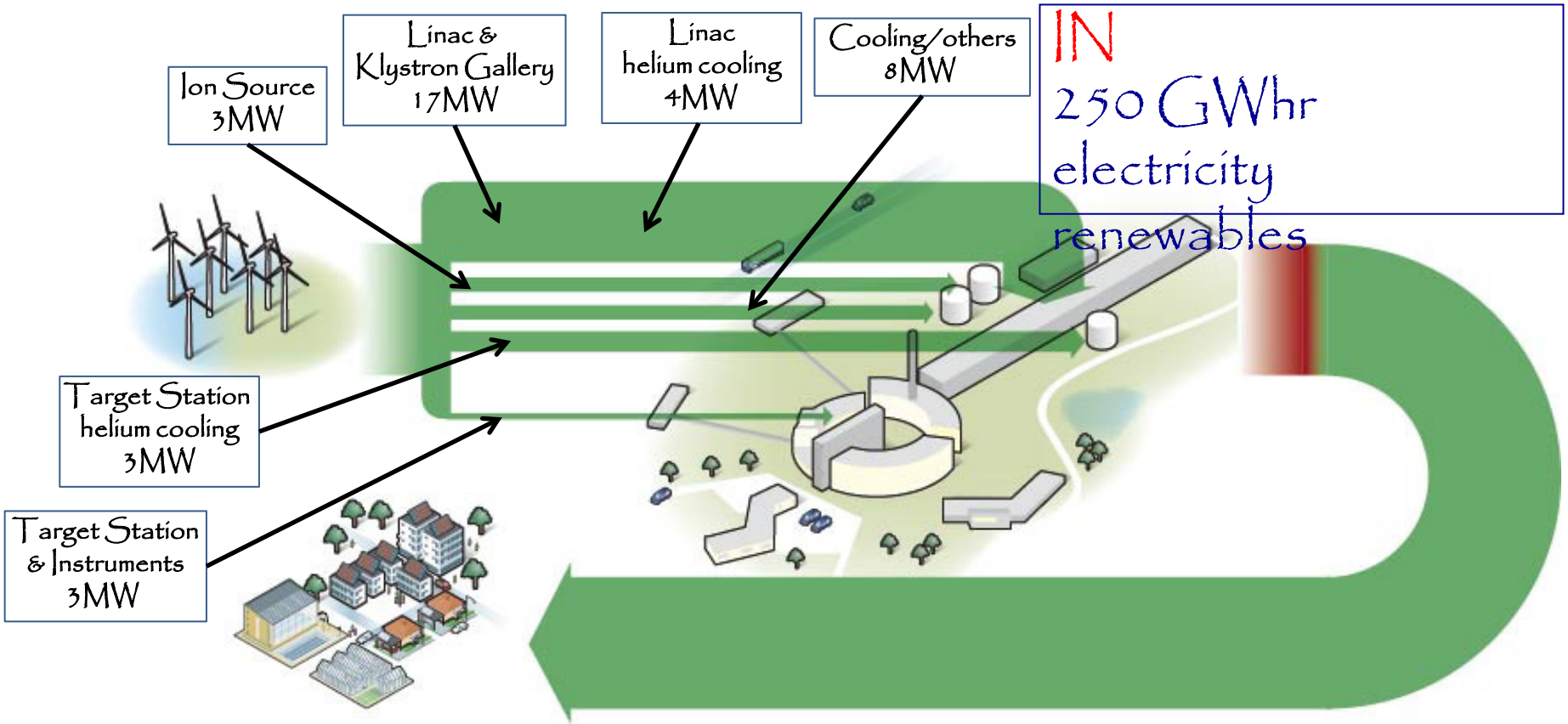
This is how ESS will do it in 2020

EUROPEAN SPALLATION SOURCE



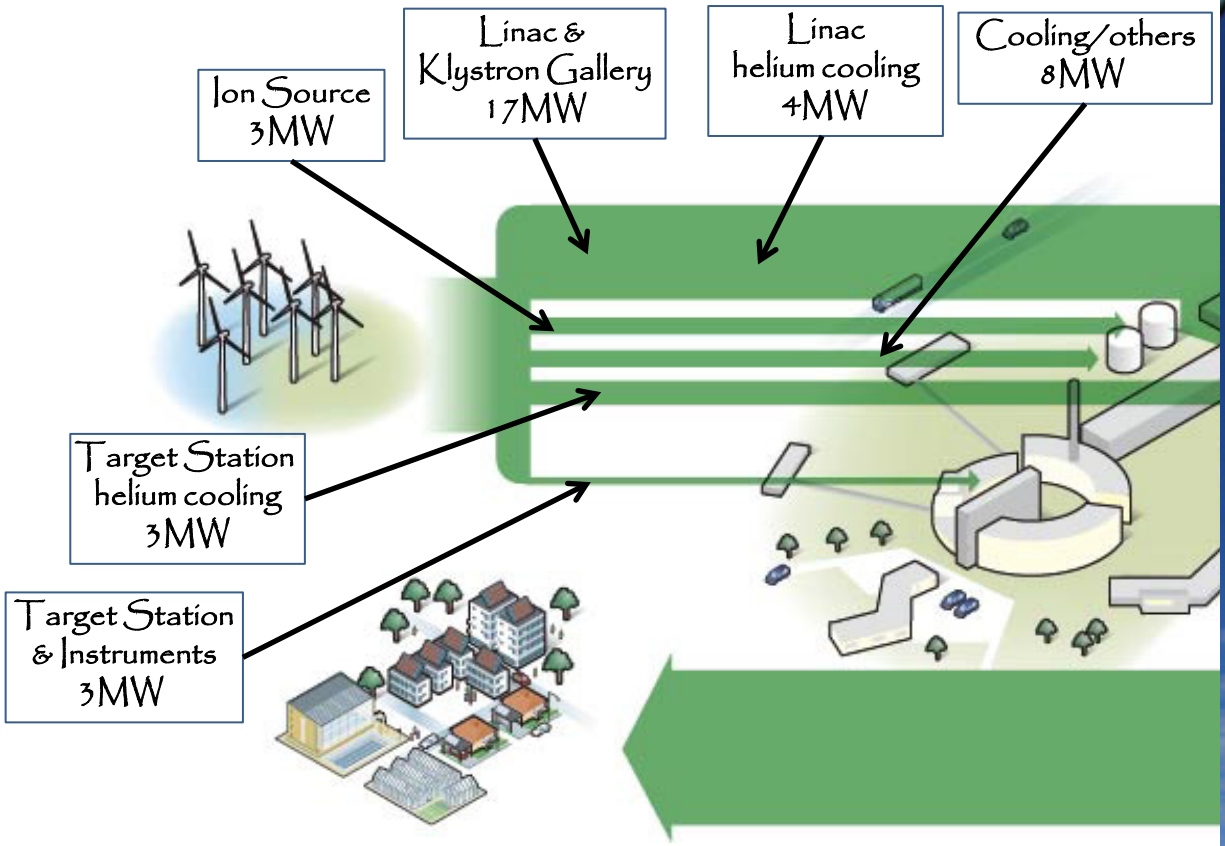
ESS Energy concept 2011

The world's first sustainable large-scale research facility ?



ESS Energy concept 2011

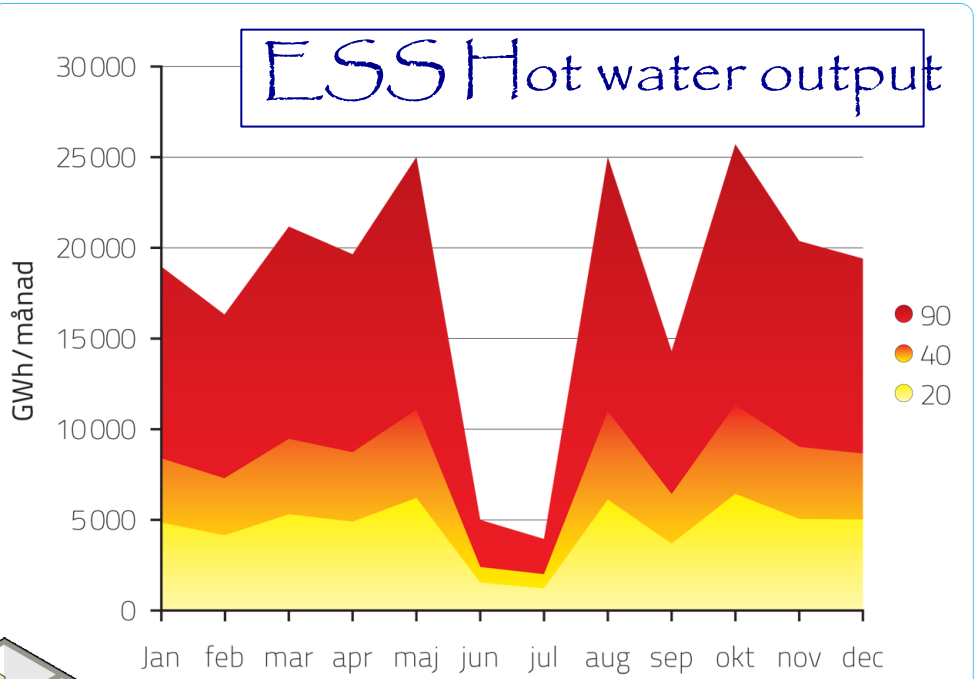
The world's first sustainable large-scale

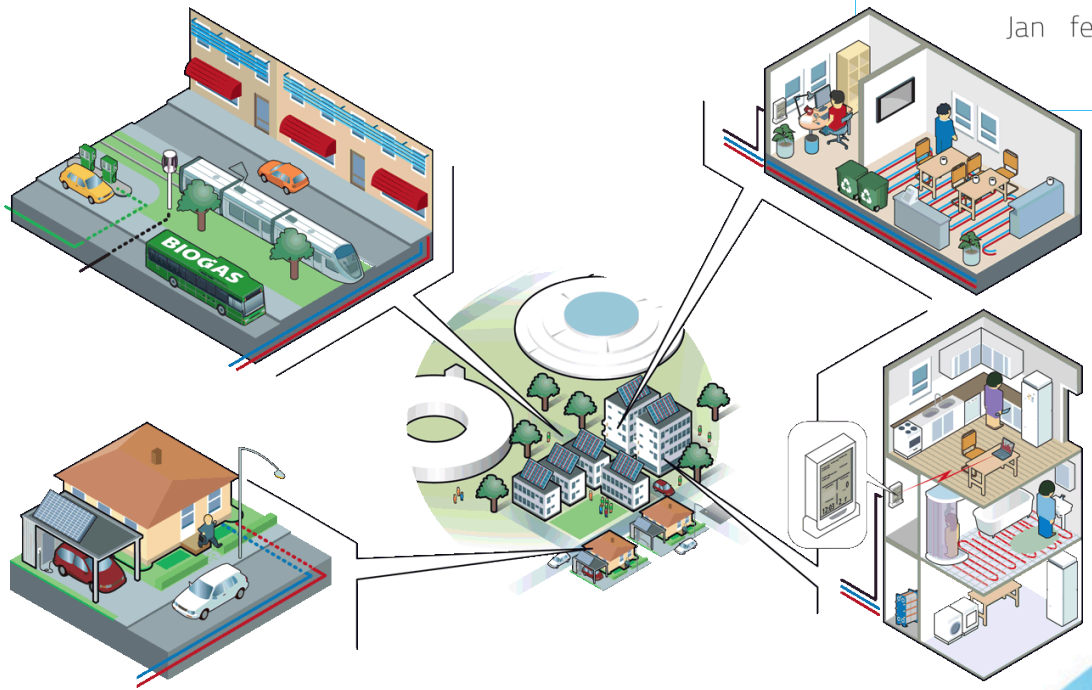


OUT
174 GWhr
heat
recycled

EUROPEAN SPALLATION SOURCE

ESS's Cooling water becomes someone else's Heating water

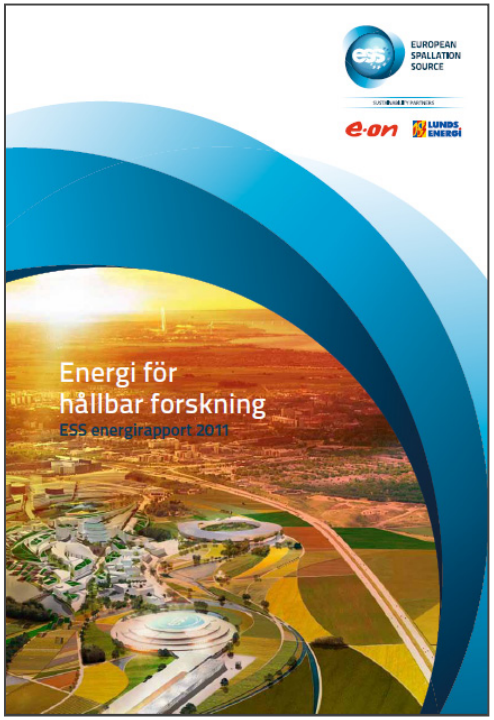




ESS will provide 20% of Lund's Heating needs

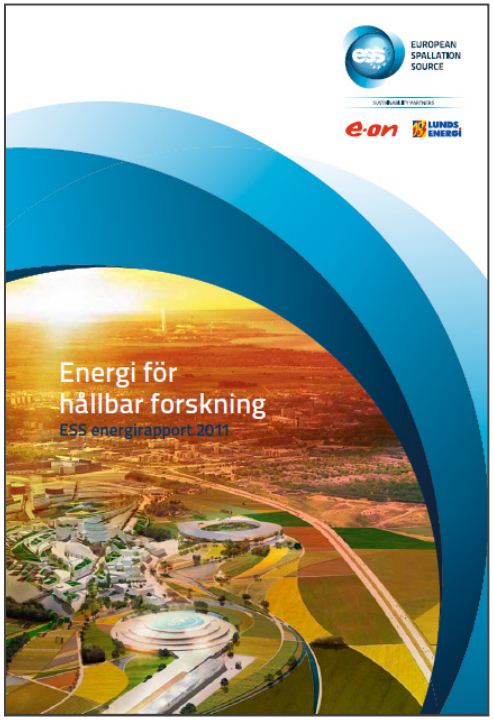
Conclusions: ESS energy solution

- **Electricity consumption** is reduced from 350 GWh to 250 GWh, partly because of smart cooling systems and building technology.
- **Carbon dioxide savings** of 165,000 tonnes per year, compared with a conventional energy solution.
- **Operational costs** for ESS reduced by up to 15M€/year.
- **10,000 houses** in the Swedish towns Lund, Lomma and Eslöv can be heated by district heating.
- **International** role model – we hope.
- Factor out the effect of electricity cost fluctuations



Conclusions: ESS energy solution

- **Electricity consumption** is reduced from 350 GWh to 250 GWh, partly because of smart cooling systems and building technology.



:ar,

5M€/year.

ıa and Eslöv

ns

We are seeking more staff

ns avsikt med platsannonsen var att rekrytera personer
ot Sydpolen 1908.

www.esss.se

EUROPEAN SPALLATION SOURCE

The World's Ultimate Slow Neutron Source ?

LHC !

EUROPEAN SPALLATION SOURCE

Thanks for listening !

Thanks for a great week !

EUROPEAN SPALLATION SOURCE

Thanks for listeni

Thanks for a great