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ESCC

Bayesian Network for Using Electrical Vehicles as Power Storage

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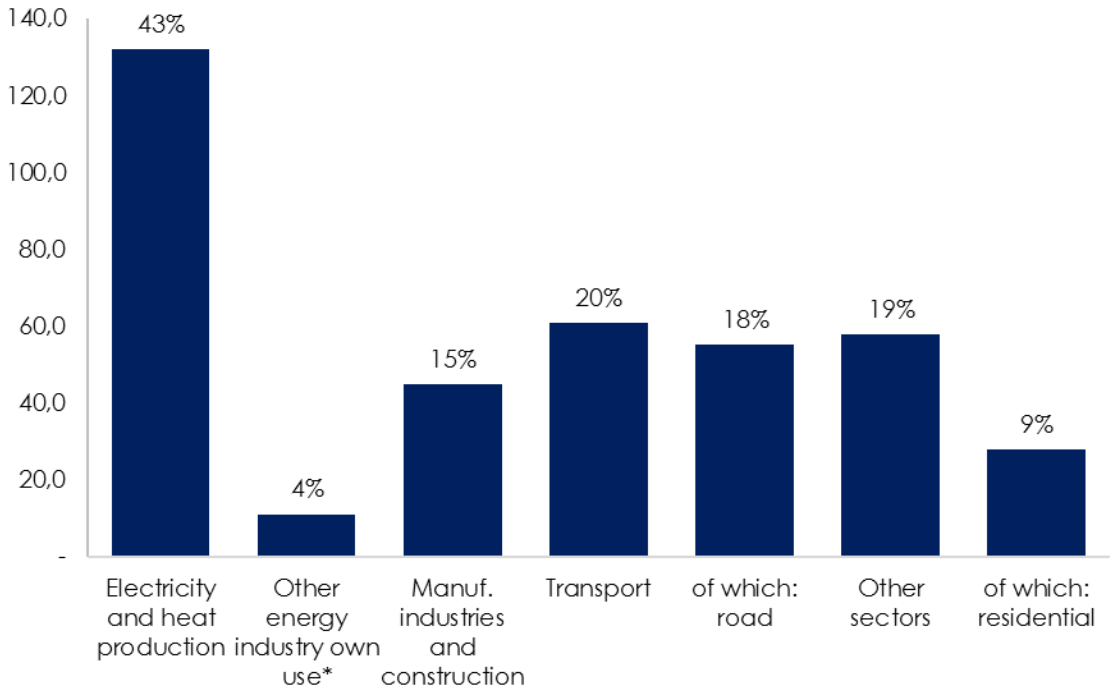
Context

1. Urge for EV usage
2. Bayesian Belief Networks
3. Case
4. Preliminary Scenarios
5. Conclusion

Goal

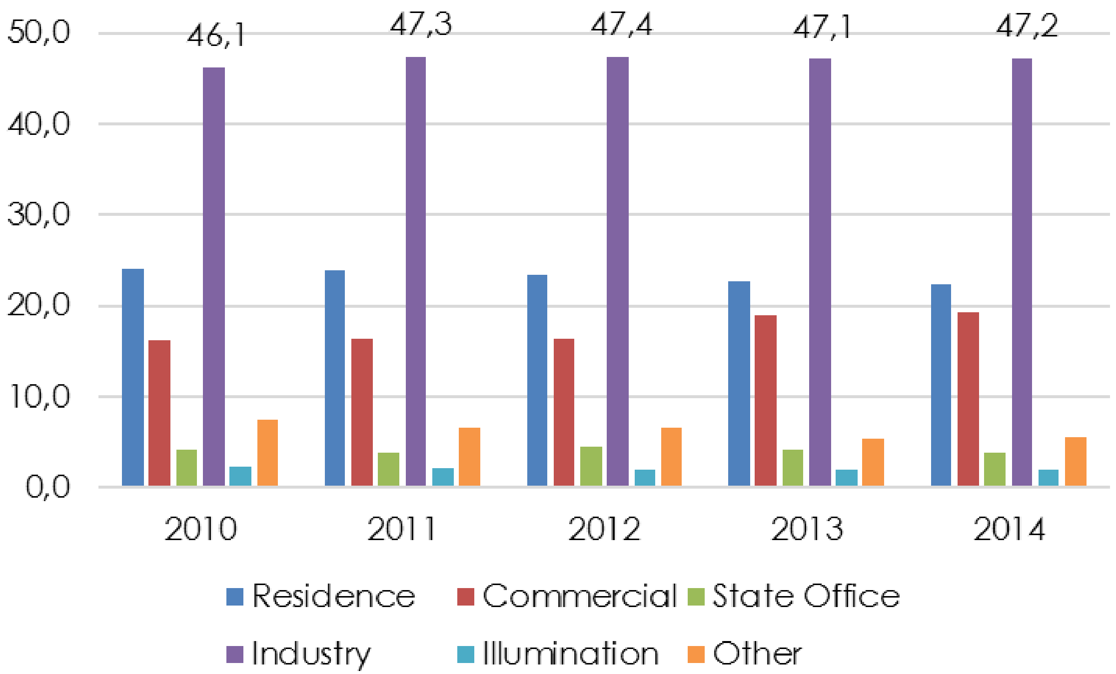
FACT: 78.6 000 MW Power(Turkey April-2017) 6% RES

- Continuous Energy Supply
- Decrased CO_2 emissions
- Confidence in Renewable energy resources



Distribution of carbon emission in Turkey (IEA, 2014)

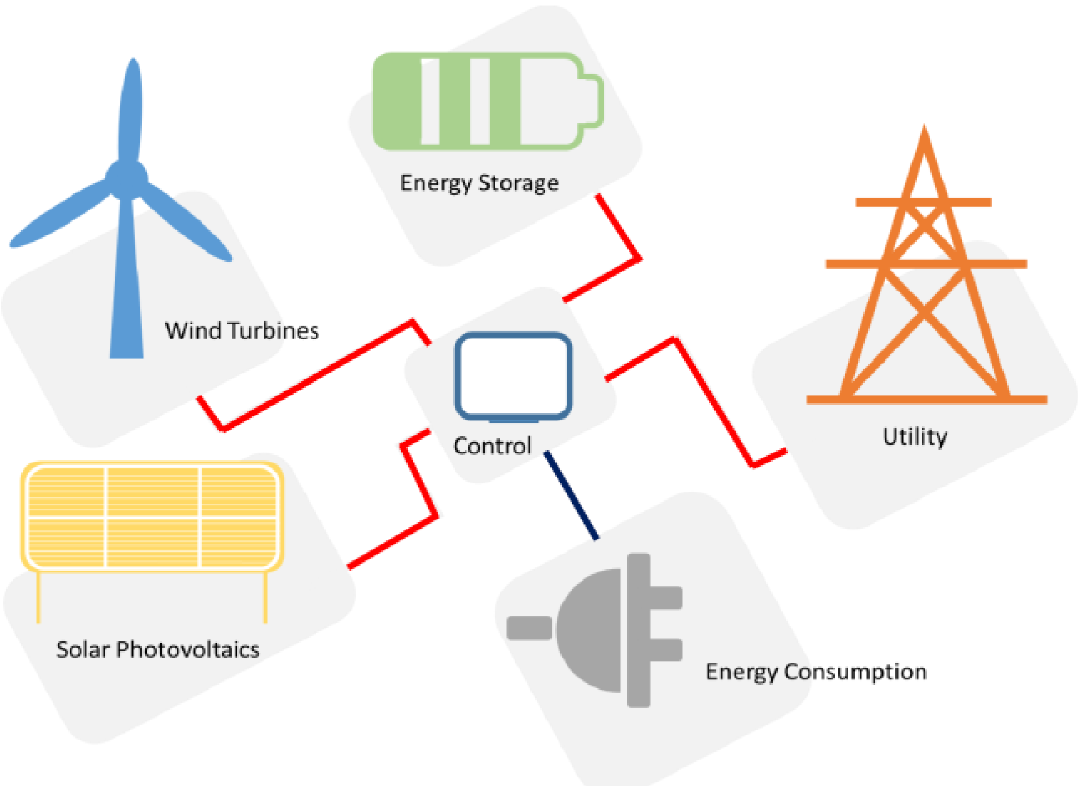
Need in Industrial Zones



Distribution of net energy consumption by sectors (Turkish Statistical Institute)

✓ It is clear that the most energy consuming sector in Turkey is in industrial zones.

Smart Micro Grids



- ✓ Elimination of current fluctuation, interruption or disruption
- ✓ Preventing peak loads
- ✓ Preventing environmental pollution
- ✓ Providing stable electrical supply
- ✓ Enhancing reliability and flexibility
- ✓ Economic
- ✓ Preventing current losses due to long distrubution lines
- ✓ Preserving system from blockout

Vehicles as Storage

The uncertainity of renewable energy resources → Power Storage

- Employee Shuttles
- Urban cars

→ **Stay during the day as majority of the cars used**

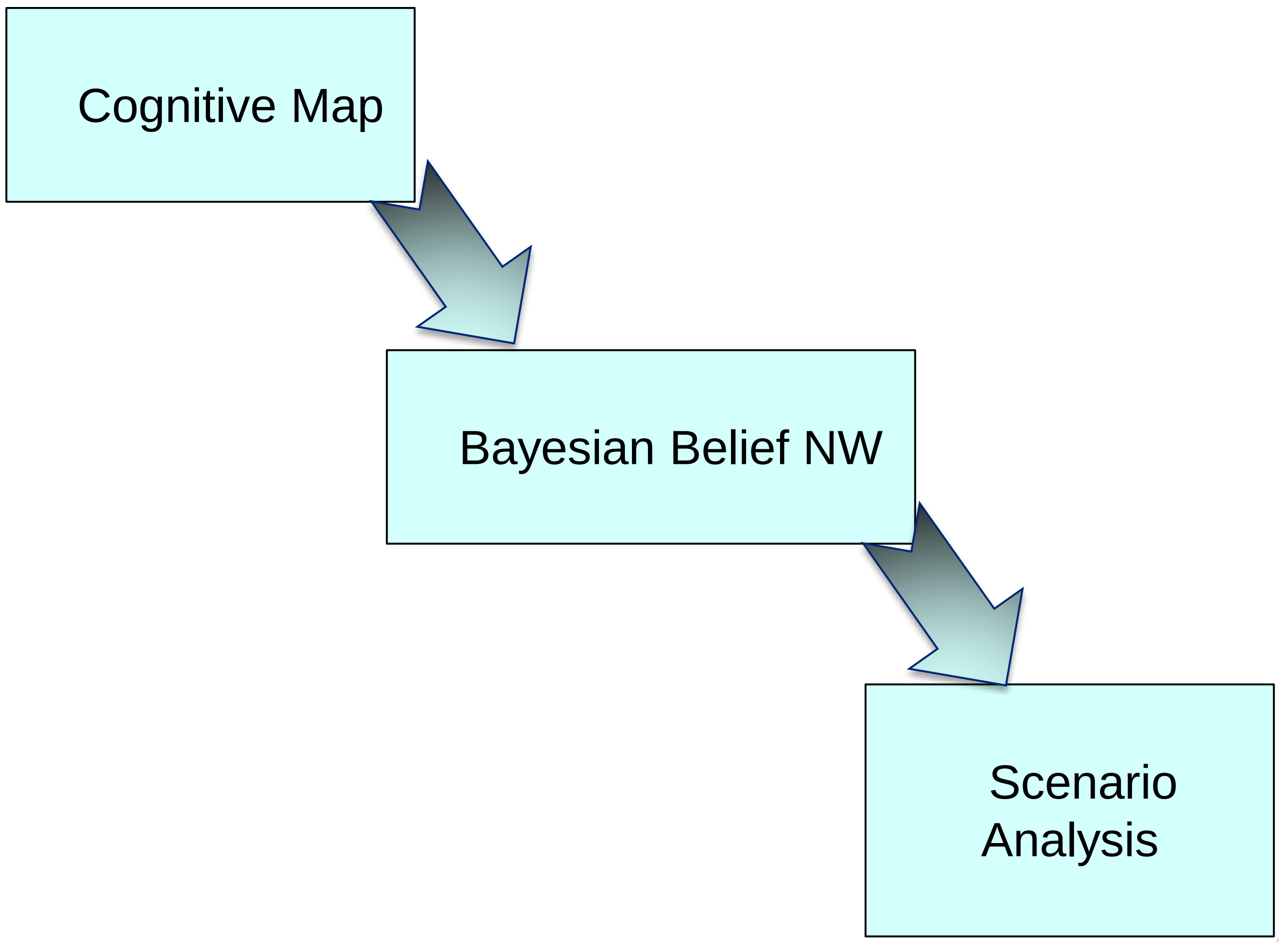
- Trucks

→ **mainly out of the zone daily or long duration, but parked in the zone**

Considerations with EV

- Demand
- Uncertainity of capacities
- Grid connection
- Peak hours
- Electricity price
- Emission margin
- Energy storage capability
- Amount of Inactive EVA
- Self Sufficiency

Methodology



Cognitive Maps

- "The demonstration of causal relations between the elements of a given community to be used to make decisions in social and political systems" (Axelrod, 1976)

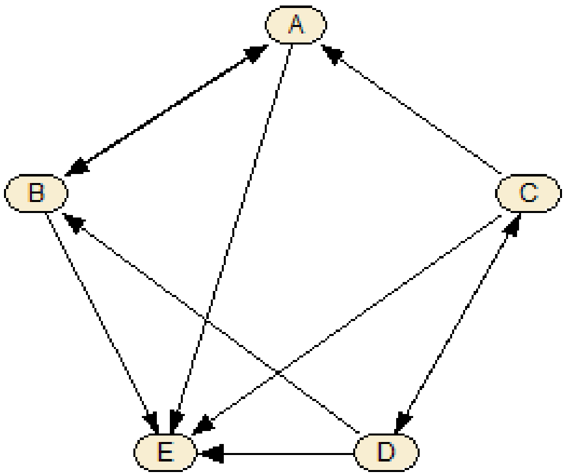


Fig.4: A cognitive map

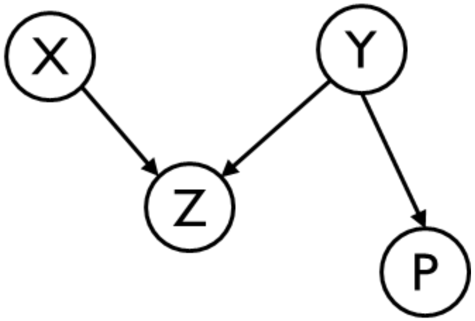
	K1	K2	K3	K4	K5
K1	0	1	1	1	1
K2	1	0	0	-1	1
K3	1	0	0	1	-1
K4	1	-1	-1	0	-1
K5	-1	0	-1	-1	0

Table.1: A pairwise comparison matrix

Bayesian Belief Networks

- Bayesian Theorem explains the relationship between conditional probability and marginal probabilities under the probability distribution of two variables that are related to each other.

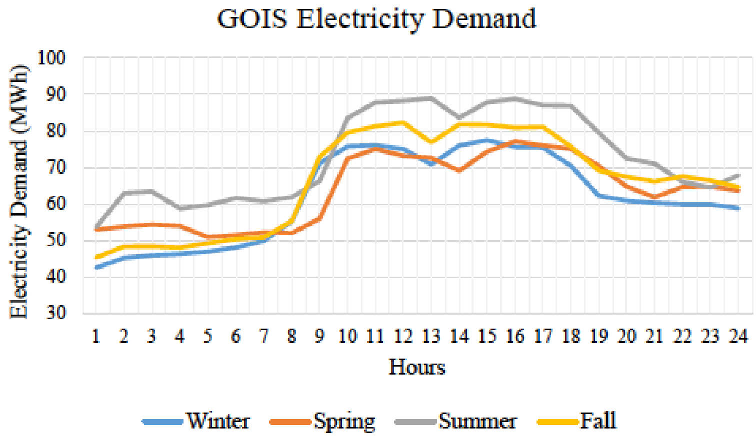
  - $P(W)$ is the prior assumption of a parameter before any calculation from the probability from the data,
  - $P(D|W)$ is called the likelihood. It is the probability of the data D given W.



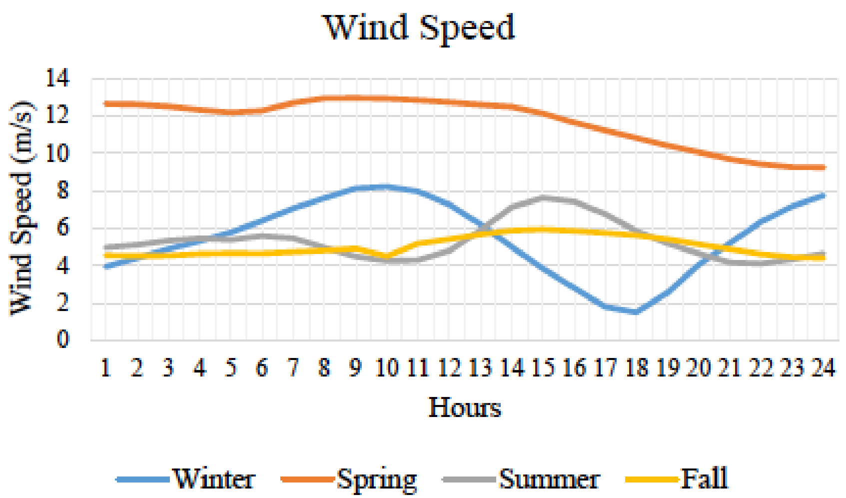
$$P(W|D) = \frac{P(W)P(D|W)}{P(D)}$$

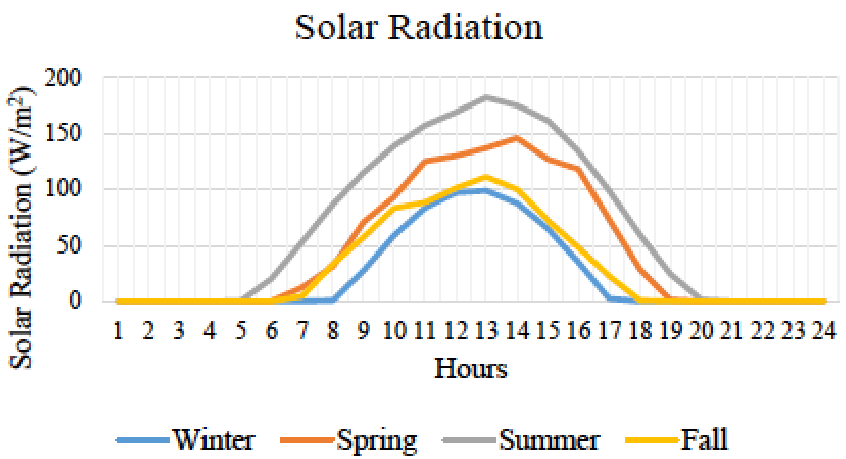
Fig.2: A Bayesian Network

Case: Gebze Industrial Zone

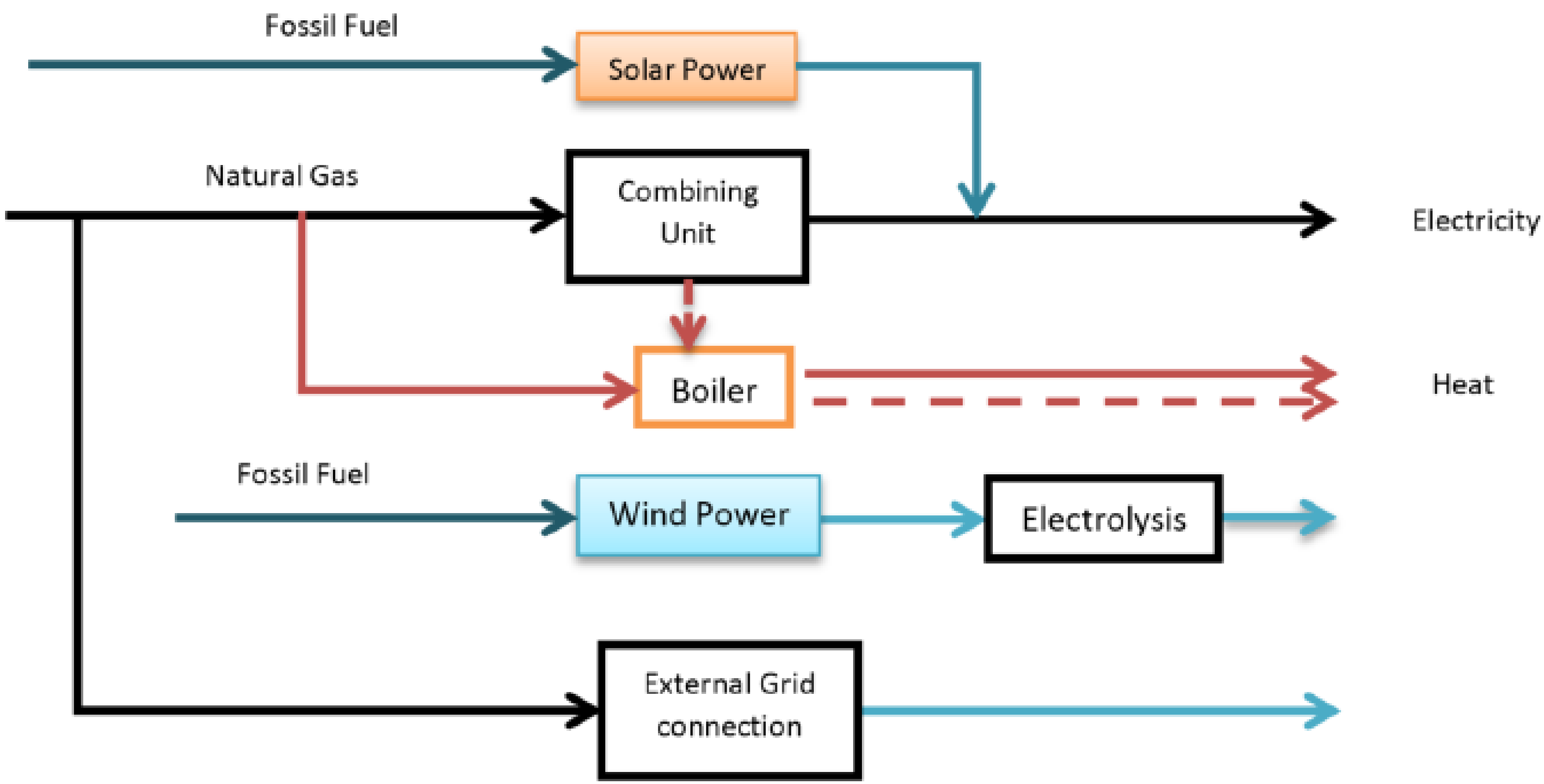


Demand: 546 Mw Electricity
By 224 Manufacturing Companies
metal, chemical, food
from major industries





GIZ Microgrid

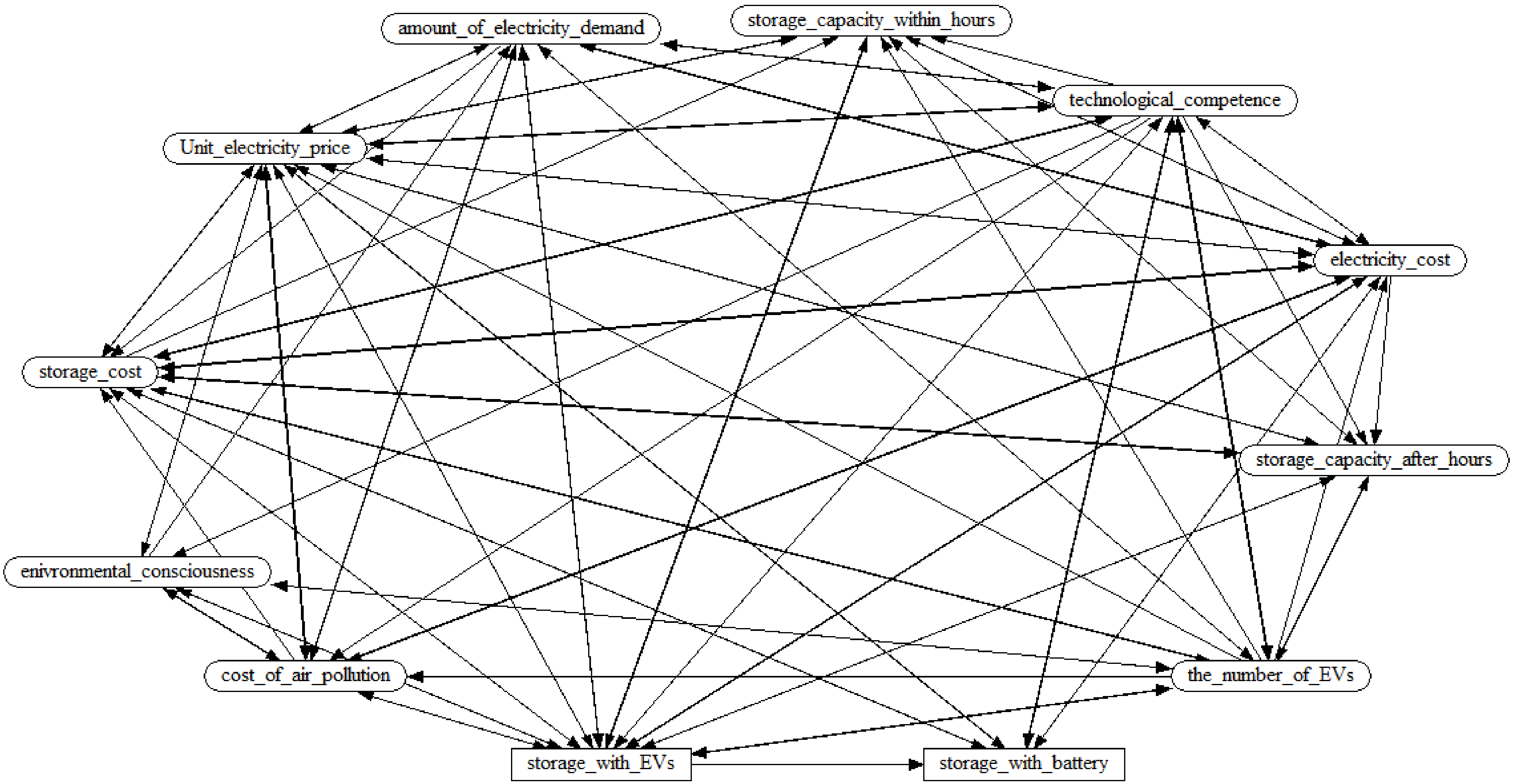


With 1 Nat-gas turbine of 12 MW,capacity 12 Wind Turbines of 3.4 MW capacity and PV of 6 MW 25 % cost reduction 30 % Carbon emmision reduction (Öztürk, Kayakutlu, 2017)

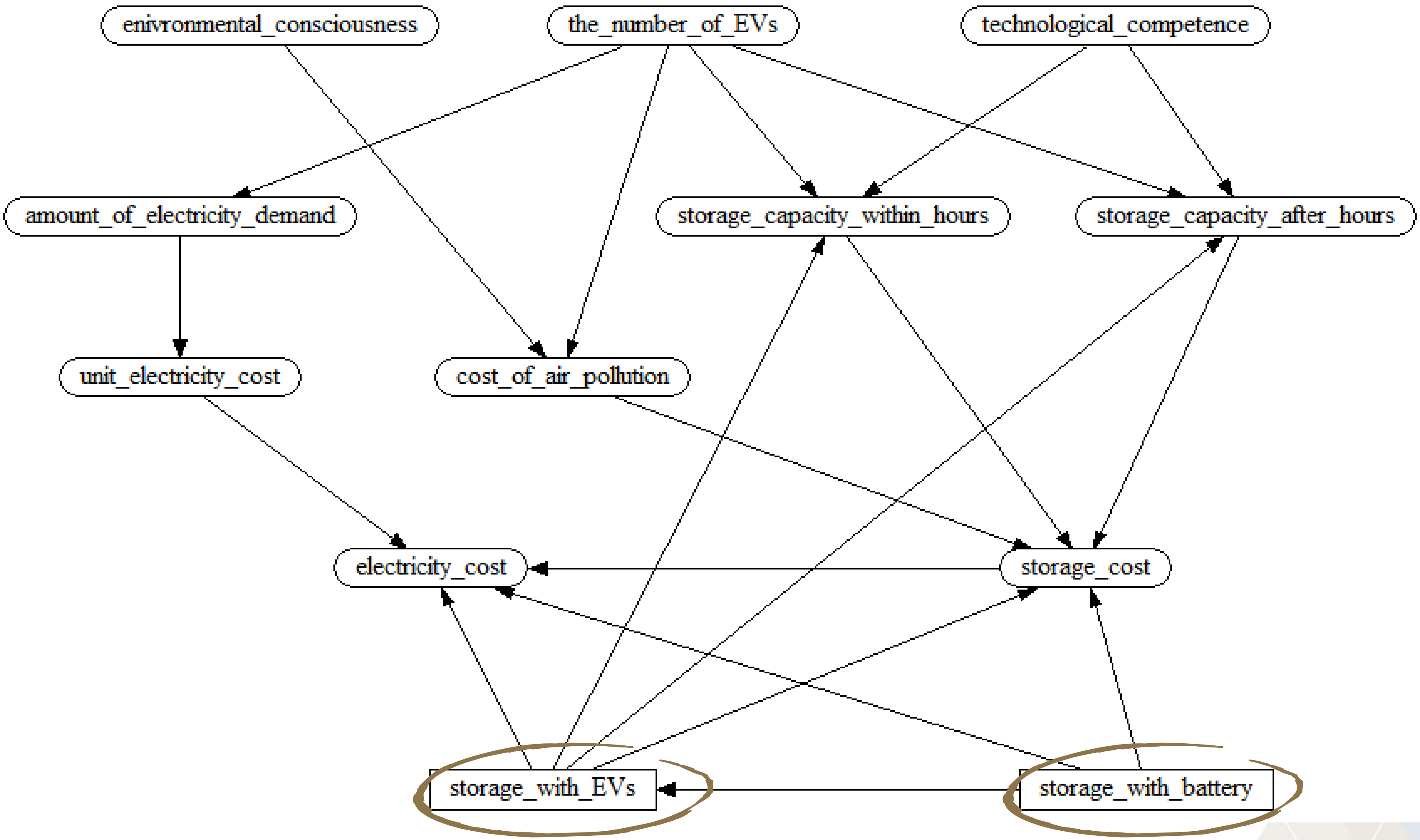
Criteria Chosen by Experts

- Unit electricity price
- Amount of electricity demand
- Storage cost
- Electricity cost
- Storage with EVs
- Storage with battery
- Environmental consciousness
- Cost of air pollution
- # of EVs in organized industrial zones
- Technological competence
- Storage capacity within the working hours
- Storage capacity after the working hours

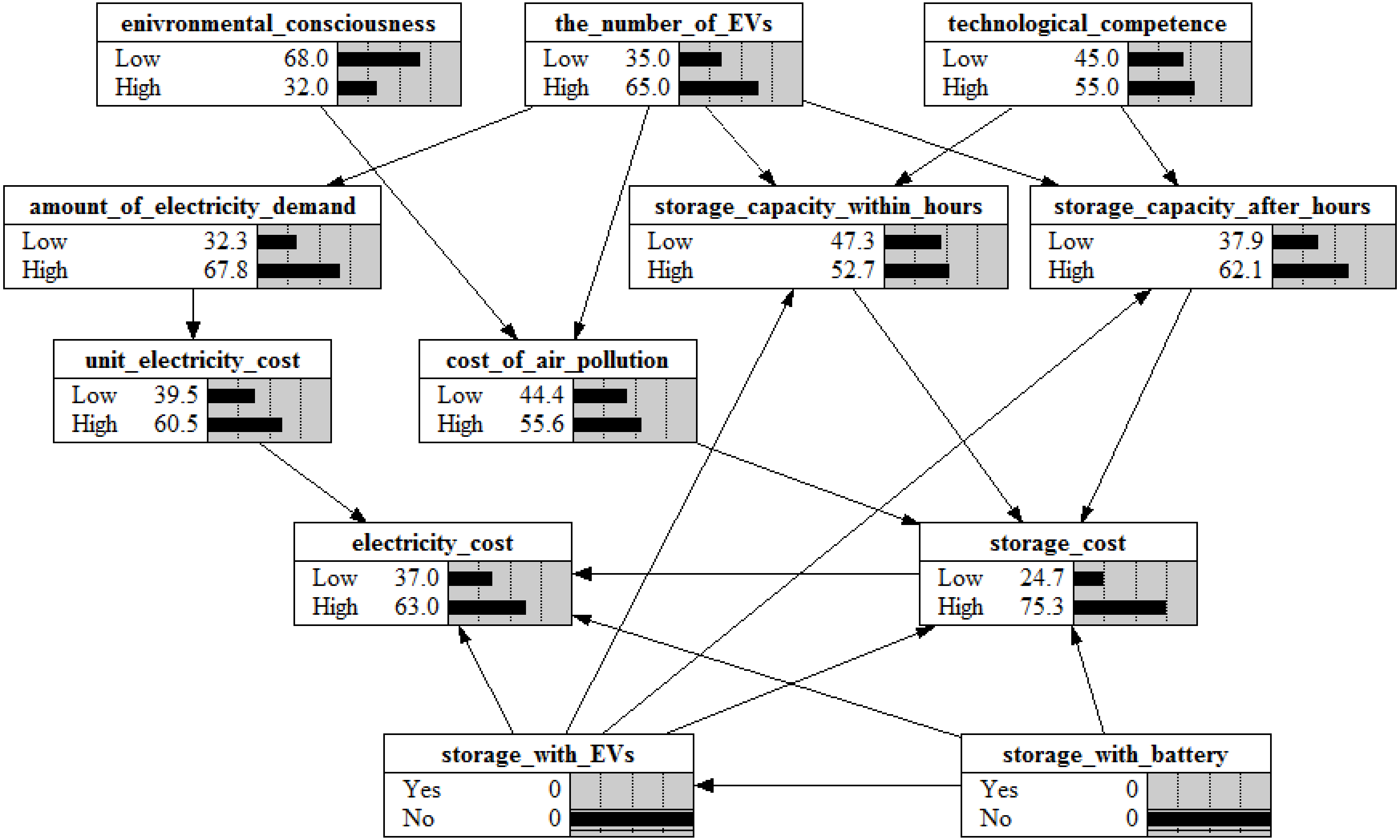
Cognitive Map for Gebze/Istanbul



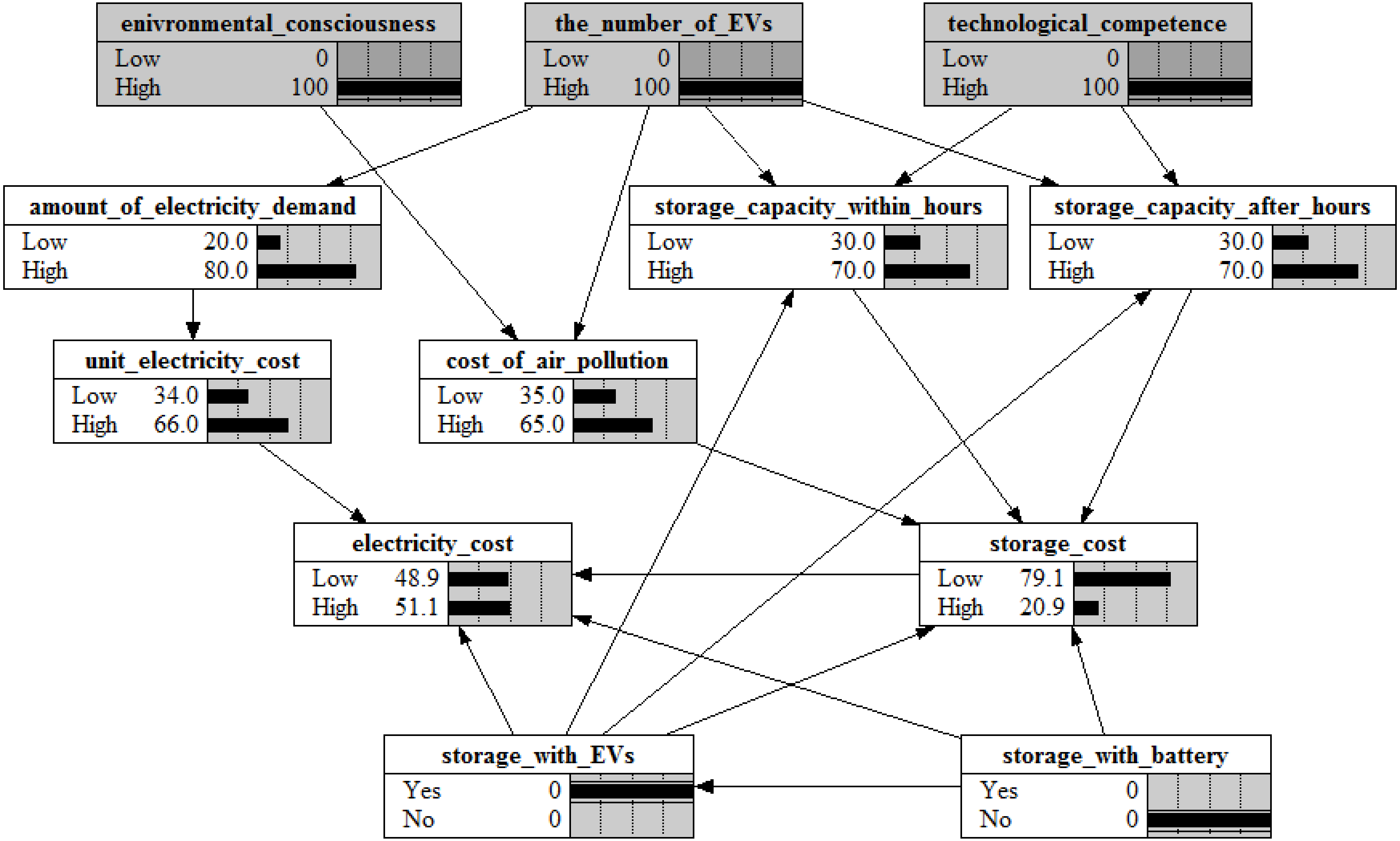
Bayesian Belief Network for Gebze Istanbul



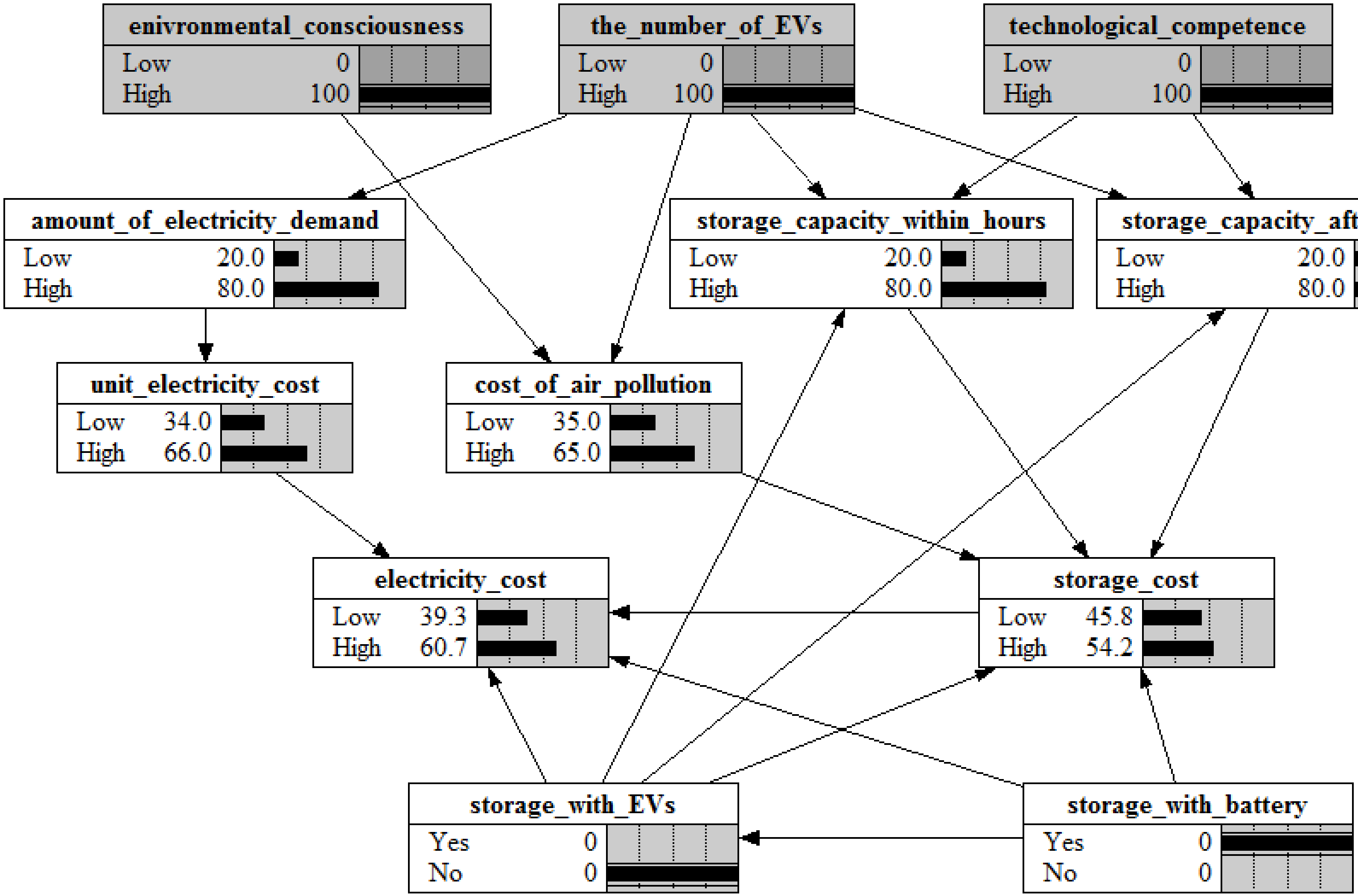
Bayesian Belief Initial State



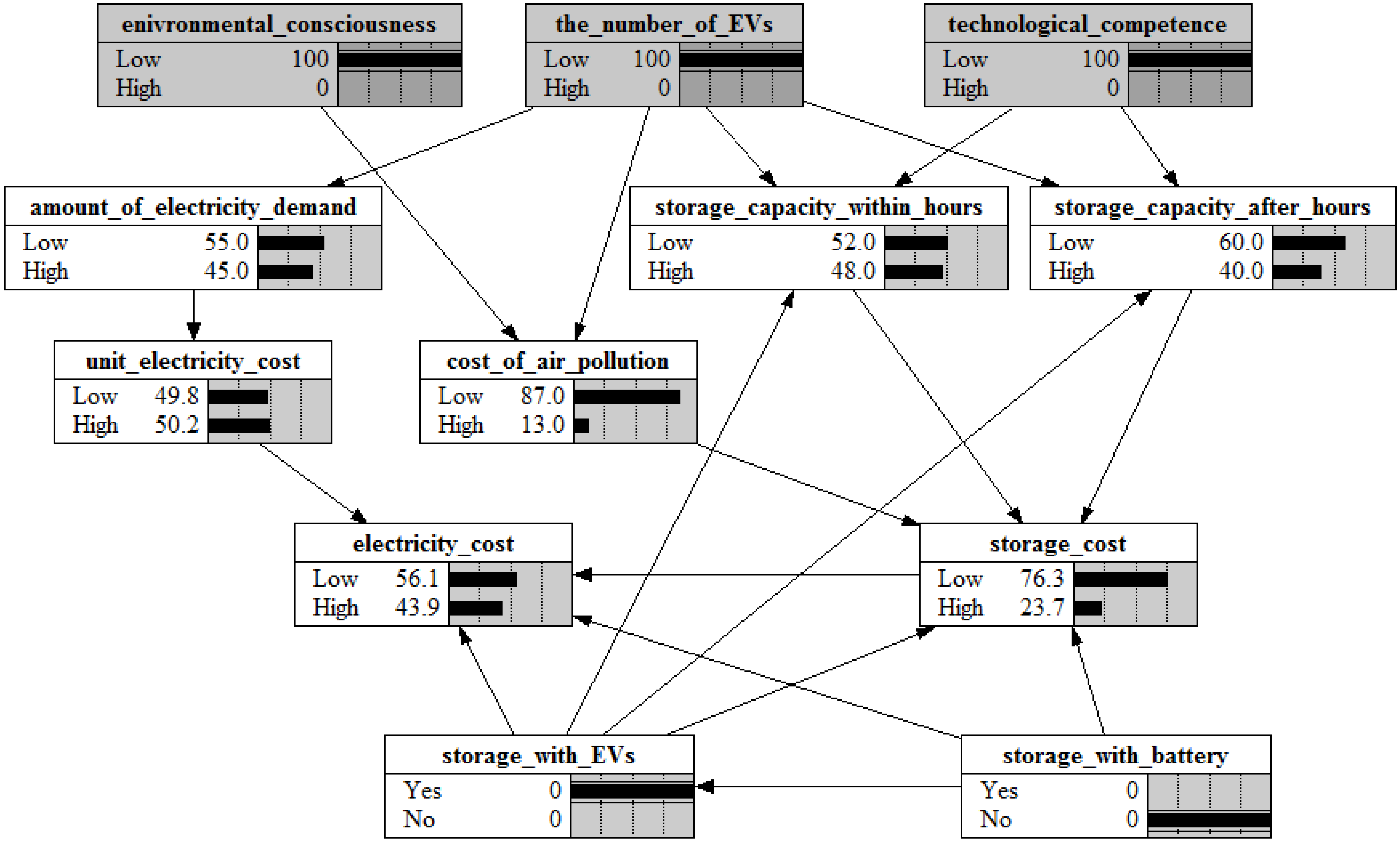
Optimistic Scenario with EVs



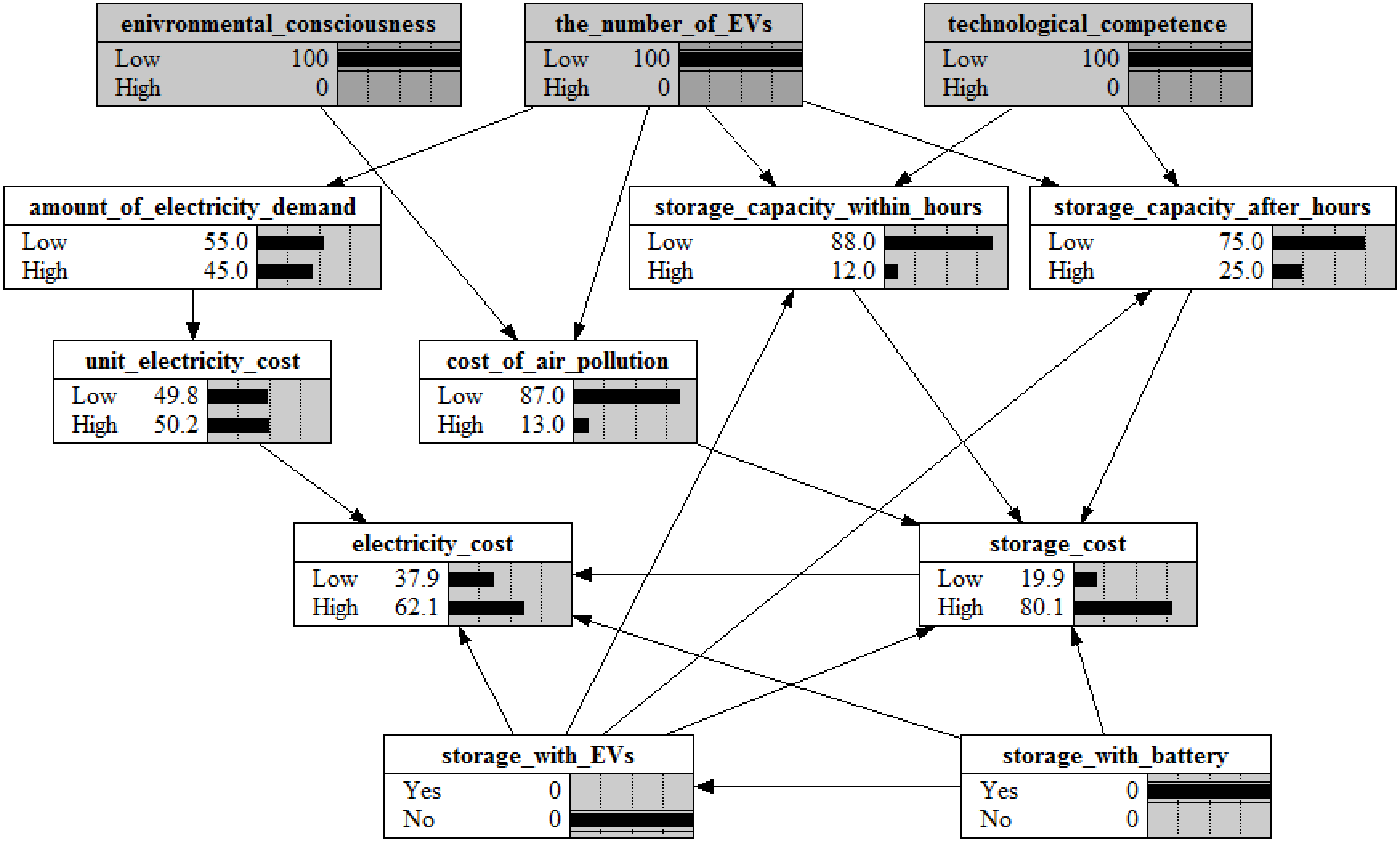
Optimistic Scenario with Batteries



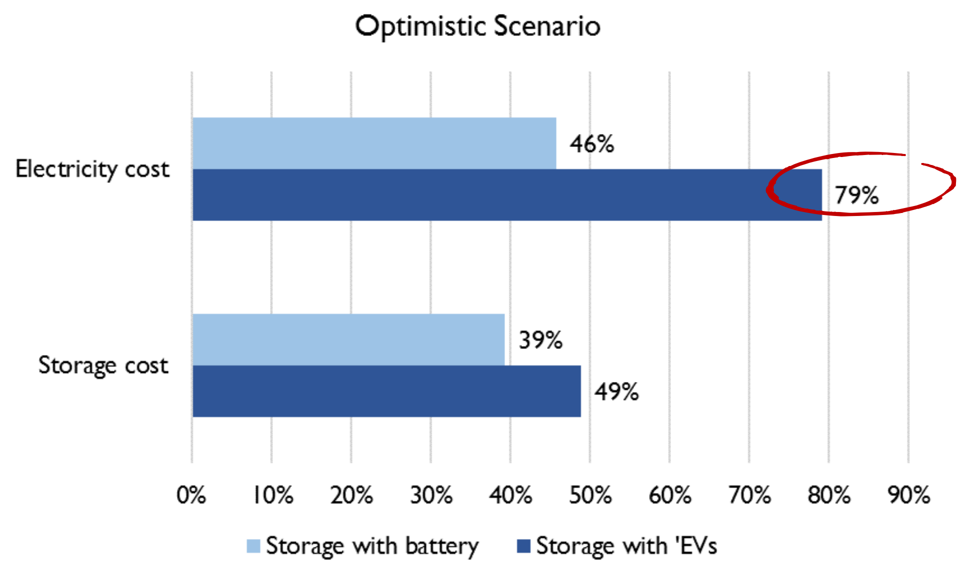
Pessimistic Scenario with EVs

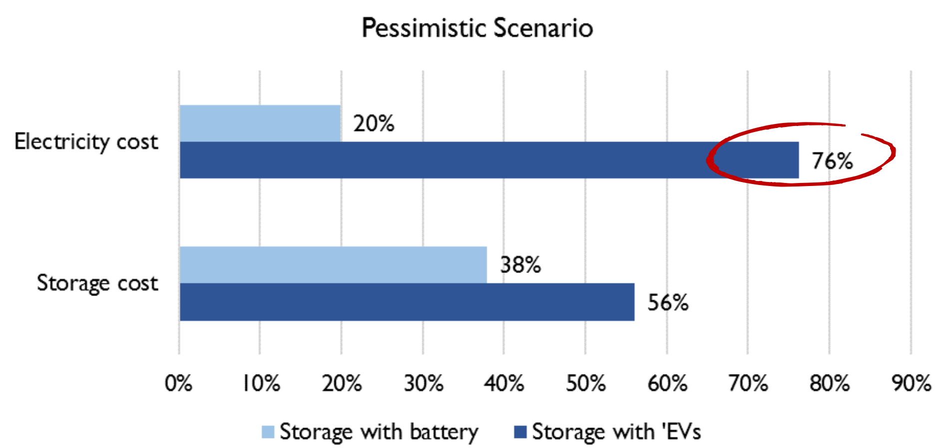


Pessimistic Scenario with Batteries



Results &Discussions





Conclusions for an Industrial Zone

- Scenarios indicate lower power and storage costs
- Continuous energy system with lower carbon emission
- Intelligent power management would be possible with this "vehicle to grid" model
- Continuing with real numbers and new scenarios

Suggestions for Future Research

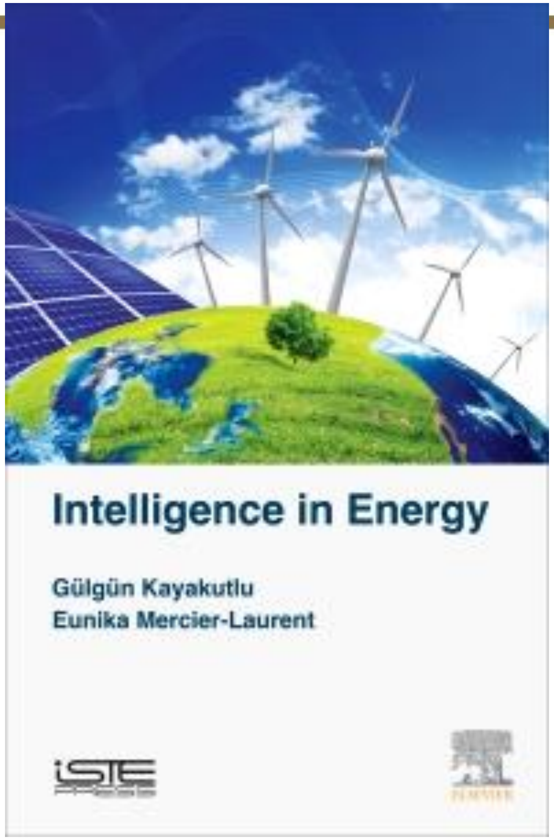
- Different battery types
- Compare high tech EVs
- Charging Implications
- Compare Residential and Industrial uses

Objective for Our Future:

Not Just Energy Efficiency
Not Just Renewable Energies
Not Just Self Sufficient Energy use

Standalone Ecosystem

Green & Eco-Designed Technologies
Flexible Management
Environmental Policies
Industrie 4.0



https://www.elsevier.com/books/intelligence-in-energy/kayakutlu/978-1-78548-039-3