Key Note:
An Overview on the Status of Nuclear Decommissioning

Dr.-Ing. Rebekka Volk
7th NUCLEAR DECOMMISSIONING & WASTE MANAGEMENT SUMMIT 2020,
12/13. Feb 2020
The Institute

Institute of Industrial Production (IIP)

Chair of Business Administration, Production and Operations Management (Prof. Dr. Frank Schultmann)
- Techno-economic analyses of industrial value chains

Chair of Energy Economics (Prof. Dr. Wolf Fichtner)
- Techno-economic analyses along the whole energetic value chain

French-German Institute for Environmental Research (DFIU) (Dr. Kira Schumacher)
- Joint research in French-German context in the environmental areas of air, water, land, waste and energy
My Profile

Research focus

- **Sustainable decommissioning**
- **Nuclear decommissioning**
- **Sustainable value chains in the C&D sector**
- **Project and resource management in the built environment**
- **Sustainable urban development**

→ Modelling and mathematical optimization of decommissioning projects
→ Decision making support for operators, planners, decision/policy makers

Experience

2016: PhD at KIT
2016-today: PostDoc and Head of research lab at KIT

Research Experience:
Projects for the Federal Ministry of Education and Research (BMBF) Germany, especially
- MogaMaR, [https://www.iip.kit.edu/english/773_2489.php](https://www.iip.kit.edu/english/773_2489.php)

Dr.-Ing. Rebekka Volk

Head of research lab: Project and resource management in the built environment

rebekka.volk@kit.edu
0721 608 44699

Volk et al. (2019)
Aging Nuclear Power Generation Reactors induce a massive change in the energy sector worldwide

- Aging reactors are raising questions about the schedule of their retirements
- Increased focus on retrofitting, replacement or shutdown measures
- Need for decommissioning schedules, dismantling and capacity replacements

Total Number of Operational Reactors
449

Share of Worldwide Energy Supply
11%

Average Age of Operational Reactors
30 years

Source: DAfT (2017), IAEA PRIS (Status: November 2019)
The Fukushima Shock and the Trend of Permanent Shutdowns (IAEA)

Source: IAEA PRIS, https://pris.iaea.org/pris/ (Status : January 2020)
What is the **status** of nuclear power generation reactors worldwide and their **grid disconnection and dismantling dates**?

What are **interesting nuclear dismantling markets** and how is their expected development over time?

What are **consequences** of future nuclear dismantling?
Scope of Nuclear Decommissioning Market Potential Study

We considered 18 countries with their nuclear facilities listed in IAEA PRIS database
- The analysis comprises 80% of all listed reactors worldwide.
- We focus on older nuclear facility stocks (e.g. excluding India, China, etc.)

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of reactors in operation [#]</th>
<th>Average age of nuclear reactors [years]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>7</td>
<td>39</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td>Canada</td>
<td>19</td>
<td>33</td>
</tr>
<tr>
<td>France</td>
<td>58</td>
<td>31</td>
</tr>
<tr>
<td>Germany</td>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>Italy</td>
<td>0</td>
<td>49</td>
</tr>
<tr>
<td>Japan (ready-for operation)</td>
<td>42</td>
<td>28</td>
</tr>
<tr>
<td>Lithuania</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Russia</td>
<td>37</td>
<td>30</td>
</tr>
<tr>
<td>Slovakia</td>
<td>4</td>
<td>24.5</td>
</tr>
<tr>
<td>South Korea</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>Spain</td>
<td>7</td>
<td>35.8</td>
</tr>
<tr>
<td>Sweden</td>
<td>8</td>
<td>37</td>
</tr>
<tr>
<td>Switzerland</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Taiwan</td>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td>UK</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td>Ukraine</td>
<td>15</td>
<td>26.6</td>
</tr>
<tr>
<td>USA</td>
<td>99</td>
<td>36</td>
</tr>
</tbody>
</table>

Reactor Status
- In Operation
- In Construction
- In Permanent Shutdown

<table>
<thead>
<tr>
<th>Reactor Status</th>
<th>Considered</th>
<th>PRIS</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Operation</td>
<td>357</td>
<td>450</td>
<td>79%</td>
</tr>
<tr>
<td>In Construction</td>
<td>22</td>
<td>56</td>
<td>39%</td>
</tr>
<tr>
<td>In Permanent Shutdown</td>
<td>161</td>
<td>166</td>
<td>97%</td>
</tr>
<tr>
<td>Total</td>
<td>540</td>
<td>672</td>
<td>80%</td>
</tr>
</tbody>
</table>

Source: IAEA PRIS (status: April 2018), Volk et al. (2019)
Within the considered Countries different Types of Reactors have to be decommissioned.

- Most reactors are Boiling Water Reactors (BWR) and Pressurized Water Reactors (PWR)
- Korea, Ukraine, Belgium, Slovakia and Bulgaria have almost exclusively PWR technology
- France and UK have a considerable share of Gas-Cooled Reactors (GCR, HTGR)

Source: Volk et al. (2019) based on IAEA PRIS (status: April 2018)
### Aging Reactors require Decommissioning Schedules, Dismantling and Capacity Replacements

<table>
<thead>
<tr>
<th>Age classes [years]</th>
<th>BE</th>
<th>BUL</th>
<th>CAN</th>
<th>CH</th>
<th>ES</th>
<th>F</th>
<th>GER</th>
<th>IT</th>
<th>JP</th>
<th>KOR</th>
<th>LIT</th>
<th>RUS</th>
<th>SLO</th>
<th>SW</th>
<th>TW</th>
<th>UK</th>
<th>UKR</th>
<th>USA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td></td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-15</td>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-20</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-25</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-30</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td></td>
<td>41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-35</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>5</td>
<td>24</td>
<td>9</td>
<td>11</td>
<td>5</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>33</td>
<td>128</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35-40</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>21</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>14</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-45</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>8</td>
<td>13</td>
<td>1</td>
<td>9</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>39</td>
<td>94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-50</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>20</td>
<td>51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50-55</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>12</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-60</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60-65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8</td>
<td>6</td>
<td>71</td>
<td>36</td>
<td>4</td>
<td>62</td>
<td>29</td>
<td>2</td>
<td>48</td>
<td>9</td>
<td>13</td>
<td>8</td>
<td>45</td>
<td>21</td>
<td>137</td>
<td>540</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- More than 60% of all Reactors are older than 30 years; 37% are older than 40 years
- USA, France and UK have a high number of ageing nuclear reactors
- Decommissioning decisions also depend on the countries’ policy and societal acceptance

Source: Volk et al. (2019) based on IAEA PRIS (status: April 2018)
### Countries’ Policies differ, but ultimately require Dismantling and lead to increasing Market Volume

<table>
<thead>
<tr>
<th>Country</th>
<th>Normal operation duration [years]</th>
<th>Possibility of prolongation of operation [yes/no] [times]</th>
<th>Prolongation of operation [years]</th>
<th>Duration of post-operational phase [years]</th>
<th>Possibility of deferred dismantling [yes/no]</th>
<th>Duration of deferred dismantling [years]</th>
<th>Planned duration of direct dismantling [years]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE</td>
<td>40*</td>
<td>Yes, (preferred is 1x)</td>
<td>10</td>
<td>5</td>
<td>Yes, but not probable</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>BUL</td>
<td>30</td>
<td>Yes, 1x</td>
<td>30</td>
<td>8-12 (for first 2 reactors)</td>
<td>No information</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>CAN</td>
<td>25</td>
<td>Yes, 1x</td>
<td>30-35</td>
<td>No information</td>
<td>Yes, preferred strategy</td>
<td>30</td>
<td>No information</td>
</tr>
<tr>
<td>F</td>
<td>10-yearly review</td>
<td>Yes, 1-5x</td>
<td>10; max. 60 years of operation</td>
<td>5</td>
<td>Yes, but not preferred</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>GER</td>
<td>40</td>
<td>No</td>
<td>0</td>
<td>5</td>
<td>Yes</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>JP</td>
<td>40</td>
<td>Yes, 1x</td>
<td>20</td>
<td>5-10</td>
<td>Yes</td>
<td>5-10</td>
<td>3-4</td>
</tr>
<tr>
<td>IT</td>
<td>-</td>
<td>No</td>
<td>0</td>
<td>No information</td>
<td>No</td>
<td>0</td>
<td>No information</td>
</tr>
<tr>
<td>LIT</td>
<td>No information</td>
<td>No information</td>
<td>No information</td>
<td>No information</td>
<td>No</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>RUS</td>
<td>30</td>
<td>Yes</td>
<td>15-30</td>
<td>3-5</td>
<td>Yes</td>
<td>No information</td>
<td>5</td>
</tr>
<tr>
<td>SLO</td>
<td>30</td>
<td>Yes, 1x, (linked to EU membership)</td>
<td>0</td>
<td>5</td>
<td>No</td>
<td>0</td>
<td>13 (incl. shutdown, but already delayed)</td>
</tr>
<tr>
<td>KOR</td>
<td>30 (Wolsong 1, Kori 1), 40 (others)</td>
<td>Yes, up to 2x</td>
<td>10 (each prolongation)</td>
<td>4</td>
<td>No information</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>ES</td>
<td>40**</td>
<td>Yes, no information on the number of times</td>
<td>10 (each prolongation)</td>
<td>No information</td>
<td>Yes, but not preferred</td>
<td>Until 2028 (38 years) for a single reactor</td>
<td>No information</td>
</tr>
</tbody>
</table>

*: Changed in 2014 to maintain national power supply in Belgium  
**: This was deleted in 2011 from the law so that currently the Spanish government can decide on the operation duration.

Source: Volk et al. (2019) based on Ake Anunti et al., 2013; Ananiev et al., 2015; ASN, 2016; Barsebäck, 2016; Bruce Power, 2016b; European Commission, 2016b; European Court of Auditors, 2016; Hyung, 2013; IAEA 2015; IAEA, 2004; IAEA, 2015; Joo Hyun Moon, 2013; Kennes et al., 2008; KHNK, 2016; Laraia, 2012; Larsson et al., 2013; OECD and NEA, 2011a; OECD and NEA, 2015; Oskarsson, 2016; RWE, 2016; Schmittem, 2016; Schneider et al., 2016, SOGIN 2016a-d,, SSM, 2008; Ternon-Morin and Degraeve, 2012; Waler et al., 2015; WNA, 2016c; WNA, 2016; WNA, 2016k; WNA, 2016d; WNA, 2016f; WNN, 2014
### Countries’ Policies differ, but ultimately require Dismantling and lead to increasing Market Volume

<table>
<thead>
<tr>
<th>Country</th>
<th>Normal operation duration [years]</th>
<th>Possibility of prolongation of operation [yes/no] [times]</th>
<th>Prolongation of operation [years]</th>
<th>Duration of post-operational phase [years]</th>
<th>Possibility of deferred dismantling [yes/no]</th>
<th>Duration of deferred dismantling [years]</th>
<th>Planned duration of direct dismantling [years]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW</td>
<td>40-50</td>
<td>Yes</td>
<td>10-20</td>
<td>1</td>
<td>Yes, applied in two cases but not preferred</td>
<td>Dismantling is permitted only when a final storage is ready</td>
<td>No information</td>
</tr>
<tr>
<td>CH</td>
<td>Unlimited*</td>
<td>No, but adherence to safety regulation required</td>
<td>0</td>
<td>5</td>
<td>No information</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>TW</td>
<td>40</td>
<td>No</td>
<td>0</td>
<td>8 (for first reactor Chinshan 1)</td>
<td>Not for Chinshan 1, no information for the other reactors</td>
<td>No information</td>
<td>15 (for Chinshan 1)</td>
</tr>
<tr>
<td>UK</td>
<td>20 (design life time) with periodic reviews</td>
<td>Yes, up to 4x (but not for the older gas-cooled reactors)</td>
<td>10 (each prolongation)</td>
<td>10 (PWR, gas-cooled)</td>
<td>Yes, deferred dismantling is the main strategy used</td>
<td>85 (gas-cooled reactor)</td>
<td>10 (PWR), no information for gas cooled reactors</td>
</tr>
<tr>
<td>UKR</td>
<td>30 (e.g. Rovno 1+2)</td>
<td>Yes</td>
<td>10-20</td>
<td>No information</td>
<td>Yes (Chernobyl)</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>USA</td>
<td>40</td>
<td>Yes, 1(-2)x</td>
<td>20</td>
<td>2 (or 1-5 dep. on source)</td>
<td>Yes</td>
<td>60 years: max. 50 years waiting time and 10 years dismantling</td>
<td>10</td>
</tr>
</tbody>
</table>

* : Limitations for specific reactors are proposed by the Swiss government

- Operating life times range from 20 years (UK) to 50 years (Sweden)
- Prolongation range from 0 years (Germany) to 30 (Russia, Canada) and 40 years (USA)
- Germany, Belgium, Taiwan, Spain, Italy, Lithuania, and Sweden decided a nuclear phase-out

A detailed Classification of the Reactor States allow estimating the Nuclear Decommissioning Market Potential

<table>
<thead>
<tr>
<th>Our denomination:</th>
<th>PRIS denomination:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Decommissioning completed</td>
<td>-*</td>
</tr>
<tr>
<td>1 In decommissioning</td>
<td></td>
</tr>
<tr>
<td>2 In safe entombment/deferred dismantling</td>
<td>Permanent shutdown</td>
</tr>
<tr>
<td>3 In preparation for safe entombment/deferred dismantling</td>
<td></td>
</tr>
<tr>
<td>4 In shutdown</td>
<td></td>
</tr>
<tr>
<td>5 In operation</td>
<td>Operational</td>
</tr>
<tr>
<td>6 Ready for operation</td>
<td></td>
</tr>
<tr>
<td>7 Under construction</td>
<td>Under construction</td>
</tr>
<tr>
<td>8 Others</td>
<td>-*</td>
</tr>
</tbody>
</table>

*: This category does not exist in PRIS. When the decommissioning is completed, the reactor will be removed from the database

- A detailed overview of the current reactor states is given
- Enables a better estimation of the decommissioning market potential in the upcoming years
- Foundation for a scenario analysis of the market development over time

Source: Volk et al. (2019), IAEA PRIS
A detailed Classification of the Reactor States allow estimating the Nuclear Decommissioning Market Potential

Source: Volk et al. (2019)
A detailed Classification of the Reactor States allow estimating the Nuclear Decommissioning Market Potential

Source: Volk et al. (2019)
What is the **status** of nuclear power generation reactors worldwide and their **grid disconnection and dismantling dates**?

What are **interesting nuclear dismantling markets** and how is their expected development over time?

What are **consequences** of future nuclear dismantling?
A Scenario Analysis projects the Electrical Capacity that will be shut down in the 18 Countries until 2047

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Start of shutdown (on reactor-level)</th>
<th>Post-operational phase durations (on national level)</th>
<th>Dismantling phase durations (on national level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1 (expected)</td>
<td>Expected start date</td>
<td>Moderate duration (5.5 years*)</td>
<td>Moderate duration (10 years*)</td>
</tr>
<tr>
<td>Scenario 2 (intermediate)</td>
<td>Expected start date</td>
<td>Minimum duration (5 years*)</td>
<td>Minimum duration (9 years*)</td>
</tr>
<tr>
<td>Scenario 3 (earliest decommission)</td>
<td>Earliest start date</td>
<td>Minimum duration (5 years*)</td>
<td>Minimum duration (9 years*)</td>
</tr>
<tr>
<td>Scenario 4 (intermediate)</td>
<td>Expected start date</td>
<td>Maximum duration (6 years*)</td>
<td>Maximum duration (11 years*)</td>
</tr>
<tr>
<td>Scenario 5 (latest decommission)</td>
<td>Latest start date</td>
<td>Maximum duration (6 years*)</td>
<td>Maximum duration (11 years*)</td>
</tr>
</tbody>
</table>

*: default value, if no national value is available

Source: Volk et al. (2019)
The highest Decommissioning Market Potential can be seen in the USA, Japan and Germany

Nuclear reactors in dismantling according to their country (scenario 1)

- The dismantling markets in the USA and Japan increase continuously until the 2040s
- The German market is limited to the complete decommissioning of its reactor stock in 2037
- A peak around 2040 and a following stagnation of the total dismantling market are expected
- Ukraine, Spain, Sweden and Canada are interesting smaller markets in the next years
- Starting 2030: Belgium and Switzerland rises; Starting 2040: France is following.

Source: Volk et al. (2019)
Operating Reactors Power Capacity will be in Decommissioning and has to be substituted

- All 17 German reactors will be dismantled completely in 2037 (capacity reduction: 100%)
- The Japanese market depends on the political decisions (projected capacity reduction: 91%)
- Until 2047, 55 nuclear reactors will be dismantled in the USA (capacity reduction: 81%)
- In this study, around 260 GWe are expected to be retired until 2047

Source: Volk et al. (2019)
1. What is the **status** of nuclear power generation reactors worldwide and their **grid disconnection and dismantling dates**?

2. What are **interesting nuclear dismantling markets** and how is their expected development over time?

3. What are **consequences** of future nuclear dismantling?
### Key Findings

- **Need for technology innovations and large investments** in reactor refurbishments or alternative energy systems and infrastructure to overcome large scale reactor shutdowns by 2047.

- **Upcoming project, job and business opportunities** with increasing decommissioning activities.

- **Increased pressure** on governments to establish safe storage for radioactive material.

- **Potential bottlenecks** are expertise, dismantling/cleaning equipment and shifts to deferred dismantling.

### Required R&D

- **Impact of new constructions and retrofit investments** in prolongation of operating time of reactors.

- **Extension of study to all countries** worldwide and all types of nuclear facilities.

- **Investigation of entry barriers** for markets to define competition.

- **Efficient technologies and project management** for nuclear decommissioning required.

Source: Volk et al. (2019)
MogaMaR:
Development of an integrated project management system for nuclear decommissioning

Duration: 01/01/2014 – 31/03/2017
Funding code: 02S9113A

Project goals:
- Integrated consideration of time, cost and resources in planning
- Cost-optimization
- Consideration of uncertainties during planning

Source: Hübner (2019)

+ Integrated consideration of time, cost and resources as well as uncertainty and buffers
+ Availability of alternative schedule in the case of changes
NukPlaRStoR:
Development of a user-friendly cost-optimizing planning tool for nuclear dismantling projects taking into account material flows for resource planning

Duration: 01/06/2019 – 31/05/2022
Partners: 
Funding code: 15S9113A
Info: http://www.iip.kit.edu/english/1064_4605.php

Project goals:
- Integrated consideration of dismantling and material flow planning
- Cost-optimizing time and logistics planning
- Development of a user interface and interfaces to project management software
References


References


References


Recent work


Thank you.

Dr.-Ing. Rebekka Volk
Lab: „Project and resource management in the built environment“
KIT - Karlsruhe Institute of Technology, Institute for Industrial Production (IIP)
Contact: +49 (0) 721 608 - 44699 / rebekka.volk@kit.edu / www.iip.kit.edu

Volk et al. (2019)