Driver Selection Integration with Utility System Design

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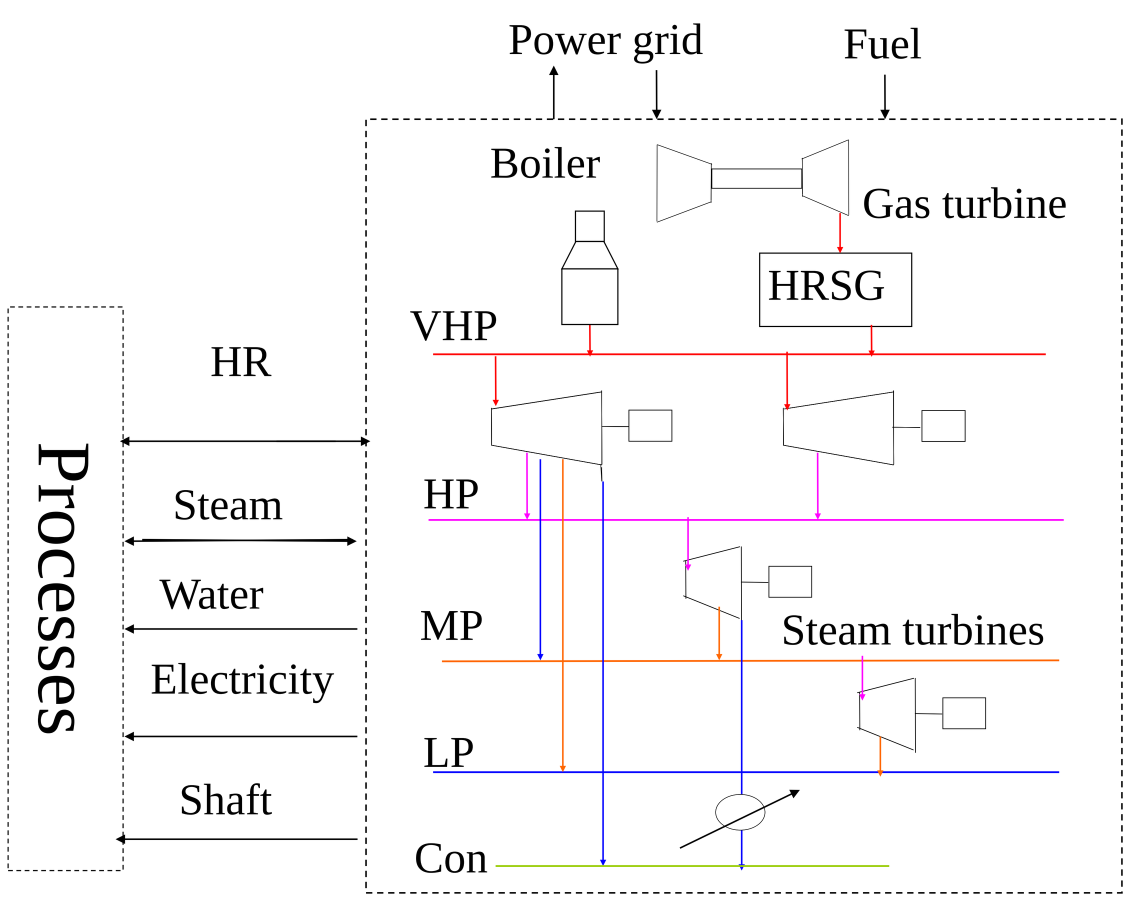
Driver options

- Electric motor
- Helper motor and generator
- Steam turbine
- Gas turbine
- Combustion engine

Driver selection criteria

- Process steam and power balances
- Economic analysis
- Power and energy efficiency
- Flexibility and reliability
- Others

Utility system design analysis



Main components:

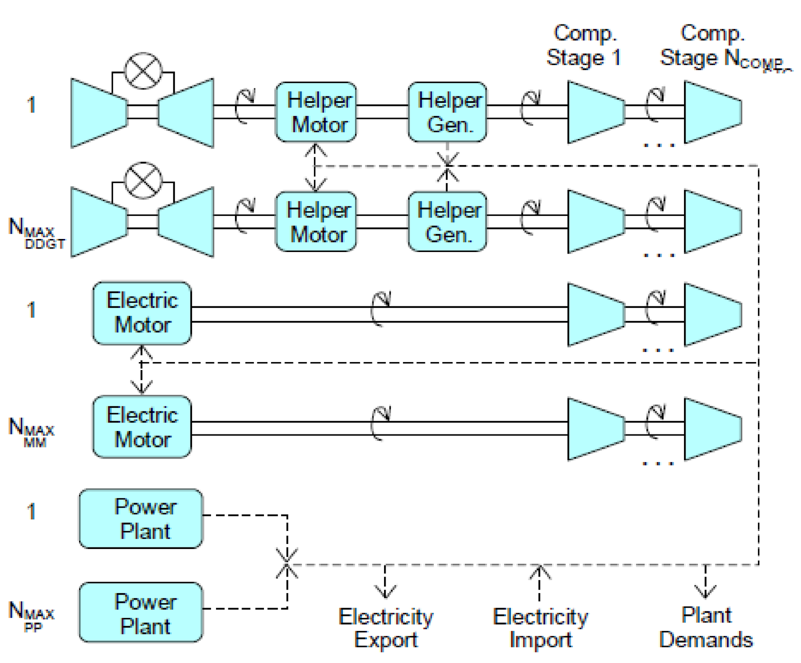
- Fuel
- Steam mains
- Steam generation/distribution/expansion
- Power/electricity generation
- Heating and cooling media
- Water
- Air and nitrogen
- Driver selection

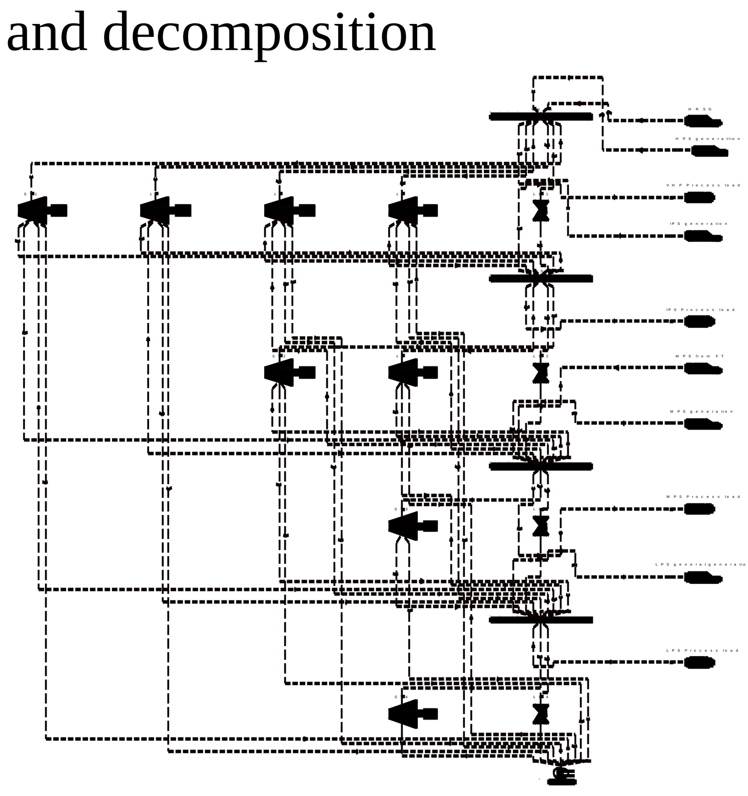
Methodology of utility system design considering driver selection

Step 1 System components analysis

Step 2 Steam mains selection

Step 3 Superstructure construction and decomposition





Combustion driving subsystem **Steam driving subsystem**

Step 4 Mathematical models formulation

$$\text{Min} \quad O = f(x,y)$$

$$\text{s.t.} \quad F(x,y) = 0, \quad G(x,y) \le 0, \quad Ax \le b,\; x \in X,\; y \in Y$$

Step 5 Reliability analysis

$$A_s = 1-\{1-[1-(1-A_1)(1-A_2)]\, A_3\}(1- A_4 A_5)$$

Discussion

- Methodology of utility system design has been developed. A superstructure is constructed containing all potential and feasible system alternatives. With the superstructure decomposition and reduction approach, mathematical programming is applied for Pareto solutions.
- Utility system is designed without redundancy in this work. Future work to obtain higher availability system by considering redundancy and sparing methodology in the design.

Acknowledges

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Case study

Steam mains

	T_{SAT} ºC	T_{SUP} ºC	P_{SAT} Bar
VHPS	320	555	113
HPS	245	400	36.5
MPS	200	280	15.5
LPS	130	150	2.7

Process steam generation and loads

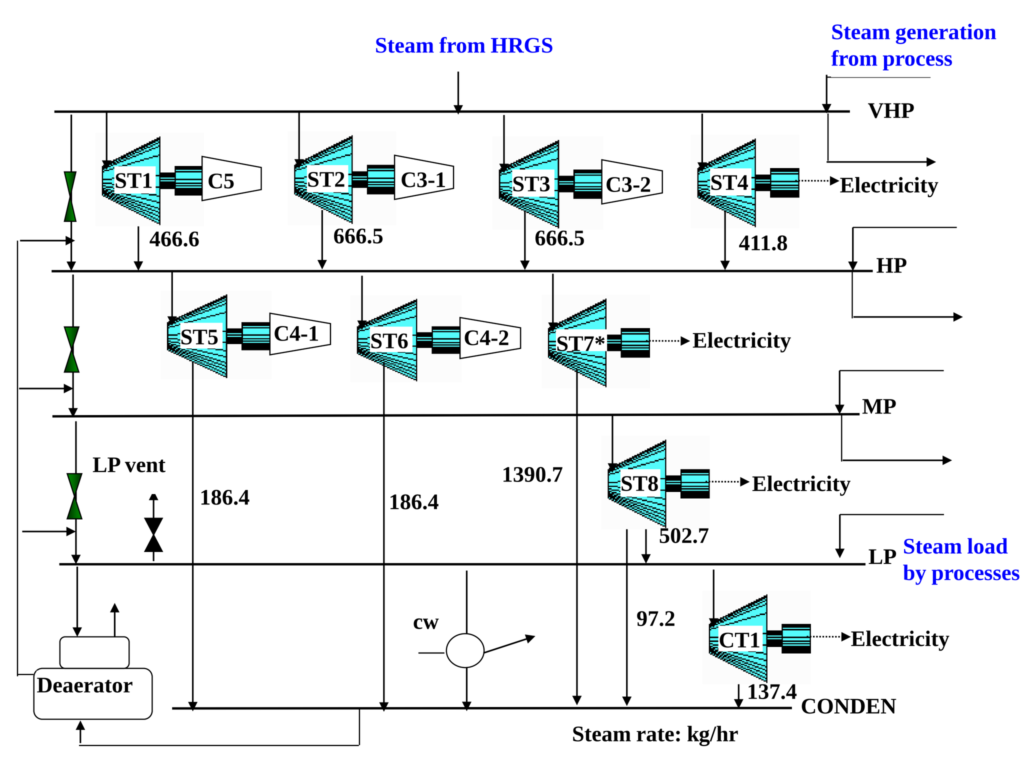
	Steam generation t/hr	Process loads t/hr
VHPS	1557.5	140.9
HPS	103.6	550.9
MPS	1693.6	1079.2
LPS	620.0	984.1

Processes power demand

Equipment	Symbol	Power MW	Number	Driving options
Compressor	C1	55.0	4	ST/GT/Electricity
Compressor	C2	41.0	1	ST/GT/Electricity
Compressor	C3	50.0	2	ST/GT/Electricity
Compressor	C4	43.0	2	ST/GT/Electricity
Compressor	C5	35.0	1	ST/GT/Electricity
Pumps & others site demand		100		Electricity
Total		582		

Pareto solutions

	C1-C5 drivers	Electricity export MW	Capital cost M$	Availab	Combustion driving subsystem	Steam driving subsystem
					Standard GTs	STs number
GO1	Elect	509.1	193.5	0.7962	Industrial GT: PG7121EA, PG9171E, W501G	13
GO2	STs	518.9	193.7	0.7804	Industrial GT: PG7121EA, PG9171E,W501G	15
GO3	Driver GTs	563.1	269.0	0.6576	Driver GT: 10*LM6000; Houseplant GT: PG5371, PG6581	13
GO4	Driver GTs/ STs	530.1	220.8	0.7396	Driver GT: 5*LM6000; Houseplant GT:PG9231EC, PG7121EA	14



- GO3 is optimal for maximum electricity export, but its capital cost is most expensive.
- GO1 is reliable design without redundancy.

Steam Driving Subsystem Configuration of the General Option 4(GO4)