Where to start?
Energy efficiency potential

Buildings

Buildings energy efficiency sessions in partnership with:

UCL ENERGY INSTITUTE

INDO-SWISS BUILDING ENERGY EFFICIENCY PROJECT
Energy Efficiency Training Week: Buildings programme

1. **Where to start:** 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
   - *Special session:* Technology demonstration
5. **Toolkit:** Energy efficiency policies and target setting
6. **What are the steps?** Enabling investment with energy efficiency policies
7. **What are the steps?** Implementing building energy codes and standards
8. **What are the steps?** Building operations and procurement
   - *Special session:* The multiple benefits of energy efficiency
9. **Did it work?** Evaluation and energy efficiency indicators
   - *Where do I get help?* International and regional energy efficiency initiatives
10. **Energy efficiency quiz:** Understanding energy efficiency in buildings
2. Where to start: Energy efficiency potential in buildings

Trainers: Brian Dean and Maxine Jordan

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

Energy efficiency potential by sector

70% of the economic potential to improve energy efficiency in buildings remains untapped

Source: IEA Energy Efficiency Market Report 2018
Reversing historical trends...

Decomposition of global final energy demand in buildings by key contribution

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
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

Global residential floor area growth and opportunity (business as usual)

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
There are multiple ways to increase the efficiency through building technologies.
What can drive potential: timing

Consequences of a ten-year delay

Delivering 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
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)

Residential (90 EJ)
- Space heating: 31%
- Space cooling: 4%
- Water heating: 22%
- Lighting: 11%
- Cooking: 11%
- Appliances: 11%
- Other: 3%

Non-residential (35 EJ)
- Space heating: 28%
- Space cooling: 12%
- Water heating: 11%
- Lighting: 11%
- Cooking: 11%
- Appliances: 11%
- Other: 3%

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)
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**

cQUEST® 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**

Source: US DOE BEST Directory and Copenhagen Center for Energy Efficiency

Many tool resources are already available
Energy models are essential to better estimating the energy efficiency potential.

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