

**System Integration**  
**a Perspective on the**  
**Integration of Renewable Energy**  
**into Remote Stations' Power Infrastructure**  
**from ongoing work for the Australian and French**  
**Antarctic research stations**

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# A Preview of Essentials

- Need for flexible, modular systems
- Cannot jump straight to the solution, need for long-term, “big picture” plans
- Need for design toolbox and design framework more than a range of ready-made systems
- Need for open, collaborative action and open technologies and standards

# 1. Background

- “Alternative Energy” research project started 1993
  - Main objective: towards stations independent or near independent of fossil fuels.
  - Target: Australian and French Antarctic research stations



## 2. Scope - Siting

- Remote stations, summer-only access
- Resupply by sea with small to mid-size vessels
- Limited unloading capabilities
- Limited real estate and competition with wildlife
- Strong gusty winds

## 2. Scope - Power

- Typical needs of current systems:
  - Thermal 150-350 kW
  - Electrical 70-250 kW
- Diesel Gen-Sets with heat recovery + boilers
  - 350,000 to 700,000 litres of Diesel a year
- Summer surge of activity - little seasonal variation of total load but variation of thermal/electrical mix

## 2. Scope - social

- No permanent population – maximum stay 1 year
- Limited range of trades on station
- Different expectations Trades vs Researchers?
- High turnover – limited “hold” on personnel
- Stations are here to “stay” – long term view possible

## 3. Objectives

- Towards stations independent or near independent of fossil fuels (ie using renewable energy)

with a view to:

- Reducing logistical needs and constraints
- Reducing operational pollution and risks of fuel spills
- Reducing operating costs

## 4. Issues

1. Current (fossil) systems
2. Alternative Energy & Power production methods
3. Integrated systems - Possible architectures
4. Implementation & maintenance
5. Assessment / Benchmarks
6. Social comprehension & acceptance

## 4.1 Current (fossil) systems

### ENERGY PRODUCTION FOSSIL FUELS

- Generator Set - to run in specified load range  
Produces electricity on demand and heat as by-product
  - 37% Electrical efficiency
  - 42% Thermal efficiency
    - ie 79% Cogeneration efficiency
- Boiler - inertia of thermal carrier allows on/off operation  
Produces heat on demand
  - 80% Thermal efficiency

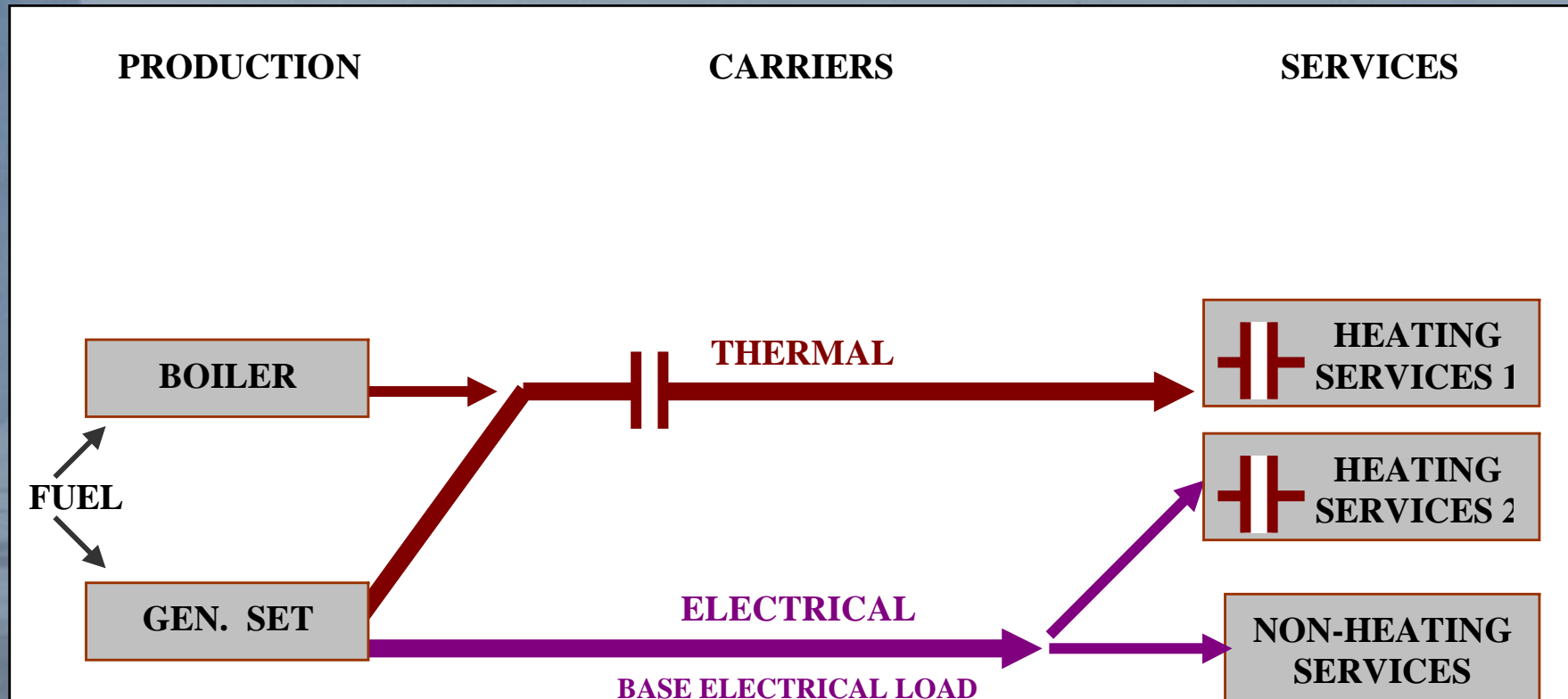
## 4.1 Current (fossil) systems

### GUIDING PRINCIPLES

- Electrical load stable and within optimal load range of generator set
  - adequate sizing of generator
  - management of the electrical load
- Heat recovery on generator set not exceeding heat demand
  - minimise load on generator set

# 4.1 Current (fossil) systems

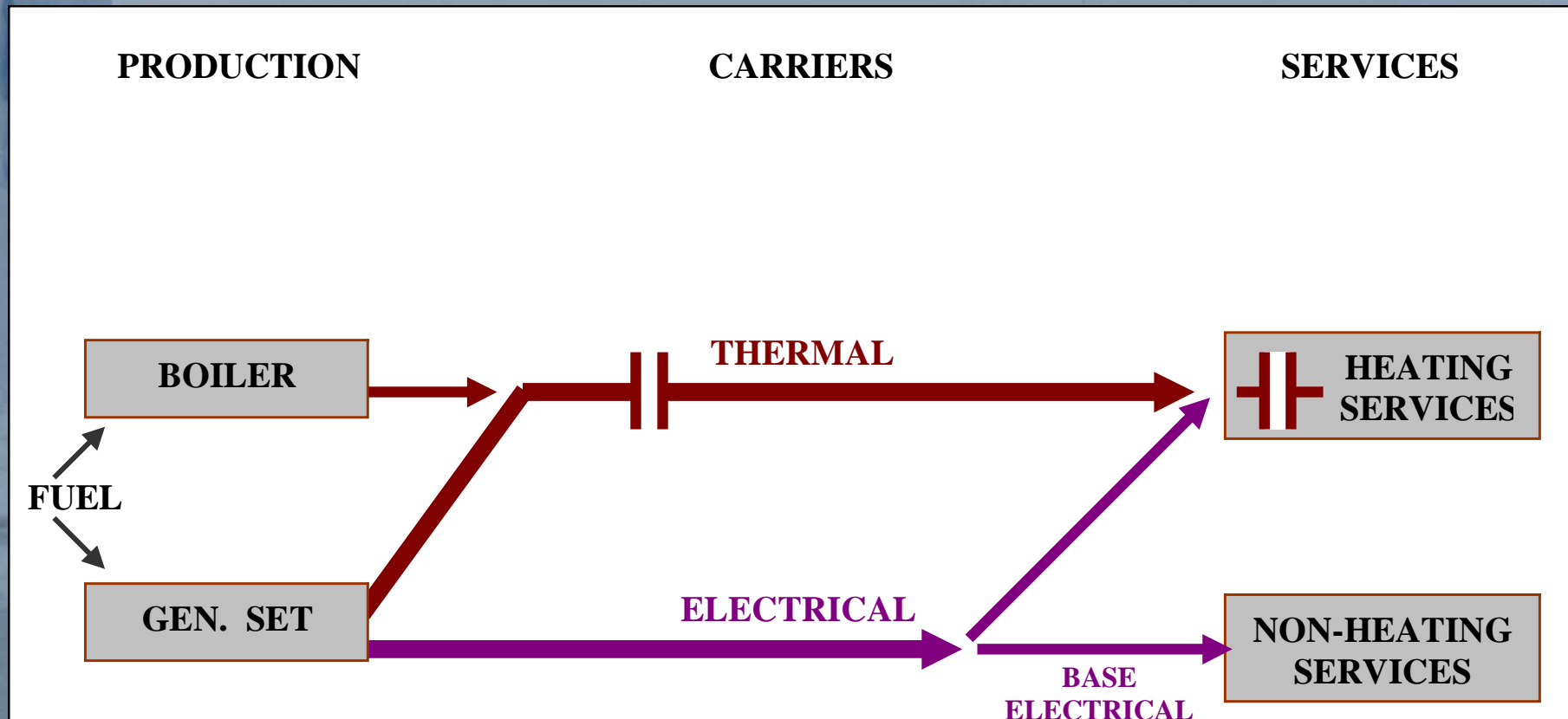
## FOSSIL - BASIC OPTION



- Limited load shedding capabilities
- High relative base load and potential heat excess

# 4.1 Current (fossil) systems

## FOSSIL – ADVANCED OPTION



- Advanced load shedding capabilities
- Low relative base load and stable equilibrium

## 4.2 Alternative Energy and Power production RENEWABLES

- Extensive work done on production potential  
time variability / siting / pilot projects
  - Wind generators: electricity
  - Solar electrical (eg. Photovoltaics): electricity
  - Solar Thermal (eg. SHW): heat
  - Tidal flow: electricity
  - SEMAS Solar modelling tool

## 4.3 Alternative Energy and Power production

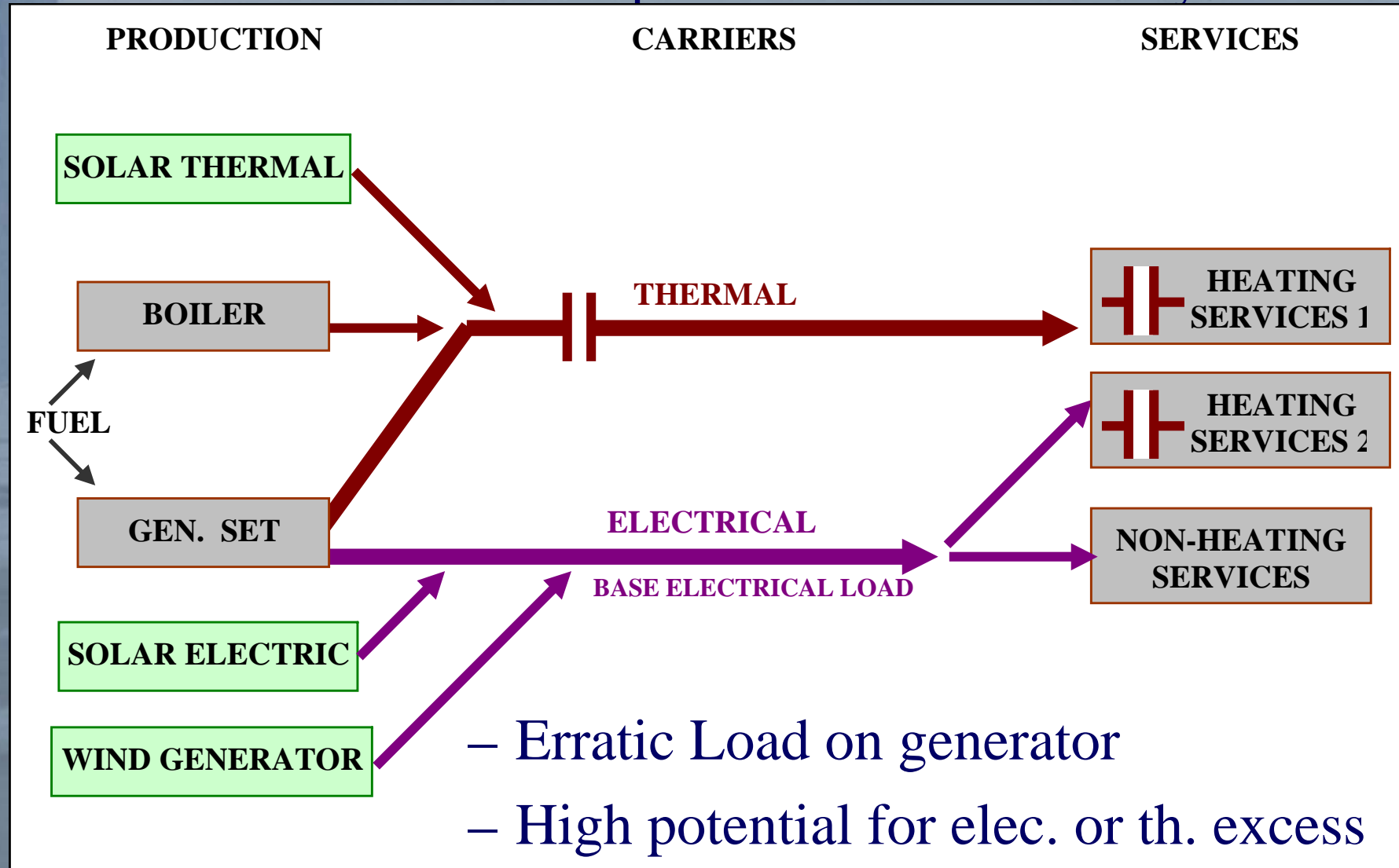
### RENEWABLES GUIDING PRINCIPLES

- Minimise waste of renewable production

The resource may be free but harnessing it is not free  
waste = higher production costs per unit used

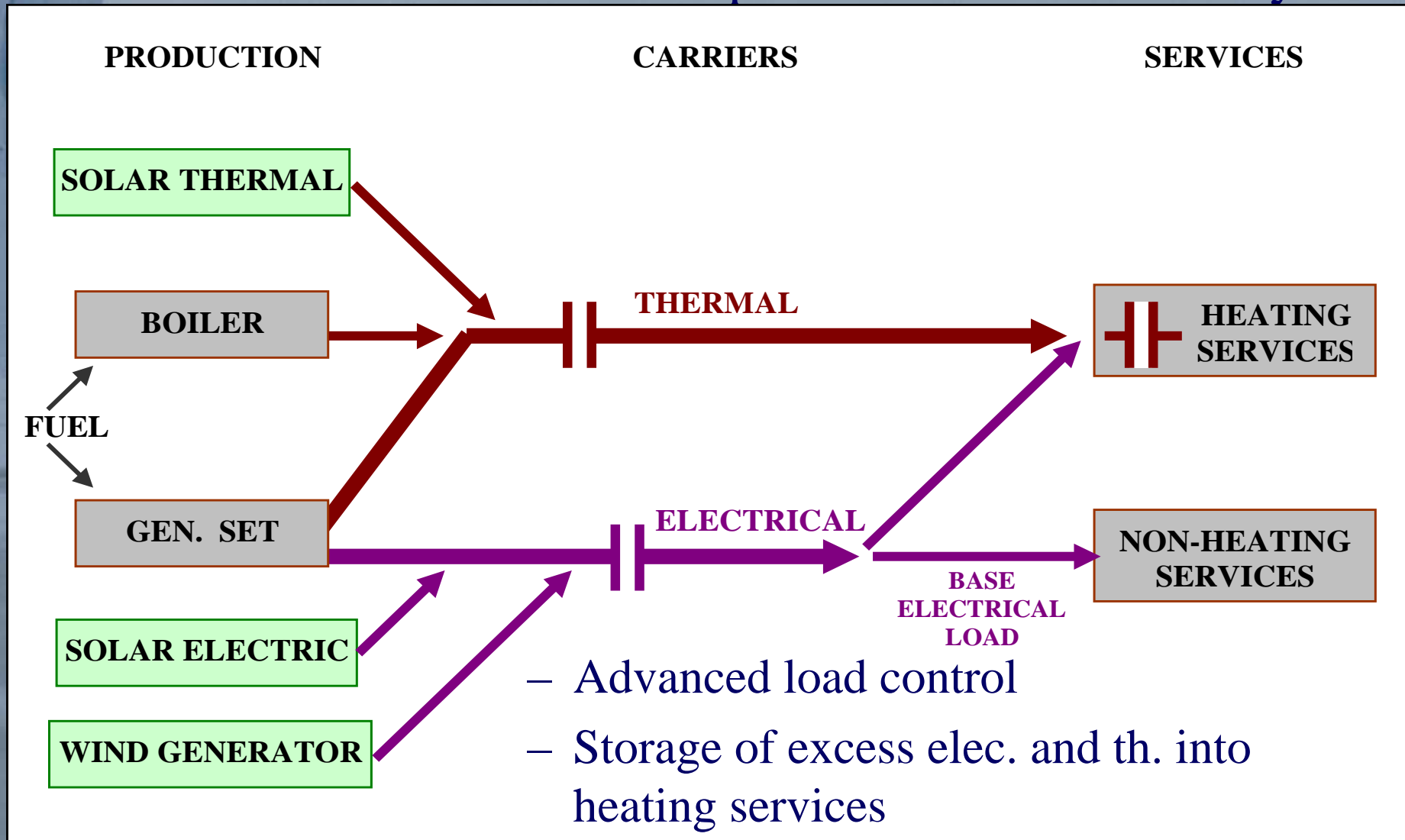
# 4.3 Integrated Systems – Possible Architectures

BASIC OPTION – built up on current common systems



# 4.3 Integrated Systems – Possible Architectures

ADVANCED OPTION – built up on current advanced systems



## 4.3 Integrated Systems – Possible Architectures

ADVANCED OPTION – built up on current advanced systems

Such an architecture can provide the means of

- optimising the efficiency of fossil based systems
- allowing a large penetration of renewable energy with little waste of excess power and a limited need for add-on storage media

But requires Advanced Energy Management Systems controlling a large number of heating services

- fed with either heat or electricity
- with significant thermal inertia

## 4.4 Implementation & Maintenance

- Long term, progressive planning
- Modularity
- Sophistication vs Simplicity (eg control systems)
- Skills availability
- Advance deployment of equipment (eg cranes)
- Open systems and standards for modular capability

## 4.5 Assessment / Benchmarks

- What do we want?
  - Renewable?
  - Clean?
  - Efficient (with what definition of efficiency?)
  - Cheap?
  - Reliable?
  - Politically correct?
- How do we measure success?
  - Clear understanding of system behaviour
  - Good monitoring system
  - Modelling and assessment tools

## 4.6 Social Comprehension & Acceptance

- What do people know about renewables?
  - How it works - What it can do and cannot do
  - How much it costs
  - Storage issues – the on/off button
  - Renewable vs resource efficiency
- What are people ready to accept?
  - The on/off button syndrome
  - Motivations and Commitment

# Some Conclusions

Call for:

- Re-analysing and re-thinking systems and needs
- Keeping a close eye on electrical vs thermal
- Improving modularity and evolution paths
- Developing modelling and assessment tools
- Clarifying performance expectations
- Working on social issues, incl education

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