POLITECNICO DI MILANO





Data-driven building energy performance evalaution and consumption prediction

Energy and Environmental Technologies for Building Systems

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Methodology

- ✓ Predicting the behaviour (consumption) just employing input-output information and without utilizing the physical governing equations

Context

- ✓ Missing information about the characteristics of the building (neither the utility nor the grid operator have access to the information about the geometric and material characteristics of all buildings !!
- ✓ Physical Models are not rapid and robust enough to be used for real-time modelling and control

Applications:

- ✓ Smart Homes, smart thermostats
- ✓ Smart Buildings, and automatic building performance optimization systems
- ✓ Smart HVAC optimization devices
- ✓ Load prediction by utilities

Smart Building and data-driven approach: technical motivations

Advantages

- ✓ Possibility of real-time monitoring of building's load and optimization of HVAC system; thus notable energy saving opportunities
- ✓ Possibility of real-time load balancing in the grid
- ✓ Possibility of fault diagnosis of HVAC units and diagnosing unexpected losses in the building

Why Now?

- ✓ Connected sensors and connected homes are becoming rapidly widespread
- ✓ Calculation cost is significantly increasing (cloud computing progress)
- ✓ Cost of connected sensors (internet of things is notably reducing)

data-driven approach: economic motivations

- Result:

✓ Notable public investment in the area of smart buildings, several EU funded initiatives

✓ Similarly very significant private investment, over 70% of startups focused on application of digital technologies in the energy sector are working in this area

✓ Significant increment in the research activities in this area

Case 1

Consumption Prediction of a detached Residential building

Dataset – Pecan Street Dataport

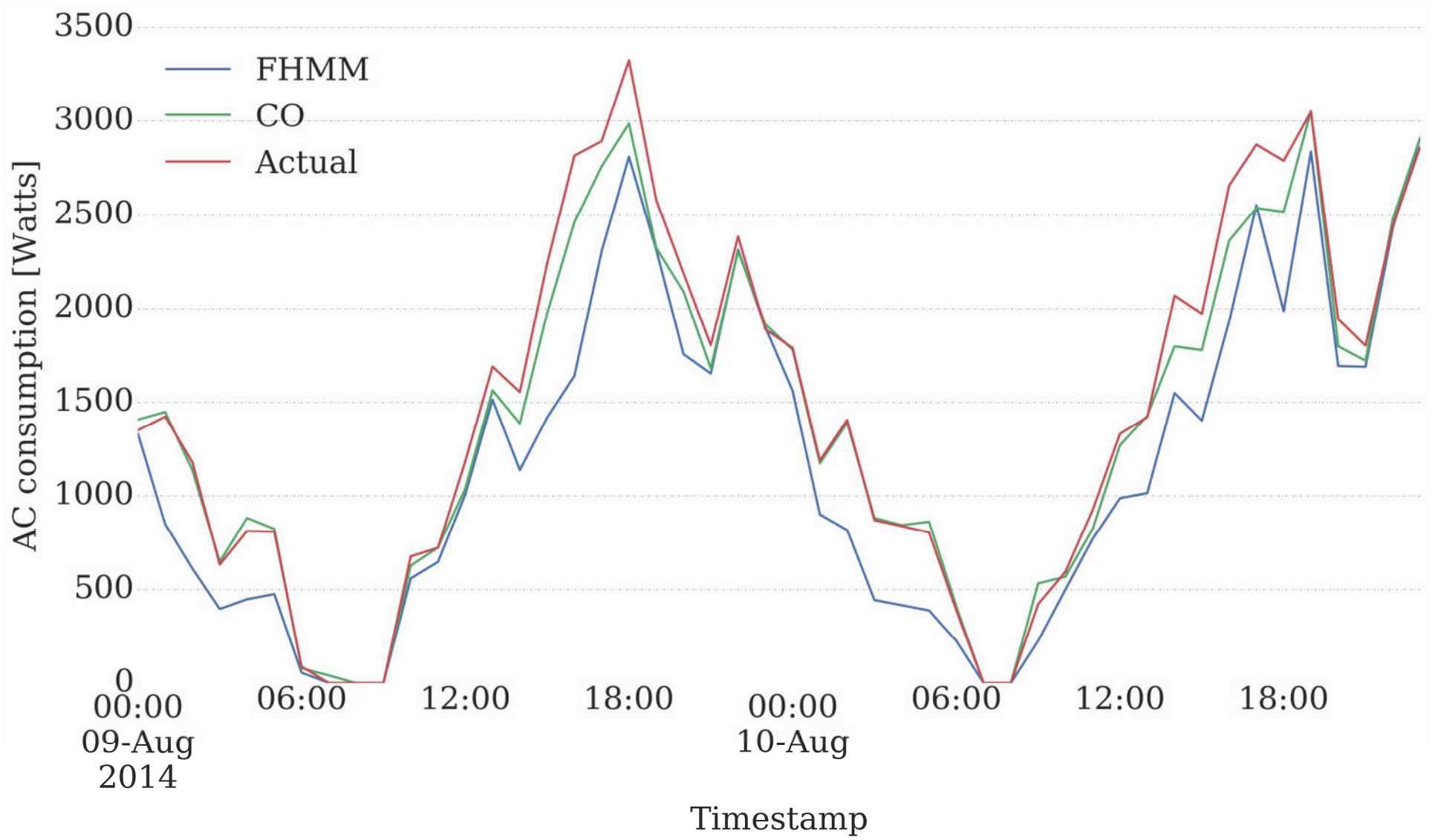
PECAN STREET

DATAPORT FROM PECAN STREET

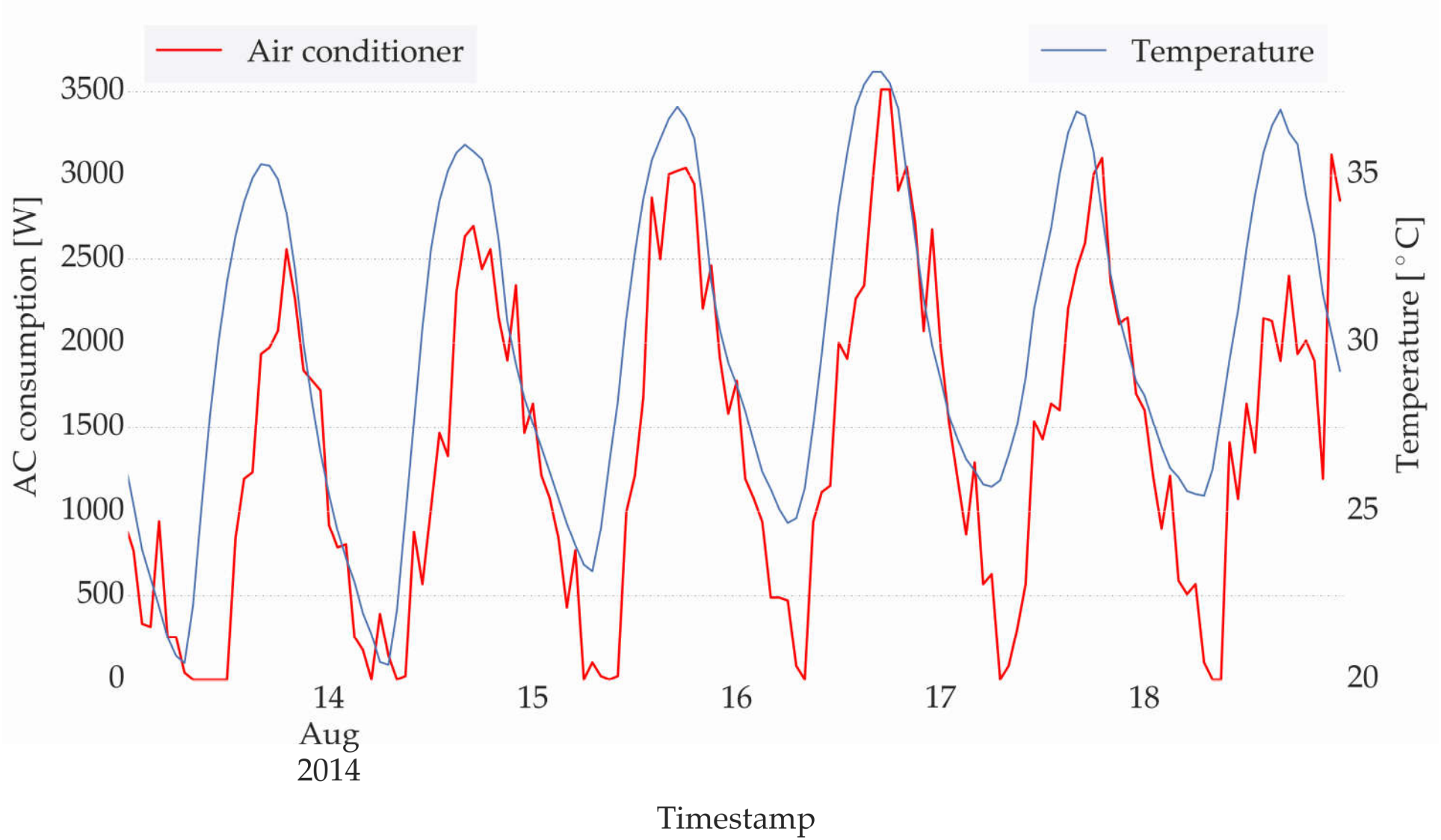
- Location: Austin, Texas
- Time-stamped data including:
  - ✓ Aggregate consumption
  - ✓ Appliance-by-appliance consumptions including Air conditioner
  - ✓ Ambient temperature

- ➢ Time-stamped PV generation from buildings: represents solar irradiation

Air conditioner disaggregation results



Correlation investigation and feature selection



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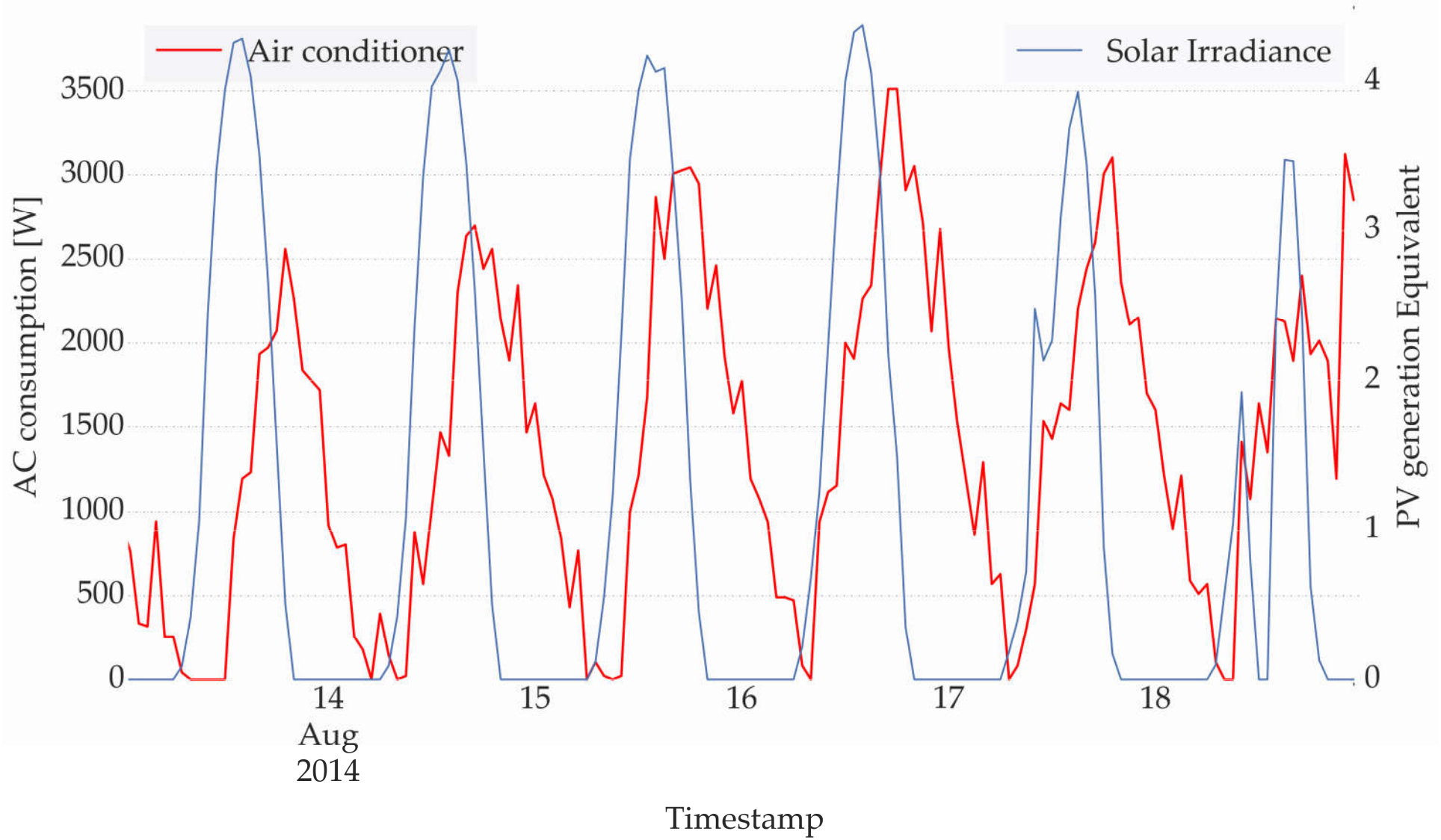

Preprocessing: Features Selection

Independent Variables

Dependent Variable

S.No	Date	Time	Hour Of day (0-23)	Day or Night (1/0)	Temperature (°C)	Irradiance (0-1)	Relative Humidity (0-100)	Energy consumed by AC (W)
1	01-01-2017	14:00:00	14	1	44	0.83	60	2400
2	01-01-2017	15:00:00	15	1	44.5	0.85	60	2500
3	…	…	…	…	…	…	…	…

$$Energy\ consumed(t) = \mathrm{F}(Date \quad time(t), Hour(t), Temperature(t), IRR(t), RH(t))$$

Question:
What other independent variables affect Energy consumed by an Air conditioner ?