Chapter 13:
Energy Recycling

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Outline

1. Abstract
2. Architecture of energy recycling
3. Benefit of waste energy recycling
4. Facts about recycling energy
5. Combined heat and power (CHP)
6. Waste heat recovery
7. On-going project
8. Conclusion
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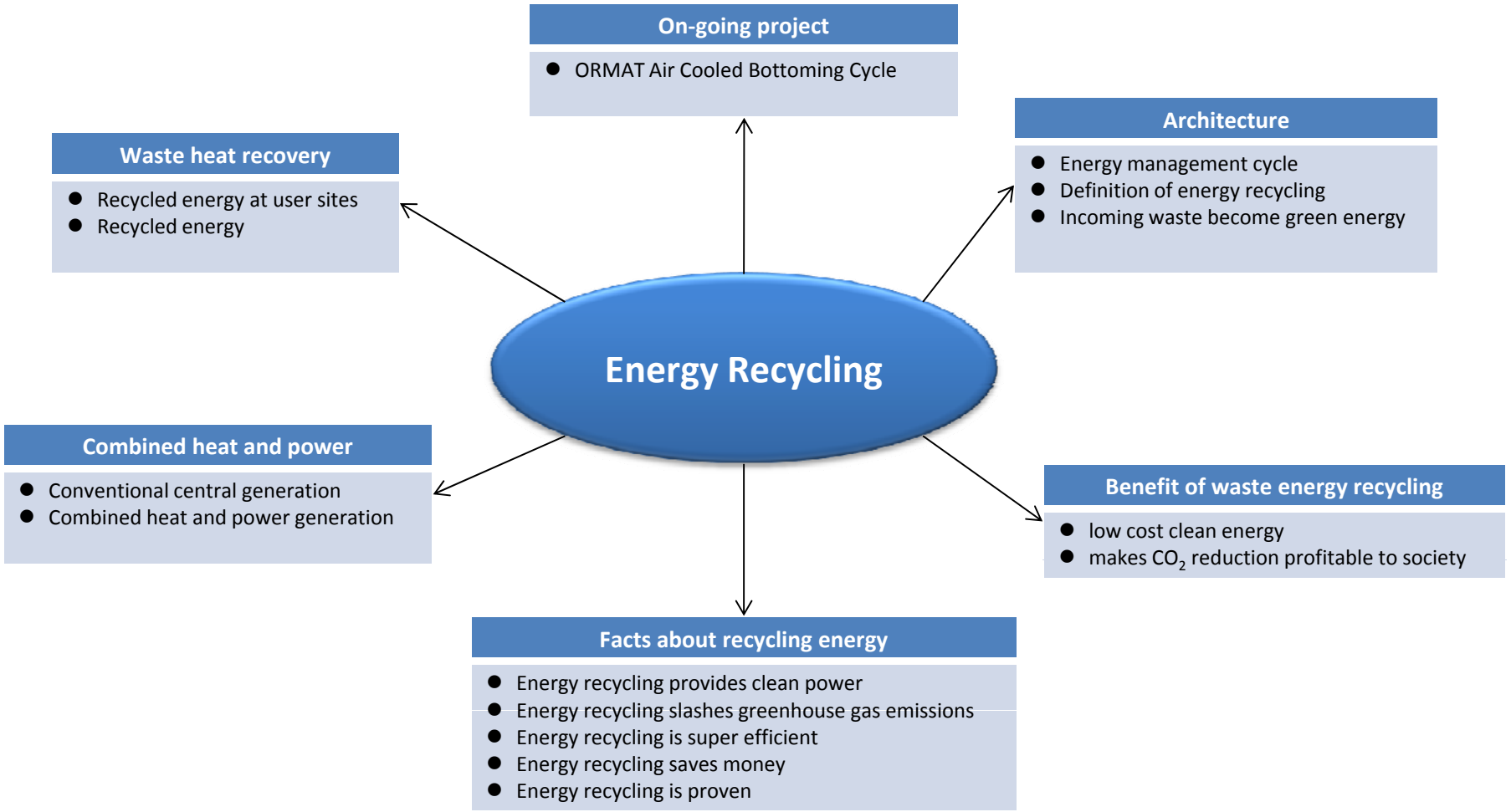
1. Abstract

- A 2007 Department of Energy study found untapped potential for 135,000 megawatts of combined heat and power in the U.S. Meanwhile, a Lawrence Berkley National Laboratory study identified another 64,000 megawatts that could be obtained from industrial waste energy recycling.
- These two forms of energy recycling could provide 40 percent of total U.S. electricity needs.
- Based on the successful practices of ENERGY STAR partners, these guidelines for energy management can assist your organization in improving its energy and financial performance while distinguishing your organization as an environmental leader.

Definition of energy recycling

- Recycled Energy Development (RED) provides all of the equipment, capital and services needed to create recycled energy projects:
  - Development
  - Financing
  - Engineering
  - Installation
  - Long-term operation
- RED captures an industrialist's waste energy and converts it into clean power and processed heat.

The organization of energy recycling



Overview of Energy Recycling

- Energy recycling is the energy recovery process of utilizing energy that would normally be wasted, usually by converting it into electricity or thermal energy.
- Undertaken at manufacturing facilities, power plants, and large institutions such as hospitals and universities, it significantly increases efficiency, thereby reducing energy costs and greenhouse gas pollution simultaneously.

2. Architecture of energy recycling

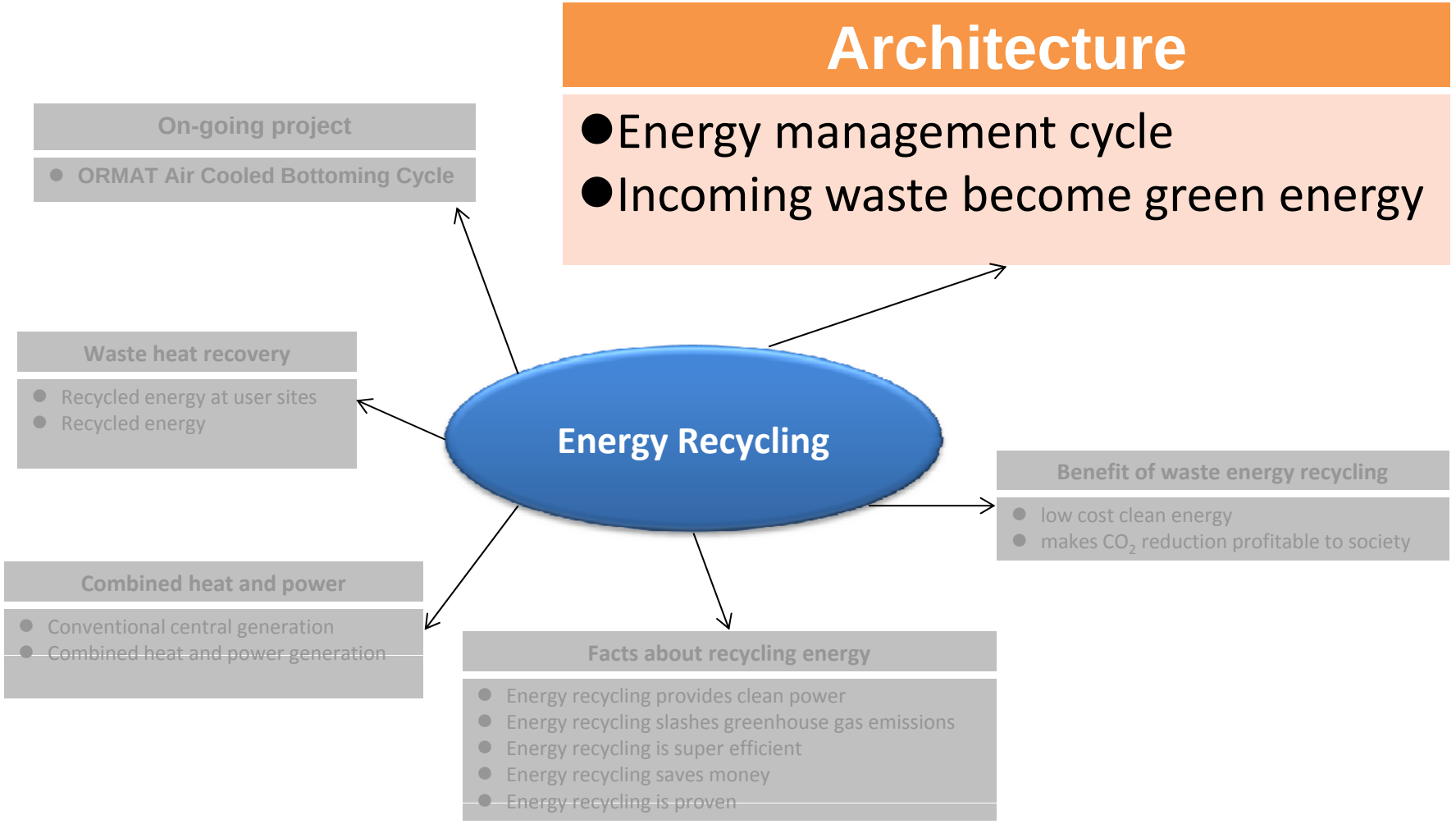
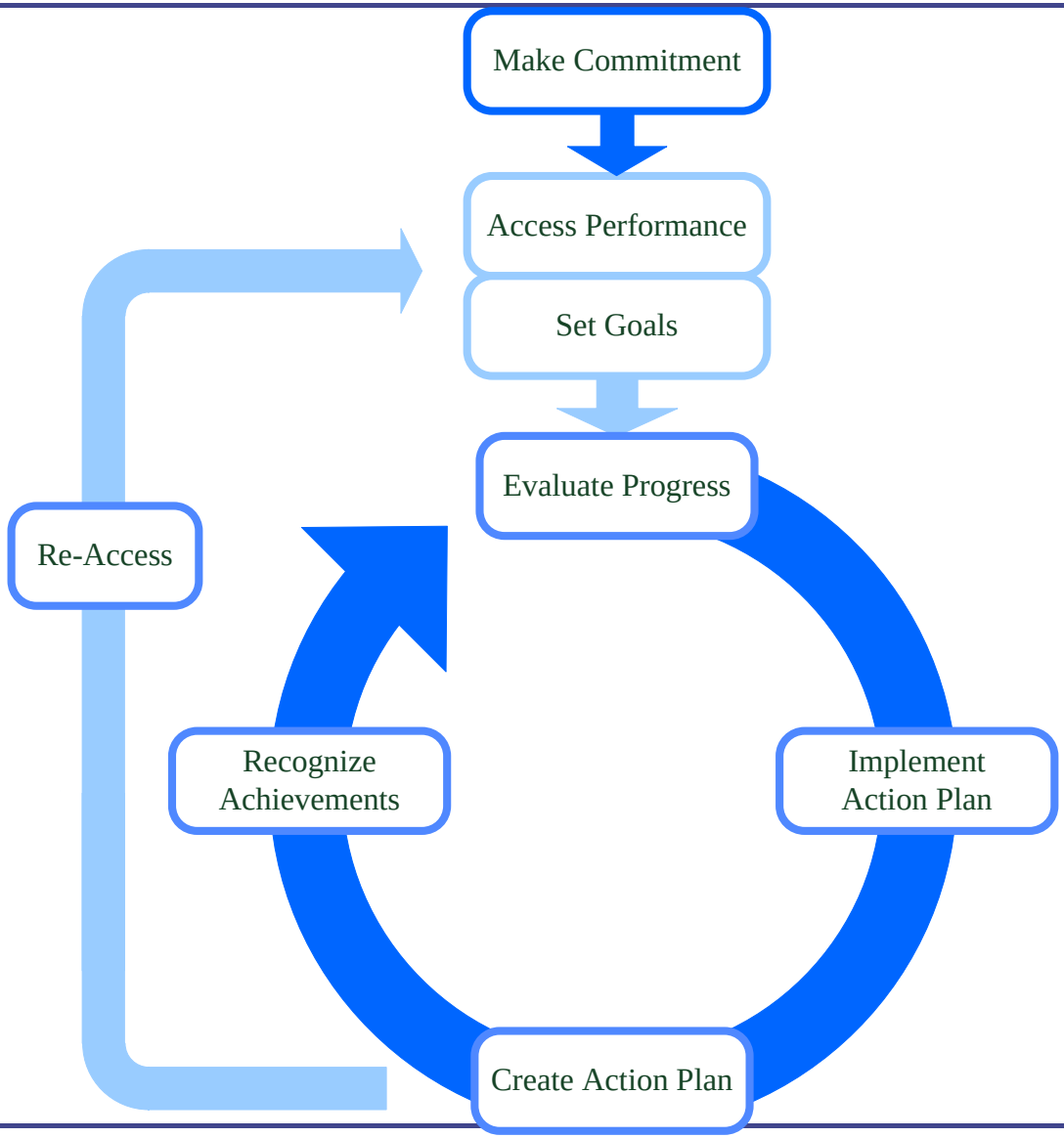


Figure of Energy management cycle

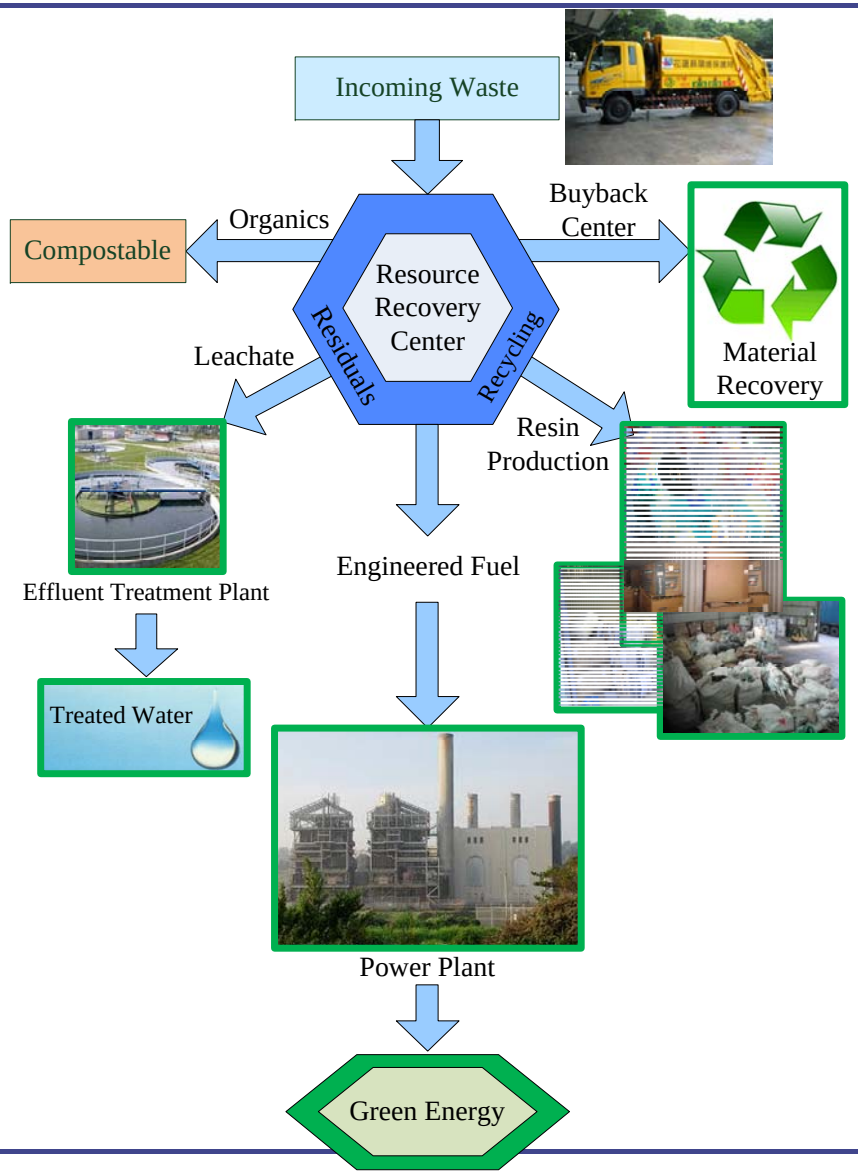


src: [2] Recycled Energy Development, http://www.recycled-energy.com/

Energy management cycle

- When an industry or organization wants to make an energy recycling, first thing they need to do is making a commitment.
- After making a commitment, they will set the goals and access performance to discuss what they can achieve.
- Create an action plan to achieve the goals, and implement the action plan to work on the project.
- When the action plan is on-going, they will evaluate progress and recognize achievements to see whether the plan can achieve the goals or not.

Figure of incoming waste become green energy

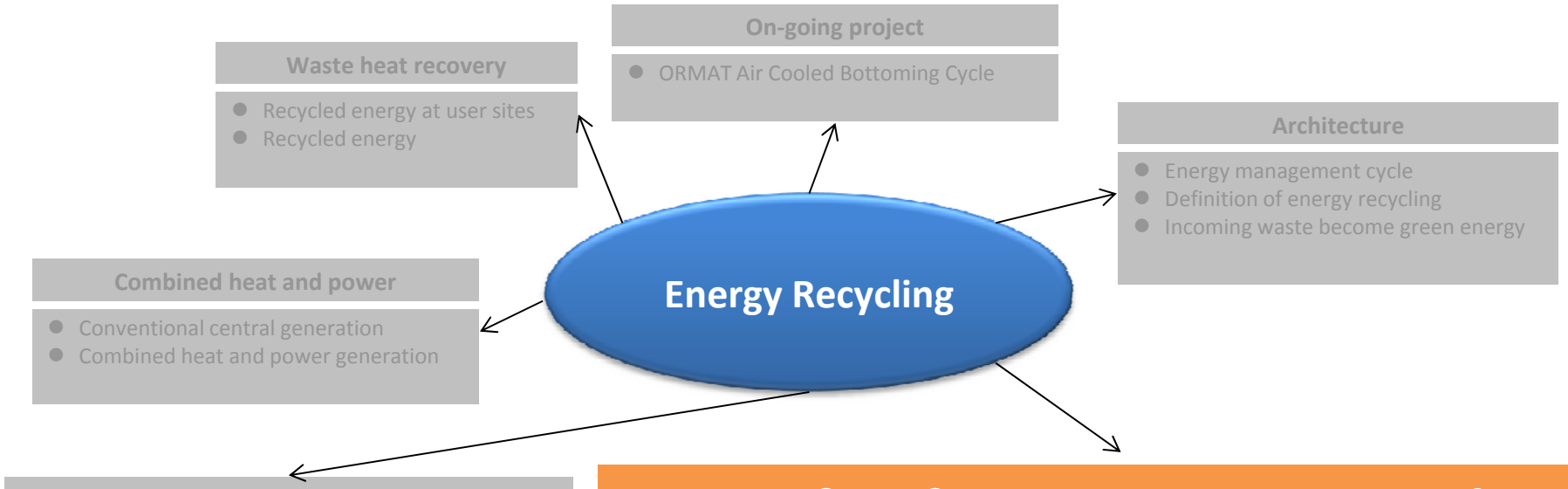


src: [2] Recycled Energy Development, http://www.recycled-energy.com/

Incoming waste become green energy

- When the incoming waste comes to the resource recovery center, it will separate into two parts: recycling and residuals.
- In residual part, organics will be sent to compostable, leachate will send to Effluent Treatment Plant to become treated water an be reused.
- In recycling part, things which can be recycled will send to the place like buyback center or resin production to recycling.
- The engineered fuel will be turned into green energy and reused the energy to reduce the pollution which will discuss in the later chapter.

3. Benefit of waste energy recycling



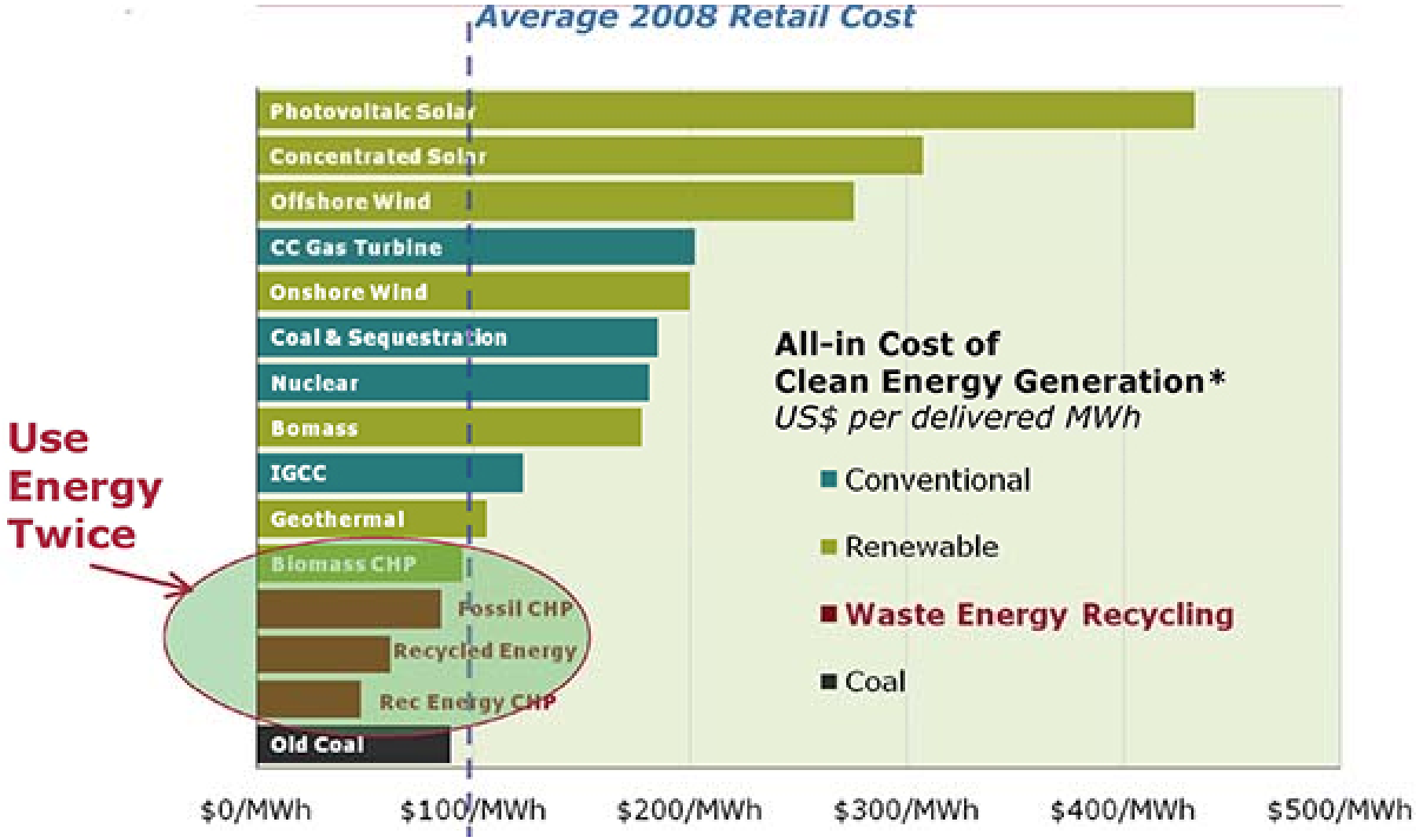
Benefit of waste energy recycling

- low cost clean energy
- makes CO_2 reduction profitable to society

Outline of benefit of waste energy recycling

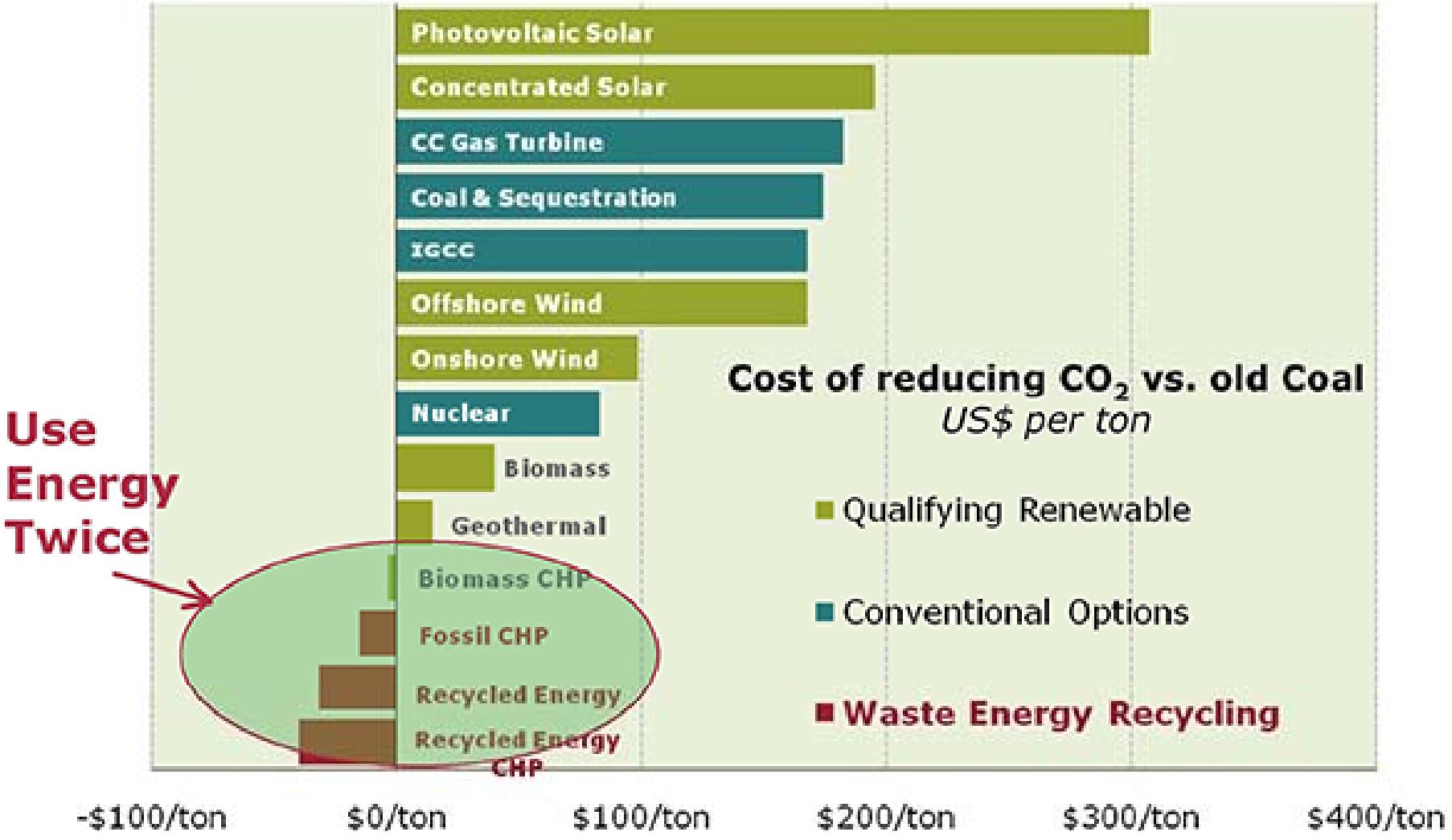
- Low cost clean energy
- Makes CO_2 reduction profitable to society

Waste energy recycling is the low cost clean energy



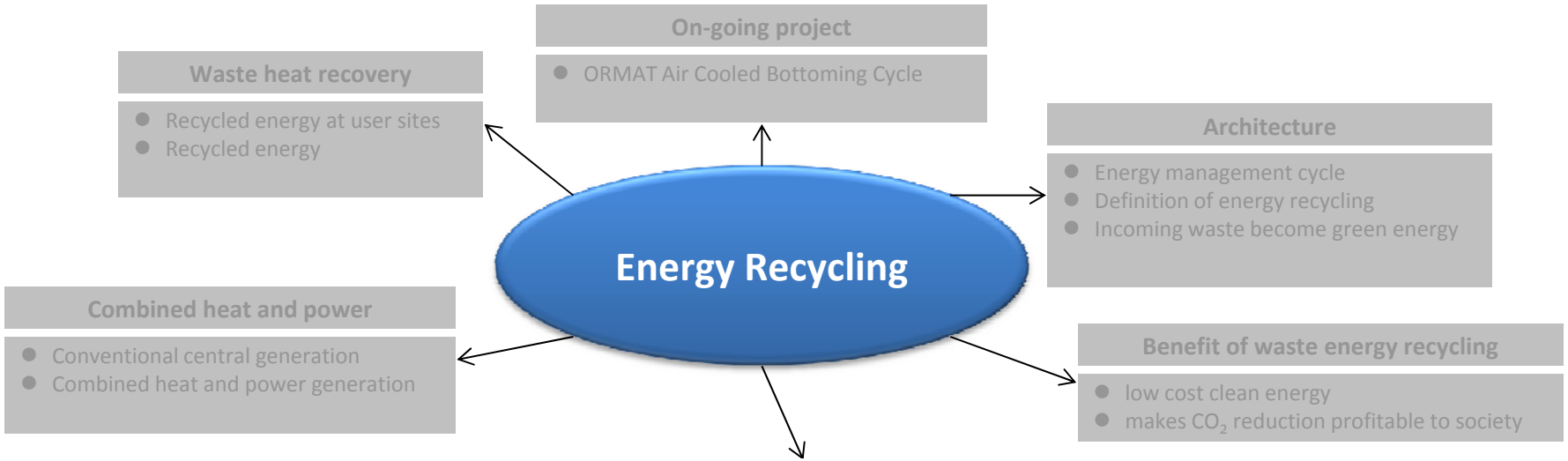
src: [3] Thomas R. Casten, Dick Munson, “Deploying Clean Energy: Overcoming Regulatory Barriers”, January 2009

Waste energy recycling makes CO_2 reduction profitable to society



src: [3] Thomas R. Casten, Dick Munson, “Deploying Clean Energy: Overcoming Regulatory Barriers”, January 2009

4. Facts about recycling energy



Facts about recycling energy

- Energy recycling provides clean power
- Energy recycling slashes greenhouse gas emissions
- Energy recycling is super efficient
- Energy recycling saves money
- Energy recycling is proven

Outline of facts about recycling energy

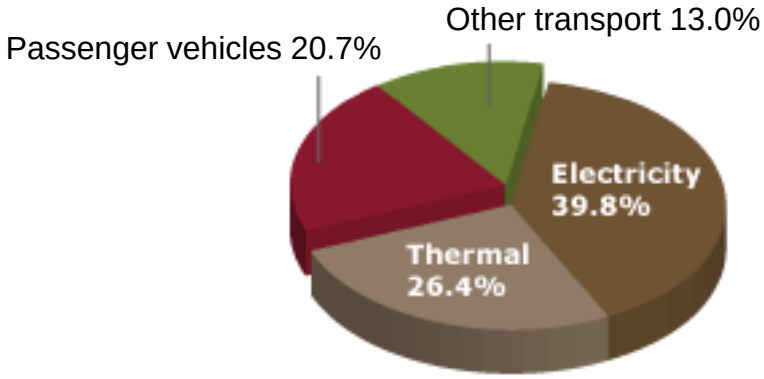
- Energy recycling provides clean power
- Energy recycling slashes greenhouse gas emissions
- Energy recycling is super efficient
- Energy recycling saves money
- Energy recycling can be implement

Energy recycling provides clean power

- Recent U.S. Environmental Protection Agency and Department of Energy studies suggest energy recycling could provide 40% of U.S. electricity needs — twice what we now get from nuclear power.
  - One-third (65,000 megawatts) would come from waste energy recovery, which is 100% clean, fossil-fuel free energy
  - Two-thirds (135,000 megawatts) would come from combined heat and power.
- That's 200,000 megawatts of clean power.

Energy recycling slashes greenhouse gas emissions

- The two thirds of U.S. greenhouse emissions comes from the production of power and heat:
  - 40% from generating electricity
  - 26% from generating heat
- Studies indicate that energy recycling could slash greenhouse pollution by 20%, which is as much as if we took every passenger vehicle off the road.



Two-thirds of US CO2 emissions come from heat and power production.

src: [2] Recycled Energy Development, http://www.recycled-energy.com/

Energy recycling is super efficient

- Most U.S. power plants are only 33% efficient. The typical plant throws out two of every three units of energy, largely in the form of waste heat. This efficiency rate has not changed since the 1950s.
- Cogeneration plants — also known as combined heat and power (CHP) — recycles the waste heat into clean electricity and useful steam. Cogeneration plants are at least 67% efficient and often 80-90% efficient.

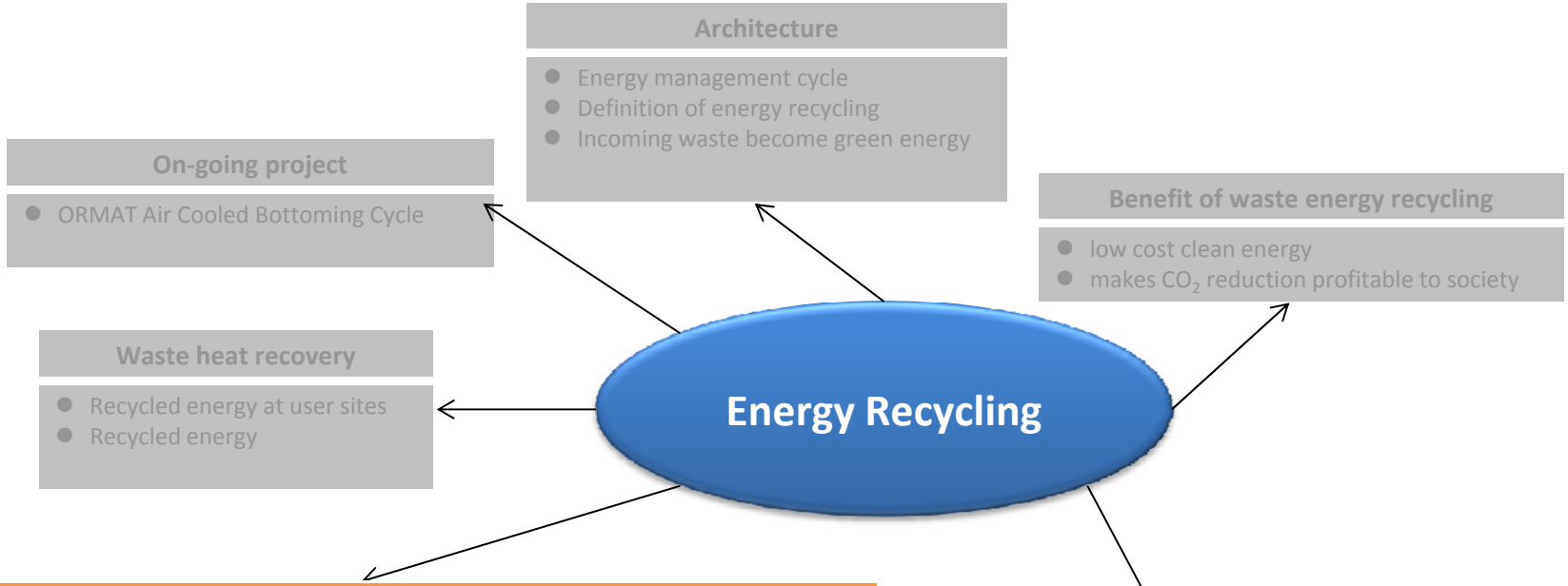
Energy recycling saves money

- Energy recycling could save the United States an estimated $70-150 BILLION a year on energy costs by generating heat and power more efficiently.
- The facilities that undertake such projects are generally able to cut their energy expenses by about 20%.

Energy recycling can be implement

- Denmark obtains over half of its energy from combined heat and power systems, leading it to be the global model for energy efficiency and clean power.
- Denmark uses about 40% as much energy as the U.S. does to produce a dollar of GDP. By contrast, the U.S. utilization rate languishes in the single digits, among the lowest in the world.

5. Combined Heat and Power



Combined heat and power

- Conventional central generation
- Combined heat and power generation

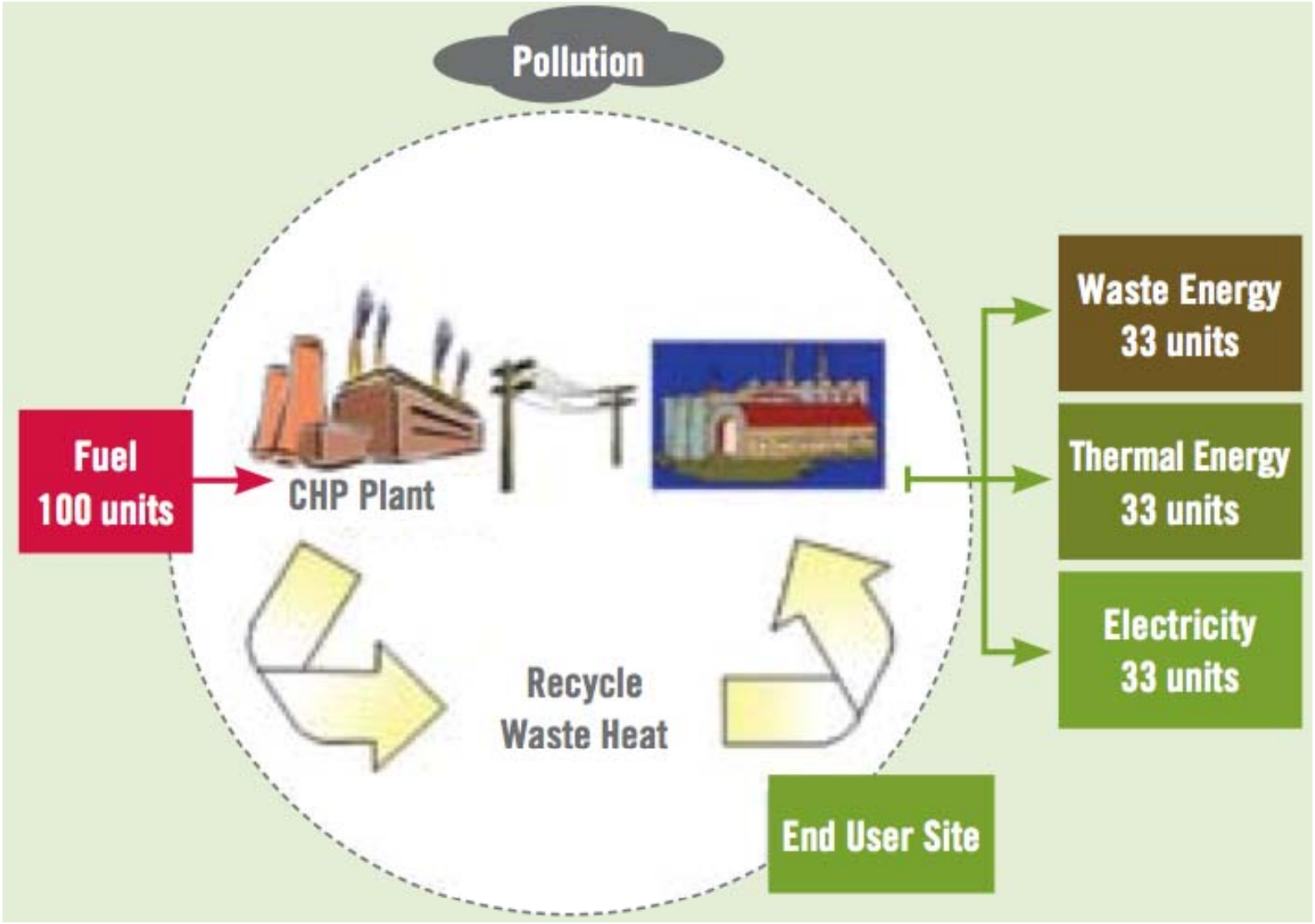
Facts about recycling energy

- Energy recycling provides clean power
- Energy recycling slashes greenhouse gas emissions
- Energy recycling is super efficient
- Energy recycling saves money
- Energy recycling is proven

Outline of combined heat and power

- Conventional central generation
- Combined heat and power generation

Figure of Combined heat and power



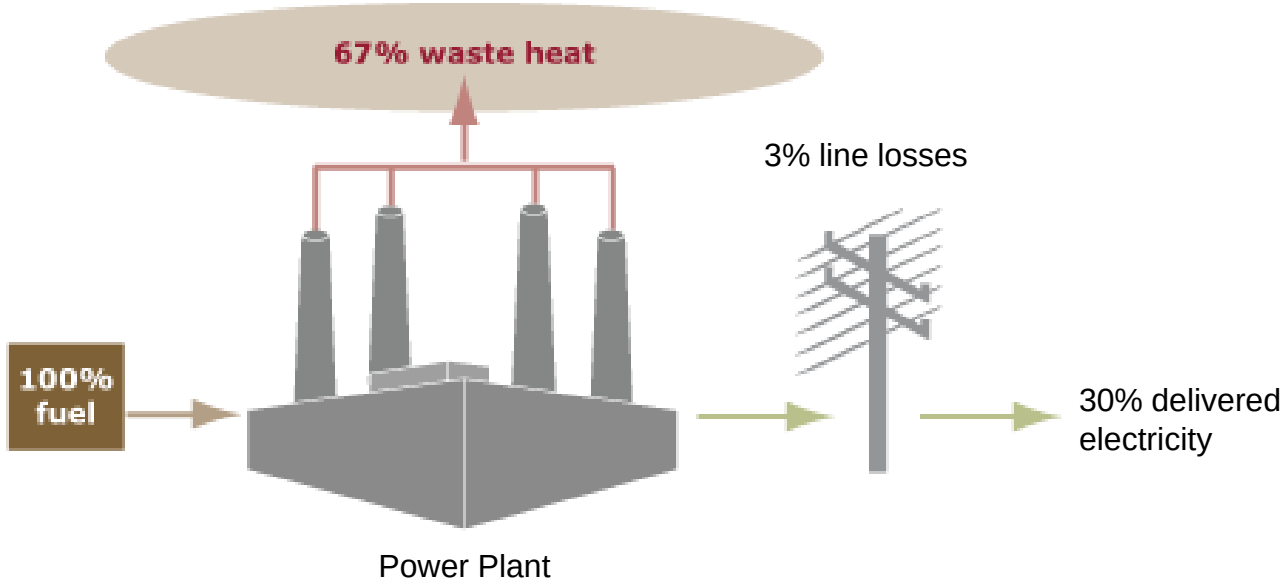
src: [4] Thomas R. Casten, “Profitably Reducing Greenhouse Gas Emissions”, August 2008

Combined heat and power

- The typical U.S. power plant is only about 33 percent efficient, using three units of fuel to produce one unit of electricity, the rest gets turned into waste energy, mainly heat that's vented into the atmosphere.
- Most plants can't recycle this heat because they're located remotely, far from consumers, and heat cannot travel far before turning cold.
- This kind of energy production—called "central" generation—is the dominant way of making power in the U.S.

Conventional central generation

- For every 100 units of fuel, approximately 67 units are released as waste heat.
- About 3 more units are abandoned through transmission line losses.
- As a result, only 30 units of power are actually delivered the customer.



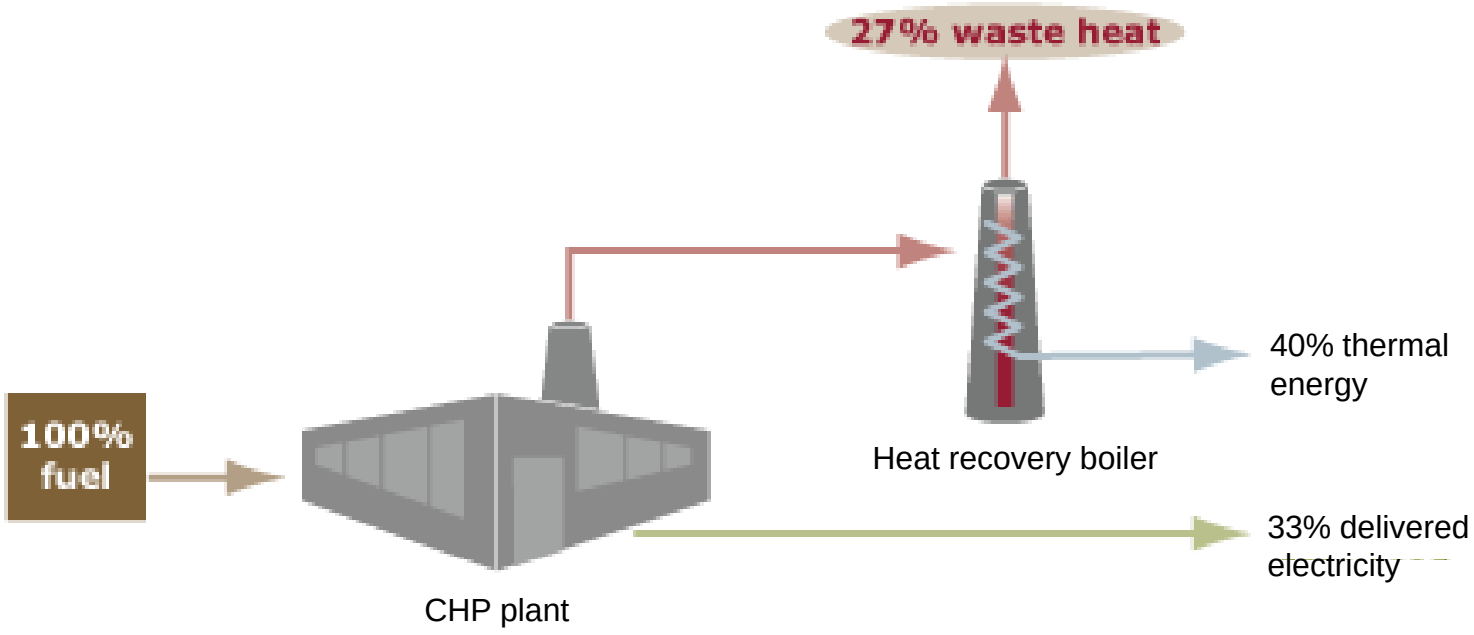
src: [2] Recycled Energy Development, http://www.recycled-energy.com/

Conventional central generation (cont.)

- Combined heat and power turns these numbers on their head, providing what the U.S. Environmental Protection Agency (EPA) calls “an efficient, clean, and reliable approach to generating electricity and heat energy from a single fuel source.”
- The key is that cogeneration plants generate energy on site at manufacturing facilities and other large institutions.
- That enables these plants to recycle their waste heat into clean electricity and useful steam, which can be used to warm nearby buildings or to assist various industrial processes.

Combined heat and power cogeneration

- Excess heat recycled at a CHP plant (on site at manufactures or other large institutions) through a heat recovery boiler.
- The process recaptures about half the waste energy as thermal energy.
- 73 units of usable energy are available.

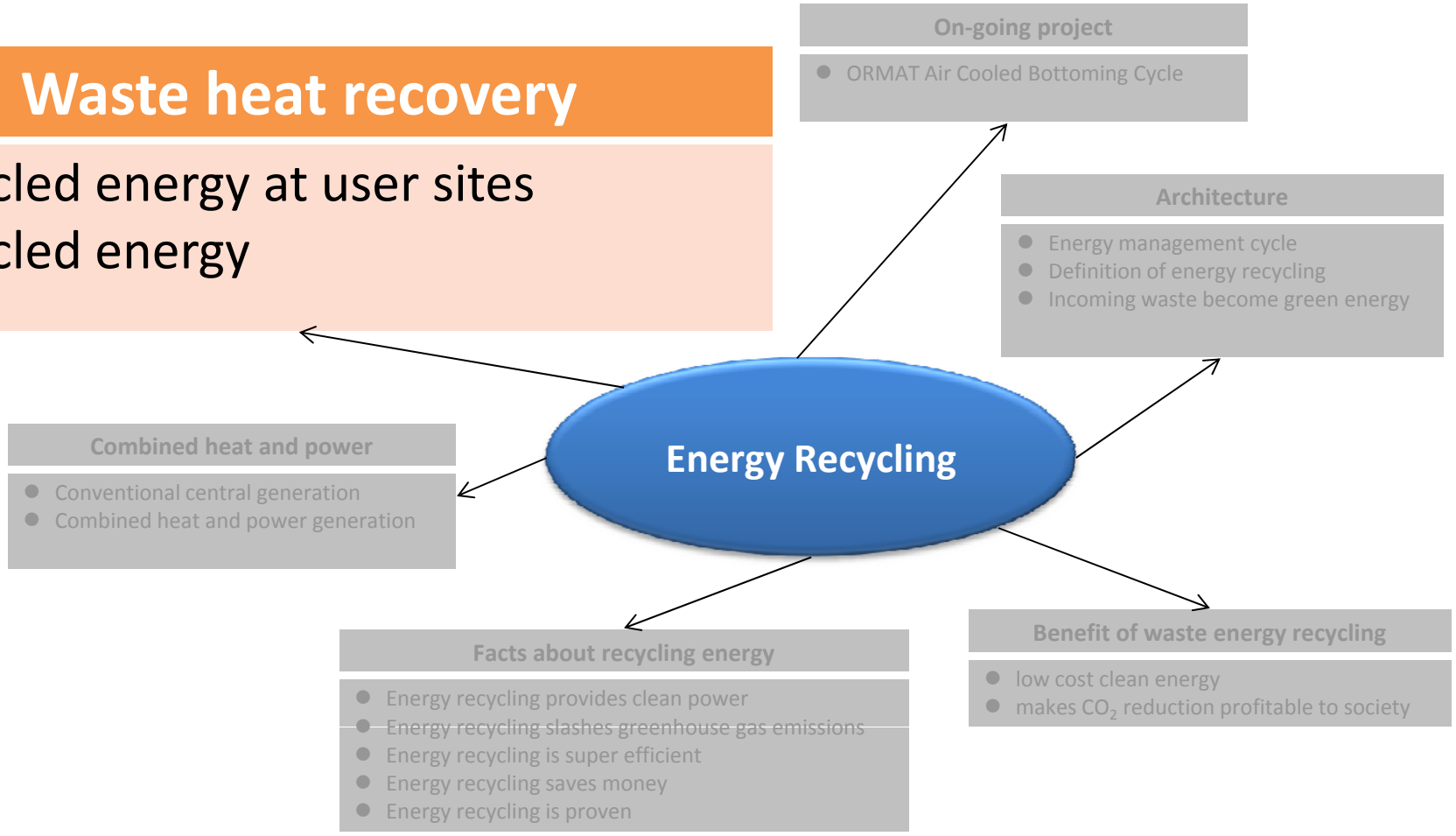


src: [2] Recycled Energy Development, http://www.recycled-energy.com/

6. Waste Heat Recovery

Waste heat recovery

- Recycled energy at user sites
- Recycled energy



Outline of combined heat and power

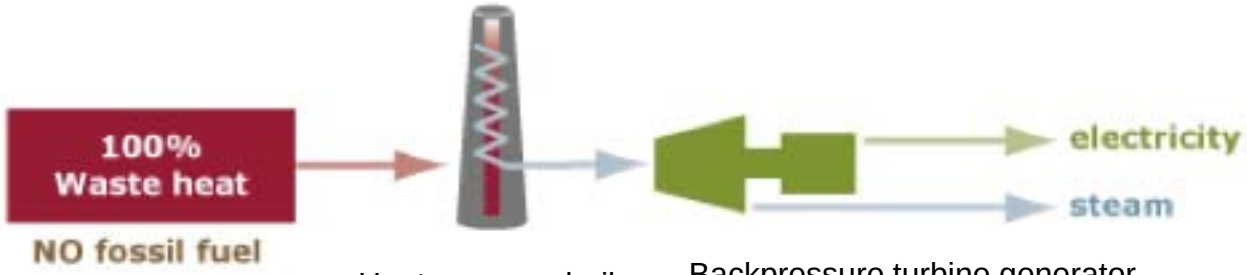
- Conventional central generation
- Combined heat and power generation

Waste Heat Recovery

- Waste heat recovery is combined heat and power's sister technology. Like combined heat and power, it turns excess heat into clean electricity and useful steam.
- The difference is that it captures the waste heat a manufacturer already emitting rather than providing all of the energy from scratch.

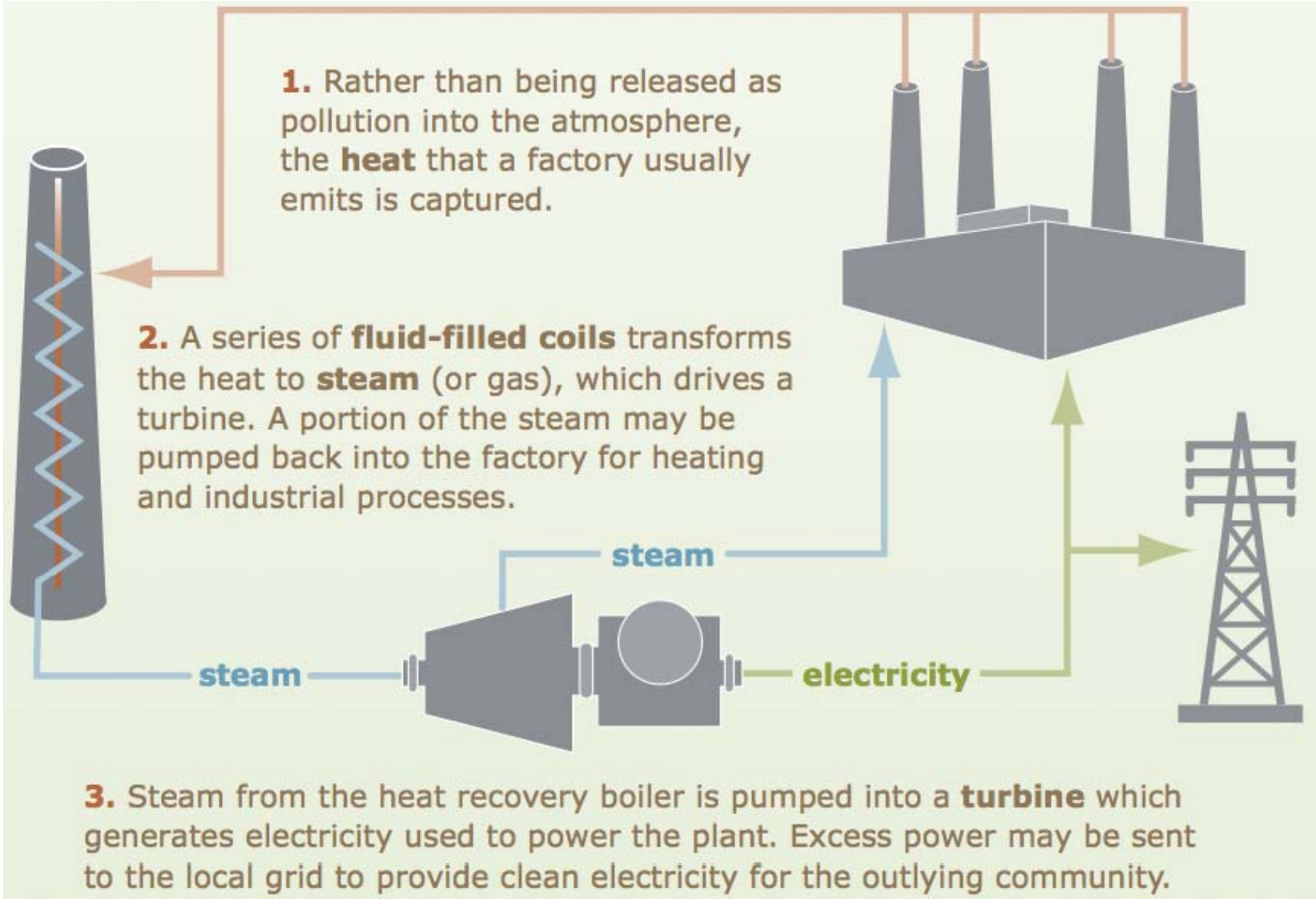
Recycled energy at user sites

- A “waste heat recovery boiler” contains a series of fluid-filled tubes placed throughout the area where heat is released.
- When high-temperature heat meets those tubes, a vapor (traditionally steam) is produced, which in turn powers a turbine that creates electricity.
- This process is similar to that of other fired boilers, but in this case, waste heat replaces a traditional flame as the initial source of energy. No fossil fuels are used in this process.
- Metals, glass, pulp and paper, silicon and other production plants are typical locations where waste heat recovery can be effective.



src: [2] Recycled Energy Development, http://www.recycled-energy.com/

Recycled energy (cont.)

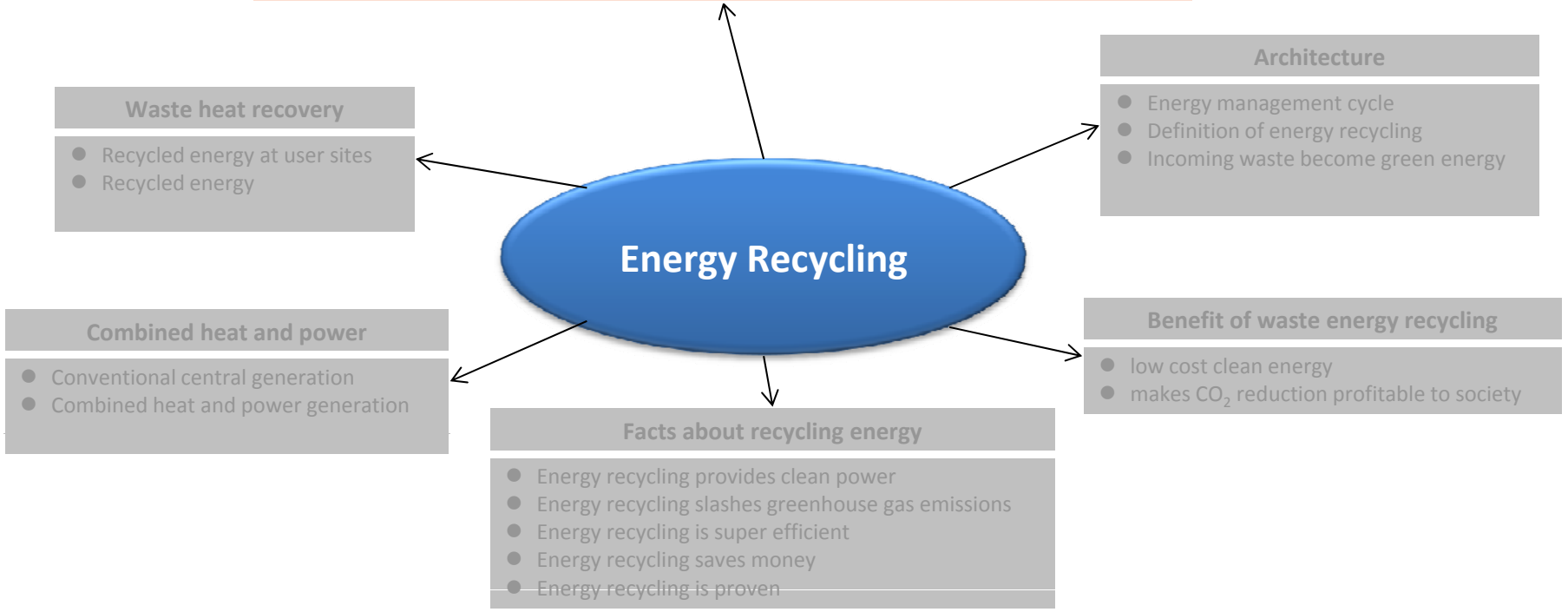


src: [2] Recycled Energy Development, http://www.recycled-energy.com/

7. On-going Project

On-going project

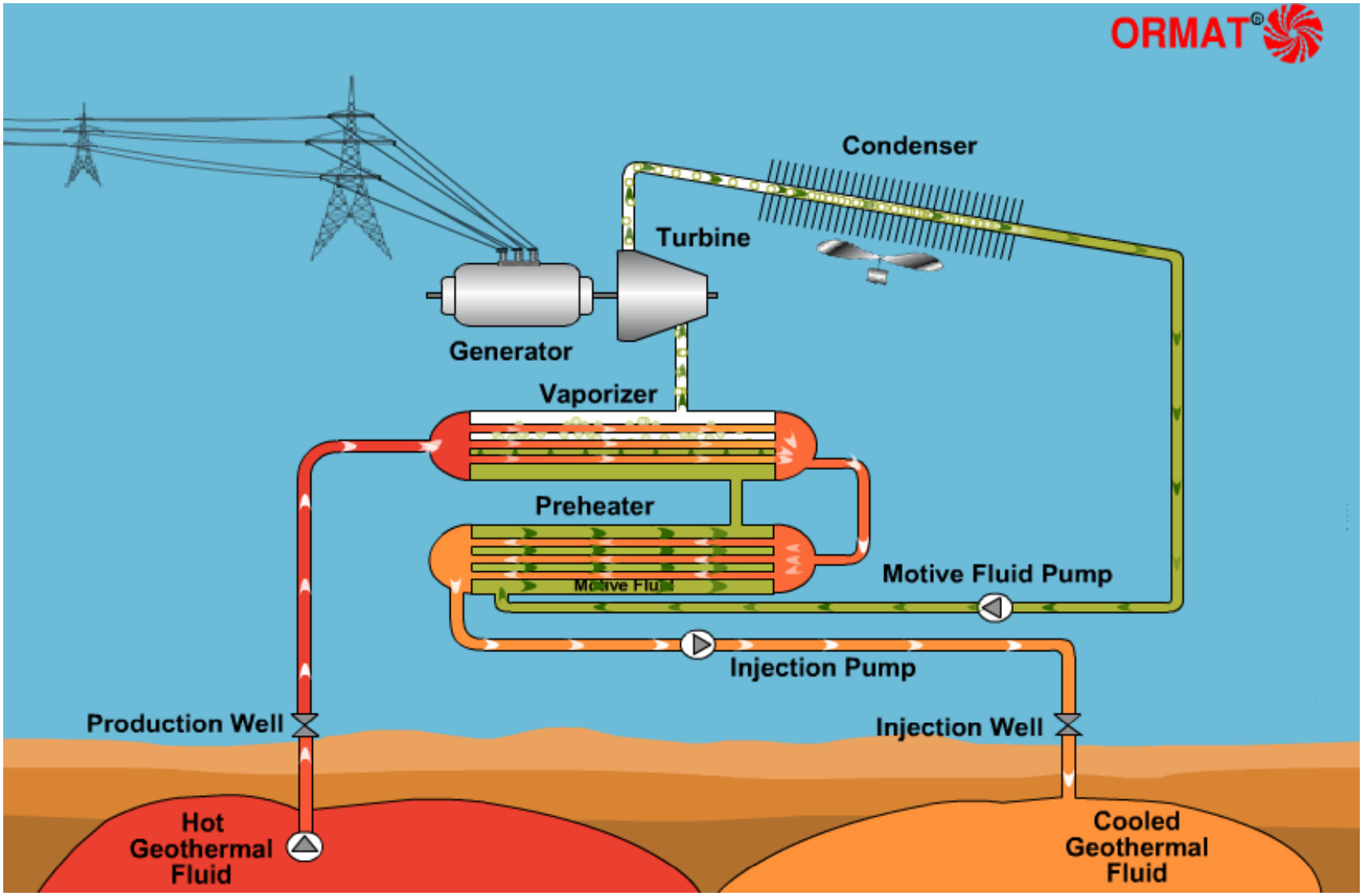
- ORMAT Air Cooled Bottoming Cycle



ORMAT Air Cooled Bottoming Cycle

- All ORMAT® ENERGY CONVERTER (OEC), units are self-contained, fully automatic and produce grid compatible power.
- The OEC is based on the Rankine Power Cycle but uses organic working fluid which has the advantage of being more efficient than steam when operating on low-to-moderate temperature heat sources.
- The vapor expands as it passes through the organic vapor turbine, which is coupled to the generator.
- The exhaust vapor is subsequently condensed in a water or air-cooled condenser and is recycled to the vaporizer by the motive fluid cycle pump.

ORMAT Air Cooled Bottoming Cycle (cont.)



src: [5] Ormat Technologies, Inc., http://www.ormat.com/

Conclusion

- In this chapter, we have described the architecture, benefit, and some facts about energy recycling.
- Combined heat and power (CHP) cogeneration is a very good approach to recycle waste energy. It can provide electricity and thermal energy.
- Energy recycling could provide 40 percent of total U.S. electricity needs

Reference

1) WIKIPEDIA, http://en.wikipedia.org/wiki/Main_Page
2) Recycled Energy Development, http://www.recycled-energy.com/
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7) Li, G., ” Flue gas treatment and carbon recycling for clean electric energy”, Dielectrics and Electrical Insulation, August 2011

Homework

- 1. What is the energy management cycle ?
- 2. What are the facts about recycling energy ?
- 3. What is the combined heat and power cogeneration ?