

Engineering Education and Sustainability

International Comparisons

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This is a “Thin” paper

MY SUSTAINABLE SOCIETY AT HOME



MY SUSTAINABLE SOCIETY AT HOME



- **This is not a paper about the teaching of sustainability!**
- **It asks the question about how well our engineering graduates are prepared to communicate sustainability issues within the general community.**
- **Are our graduates able to sensibly discuss such issues within the general community?**
- **Can they use their scientific and engineering knowledge in explaining the important sustainability issues to the general community? (and the media)**

**If they can why are they not doing
this?**

“Greenhouse gases such as CO₂ must be drastically reduced says the Prime Minister!”



My Talk

- **Let me start by stating that I do not think that the vast majority of engineering graduates are capable of working and communicating with Society on issues such as sustainable development**
- **Define what I mean by a sustainable society with some sustainability goals.**
- **Essential requirements of an engineering education – quality, numbers & breadth.**
- **How many engineering graduates are produced worldwide.**

My Talk

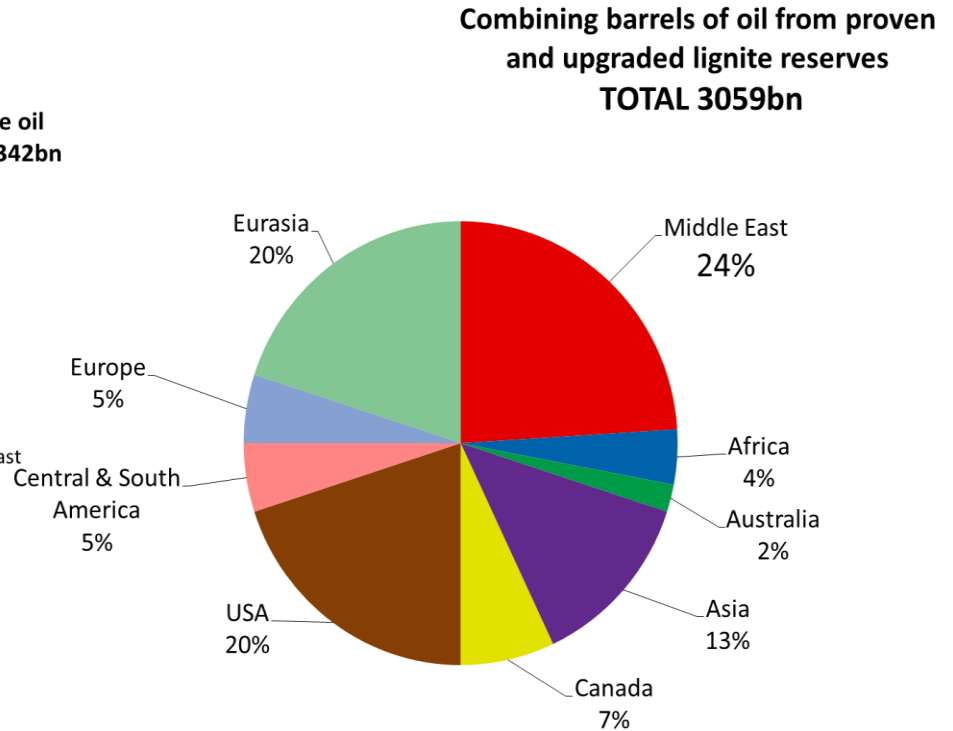
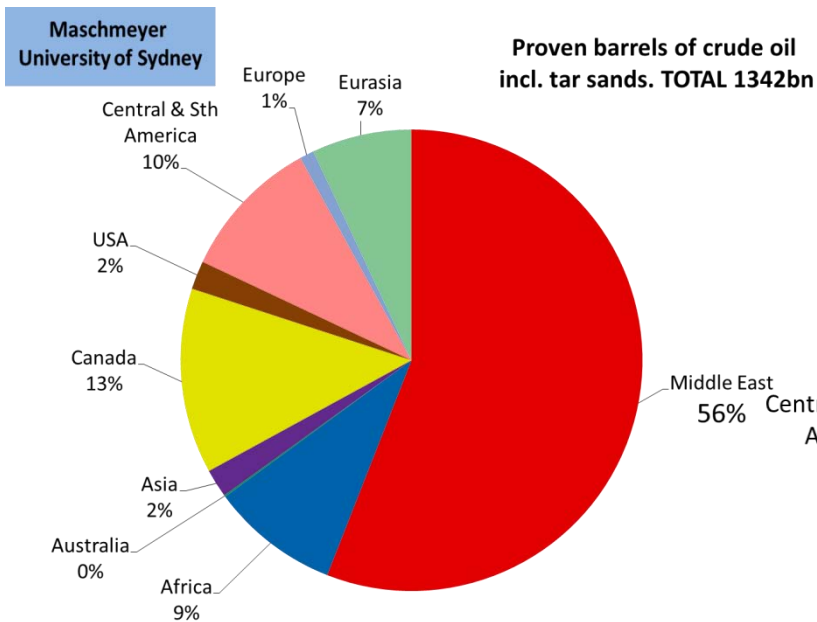
- **How is the breadth of an engineering education constrained by the program structure.**
- **The many models of engineering education.**
- **The impact of the models on the ability to deliver a well rounded engineering graduate.**
- **Introduce you to combined degrees and the Melbourne Model which is designed to produce a well rounded graduate who can rapidly assimilate into the complex World of employment & society.**

What is a sustainable Society?

I think about this as I look at the World of my
Grandfather and that of my Grandson:



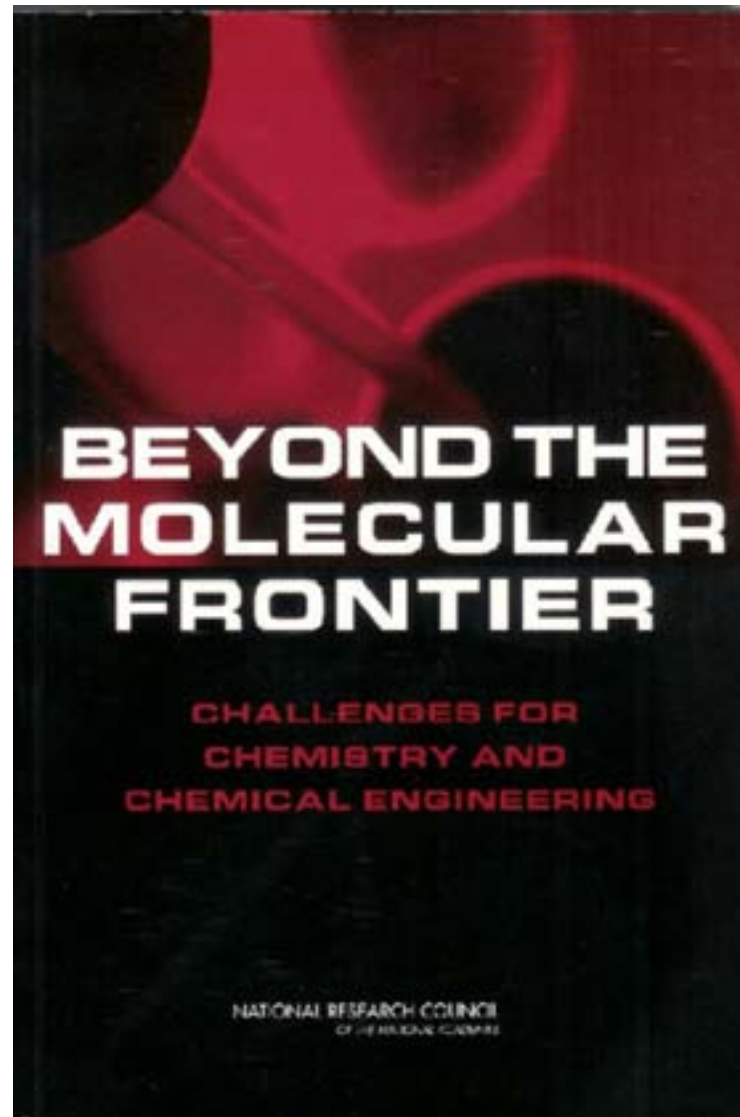
What is a sustainable Society?



Sustainability Goals

- **Climate that will not wreck the Globe**
- **Provision of energy for the present and the future**
- **Provision of water for our land and its natural plants as well as for animals including humans**
- **The ability to provide food and nutrition for all**

Challenges for engineering graduates



Three Essential requirements from an Engineering Education

1. The education of the graduates must be of an appropriate quality
2. There must be a sufficient number of high quality graduates produced.
3. The undergraduate program must contain high quality breadth material to enable the graduates to have the skills to communicate to all sectors of Society including politicians.

Three Essential requirements from an Engineering Education

- **Quality**
- **Number**
- **Breadth**

Quality ?

- **My experience including accreditation and many reviews suggests that overall the quality of engineering education in terms of the scientific and engineering knowledge is very good.**
- **Quality is quite variable from country to country and in some cases within a country.**

Quality ?

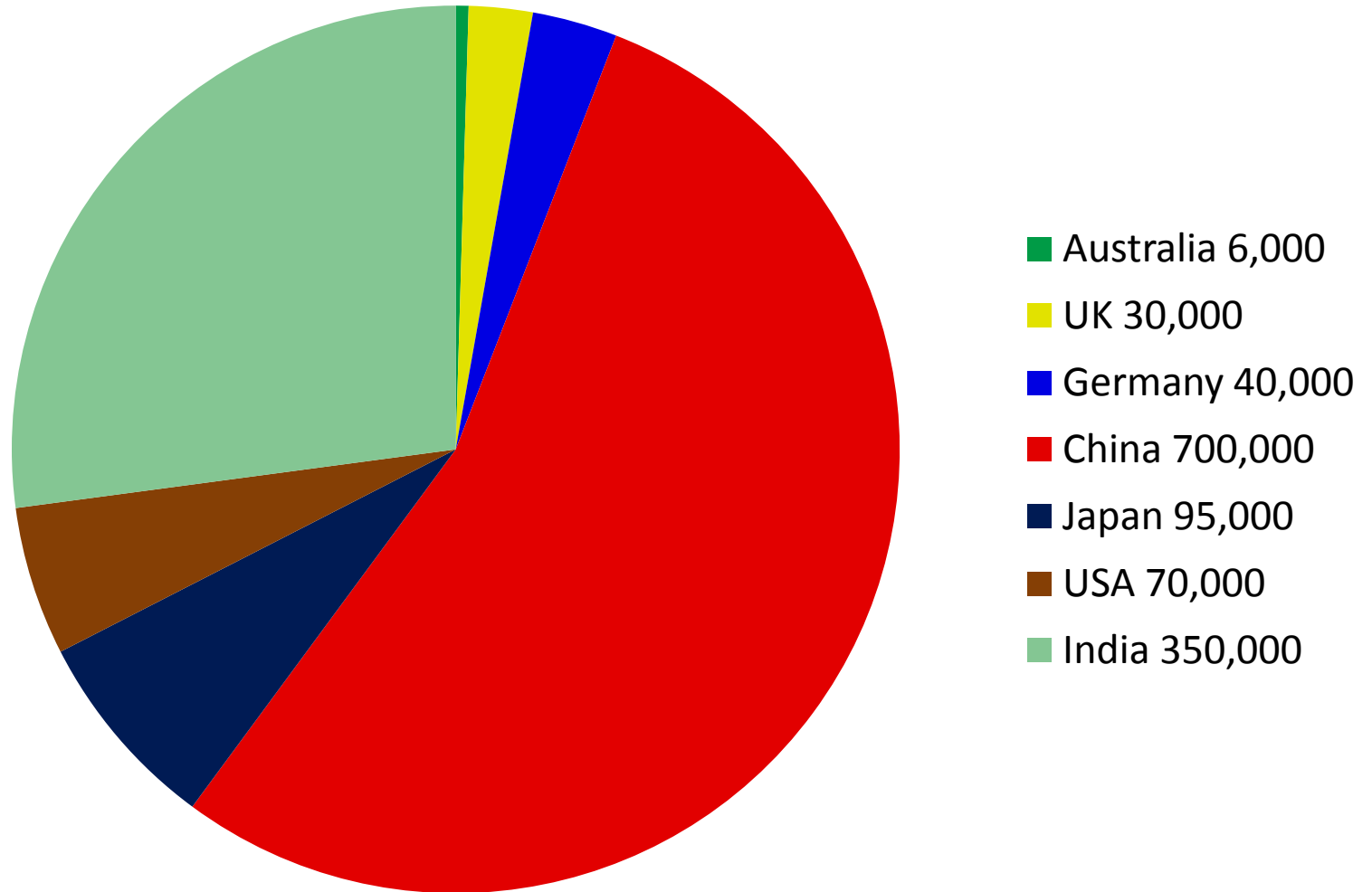
- **An example is in China where there has been an enormous growth in tertiary education over the past 20 years.**
- **e.g. 3 new chemical engineering departments per year on average over this time!**
- **The top 9 Chinese universities are as good in terms of quality as any in the World.**

Three Essential requirements from an Engineering Education

- **Quality √**

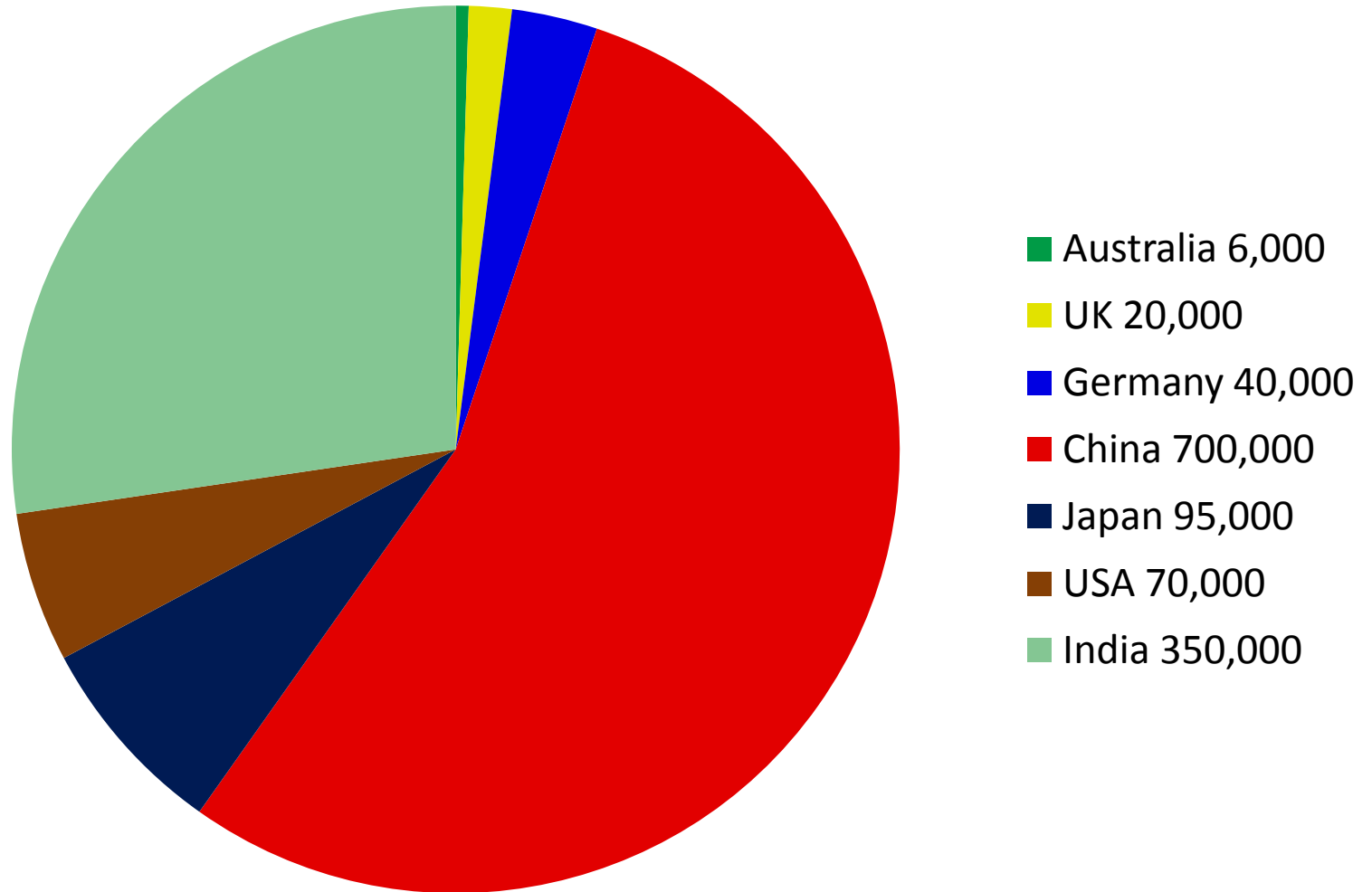
Number ?

Engineering Graduate Numbers



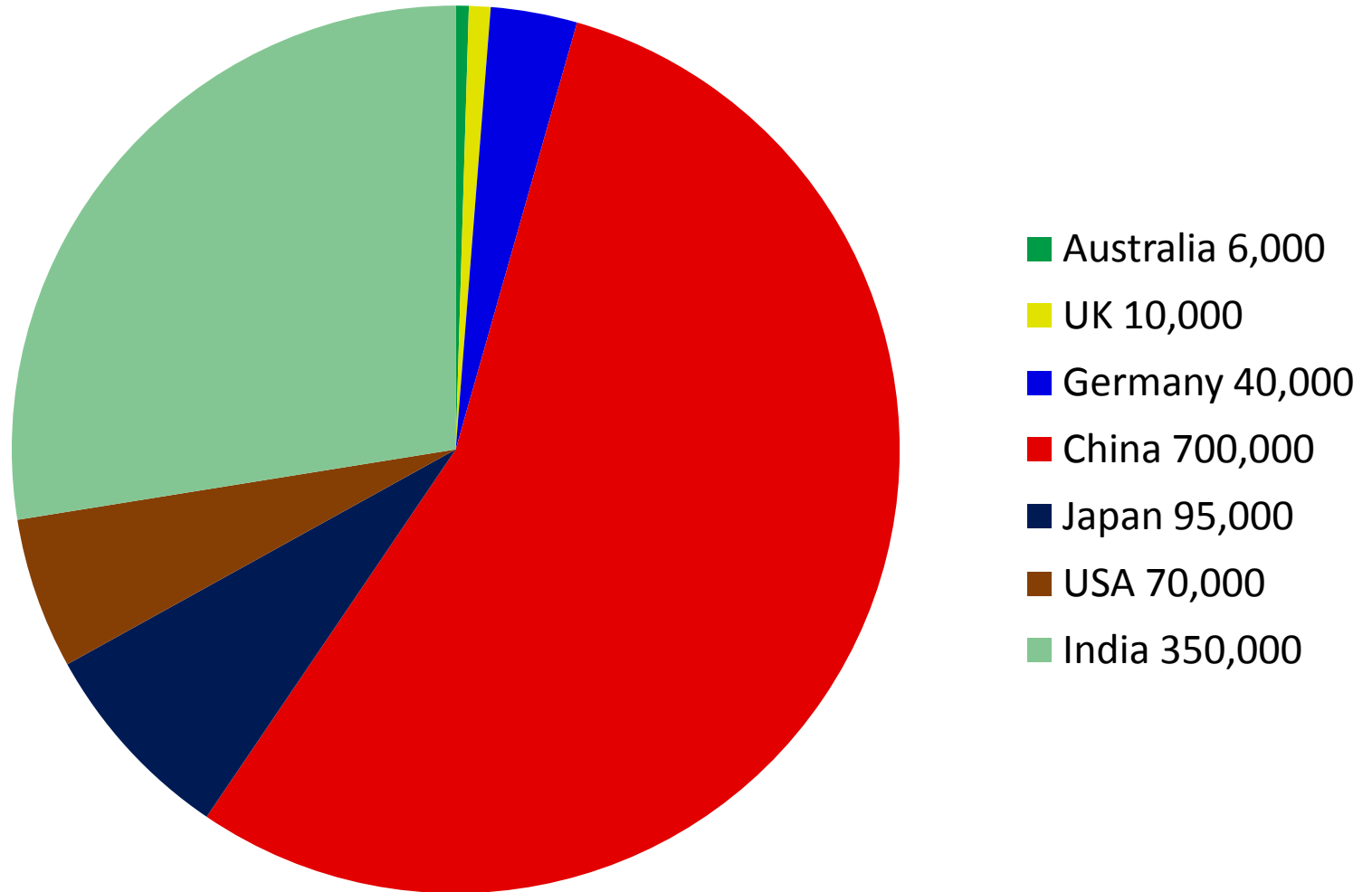
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Engineering Graduate Numbers



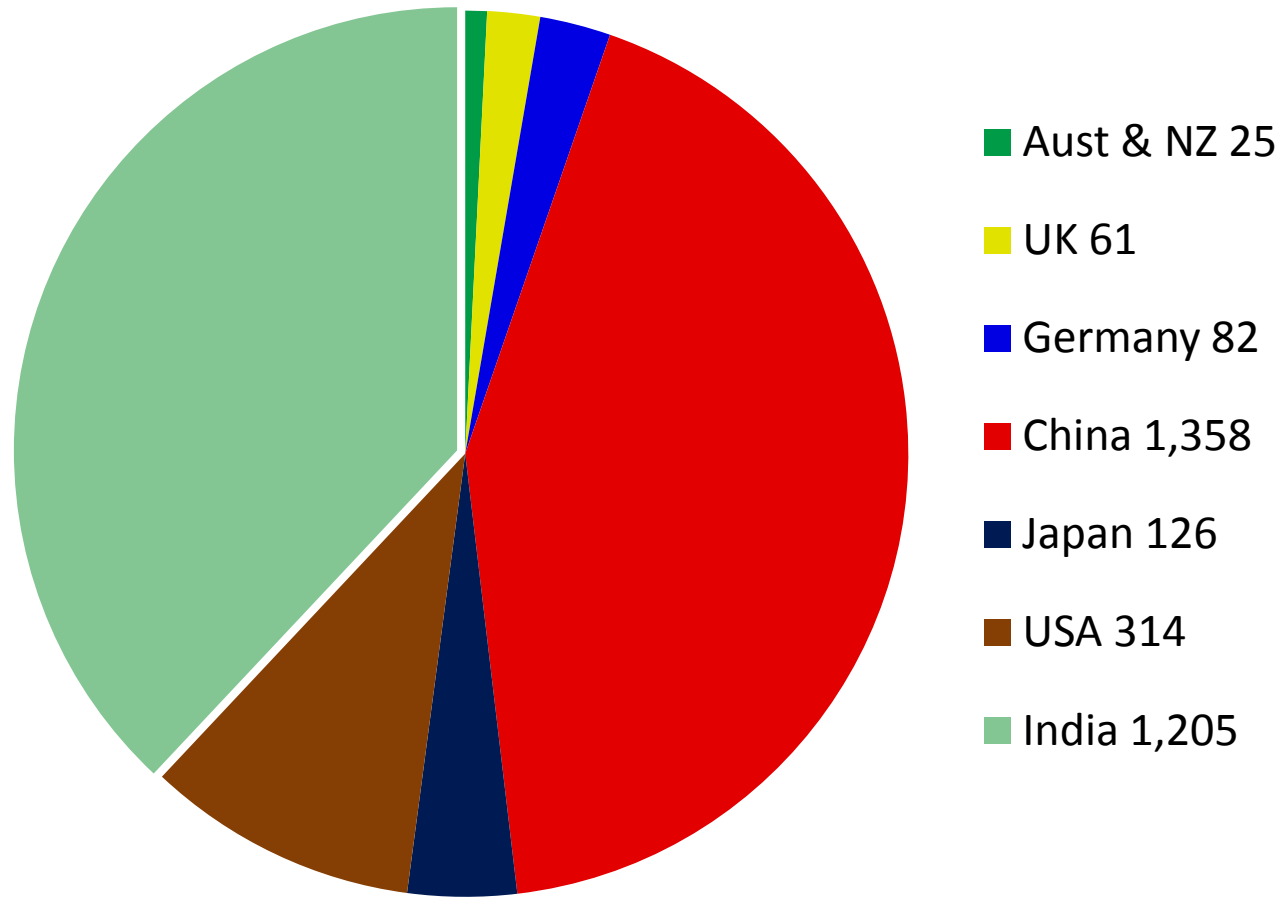
Number ?

Engineering Graduate Numbers



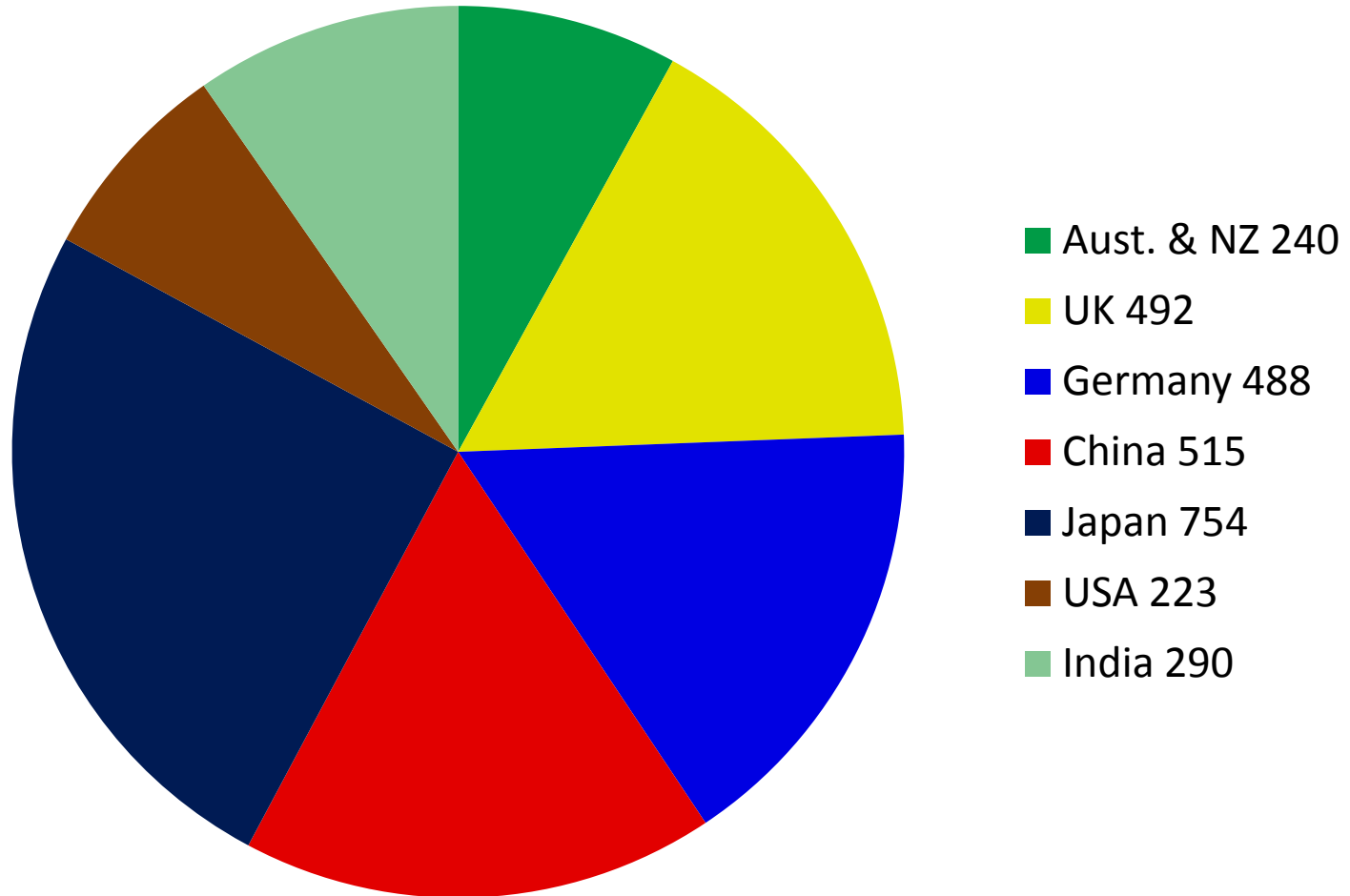
Number ?

Population



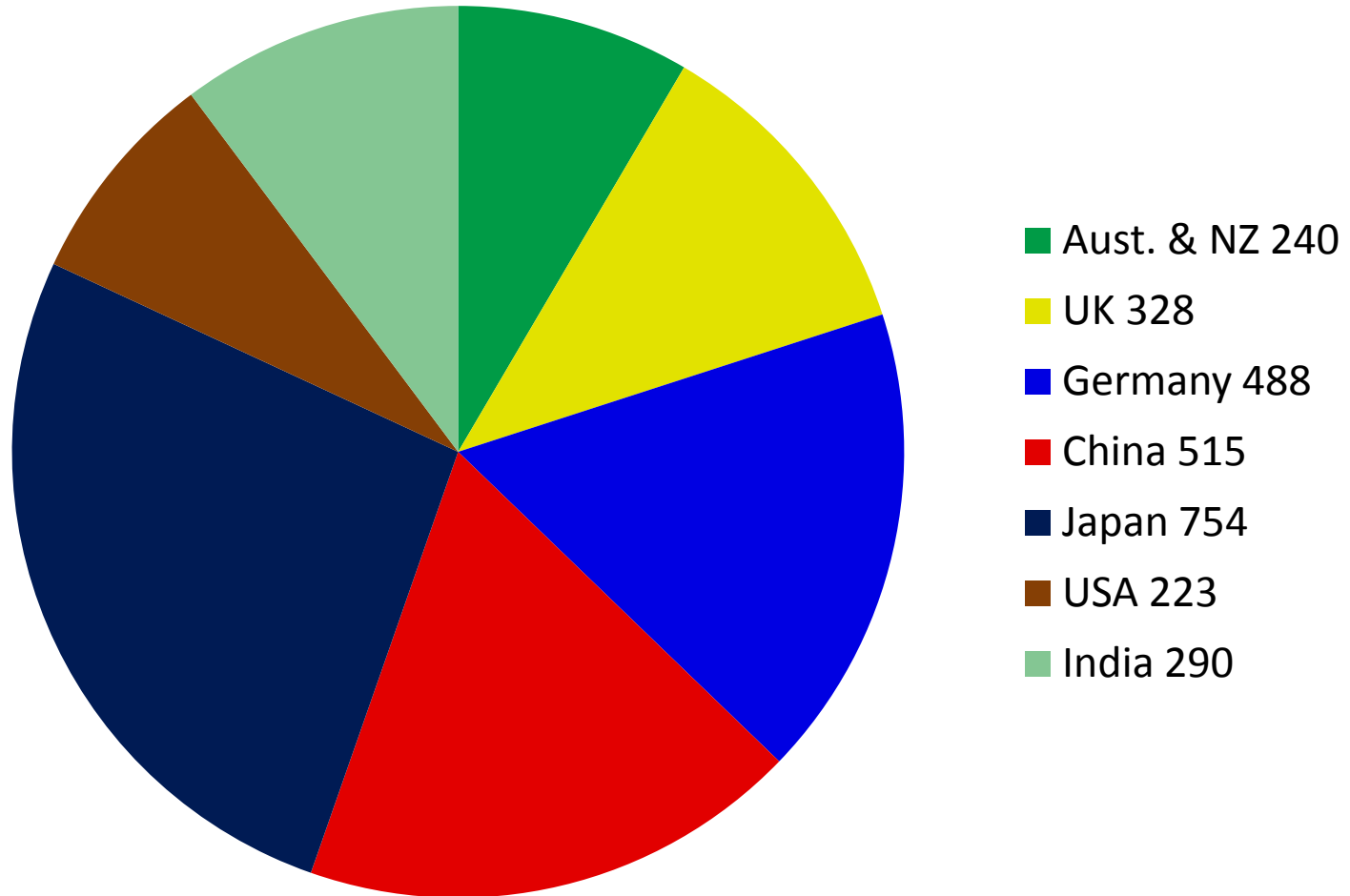
Number ?

Graduates per million pop.



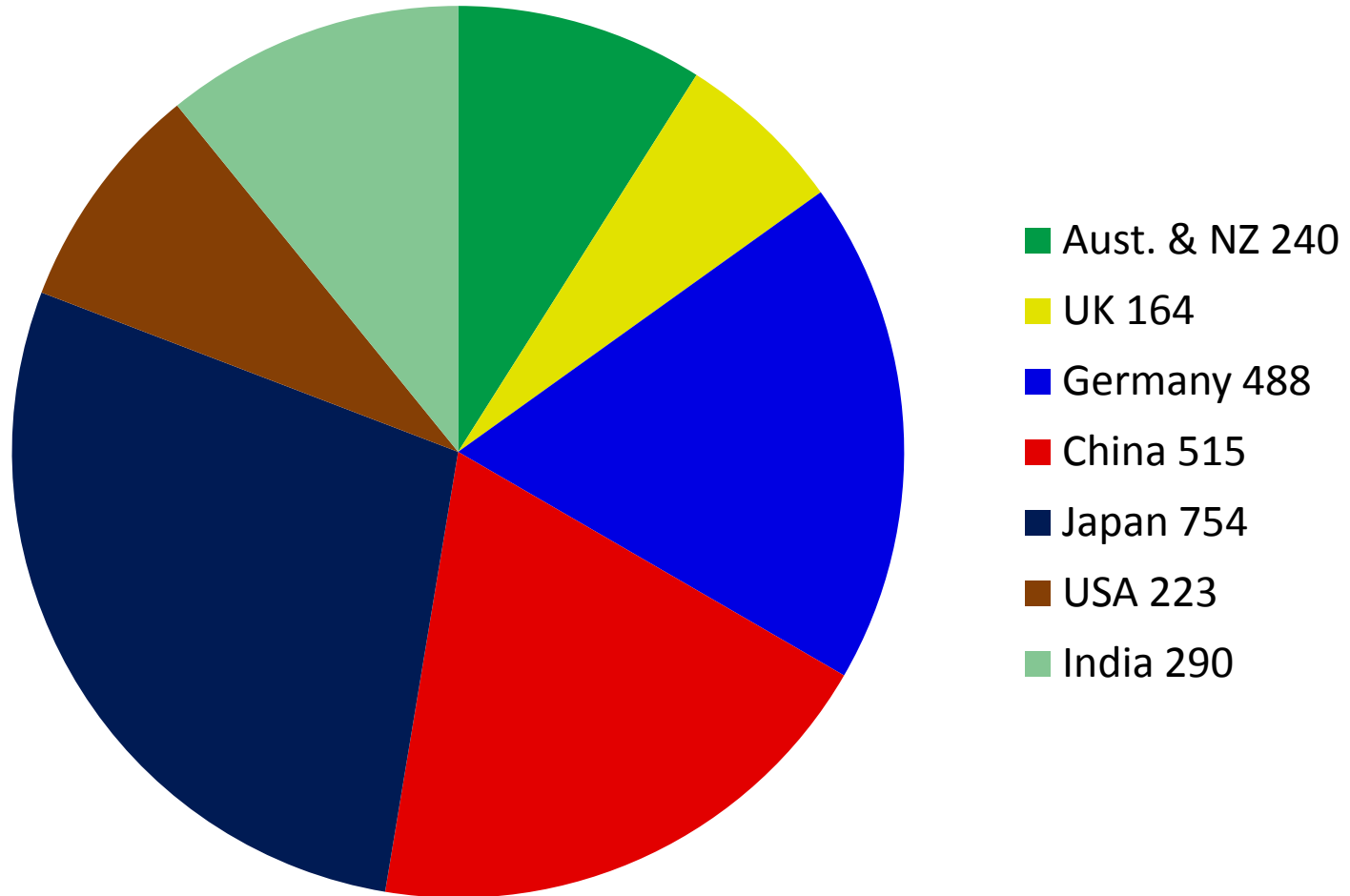
Number ?

Graduates per million pop.



Number ?

Graduates per million pop.



Three Essential requirements from an Engineering Education

- **Quality √**
- **Number √**

And Breadth?

Engineering Degree Programs

- **Engineering degree programs consist of a particular content which is constructed within a program structure e.g. years, semesters, terms etc.**
- **Hence to look at Breadth we need to examine both content and structure.**
- **Breadth is part of the content but it is usually constrained within a particular structure**

Engineering Degree Programs

- **Structure**

3

3+1

4 (M)

4 (B)

“Combined”

3+2

- **Content**

Foundation

Depth

Breadth

Engineering Degree Programs

Typically Structure:

- **3 & 3+1 occur in many developing countries**
 - **4 (M) are in the UK**
- **4 (B) are in the USA and in countries that have adopted the US system including many Universities in Australia**

Engineering Degree Programs

- “Combined” are in Australia
 - 3+2 is the Bologna structure
 - 3+2 is also the basis of the new Melbourne Model (Also now in WA)
- There is a great variation

Engineering Degree Programs

Typically Content:

In terms of foundation and depth, content is scientifically and in engineering, rigorous, as far as the structure will permit.

Programs other than the 3+2 format tend to be constrained in Breadth and whilst in good universities the graduates are very highly valued in terms of science & engineering knowledge, the breadth is often lacking.

Combined & 3+2 Programs

- The “Combined” & 3+2 programs have enormous potential to produce graduates who are far better rounded in terms of breadth.
 - These graduates have had a great opportunity to develop the necessary skills, with great strength in communication, to apply engineering knowledge to “everyday” issues related to sustainable development.

Combined & 3+2 Programs

- **By working with politicians, community leaders and the general public they are capable of assuring the community that Engineering and Science can provide the best pathways to lead to a more sustainable future for the World.**
 - **The “combined” experience which now stretches for 40 years demonstrates this.**

Combined & 3+2 Programs

Whilst the Bologna program is a 3+2 program my analysis of the chemical engineering programs shows that the content tends to be very much of the 20th Century and there is little to demonstrate that the 3+2 structure is being well used to optimally provide a well balanced “Breadth” program.

“Combined” & The Melbourne Model

- **The Combined programs in Australia and the Melbourne Model have been very well designed to encourage students to complete 25% of the program in majors completely outside of engineering producing a much better balanced graduate.**
- **The “downside” is that the program is of 5 years duration and correspondingly potentially very expensive.**

“Combined” & The Melbourne Model

- An unintended consequence is a significant improvement in the quality of learning for students taking both combined degrees and the Melbourne Model!**

In Summary

- **In terms of quality, globally, there are some Engineering programs, particularly in developing countries where the graduates are inadequately prepared to fully comprehend the science and engineering of sustainability.**
 - **BUT**
- **The majority of engineering graduates emerging today are very well prepared scientifically to take the communities of the World through the challenges of sustainability.**

In Summary

- **Whilst there are some countries where the number of engineering graduates are surprisingly low at a global level there is certainly a sustainable number of graduates being produced.**
- **China has become a very dominant country in terms of the number of graduate engineers produced in the past 20 years.**

In Summary

- **University engineering graduates from countries such as China, India, Japan and many from the USA and Europe are not sufficiently well educated in a broad sense to have the breadth skills in convincing politicians, the media and the general community that sustainability challenges facing humankind can be resolved with good science and engineering.**

In Summary

Today's global challenges receive commentary & widespread publicity from the sceptics, the scientifically ignorant & many other ignorant humans.

Such commentary is frequently well received by the media and the politicians with particular agendas.

Whilst we engineers far too frequently simply talk amongst ourselves

Engineering education can change and in my view it must change!

谢谢!

Thank You