



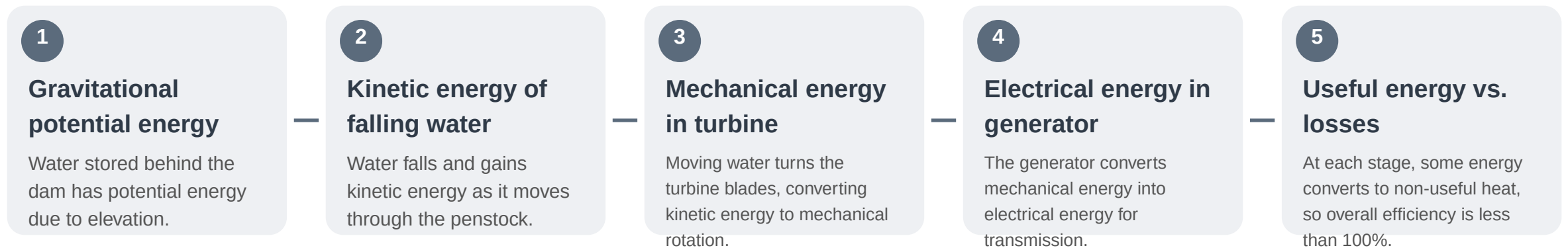
Energy Flow in Technological Systems

Science 10, Unit B: thermodynamics, efficiency, and energy conversion devices

Learning Intentions and Success Criteria

- I can illustrate how energy exists in multiple forms in natural and technological systems.
- I can describe how energy transfer technologies produce measurable changes in motion, shape, or temperature.
- I can explain, quantitatively, efficiency as useful work compared to total energy input.
- I can apply the first and second laws of thermodynamics to explain why no conversion is 100% efficient.
- I can relate $E_p = mgh$, $W = Fd$, and $E_k = \frac{1}{2}mv^2$ to energy transformations in a system.

Tracing Energy Through a Hydroelectric System



First and Second Laws in Everyday Devices

First Law: Conservation

Energy is neither created nor destroyed during a conversion; total energy in equals total energy out for a system such as an automobile engine or a heat pump. This principle is the basis for $\Delta E = W$, the relationship between work done on a system and its change in energy.

Second Law: Degradation of Useful Energy

Some input energy always converts to non-useful heat, which is why heat engines can never reach 100% efficiency. This limit explains why designers of high-efficiency furnaces and automobile engines focus on minimizing these losses rather than eliminating them.

Case Study: Efficiency of a Thermal Power Plant

Comparing coal and natural gas generation in Alberta

Alberta's thermal power plants convert chemical potential energy stored in fuel into thermal energy, then into mechanical energy, and finally into electrical energy. At each stage, some energy escapes as waste heat rather than becoming useful electrical output. Comparing coal and natural gas requires weighing energy content, cost, efficiency, and sustainability side by side, then judging which fuel better protects the environment while making reasonable use of natural resources.

Bringing It Together

Energy exists in many forms and moves through technological systems in traceable stages, with useful energy diminishing at every conversion because of the second law of thermodynamics. Quantitative tools such as $E_p = mgh$, $E_k = \frac{1}{2}mv^2$, and the efficiency ratio let us measure and compare how well real devices perform. Efficiency and sustainability matter because they determine how well a technology protects the environment and conserves natural resources.

If you designed a more efficient version of one device you traced today, which stage of energy loss would you target first, and what evidence would you collect to test your design?