Where to start:
Energy efficiency potential in buildings
Energy Efficiency Training Week: Buildings Program

1. **Where to start:** Understanding energy use in buildings
2. **Where to start:** Energy efficiency potential in buildings
3. **Toolkit:** Energy efficient building design
4. **Toolkit:** Energy efficient building technologies
   
   *Where do I get help?* IEA’s Technology Collaboration Programmes
5. **Toolkit:** Enabling investment with energy efficiency policies
6. **What are the steps:** Building energy codes and standards
   
   *Site Visit:* Schneider Electric
7. **What are the steps:** Set targets and develop policies
8. **Did it work:** Evaluating the multiple benefits of energy efficiency
9. **Did it work:** Tracking progress with energy efficiency indicators
   
   *Where do I get help?* International and regional energy efficiency initiatives
10. **Energy Efficiency Quiz:** Understanding energy efficiency in buildings
Energy Efficiency Training Week: Buildings

2. Where to start: Energy efficiency potential in buildings

Trainers: John Dulac and Ian Hamilton

Session: 1 hour

Purpose: To teach the fundamentals of the energy efficiency potential in buildings. This includes information on IEA’s scenarios analysis modelling to determine potential impacts.

Scenario: You have been asked to create new policies for energy efficient buildings. How do you determine where to start?
How much potential is there?

What type of potential is there?

What can drive the potential?
Type of energy efficiency potential: analysis approaches

1. **Technical potential**: analysing the total energy efficiency potential without any economic or market constraints (e.g. analysing the energy savings potential if all buildings used best available technology)

2. **Economic potential**: analysing the energy efficiency potential assuming economic constraints for cost effectiveness (e.g. analysing the energy savings potential if buildings used the most-efficient cost-effective technology)

3. **Market potential**: analysing the energy efficiency potential assuming market constraints in implementing energy efficiency (e.g. analysing the energy savings potential using a adoption curve to estimate typical market implementation given the available policies and technologies)

Technical potential, economic potential and market potential are used for different purposes
Global energy efficiency potential

80% of the economic potential to improve energy efficiency in buildings remains untapped.

Source: IEA World Energy Outlook 2012
Reversing historical trends...

Energy efficiency measures can reverse historical trends, offsetting the effect of increasing global population, building activity and growing floor area in buildings.

Source: IEA Energy Technology Perspectives 2017
Global energy efficiency potential

Global energy savings potential to 2060

- Envelope improvements (thermal demand reduction through better insulation)
- Product performance enhancements (higher yields, COPs...)
- Switch to cleaner technologies (deployment of heat pumps, renewables...)

Energy efficiency can save 1750 EJ cumulatively to 2060, 14 times the energy consumed by buildings in 2017.

Source: IEA Energy Technology Perspectives 2017: Beyond 2 Degrees Scenario
More than 50% of cumulative CO2 emissions reduction in buildings to 2060 under the B2DS results from shifts to low-carbon and high-performance technologies.

Source: IEA Energy Technology Perspectives 2017
What can drive potential: floor area

Global residential floor area growth and opportunity

Opportunity exists in both the historic stock and new building additions.

Source: IEA Energy Technology Perspectives 2017
What can drive potential: floor area

With business as usual growth, we expect continued high levels of non-compliance in new construction and minimal retrofits of existing stock.

Source: IEA Energy Technology Perspectives 2017
What can drive potential: floor area

Global residential floor area growth and opportunity (more efficient)

In a below 2 degree scenarios, we expect less non-compliance and high levels of deep energy retrofits that can contribute to significant energy reductions.

Source: IEA Energy Technology Perspectives 2017
What can drive potential: building technologies

There are multiple ways to increase the efficiency through building technologies

Sources: IEA Energy Technology Perspectives 2016
Delaying implementation and enforcement of building envelope measures would result in the equivalent of three years of additional energy consumption for heating and cooling in the buildings sector.

Source: IEA Energy Technology Perspectives 2017
All regions have potential to improve the building energy policies adoption and enforcement.

Source: IEA Future of Cooling, 2018

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.
What can drive potential: behaviour

Impacts of Occupant Behaviour

Occupant and Operator Behavior is critical: the impact of day to day comfort and building operations decisions can have a very dramatic impact on energy consumption.

Source: Tianzhen Hong, Lawrence Berkeley National Lab, 2013
How do I calculate potential?

Scenario:

You have been asked to create new policies for energy efficient buildings.

How do you determine where to start?
How do I calculate potential?

Ask questions
Data
Modelling
How do I calculate potential: where do I start?

 Asking some questions…

- Why is it important to know the potential?
- What is energy efficiency potential in buildings?
- How big is it?
- How do I estimate it?
- What are the challenges?
If You Can't Measure It, You Can't Improve It

(William Thomson, Lord Kelvin)
How do I calculate potential: data

Start with the existing data (as shown in Session 1 and discussed in detail in Session 9)

Use existing data to understand the energy efficiency potential.

Source: IEA Energy Technology Perspectives 2017
How do I calculate potential: data

Example: Building stock accounting for Turin (Italy)

Breaking the data down in a stock model can help you identify where the potential is.

Source: IEA Energy Technology Perspectives 2017
All models are wrong but some are useful

George E.P. Box (Statistician)
How do I calculate potential: modelling

Modelling approaches:

1. **Bottom-up**: constructing a “stock model” of building data to analyse
2. **Top-down**: disaggregating economy-wide data
3. **Hybrid top-down and bottom-up**: using the best available data and calibrating bottom-up data to top-down statistics
How do I calculate potential: modelling (bottom-up)

Use existing resources (many are free)

**EnergyPlus**
EnergyPlus is DOE’s whole-building energy simulation engine.

Whole-building Energy Simulation | HVAC System Selection and Sizing | Code Compliance
Last Software Update: 30 September 2015 | Last Entry Update: 12 December 2015
Ratings ★★★★★ | Reviews 0 | Add to compare

**OpenStudio**
OpenStudio is an open-source SDK (software development kit) for building energy simulation.

Whole-building Energy Simulation | Energy Conservation Measures | Lighting Simulation
Last Software Update: 30 September 2015 | Last Entry Update: 15 December 2015
Ratings ★★★★★ | Reviews 0 | Add to compare

**eQUEST**
eQUEST® is a widely used, time-proven whole building energy performance design tool.

Whole-building Energy Simulation
Last Software Update: 30 June 2010 | Last Entry Update: 03 October 2015
Ratings ★★★★ | Reviews 0 | Add to compare

Many tool resources are already available

Source: US DOE BEST Directory and Copenhagen Center for Energy Efficiency
How do I calculate potential: modelling (top-down and hybrid)

**Example:** IEA’s Buildings Energy Model (ETP)

Energy models are essential to better estimating the energy efficiency potential

**Source:** IEA Energy Technology Perspectives 2017
Discussion and questions

- Do you have data on energy consumed in residential buildings vs. non-residential?

- Do you have data on the overall floor area stock, and annual new additions to the stock?

- What portion of building energy is used in urban areas vs rural areas?

- Do you have an building sector energy model?