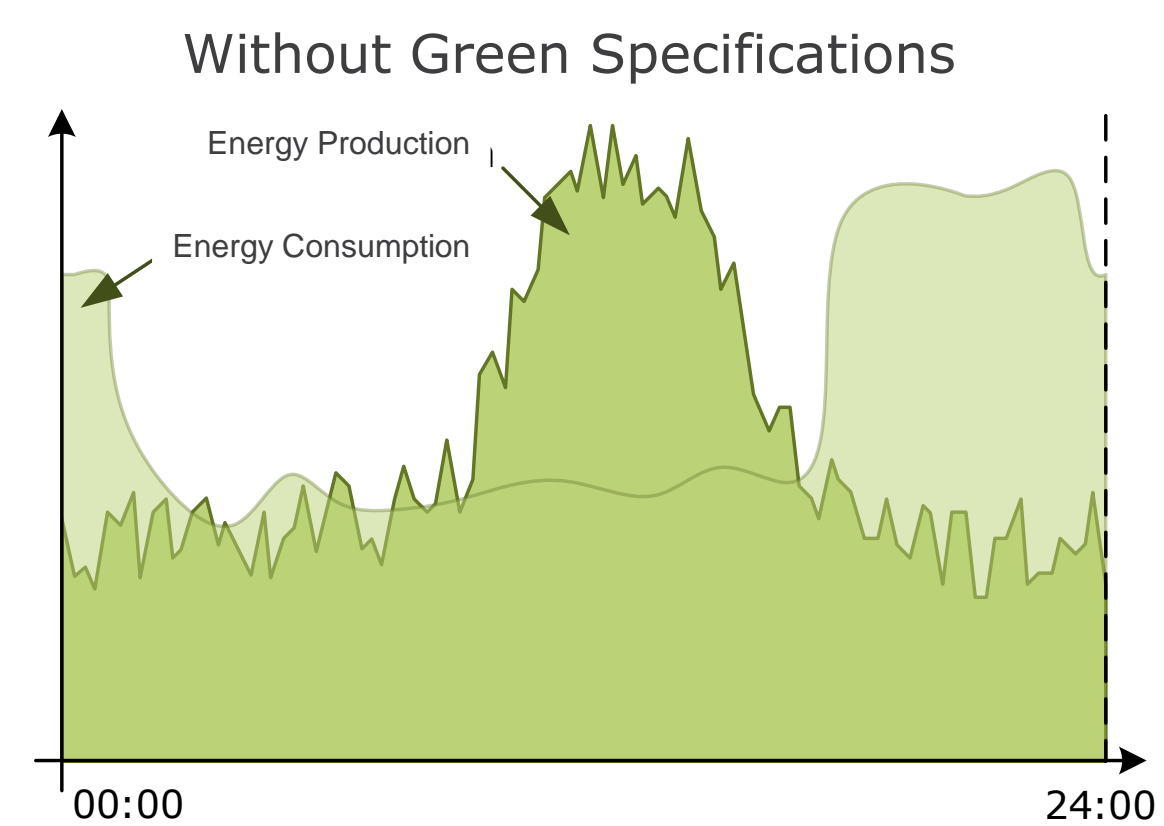




WhatsApp, Facebook, Twitter, Google and Netflix. Everybody knows and uses these services. Software has become part of our daily life. However, software is also consuming a lot of energy. Green Specifications have been developed to increase eco-efficiency, i.e. also energy efficiency. The outcome is more flexible and more efficient software which perfectly fit the needs of citizens of a "smart" city and at the same time make better use of renewable energy sources.

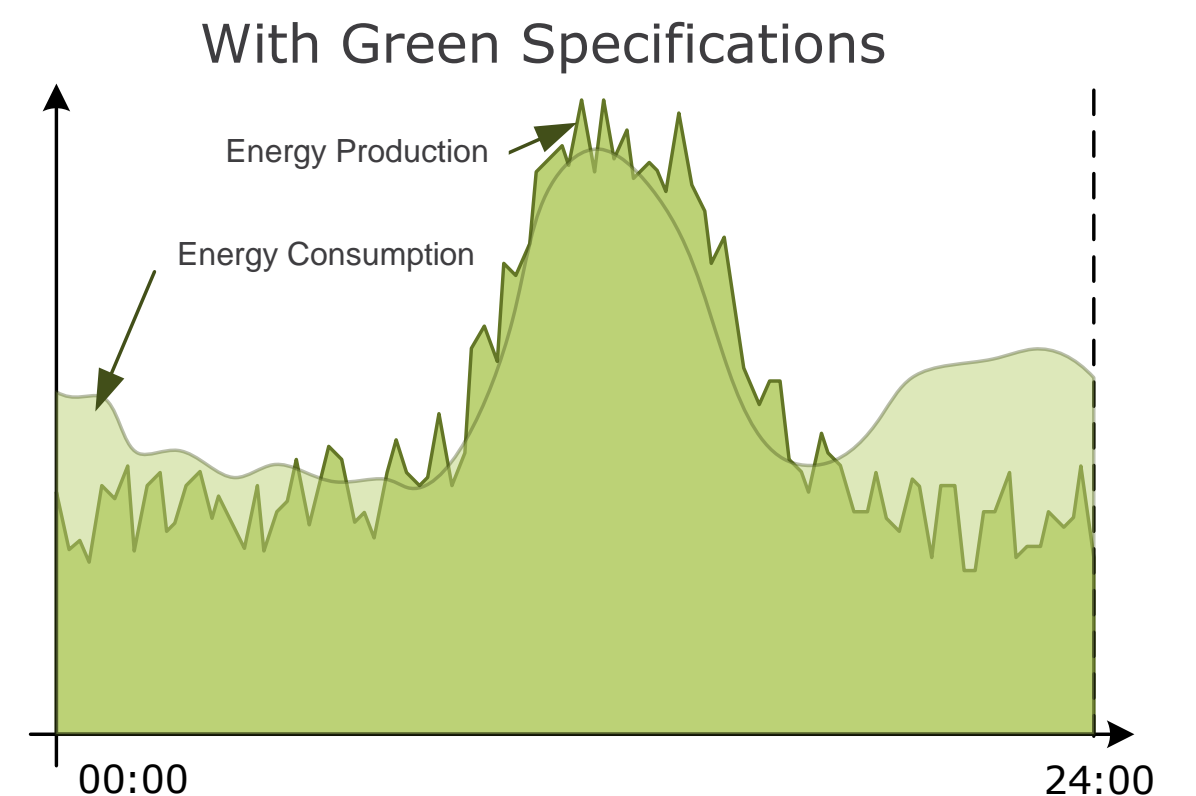
## RENEWABLE ENERGY IN A SMART CITY

- Problem of **Storage**
- Problem of high **Fluctuations** and general **Availability**
- Problem of **Awareness**
- Problem of missing **Options**



## GREEN SPECIFICATIONS

- Green Specifications help to unveil **optimisation potentials** and highlight **trade-offs** between energy/eco-efficiency and functionality, data as well as user behaviour.
- The result is more **flexible** and more **efficient** software which perfectly fit the needs of citizens of a "smart" city and at the same time make better use of renewable energy sources.



Enable all **stakeholders** to make well informed **choices** also with respect to energy- and eco-efficiency.

Providing **constraints** and **goals** guiding **programmers** during the implementation phase.

Enable to define **SLAs** on a more detailed level and therefore facilitates to maximize the **optimisation**

Specification

Implementation

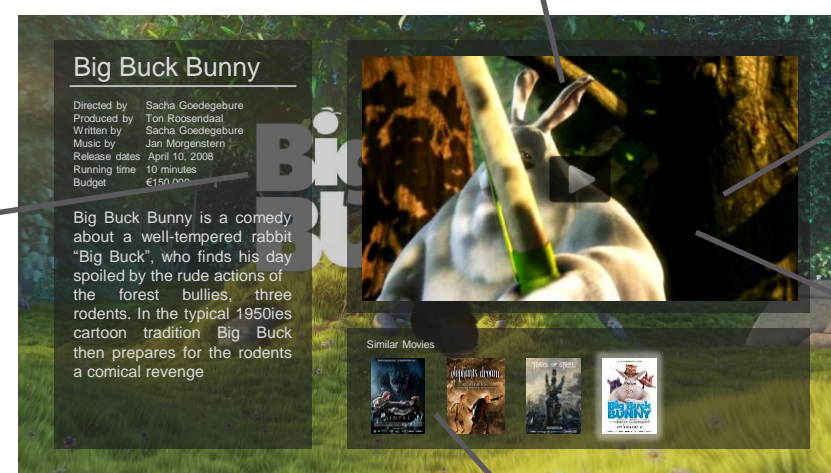
Use

## A VIDEO ON DEMAND (VOD) EXAMPLE

**Contractually** defined that all movies are streamed without **credits** at the end

**Lower availability** for less important data

**Execution** of none time-critical tasks like "movie suggestions" at times where renewable energy is available



Contractual **bonus** for all movies that have been added to the **watchlist** between 12 and 48 hours in advance

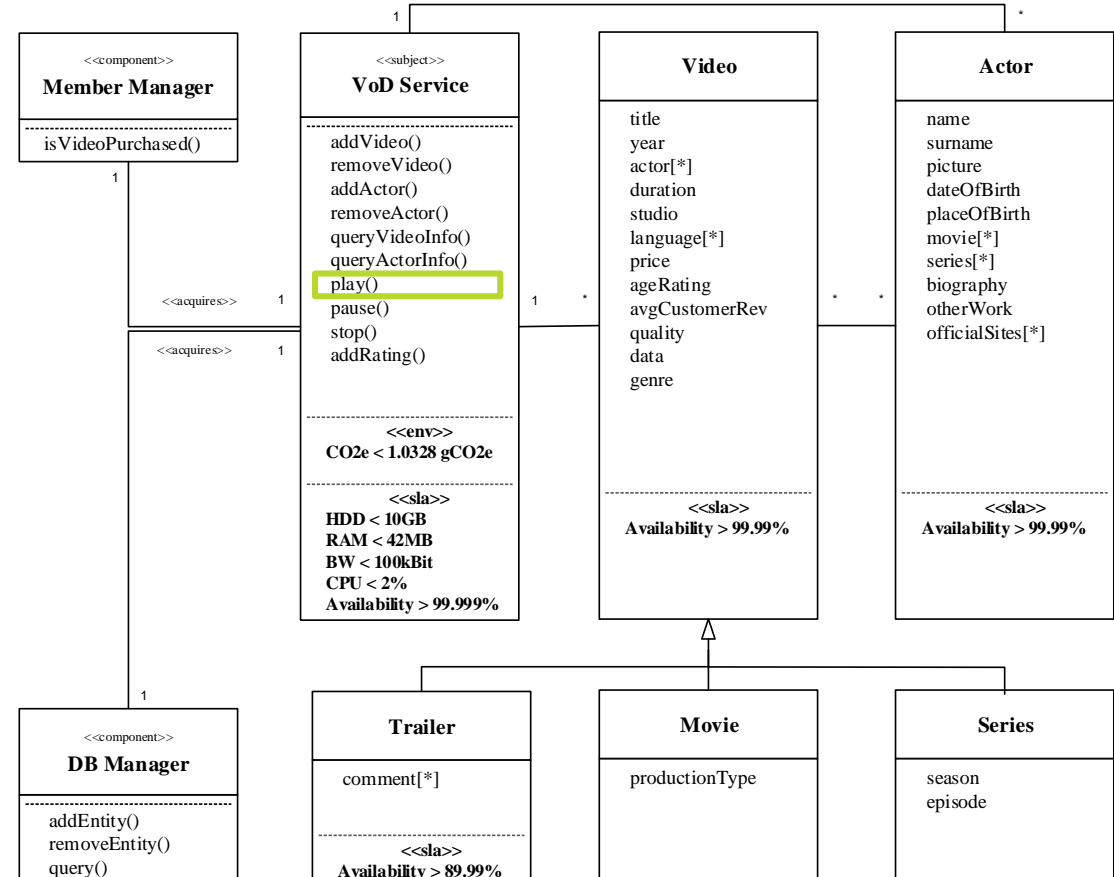
Using **copyright protection** based on **watermarking** and reducing the number of frames to which a watermark is added. Shift analysis to times where sun is available

## GOALS

- Create a formal **definition**
- Specify a **meta-model**
- Develop an approach to **estimate the environmental impact** of a concrete specification already during the development phase
- Define **metrics** that enable to compare the effects of decisions on the eco-efficiency of a software service
- Implement a video on demand (**VoD**) service as a **showcase**
- Add support for green specification in **MS Visio**
- Evaluate the **effect** and **potential** of green specifications

## STRUCTURAL VIEW

- Shows eco-efficiency of **Data** and **Components**



## FUNCTIONAL VIEW

- Shows eco-efficiency of the **functionality**

|                                |   |
|--------------------------------|---|
| <b>Name</b>                    | play  |
| <b>Description</b>             | The operation retrieves the video from the database, enacts copyright methods, encodes the video and streams it to the client   |
| <b>Receives</b>                | name: the name of the video<br>memberID: the ID of the member   |
| <b>Returns</b>                 | A protected and encoded video stream  |
| <b>Assumes</b>                 | The VoD service has been started and a member has logged in   |
| <b>Result</b>                  | <ul style="list-style-type: none"> <li>• If the video was located in the database, it has been retrieved,</li> <li>• If the video did not contain a watermark before, it has been included into ten percent of the frames. These frames are larger groups, distributed randomly,</li> <li>• The video has been encoded, and</li> <li>• has been streamed</li> </ul> |
| <b>Constraint: Environment</b> | CO2e < 0.0473mg * video.duration  |
| <b>Constraint: Resources</b>   | HDD < 7.76MB * video.duration<br>RAM < 16MB<br>BW < 195kBit<br>CPU < 5%   |
| <b>SLA: Availability</b>       | Availability > 99.99%   |
| <b>SLA: Cost</b>               | If the video was added to the playlist between 12 and 48 hours ago<br>cost = 0.02€ * video.duration / 100<br>else cost = 0.10€ * video.duration / 100   |

## BEHAVIOURAL VIEW

- Shows **user behaviour**

